The CESME White Book

Contents

Introduction

During the last decade the European Union had started elaborating the transition from a linear to a more circular economy. In particular, the European Commission presented a new circular economy package on 2 December 2015. The package contains an action plan in order to promote circular economy. It also maps a series of actions planned for the coming years and four legislative proposals on waste setting targets for landfill, reuse and recycling to be met by 2030. These actions include the adoption of specific measures to improve waste management as well as to promote eco-innovation and resource efficiency. The main difference between these types of economy is that linear economy follows the 'take-make-consume-throw' pattern, whereas circular economy is based on sharing, leasing, reuse, repair, refurbishment and recycling, where materials and products are highly valued (European Parliament, 2016).

In this frame, many companies have started shifting towards circular economy after noticing that linear system increases their exposure to risks including higher resource prices and supply disruptions. In particular, price volatility levels for resources and products such as metals, food and non-food agricultural output in the first decade of the 21st century were higher than in any single decade in the 20th century. The replacement of the 'end-of-life' concept with resources restoration, leads to the use of renewable energy, eliminates the use of toxic chemicals and aims for waste elimination through the superior design of materials, products, systems and business models (Ellen MacArthur Foundation, 2013).

In general, the transition from linear to circular economy affects not only the economic status of companies but also creates benefits for society and employment. In terms of employment, studies have shown that circular economy helps in its growth through the adoption of reuse programmes (retail of second hand goods in store), closed and open loop recycling (waste recycling and wholesale), repair and manufacturing programmes (repair of machinery equipment, electronics and household goods) and servitisation in renting and leasing of goods (WEF, 2016; EY, 2015; WRAP, 2015).

However, the movement towards circular economy requires a significant boost in terms of investments, which will temporarily increase economic activity and employment. In the longer time perspective, investments will help economies to be more energy efficient, more material efficient and more performance oriented. It has been estimated that the extra investments required for the transition to a circular economy are no higher than 3% of GDP per annum, from now on until 2030.The extra investments may include a) the extension of the electric power grid (smart grids, solar and wind power, charging stations for electric vehicles), b) interventions in public transport and commuter services (road network, railways, vehicle fleet, c) development of bio-refineries, d) interventions in farming and forest systems and e) retrofitting of old buildings (The Club of Rome, 2015).

Most public organisations as well as private companies realise the need to operate differently. However, there are barriers to fully integrate circular economy such as 1) lack of information and understanding of the principles of circular economy, in particular among SMEs, 2) inconsistent legislation and regulations and 3) lack of finance.

This White Book is one of the outcomes of the INTERREG Europe project CESME (Circular Economy for SMEs) 2016-2020. The aim of the White Book is to provide policy makers and private companies with knowledge and insight within the field in order to enable more SMEs to enter the circular economy. This White Book includes all the lessons learnt and recommendations from the CESME project targeted 1) SMEs at practical level and 2) policy makers at strategic level.

1.1 European Policies

In July 2014, the European Commission put forward an initial circular economy package. In particular it adopted a communication '***Towards a circular economy: a zero waste programme for Europe***', together with a review of the targets in six waste management directives. According to the Commission, the communication and the accompanying legislative proposal fit into the Roadmap to a resource efficient Europe and more broadly into the Europe 2020 Strategy for smart, sustainable and inclusive growth (European Parliament, 2014).

"*Turning waste into a resource is part of 'closing the loop' in circular economy systems*", as it is stated in the communication and although Europe has made substantial progress in this direction, performance varies considerably between Member States. Thus, strong policy signals are needed so that materials, such as plastics, glass, metals, paper, wood, rubber and other recyclables, re-enter the economy as secondary raw materials at competitive prices. The communication sets clear recycling targets for the period to 2030 which can provide predictability for investment and change (European Commission, 2014a).

In order to boost the economic, social and environmental benefits gained from the better management of municipal waste, the Commission proposes to:

• *Boost reuse and recycling of municipal waste to a minimum of 70% by 2030;*

• *Increase the recycling rate for packaging waste to 80% by 2030, with interim targets of 60% by 2020 and 70% by 2025, including targets for specific materials;*

• *Ban the landfilling of recyclable plastics, metals, glass, paper and cardboard, and biodegradable waste by 2025, while Member States should endeavour to virtually eliminate landfill by 2030;*

• *Further promote the development of markets for high quality secondary raw materials, including through evaluating the added value of end-of-waste criteria for specific materials;*

• *Clarify the calculation method for recycled materials in order to ensure a high recycling quality level.*

AND

To address specific waste challenges the Commission:

• *Proposes an aspirational target of reducing marine litter by 30% by 2020 for the ten most common types of litter found on beaches, as well as for fishing gear found at sea, with the list adapted to each*

of the four marine regions in the EU;

• Envisages measures to stimulate markets in recycled materials derived from construction and demolition waste and develop a common EU assessment framework for the environmental performance of buildings;

• Proposes that Member States develop national food-waste prevention strategies and endeavour to ensure that food waste in the manufacturing, retail/distribution, food service/hospitality sectors and households is reduced by at least 30% by 2025;

• Envisages developing a proper registry system for at least hazardous waste in all Member States;

• Further to its proposal to reduce the use of lightweight plastic bags, proposes that plastics be banned from landfill by 2025;

• Proposes that Member States shall include measures regarding collection and recycling of waste containing significant amounts of critical raw materials in their national waste management plans; and

• Is considering developing a policy framework on phosphorus to enhance its recycling, foster innovation, improve market conditions and mainstream its sustainable use in EU legislation on fertilisers, food, water and waste.

In March 2015, the Commission withdrew the legislative proposal on waste included in that package, to make way for 'a more ambitious proposal that will cover the whole of the circular economy'. As part of a new circular economy package, in December 2015 the Commission presented an action plan for the circular economy, as well as four legislative proposals amending the following legal acts: a) Waste Framework Directive; b) Landfilling Directive; c) Packaging Waste Directive; d) Directives on end-of-life vehicles, on batteries and accumulators and waste batteries and accumulators, and on waste electrical and electronic equipment (WEEE) (European Parliament, 2016).

According to this particular communication titled '***Closing the loop - An EU action plan for the Circular Economy***' (European Commission, 2015a), the legislative proposals on waste, adopted together with this action plan, include long-term targets to reduce landfilling and to increase preparation for reuse and recycling of key waste streams such as municipal waste and packaging waste. As it is pointed out, "*by stimulating sustainable activity in key sectors and new business opportunities, the plan will help to unlock the growth and jobs potential of the circular economy. It includes comprehensive commitments on ecodesign, the development of strategic approaches on plastics and chemicals, a major initiative to fund innovative projects under the umbrella of the EU's Horizon 2020 research programme, and targeted action in areas such as plastics, food waste, construction, critical raw materials, industrial and mining waste, consumption and public procurement. Other key legislative proposals on fertilisers and water reuse will follow. Finally, horizontal enabling measures in areas such as innovation and investment are included to stimulate the transition to a circular economy. The proposed actions support the circular economy in each step of the value chain – from production to consumption, repair and remanufacturing, waste management, and secondary raw materials that are fed back into the economy*".

Priority areas. *A number of sectors face specific challenges in the context of the circular economy, because of the specificities of their products or value-chains, their environmental footprint or dependency on material from outside Europe. These sectors need to be addressed in a targeted way, to ensure that the interactions between the various phases of the cycle are fully taken into account along the whole value chain.*
Plastics
Food waste
Critical raw materials
Construction and demolition
Biomass and bio-based products
Innovation, investment, and other horizontal measures
Monitoring progress towards a circular economy

The Annex to the communication (European Commission, 2015b) presents the measures that need to be taken forward, followed by a timetable. The measures refer to the broader actions of production, consumption, waste management and market for secondary raw materials, as well as sectoral actions, as referred to in the above box (i.e. plastics, food waste etc).

The 2008 ***Waste Framework Directive*** (European Parliament, 2008) sets the overarching legislative framework. It defines the main concepts linked to waste management and it sets binding targets to be achieved by 2020: preparing for reuse and recycling of 50% of certain waste materials from households and similar sources, and preparing for reuse, recycling and other recovery of 70% of construction and demolition waste (European Parliament, 2016). The proposal (European Commission, 2008) amending the Waste Framework Directive sets targets regarding the share of municipal waste prepared for reuse and recycling to be met by 2025 and 2030. It also defines general requirements for extended producer responsibility schemes. It requires in particular financial contributions paid by producers to EPR schemes to be modulated based on the costs necessary to treat their products at the end of their life. In addition, the proposal requires Member States to use economic instruments to implement the waste hierarchy, to take measures to prevent waste generation and to ensure the separate collection of bio-waste where appropriate (European Parliament, 2016).

The 1999 ***Directive on the landfill*** (European Commission, 1999) of waste bans landfilling of untreated waste and sets targets. Compared to 1995, the base year, the share of biodegradable municipal waste going to landfills may not be greater than 75% in 2006, 50% in 2009 and 35% in 2016, with derogations granted to 16 Member States. The proposal (European Commission, 2015c) amending the Landfilling Directive introduces a landfilling ban for separately collected waste and limits the share of municipal waste landfilled to 10% by 2030.

The 1994 ***Directive on packaging and packaging waste*** (European Commission, 1994) aims to protect the environment and to safeguard the functioning of the internal market. It requires Member States to take measures to prevent packaging waste and to develop packaging reuse systems. The original 1994 Directive, and the amended version from 2004, set targets with regard to recovery and recycling of packaging waste. The Directive was modified in 2015 to introduce requirements on lightweight plastic carrier bags (European Parliament, 2016). The proposal (European Commission, 2015d) amending the Packaging Waste Directive sets targets for the share of packaging waste prepared for reuse and recycling to be met by 2025 and 2030, with specific targets for various packaging materials.

The 2000 ***Directive on end-of-life vehicles*** (European Commission, 2000) aims to ensure appropriate management of end-of-life vehicles (ELVs) in the EU. It encourages manufacturers and importers to limit the use of hazardous substances and to develop the integration of recycled materials. The Directive sets targets for recovery and recycling to be met by 2006 and 2015 (European Parliament, 2016).

The 2006 ***Directive on batteries and accumulators*** (European Commission, 2006) aims to improve the waste management and environmental performance of batteries and accumulators, as well as to ensure the functioning of the single market by establishing rules for their collection, recycling, treatment and disposal. It also sets limit values for certain hazardous substances (in particular mercury and cadmium) in batteries and accumulators. The Directive provides for the creation of extended producer responsibility schemes and sets recycling and collection targets to be met by 2010, 2012 and 2016 (European Parliament, 2016).

The ***Directive on waste electrical and electronic equipment*** (WEEE Directive) (European Commission, 2012a), updated in 2012, sets incremental targets on several aspects: minimum rates for separate collection, recovery and recycling/preparing for reuse (European Parliament, 2016). The proposal amending the above three directives (European Commission, 2015e) is based on the realization of the need, among others, to improve waste management in the Union, "*with a view to protecting, preserving and improving the quality of the environment, protecting human health, ensuring prudent and rational utilisation of natural resources and promoting a more circular economy*".

Overall, the revised legislative proposals on waste set clear targets for reduction of waste and establish an ambitious and credible long-term path for waste management and recycling. Key elements of the revised waste proposal include:

- A common EU target for recycling 65% of municipal waste by 2030;
- A common EU target for recycling 75% of packaging waste by 2030;
- A binding landfill target to reduce landfill to maximum of 10% of municipal waste by 2030;
- A ban on landfilling of separately collected waste;
- Promotion of economic instruments to discourage landfilling ;
- Simplified and improved definitions and harmonised calculation methods for recycling rates throughout the EU;
- Concrete measures to promote re-use and stimulate industrial symbiosis - turning one industry's by-product into another industry's raw material;
- Economic incentives for producers to put greener products on the market and support recovery and recycling schemes (eg for packaging, batteries, electric and electronic equipments, vehicles) (European Commission, 2017a).

The proposals that amend the six directives are in line with the objectives of the Roadmap to a Resource Efficient Europe and the 7th Environment Action Programme. Briefly, the Roadmap to a Resource Efficient Europe (COM(2011) 571) outlines how we can transform Europe's economy into a sustainable one by 2050. It proposes ways to increase resource productivity and decouple economic growth from resource use and its environmental impact. It illustrates how policies interrelate and build on each other (European Commission, 2016a).

The 7th Environment Action Programme (EAP) will be guiding European environment policy until 2020. It identifies three key objectives:

- *to protect, conserve and enhance the Union's natural capital*
- *to turn the Union into a resource-efficient, green, and competitive low-carbon economy*

- *to safeguard the Union's citizens from environment-related pressures and risks to health and wellbeing*

Four so called "enablers" will help Europe deliver on these goals:

- *better implementation of legislation*
- *better information by improving the knowledge base*
- *more and wiser investment for environment and climate policy*
- *full integration of environmental requirements and considerations into other policies*

Two additional horizontal priority objectives complete the programme:

- *to make the Union's cities more sustainable*
- *to help the Union address international environmental and climate challenges more effectively*
  European Commission, 2016b)

One year after adopting its Circular Economy Package, the Commission reports on the delivery and progress of key initiatives of its 2015 Action Plan with the 'Report on the implementation of the Circular Economy Action Plan' (European Commission, 2017a). The aim of the report (European Commission, 2017b) is to present an overview of the actions delivered in the implementation of the EU Action Plan since its adoption in December 2015, and to introduce key deliverables for 2017. As it is referred in the report, key actions have been undertaken in areas such as food waste, ecodesign, organic fertilisers, guarantees for consumer goods and innovation and investments.

Circular economy principles have also been gradually integrated in industrial best practices, green public procurement, the use of cohesion policy funds and through new initiatives in the construction and water sectors. More particularly, the following initiatives have been put forward to support the circular economy: Legislative proposal on online sales of goods (December 2015); Legislative proposal on fertilisers (March 2016); Launch of the Innovation Deals (May 2016); Ecodesign (November 2016); Food waste (throughout 2016); Waste-To-Energy (January 2017); Proposal to amend the Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment (January 2017); The platform to support the financing of circular economy (January 2017); An additionally: Guidance on circular economy into BREFs for several industrial sectors; Green Public Procurement; Updated Guidance on Unfair Commercial Practices Directive - Action on environmental claims; Stepping up enforcement of the revised Waste Shipment Regulation; Good practices in waste collection systems; Water reuse; Construction and demolition; Biomass and bio-based products; Support for circular economy through cohesion policy funds and smart specialisation strategies; Research and Innovation: Industry 2020 in the circular economy; Technology services to accelerate the uptake of advanced manufacturing for clean production by manufacturing SMEs.

Together with the above report, the Commission also (European Commission, 2017a):

- took further measures by establishing a Circular Economy Finance Support Platform with the European Investment Bank (EIB) bringing together investors and innovators
- issued guidance to Member States on converting waste to energy: Communication on the role of waste-to-energy
- proposed a targeted improvement of legislation on certain hazardous substances in electrical and electronic equipment: Proposal for amending RoHS Directive (European Commission, 2017d), impact assessment and executive summary of the impact assessment.

The communication titled 'The role of waste-to-energy in the circular economy' (European Commission, 2017c) issued in January 26th 2017, focuses on energy recovery from waste and its place

in the circular economy. "*Waste-to-energy is a broad term that covers much more than waste incineration. It encompasses various waste treatment processes generating energy (e.g. in the form of electricity/or heat or produce a waste-derived fuel), each of which has different environmental impacts and circular economy potential*".

The main aim of this communication is to ensure that the recovery of energy from waste in the EU supports the objectives of the circular economy action plan and is firmly guided by the EU waste hierarchy. It clarifies the position of different waste-to-energy processes in the waste hierarchy and what this entails for public financial support; it provides guidance to Member States on how to make better use of economic instruments and capacity planning with a view to avoiding or addressing potential overcapacity in waste incineration; and it identifies the technology and processes which currently hold the greatest potential to optimise energy and material outputs, taking into account expected changes in the feedstock for waste-to-energy processes.

A couple of months earlier (30.11.2016), a communication from the commission titled 'Ecodesign Working Plan 2016-2019' (European Commission, 2016c) was issued, aiming to contribute to the Commission's initiative on the Circular Economy. It is estimated that, in future, ecodesign should make a much more significant contribution to the circular economy, for example by more systematically tackling material efficiency issues such as durability and recyclability. This Working Plan sets out the Commission's working priorities under the ecodesign and energy labelling framework for 2016-2019. Among others, it sets out how ecodesign will contribute better to circular economy objectives.

Thus, focusing on the contribution to circular economy, it is argued that the possibility to repair, remanufacture or recycle a product and its components and materials depends in large part on the initial design of the product. It is therefore crucial that these aspects are taken into account when investigating possible ecodesign implementing measures. In this respect, the Commission will develop a circular economy 'toolbox' for ecodesign and will also improve the methodological basis for a more systematic adoption of requirements related to material efficiency in product Regulations.

Moreover, in September 2016, the "EU Construction & Demolition Waste Management Protocol" (European Commission, 2016d) was published, with the overall aim to increase confidence in the Construction & Demolition (C&D) waste management process and the trust in the quality of C&D recycled materials. This will be achieved by: a) Improved waste identification, source separation and collection; b) Improved waste logistics; c) Improved waste processing; d) Quality management; e) Appropriate policy and framework conditions.

This Protocol fits within the Construction 2020 strategy (European Commission, 2012b), as well as the Communication on Resource Efficiency Opportunities in the Building Sector (European Commission, 2014b), and it is also part of the European Commission's Circular Economy Package. It consists of 5 components, all of which contribute to the overall aim. The first three are based on the C&D waste management chain and two are of a horizontal nature: a. Waste identification, source separation and collection; b. Waste logistics; c. Waste processing; d. Quality management; e. Policy and framework conditions.

In March 2017, the Commission presented the first deliverable of Circular Economy Package with new rules on organic and waste-based fertilisers in the EU. The Commission is proposing a Regulation which will significantly ease the access of organic and waste-based fertilisers to the EU single market, bringing them on a level playing field with traditional, non-organic fertilisers. This will create new market opportunities for innovative companies while at the same time reducing waste, energy consumption and environmental damage. The Regulation sets out common rules on converting bio-waste into raw materials that can be used to manufacture fertilising products. It defines safety,

quality and labelling requirements that all fertilising products need to comply with to be traded freely across the EU (European Commission, 2016e).

1.2 National/Regional Policies per Participant Country/Region

Bulgaria

Waste Framework Directive: Bulgaria has transposed the WFD into national law by the Waste Management Act, promulgated in SG 53/ 13 July 2012.

Landfill Directive and WAC Decision: Ordinance No 8 on the conditions and requirements for construction and operation of landfills and other facilities and installations for waste disposal and recovery (SG80/13.09.2013).

Packaging Directive: Ordinance on packaging and packaging waste (adopted with CM Decree 271/202012, promulgated in State Gazette 85/06.11.2012.

Ordinance on the treatment of biowaste (Adopted with Council of Ministers Decree № 235 from 15.10.2013, published in State Gazette № 92 from 22.10.2013): Ordinance on separate collection (Adopted with Council of ministers Decree № 275 from 06.12.2013, published in State Gazette № 107 from 13.12.2013).

The National Waste Management Programme for 2014-2020 sets specific measures for the following strategic objectives of waste management:

- Waste prevention and minimisation
- Increase of the quantity of recycled and recovered waste
- Separation of the source, improvement of the collection and transportation of waste
- Environmentally sound waste disposal
- Legal regulation of waste management and acceleration of the implementation of the legislation and policy in this field
- Increase of the investments in the sector and implementation of Producer responsibility and Polluter pays principles in the system for integrated waste management
- Provision of database about waste
- Strengthening the administrative capacity of the institutions responsible for waste management
- Public participation

National Strategy on the Reduction of Bio-waste: There is a National Strategic Plan for the gradual reduction of the amount of biodegradable waste going to landfill

Collection, reuse/refill and recycling targets [BG WMP 2009-2013]: In compliance with the WFD, the following indicative targets for reuse and recycling of municipal waste are set in the new Waste Management Act:

- By 2018 at least 40% of all waste is recycled
- By 2020 at least 50% of all waste is recycled

Collection of municipal waste:

- the Waste Management Act obliges the municipalities to deliver service for collection and transportation of municipal solid waste to each holder of waste
- the coverage of service in Bulgaria is about 98.2 % in 2010 according information of the National Statistical Institute
- in most of the cases the activities for collection and transportation of waste are performed by private operators, which are selected under Public Procurement Act
- obligation for separate collection of at least 4 material streams (paper and cardboard, plastics, metal and glass) from household and similar waste generation sources
- each municipality established its own scheme for collection and transportation of MSW (e.g. different collection frequency)
- in some urban area (e.g. Sofia) this is done 7 times per week; in other areas – 2-3 times per week.; in rural areas even less;

Landfilling of biodegradable municipal waste (BMW)

It is a general requirement of the EU Landfill Directive that all Member States have to reduce the amount of biodegradable municipal waste landfilled (BMW). Considering the current level of material and organic recycling of MSW in Bulgaria, exceptional efforts will be required for fulfilling the 50 % recycling target by 2020.

The organization and treatment of waste within the territory of the municipalities is the responsibility of the municipal mayors. Commonly, mayors assign those activities via public procurement.

Municipalities in Bulgaria that build or use a common regional landfill or treatment facility, establish regional associations as legal entities and enter into an agreement with each other on waste management on a regional basis. Table 1 shows the goals for recovery and recycling for Bulgaria per years, set up in National Waste Management Plan

Table 1. Goals for recovery and recycling for Bulgaria per years.

Waste streams	**Year**	**Goals** **Recovery** **Recycling** **Collecting**
Biowaste		
	2020	min. 50% of the quantity of the MSW generated in the region in 2014
	2025	min. 75% of the quantity of the MSW generated in the region in 2014
MSW – paper, cardboard, plastics, metals and glass		
	2018	Recycling of min. 40% of their weight
	2020	Recycling of min. 50% of their weight
Building waste		
	2018	min. 55% of the their weight
	2020	min. 70% of the their weight

Greece

At a national level, Greece has not yet embedded any certain laws regarding circular economy. Relevant national and regional policies that may contribute to the achievement of circular economy are the following:

The **National Waste Management Plan** (NWMP) which is oriented to the following milestones for 2020: waste per capita should be drastically reduced, preparation for reuse and recycling with separate collection of recyclables and bio-waste should be applied to 50% of the total of Municipal Solid Waste(MSW); Energy recovery should be a complementary form of management when the margins of all other types of recovery have been exhausted and landfilling should be the last option and should be limited to less than 30% of the total MSW**.**

Based on the reference framework mentioned above, the policy axes to be addressed by Greece's NWMP are the following:

1. Ensuring the civic nature of solid waste management in order to protect public health and the environment in the context of a policy of sustainable development for the benefit of society, in terms of viability.
2. Existence of integrated planning for all waste streams at national, regional and local level, taking into account the measures and actions of the National Waste Prevention Plan (NWPP), by achieving compatibility of Waste Management Plans with the Spatial Frameworks.
3. Ensuring the outmost protection of the environment and human health by achieving self-sufficiency in appropriate and adequate networks as well as waste collection, recovery and disposal infrastructure, with an integrated waste inventory record and reinforced controls throughout the whole management grid.
4. Promoting efficient use of resources for the benefit of society in a socially acceptable manner, with priority given to: a) the promotion of preparation for re-use and recycling recyclables and bio-waste by sorting at the source, and b) enhancing the implementation of extended producer responsibility in waste management to support the planning and production of goods, which take fully into consideration and also facilitate the efficient use of resources throughout their life cycle.
5. Upgrading public and municipal waste management services for citizens and waste producers, raising awareness and encouraging active public participation through extensive consultation and through participation in small scale waste management actions at a primary level.
6. Rationalization of waste management services costs and promotion of economically viable and environmentally acceptable investments in the waste sector, as well as support of environmentally friendly technologies and innovation, making maximum use of available public funding, social control and minimum cost to citizens.

The strategies for putting into action the new national waste management policy are the following:

A. Development of an integrated framework for waste management planning which relies on the development of a NWPP, the drawing up of specific national plans, at least for hazardous waste, the revision of Regional Waste Management Plans (RWMP), harmonizing of waste management plans with the national and regional spatial plans, determining the obligation of municipalities to design and implement local decentralized waste management plans in the context of national and regional planning. Finally, the possibility of collaborating only for source-based screening and training between municipalities, social associations and / or alternative management systems where waste is integrated into alternative management.

B. Ensure high protection of the environment and human health by: a) Strengthening - developing the central mechanism for recording and processing waste production and waste management data, in order to ensure traceability from production to final destination, b) developing the appropriate

network of waste recovery and disposal infrastructures, c) creating conditions in order to prevent the export of waste, as this entails a significant loss of potential resources and, at the same time, recycling and recovery opportunities in the country, unless there is no corresponding infrastructure in the country.

C. Applying Sorting to Source as the most promising way of collection in order to achieve high-quality recycling by taking the following measures:

- Establishment of nationwide separate waste collection in order to achieve the necessary quality standards in the respective recycling sectors. Separate collection shall be set up at least for glass, paper, metal and plastic so as to ensure, as a minimum, the recycling of 60% of their total weight from the pre-screening stage, until 2020.
- Establishing separate collection of biowaste as a primary step in the new management system to facilitate the separate collection and recycling of bio-waste sorted at source to achieve the objective of separate collection of 40% of the total bio-waste by 2020. Treatment of separately collected bio-waste in order to produce compost which should meet quality standards for its re-use in accordance with international and / or national standards.
- Adoption of measures and creation of a new network of Green Points and / or Centers for Recycling and Training for Sorting at Source (CRTSS) as elements of the LWMP.
- Adoption of measures to attain at least the objectives of Greek Law 4042/2012 (A 24) by 2020 on the preparation for reuse, recycling and recovery of construction and demolition materials.
- Complementary use of energy recovery methods, provided they do not alter the goals of sorting to source and recovering materials
- Priority in the further recovery of materials, versus the production of secondary fuels, at waste treatment plants.
- Finally, limitation of the disposal on landfill areas only to non-recoverable waste

D. Rationalization of waste management services costs and promotion of economically and environmentally sustainable investments in the waste sector aiming to introduce a rewarding benefit to the citizen from recycling.

- Support for environmental technologies and innovation, which are considered to be important for developing and emerging economies, where significant increasing trends are appearing, in order to promote a hierarchy in waste management.
- Incentives for the countrywide implementation of the Green Points by the Municipalities for the re-use and recycling of waste.
- Promoting voluntary actions - agreements on green public procurement and the procurement of sustainable / green products.
- Upgrading waste management services to citizens and waste producers, raising awareness and encouraging active citizenship through extensive consultation and implementation of management actions (recycling, reuse, composting, residue) close to waste generation
- Developing a national communication strategy aimed at informing and raising awareness in the waste sector for the general public and selected target groups.
- Developing an effective mechanism for transparency, systematic updating, support and training for those involved in waste generation and management.
- Improving access to stakeholder information through e-Governance.
- Establishing the responsibilities of municipalities in order to be able to implement the full range of actions of local management plans and to enhance their technical competence as well as other waste management bodies.
- Encouraging initiatives and involving social economy actions in the context of local municipal decentralized management plans.
- Developing partnerships between local communities and stakeholders in waste management

with a view to achieving social consensus.

E. Energy recovery - Energy recovery of waste

The concepts of "energy recovery" and "energy exploitation of waste" in the NWMP are defined as “mild” environmental nuisance practices, which based on biological and/or chemical processes produce secondary gases or liquid fuels for energy production. Indicative practices are: biogas recovery from landfills, biogas production via anaerobic degradation, biodiesel production from waste oils, etc.

The **strategies** adopted according to the different waste streams are the following:

1. Urban solid waste: a) Establishment of separate collection and recovery of bio-waste, b) establishment of separate collection of paper, glass, metals and plastics, c) organizing separate collection in other MSW streams with a targeted collection for further preparation for re-use and recycling, d) consideration of domestic composting as recycling rather than prevention, e) establishment of measures to prevent waste generation, especially for food waste and packaging.
2. Sludge (urban type): Tackling sludge as a resource - source of organic substance for use for the benefit of agriculture or for energy recovery.
3. Industrial Waste: a) Priority should be given to reuse and recovery, as long as waste cannot be used as resource during the production process, b) reinforcing the co-operation between industries to ensure that industrial waste is shipped as raw materials to other industries or used in other industrial sectors.
4. Waste of public utilities, public service, etc.: Promoting the implementation of separate collection systems for paper, glass, metal and plastic using the best economic and environmental method and maximizing performance with the responsibility of the facility operators.
5. Agricultural and animal waste: a) The pursuit of full recovery of agricultural and livestock waste, with priority being given to their recovery in agriculture and strengthening cooperation with the recycling industry for biodegradable waste, b) optimal utilization of the energy content of agro-livestock waste, c) promotion of organic methods in agricultural production, in order to increase the absorption of soil-improvement material produced from agricultural and livestock waste, d) ensure the environmentally sound management of agricultural and livestock production waste (greenhouse plastics, fertilizer packaging and veterinary medicines, etc.), e)To inform and raise awareness of the producers of agricultural and livestock products about the benefits (economic and other) that can be caused by the lawful management of these wastes.
6. Alternative management flows which among others entails: Pan-Hellenic expansion of recycling, Full implementation of alternative management in public administration and in the tourism, science and social societies sectors, establishing separate waste collection per material, quality upgrade of recycling, reinforcing the collection of packaging waste / other products, reinforcing recovery – recycling, development of markets of recovered materials, integration of new streams into alternative management, registration of packaging managers / producers / other products, update - sensitize public / agencies and encouraging public participation.

Circular economy is also promoted through the Regional Waste Management Plans (RWMP) which was revised in October 2016 and is in full compliance with the NWMP and which also takes into account the “Closing the loop - An EU action plan for the Circular Economy” COM (2015)614, the goals set by the 2008/98 EC, the National Legislation regarding Packaging and alternative management of packaging and other products (Law 2939/2001, Ministerial Decree 9268/469/2007, Law 3854/2010, & Ministerial Decree 54461/1779/E.103/2013), as well as the National Waste Prevention Plan (NWPP).

The following table presents the overall proposed goals of the Regional Waste Management Plan for Central Macedonia (RWMP-CM) for MSW.

Stream/Type of waste	Year	Proposed Goal
Biodegradable Urban Waste	2020	Reduction of waste resulting in landfills to 35% by weight in relation to production levels in 1997
Biowaste	2020	40% of the total weight in a separate collection
Recyclable materials	2015	Establishment of separate collection for at least paper, glass, metals &plastic.
	2020	65% by weight preparation for reuse & recycling at least for paper, metal, plastic and glass
Total MSW	2020	50% by weight preparation for re-use & recycling with pre-qualification

The RWMP is an integrated waste management plan regarding the waste produced in the region, which identifies the general guidelines for the waste's management, in accordance with the NWMP and the National Waste Prevention Plan (NWPP), and it indicates the appropriate measures to promote in a hierarchical and combined manner: a) prevention, b) reuse, c) recycling, d) other recovery, such as energy recovery, and e) secure final disposal at Regional level.

In April of 2016, the National Strategy for Adaptation to Climate Change (NSACC) was elaborated by the Ministry of Environment. At a more general level, the implementation of the NSACC requires integration of its objectives in the wider context of a transformation strategy for and an innovative and circular Greek economy. Although the EC strategy for a circular economy is primarily concerned with the management and recycling of waste, the NSACC aspires to link the concept of circularity of productive and consumer choices on climate adaptation issues.

An Action Plan for Public Procurement (2016-2020) has been drawn up but hasn't been put to force yet. and it's actions include the "Strengthening of Sustainable Development / Green Public Contracts" with the application of certain actions: a) Obligatory observance of environmental law obligations, b) Action plan for Green Procurements and market research, c) Guidance and information regarding the Green public procurements, d) Inclusion of environmental characteristics in technical specifications/ invoices.

As far as biofuels are concerned, the effort lays in the exploitation of the domestic potential for bio-diesel production through energy crops, as well the development of the necessary biomass management networks for energy use. National targets for 2020, according to the National Renewable Energy Action Plan are expected to be met for power generation with the development of about 13300MW from RES (from about 4000MW today), where all the technologies with prominent wind farms are involved with 7500MW, hydroelectric with 3000MW and solar with about 2500MW, while heating and cooling with the development of heat pumps, thermal solar systems and biomass applications.

Italy

At regional level, the Region of Emilia Romagna has approved the first law in Italy on circular economy (Law no.16/2015, issued on October 5th 2015). This regional law (formally called *"Regulations in support of the circular economy, the reduction of waste production, the re-use of end-of-life-products and waste recycling, and changes to the regional law no.19 of August 19th 1996"*)

comes out of a bottom-up process involving 60 city councils, 1 provincial council, associations and territories.

According to the circular economy approach, wastes from activities must become “secondary raw materials” for other activities: the regional law pays therefore attention to the whole life cycle of products. Moreover, a link between supply and demand of secondary raw materials will be created, highlighting territorial productive peculiarities.

The fields of actions are three:

1. A more sustainable waste management
2. Information aimed at creating a new civic consciousness
3. Financial instruments (both for municipalities and innovative companies)

The targets set by the regional law are quite ambitious, even higher than those set by the European Union:

- Reducing the rate of the per capita production of waste: 20-25% by 2020
- Waste collection rate: 73% by 2020
- Recycling rate: 70% by 2020 (65% of urban waste by 2030 for the EU)
- Landfill disposal: 5% by 2020 (10% by 2030 for the EU)

These targets will be achieved also through the Regional Waste Plan, approved on May 3 2016, whose tools include:

- a Pay-As-You-Throw system by 2020
- public-private partnerships for the prevention and recovery of waste in different economic sectors
- an incentive fund for virtuous municipalities of 11.5 million euro per year
- a permanent working group for by-products.

Information and awareness measures are also implemented. In particular, besides the incentives for information and education activities and the regional communication campaigns, a permanent forum on circular economy has been established.

With regards to by-products, the regional Authority has established a working group with trade associations and the regional environmental control agency in order to make the identification of by-products easier and to promote a market for them. A first result of the group’s activity has been the official regional Register of By-products: so far, 5 datasheets have been provided, containing recommendations for companies (from technical and managing point of view) aiming at supporting them to identify substances or material as by-product:

1. Peach kernels
2. Apricot kernels
3. Salt deriving from salting of meats
4. Black liquor
5. Green residues from sweet corn.

Another important result coming from the regional law on Circular Economy are the Guidelines for Reuse Centers, that have been shared with the public through a participation and consultation process.

Other relevant regional policies that can contribute to a more circular economy are the following:

Regional Energy Plan: it takes the European targets for climate and energy as drivers for the development of the Region. It aims at enhancing green economy, energy saving and renewable energy and it promotes actions on transports, research and training. Thanks to the Regional Energy Plan, the circular economy principles will be applied also in the energy sector by:

- the development of plants powered by bioenergy including energy recovery from waste;
- the closure of cycles, also through the **r**euse of waste and by-products, the efficient use of resources and energy efficiency with renewable sources.

Rural Development Program: it promotes knowledge, innovation and competitiveness of the agro-industry sector, with a special attention on environment and climate and with the aim of supporting the development of the territory and local communities. With regard to circular economy, for example, the program promotes the diversification of farm activities also through energy production from agricultural by-products.

Regional Green Public Procurement Plan: on February 2017, the new three-years Green Public Procurement Plan has been released. The target is to reach 50% of sustainable public procurement. GPP could be one of the most effective incentive to promote transition towards Circular Economy (the minimization of the use of natural resources, the design of more durable products, the recycling/recovery of single components at the end-of-life, etc) GPP is a cross-cutting theme which includes, besides regulations on public contracts, also relevant regulation on environmental protection (i.e. energy efficiency, product/process certification, eco-design).

Last but not least, the ERDF Program and the Regional Smart Specialization Strategy. Sustainable development has been identified as one of the drivers of the Regional S3, where it is meant as "[…] innovation in energy efficiency and new energy technologies, in the waste management and a more rational use of resources, the reduction of harmful emissions into the environment, in promoting sustainable mobility, in the most careful management and exploitation of natural resources also from a touristic point of view […]". The ERDF Program has a specific priority Axis on Competitiveness of the industrial sector and, considering sustainable development as a cross cutting topic, it has been chosen as the policy instrument for CESME project: in fact, in order to facilitate the access of SMEs to Circular Economy, circularity should be seen as a key factor to improve competitiveness rather than a factor to reduce the environmental impact of the company.

At national level, a new national legislation was introduced in order to promote environmental measures of green and circular economy (Law no.221 issued on December 2015). It implies mandatory requirements for all Italian public entities to include Minimum Environmental Criteria (MEC) in their public procurement actions. The Criteria have been defined by the Italian Ministry of the Environment and cover the most relevant product and service areas for public procurement in Italy. MEC documents provide "Basic Environmental Criteria" (which a public authority must "at least" include in its tenders) and the so called "rewarding" criteria, which aim at a higher level of environmental performance. These are the products and services considered:

1. Electronic equipment for offices
2. Furniture for offices
3. Street furniture
4. Social aspects in public procurement
5. Devices for incontinence
6. Paper
7. Cartridge for printers
8. Building
9. Street lighting

10. Cleaning and cleaning products
11. Urban waste
12. Catering and Foodstuffs
13. Sanitization for hospitals
14. Energy services for buildings (lighting and air conditioning)
15. Textiles
16. Vehicles
17. Public green areas

Public Administrations are therefore required to use the technical specifications and requirements defined by the MEC in their public procurement tenders in order to promote the purchase of products:

- with a lower environmental impact
- with a longer lifetime
- with reduced waste.

By imposing the MEC, the national legislation has made a key step to promote circular economy since the minimum environmental criteria, if adopted on a large scale, are a key to overcome “linearity” in the approach to production and consumption.

The MEC act simultaneously on several objectives mentioned in the European Action Plan for Circular Economy. They outline requirements for eco-design of products, services and works to which they refer to and “over the entire life cycle”. They represent support measures on the demand side for products characterized by eco-design requirements. MEC outline procedures for a consistent waste collection with the aim to encouraging recycling.

For example, criteria for Building sector focus on actions that contribute to the European objective of recycled/recovered waste; some examples of these actions are the following:

- **Disassemblability:** for at least 50% (in weight) of buildings components should be possible, at their end-of-life, a selective demolition and the recycling/recovery.
- **Total content of recycled/recovered material: over the total amount of** materials used for building, the content of recycled/recovered material should be at least 15 % (in weight).

With regards to waste regulation, new legislation about by-products has been recently produced. On March 2017 a new regulation came into force: it identifies criteria that can be used to demonstrate the quality of the by-product (and not waste) of the material. Later, on June 2017, a national register of by-products has been opened, in order to match demand and offer. Any company producing or wishing to use by-products can join the register, which is managed by the local Chambers of Commerce.

Another characteristic of the Italian waste system is the existence of national consortia for several kind of waste. Many type of waste coming from separated collection of urban waste are managed at national level through the system of national consortia (required by law), which set and manage the recovery value chain: plastic, wood, used oil, compost are some of the waste managed at national level through auctions that aim at promoting material recovery.

Denmark

Circular Economy is seen as a key to ensure growth and prosperity by the Danish Government due to the ever-increasing pressure on resources. The Danish government has a clear ambition to increase

circular economy in Denmark.

The vision for Danish industry is to reach a global leadership in innovation, implementation and export of circular solutions by 2030. Furthermore, Denmark must be known as a hub for circular economy.

These goals will be reached through:

1. Denmark must gain more economic value from materials by increasing resource productivity by 40% based on the amount of materials and 15% based on the value of materials
2. Denmark must increase circularity by increasing total recycling by 80% and reducing waste by 15%
3. Denmark must remain a leader in Europe in developing circular technologies and solutions and the export of these have risen
4. Denmark must make better use of excess capacity by making 50% of the population active in sharing economy

North Denmark Region who is the partner and the policy holder in the CESME project is a so called 'Climate Region' in Denmark, which implies very ambitious climate objectives to maintain this position. At the same time the regional SMEs hold a large unrealised potential within this field, which is prioritised in the Regional Strategy for Green Growth, focusing on the regional potentials to further:

1. Identify SMEs with potentials for greater utilization of resource and energy efficiency
2. Development og green business models
3. Advice on how to unlock their potential
4. Implementation of green business models

On this behalf the Regional Authority expects the following measures within 2020:

1. 350 new jobs
2. 45 M EUR growth in revenues for the participating SMEs.

Finland

In Finland bioeconomy and clean solutions have a central role in circular economy. The main national policies promoting transformation to circular economy are the Finnish bioeconomy strategy, the current government programme and Finland's national circular economy roadmap.

The Finnish Bioeconomy Strategy

The Finnish Bioeconomy Strategy highlights the actions required to develop the bioeconomy in Finland (Sustainable growth from bioeconomy, 2014). The Bioeconomy Strategy was drafted in a project set up by the Ministry of Employment and the Economy, and drafting involved participation from the Prime Minister's Office, the Ministry of Agriculture and Forestry, the Ministry of the Environment, the Ministry of Education and Culture, the Ministry of Social Affairs and Health, the Ministry of Finance, the administrative branches under these Ministries, as well as VTT Technical Research Centre of Finland, the Finnish Innovation Fund Sitra and other relevant bioeconomy stakeholders.

The aim of the strategy was not only to focus on existing and new policy actions to support the growth of a sustainable bioeconomy but also remove obstacles. The key goals of the strategy focus on creating 1) a competitive operating environment for the bioeconomy, 2) developing business from the

bioeconomy, 3) creating a strong bioeconomy competence base, and 4) assuring accessibility and sustainability of biomasses. In Finland bioeconomy is seen as an engine of circular economy.

The Finnish Government Programme

The current Finnish Government Programme has allocated 300 million euros for *Bioeconomy and clean solutions*, which is one of strategic focus areas of the programme (Prime Minister's office, 2015; 2016). The implementation of *Bioeconomy and clean solutions* focuses on following key themes:

1. Towards carbon-free, clean and renewable energy cost-efficiently
2. Wood on the move and new products from forests
3. Breakthrough of a circular economy, getting waters into good condition
4. Finnish food production will be profitable, trade balance on the rise
5. Nature policy based on trust and fair means

The projects to be financed within the scope of that focus area have to take circular economy principles into account. For example the implementation of *Wood on the move and new products from forest* – priority area includes measures which aim at accelerating the introduction of new bioeconomy innovations through pilot projects and innovative public procurement, like for example pilot, demo and reference projects involving the reuse, recycling and other use of byproduct flows and waste from production and consumption. *Breakthrough of a circular economy* – priority area focuses strongly on water and waste management.

The implementation of priority area includes three main measures: 1) Prepare regulation and other solutions that promote recycling, 2) Increase recycling of nutrients and step up actions to protect the Baltic Sea and other waterways, and 3) Experimental programme in contaminated soil reconditioning and soil recycling. The projects of this priority area focus on promoting material and waste recycling, on removing obstacles from the circular economy and bioeconomy, and on accelerating the adoption of new innovative business models and recycling products.

Finland's national circular economy roadmap

Finland's national circular economy roadmap was created in 2016 (Sitra, 2016). The participatory roadmap process initiated by the Finnish Innovation Fund Sitra involved several ministries (Ministry of the Environment, Ministry of Agriculture and Forestry, Ministry of Economic Affairs and Employment) and other stakeholders. The aim is to make Finland a world leader in the circular economy by 2025. The roadmap describes the actions and highlights best practices and pilots that can enhance the transformation to a competitive circular economy in Finland. Four key focus areas and assumptions of the roadmap are:

1. A sustainable food system; Consumers choose food that has been produced through the wiser use of raw materials that starts in primary agricultural production. Emissions and resource consumption will be lower.
2. Forest-based loops and the related innovations; Finland is a circular bioeconomy leader because of its forestry and forest industry. Global competitiveness will increase with new commercial products, services, co-operation models and digital technology.
3. Technical loops; Minimizing the use of virgin raw materials creates a competitive edge. At the same time, maximizing the length of material and product life cycles and opportunities for reuse.
4. Transport and logistics; Transport will develop into a seamless, smart system that uses fossil-free fuels. Mobility as a Service (MaaS), the sharing economy and optimized and clean transport will take mobility to a new level.

From regional perspective the key circular economy -relevant regional policy initiatives in South Ostrobothnia region include Regional strategy, Seinäjoki region's climate strategy, Smart Specialisation Strategy, and Environmental Strategy 2014-2020 for South Ostrobothnia, Central Ostrobothnia and Ostrobothnia.

Regional strategy for South Ostrobothnia

Regional strategy is the key guiding policy for South Ostrobothnia. The current strategy sets long-term visions and goals for the regional development (2040) and gives the policy actions for the implementation (Regional Council of South Ostrobothnia, 2014a). The implementation plan is drawn every two years and the work is ongoing for the next phase (2018-2021). In the Regional Strategy circular economy approach is seen as efficient use of (raw) materials, sustainable and efficient processes and production with emphasis on sustainable food systems, use of renewable energy, energy efficiency and logistics.

The current circular economy relevant policy actions focus on 1) Creation of new sustainable and effective solutions for food systems and the bioeconomy, and 2) Development of smart and energy efficient systems, 3) Promoting the use of renewable energy and 4) Applying energy efficient solutions. Circular bioeconomy has a central role in slowing and narrowing down the material loops by increasing resource and process efficiency, by increasing the value of products and by developing new value-added, biobased products. Resource value can be extended for example by industrial symbiosis and other processes, where new products are being developed and produced from side-streams of other processes.

Strategy for Smart Specialisation

Strategy for Smart Specialisation supplements the Regional strategy. The goal of smart specialization strategy is to promote the regeneration of business and ensure future skill requirements in selected thematic business sectors (Regional Council of South Ostrobothnia, 2014b). The thematic areas relevant to circular economy are in line with the Regional strategy and focus on solutions for food systems and the bioeconomy, smart and energy efficient systems and the regeneration of service production. Enhancing smart manufacturing and digitalization, resource efficiency, efficient logistics, and servitization can be seen as prerequisites and elements of circular economy.

Initiatives linked with Smart specialization include 1) Green creative garden - a business development programme for food systems, and 2) Nordic Logistic City – a green logistics centre initiative. Green creative garden initiative was part of a national level Innovative Cities programme for bioeconomy by Ministry of Economy and Employment, and targeted sustainable and effective solutions for food systems (City of Seinäjoki, 2017).

Regional Climate, Energy and Environmental strategies

Seinäjoki region's climate strategy, Energy and climate Strategy 2014-2020 for South Ostrobothnia, and Environmental Strategy 2014-2020 for South Ostrobothnia, Central Ostrobothnia, and Ostrobothnia give guidance to circular economy related issues from climate and environmental protection perspective. Eight communities were involved in Seinäjoki region's climate strategy which sets policies on reduction of greenhouse gas emissions and promotes energy efficiency (Seinäjoki region's climate strategy, 2013). Energy and climate Strategy 2014-2020 for South Ostrobothnia, which is in line with Seinäjoki region's climate strategy and national climate strategy, aims at GHG reduction (Regional Council of South Ostrobothnia, 2014c).

The circular economy relevant policy measures focus on energy efficiency, energy production and

solutions, waste management, forestry and food chain. The strategy promotes narrowing the resource flows by efficient use of primary and secondary materials and waste reduction. Local, distributed energy production and use of bio-based local resources, e.g. agro and forest biomass, manure, non-food and other wastes as energy source are also supported.

The further processing of waste resources and side-streams into more valuable products, such as upgrading biogas to transportation fuels and fertilizers, is also fostered. Related to food chain, the policy actions target resource efficiency by minimizing the food losses and waste within the supply chain, improving the utilization of side-streams in food processing industry and in energy production (e.g. biogas), promoting the sustainable management of nutrients and nutrient recycling, and utilization of locally produced food.

United Kingdom (Wales)

Towards Zero Waste, the overarching waste strategy document for Wales, was published in 2010. Towards Zero Waste effectively sets Wales on a path towards a more circular economy. It re-emphasised the goal of using the equivalent of one planet's worth of resources by 2050. It established ambitious targets for waste prevention and recycling to help meet the one planet resource use goal. The Welsh Government published its Waste Prevention Programme in December 2013.

We are not aware of any nation that has set a specific resource efficiency outcome or target in respect of achieving a circular economy. However, Wales has set itself the one planet resource use goal for 2050, and this effectively is our resource efficiency goal for a circular economy in Wales.

Towards Zero Waste sets targets for waste prevention and management that are designed to meet the one planet goal. These provide the essential outcome targets that the circular economy approach in Wales needs to achieve in order to achieve the goal of one plant resource use, as follows:

- Waste prevention
  - 27% reduction by 2025 (against a 2006/07 baseline)
  - 65% reduction by 2050 (against a 2006/07 baseline)
- Preparation for reuse/recycling and composting:
  - 70% by 2025 (with all recycling closed loop or upcycled)
  - 100% by 2050 (with all recycling closed loop or upcycled)
- Energy from waste:
  - <30% by 2025 (with high energy efficiency)
  - 0% by 2050
- Landfill
  - 5% by 2025
  - 0% by 2050

The Welsh Government has an extensive programme in place to help deliver a more circular economy in Wales. This includes the provisions in the Environment (Wales) Act 2016 to achieve more high quality recycling by businesses and the public sector, the statutory recycling targets set for local authorities (58% in 2015/16 rising to 70% by 2025) in the Waste (Wales) Measure 2010, the £9.5 million grant awarded in October 2015 as core funding of the Waste and Resources Action Programme (WRAP) Cymru, the £1.186 million awarded also in October 2015 to Constructing Excellence in Wales for their programme for sustainable waste management in the construction sector, and the £13 million that has been provided to local authorities under the Collaborative Change Programme for them to improve their recycling services.

These programmes will help ensure the consistent supply of high quality recycle from all sources, especially from households, that can then be used by Wales based reprocessors and manufacturers. The programme will also seek to create a greater demand for goods with a high recycled content, and we see sustainable public sector procurement playing a key role here.

Environmental, Social and Economic Benefits of the Transition from Linear to Circular Economy

"Doing more with less" is one of the mottos that best describes the circular economy. This is a thought that should push each share of economic subjects, especially enterprises.

The current financial crisis has inevitably impeached the old mode of economic thought. The crisis has confounded scholars of the private sector and the market mechanism. The failures of the markets on the one hand boosted the area of Keynesian economics associated with a strong criticism of distributive inequality, and they have also opened the doors to new concepts of scarcity of resources, the defence of natural ecosystems, energy renewable.

The ISWA, the International Solid Waste Association, often talk about the dangers of a world where the open sky dumps hosting 40% of the waste produced by man. This is a global health emergency and the care is precisely represented by the circular economy (ISWA, 2017).

The benefits of circular economy are clear and from different areas: environmental, social and economic. The success of this economic model depends on how the transition will be managed, how quickly education takes root in cities, but mainly on how quickly we will be able to develop the appropriate skills and necessary to benefit from it. Now we see in detail the main advantages of circular economy.

Economic growth

The circular economy will have a positive impact on growth. By 2030, potential growth may be worth 4.5 trillion dollars globally. This was stated by the book “Circular Economy - From waste to value” written by Peter Lacy, Jakob Rutqvist and Beatrice Lamonica, the Sustainability services division executives of the consulting firm Accenture (Lacy et al., 2015).

On the other hand, argue the authors, is no longer sustainable to continue with the current economic model of "take, make and throw" if we do not change the register, we will find ourselves with a devastated environment, a surge in prices and submerged by waste.

According to the European Commission more efficient use of raw materials and resources throughout the supply chain materials could reduce the need for new raw material of 17% -24% by 2030, with savings for European industry estimated at 630 billion Euro per year. Several studies on the potential of circular economy indicate that European industry, thanks to substantial savings on the cost of raw materials, could push the growth of European GDP by about 3.9% and create millions of new jobs. The circular economy could save 8% of annual turnover to the industries while also reducing its total annual emissions of greenhouse gases by 2.4% (European Commission, 2014c).

Translating into reality the current wave of eco-innovations in rapid development in the context of a circular economy, according to a study carried out for the Ellen MacArthur Foundation, the European Union could achieve annual savings of almost 1,000 billion Euro by 2030.

New technologies and business models have already partially realized include car sharing and driverless cars, electric vehicles, advanced materials such as graphene, precision farming, the modular processes in construction and highly efficient passive housing energy.

According to the report, one can in any case provide that these technologies will reduce costs in three broad areas, namely mobility, food and built environment, from EUR 900 billion annually by 2030. If such improvements will be implemented in the framework of a circular economy rather than linear, the savings could double to EUR 1.800 billion, according to estimates of the report (Ellen MacArthur Foundation, 2015).

Greater system and collaboration between companies

The best definition of circular economy is perhaps that of Ellen MacArthur: the circular economy is "industrial economy that is conceptually regenerative and reproduces nature in actively improving and optimizing the systems through which it operates." The waste do not exist. The biological and technical components of a product are designed with the assumption of fit within a materials cycle, designed for disassembly and re-purposing. The organic nutrients are non-toxic and can simply be composted. The technical nutrients - polymers, alloys and other artificial materials - are designed to be used again with a minimum energy expenditure.

The circular is therefore a form of economy that is more collaborative, which focuses on the property and not so much the product as such, but its function and its use. The circular economy is an economy in which waste of a process of production and consumption are circulating as a new entry in the same or a different process.

All this inevitably leads to greater collaboration between companies, but also between the public administration, research and companies themselves to find new operational solutions. Companies cannot think only about their business, but they have to assess the impact of their actions on the surrounding environment confronting all other economic actors.

Improvement of products and savings on production costs

Working for a circular economy means focusing on products of longer duration, developed for the upgrade, aging and repair, considering strategies such as sustainable design. Different products, materials and systems, with many links and measures are more resilient in the face of external shocks, compared to only systems built for efficiency.

Implement the circular economy approach in the manufacture of durable goods of life expectancy is estimated to result in savings of between 340 to 630 billion per year in the EU alone, approximately 12-23% of the actual costs incurred for production materials in these areas. For some consumer goods, such as food, beverages, textiles and packaging, the savings potential for the material is even

estimated in 700 billion per year. Another study, however, estimates the benefits of reducing the costs of production/waste disposal, providing annual savings ranging from 245 billion Euro to 604 billion Euro (European Parliament, 2016c).

Obtaining benefits from the adoption of circular economy also depend on how well and quickly the necessary skills and education to the basics will be implemented and developed. Among the first goals reached there is definitely a greater self-sufficiency in relation to raw materials: already the consumer a share today between 6% and 12% of matter - including fossil fuels - is currently avoided through recycling and reuse, and careful design. Percentages that can arrive with the right efforts to 10-17%, giving a cut of almost a quarter import of raw materials by 2030[1].

Business competitiveness increase

Prolong the productive use of materials, reuse and increase its efficiency leads to an increase in competitiveness for companies that operate in this way. The companies included in a circular economy context have an important competitive advantage over competitors with consumers. Consumers are becoming increasingly aware of how a product is made and what impact it has on the surrounding environment. So consumers prefer to buy a consumer product circular rather than linear.

Reducing impact on the environment

Many experts think that the basic commodities (oil, copper, cobalt, lithium, silver, lead and tin) are likely to run out between 50-100 years from now. But between the increasingly scarce resources there is also the water: in 2050, more than 40 percent of the world population (almost 4 billion people) will live in areas afflicted by a severe water shortage. Human intervention, such as the increase in greenhouse gases and the use of fertilizers in cultivation, are threatening planetary absorption reservoirs like forests, atmosphere, oceans, etc.

Then there is the issue of waste. If we continue with the current waste model of growth by 2025, municipal waste will increase by over 75% and industrial by 35%. And so far, we reached 11 billion tonnes of waste generated each year. Experts predict tensions on commodity markets and volatility, as well as stressful situations related to water and food safety, which would create geopolitical tensions and instability[2].

Creating jobs

Concretely, walk the streets of circular economy means closing some production lines and/or services and opening others. The balance remains positive, however: according to the European Commission's assessment, in the area of waste management alone you could create 178.000 new jobs by 2030.

Advantages for families

A report of Ellen MacArthur Foundation has also tried to quantify the savings resulting from the implementation of circular economy. This would produce savings in the form of lower costs of primary resources, those related to the use of the products (for example, for the maintenance of the vehicles, if these were shared) and those associated to external effects such as congestion and gas emissions greenhouse, which should be reduced drastically.

The report found that the savings would accumulate mainly in favour of families, which would enjoy an average of 11% of disposable income in more thanks to the efficiency of circular economy. This would allow an increase in expenditure of at least 7% of GDP by 2030[3].

2.1 Sector Opportunities through Circular Economy

1. Text for thie footnote

2.1.1 Built Environment

This section is based on the key findings of a circular economy report (Welsh Government, 2017) commissioned by the Welsh Government funded Constructing Excellence in Wales. It includes how circular economy principles may be applied to the built environment, the size of the economic opportunity, challenges and recommendations on how the principles could be implemented across the sector to realise the benefits.

Potential benefits

The following are some reasons why a circular economy approach for the built environment is required:

- Resource and energy use;
- The threat of rising commodity prices;
- Resource supply constraints (especially wood & timber);
- Stricter landfill requirements;
- Higher energy efficiency targets/standards for buildings;
- Decarbonising construction
- Competing uses/priorities for materials; and
- Low residual value of the materials in end of life buildings

The scale of the opportunity for the construction sector to adopt the principles of the circular economy is significant given it is the biggest consumer of raw materials (EEA, 2011), with eighty per cent of all materials produced used in the built environment. Notably the sector is the largest producer of controlled waste in Wales (EAW Survey, 2005), reflecting a broadly similar position across the whole of the EU.

It is possible to achieve a positive residual value by adopting a more adaptable approach to building design, where disassembly and reuse are considered and planned in advance. Applying circular economy thinking can reduce construction and refurbishment time and associated costs, maintaining the value of the asset whilst protecting the rental yield.

Research commissioned by Constructing Excellence in Wales has demonstrated a potential economic opportunity to Wales of an additional £1 billion per annum by 2035 through adopting a circular economy approach in the built environment. This is an increase of 12.5 per cent in the turnover of the Welsh built environment sector. This figure is consistent with a growing body of research that identifies the economic opportunity and the importance of the sector in delivering. A circular economy approach has the potential to generate 7,300 jobs (gross) in Wales.

The circular economy approach

In order to realise the benefits the sector will need to embrace a different approach to its delivery. It will be necessary to move towards a more collaborative approach to working across the supply chain

in an earlier and more integrated manner than is currently commonplace.

In applying the circular economy to the sector it is key that any methodology demonstrates:

- a “whole life approach”;
- circular economy principles;
- value opportunities; and
- the inter-relationships between the built environment, other sectors and the natural environment

Consideration needs to be given to examining the whole construction project as one and understanding how the numerous elements interact and co-exist with each other over time. The ‘product’ is the final built asset and various construction materials are the ‘components’.

The following are key elements for circularity:

- The components need to be as resource efficient as possible (for example incorporating as much recycled content as possible) and should have as long a life as possible.
- As little of the components as possible should be wasted during the construction phase.
- Those that are unavoidably produced as waste should be kept separate for reuse or high quality recycling.
- When an asset is no longer required, it may be dismantled and its components (e.g. bricks, blocks, concrete) can be seen as a source of raw materials for reclamation and re-use as a priority, and as much high quality recycling as possible, and zero landfill. Components should be selected for their recyclability, and should be non-hazardous.

Construction is only one phase within a project as there are a number of inter-connected stages, these include concept, design, occupation and deconstruction/ demolition. These phases are linear in process but circular due to the inter-relationships between decisions and actions at one stage impacting further along the process. Circularity must be built in throughout the process. To achieve circularity no phase can work in isolation. The design stage is critical given at this stage decisions are made that impact 80% of the waste generated on a project.

The approach outlined above reflects:

- A value chain by focusing firstly on on-site reuse, refurbishment or recycling opportunities;
- Closed Loop - Connection to external collections and the ability of products, components or parts to be able to be entered back into the cycle through reuse, refurbishment or recycling and this returning back into the construction cycle by the user.

Challenges

The transition to a circular economy brings significant challenges within all phases of construction:

- **Transforming mindsets**: A lack of client awareness/demand and/or associated negative perception is a big risk to the successful implementation of circular economy principles within the sector. A change in economic model may be perceived as risky, with associated costs and benefits that are realized in the future. This will require a strong business case for change to be demonstrated.
- **Legislative barriers**: The unintended consequences of the existing waste regulatory framework, for example definitions may act as a barrier hindering trade and transportation of resources/products for reuse/remanufacturing.
- **Infrastructure**: There needs to be investment made to ensure there is the infrastructure in

place to enable products to be reused or recycled. This needs to include physical infrastructure to ensure good quality reused and recycled materials as well as generating markets for recycle, secondary materials and by-products.
- **Supply chain**: Currently there is limited information, knowledge and economic incentive for key elements in the supply and maintenance chain e.g. chemical composition and strength. This makes it difficult to repair, refurbish and/ or recycle materials, reducing the value and recovery opportunities. In addition, a lack of supply chain integration means that often decisions are made in isolation with little consideration for the wider impact.
- **Producer responsibility**: Products/components are currently on the market that are unable to be disassembled/repaired/replaced. A lack of quality assurance, traceability and the absence of certification means that even products/components that are capable of being recovered are often not identified and segregated making it very difficult. There exists a widespread planned obsolescence in products, limiting reuse, repair, refurbishment and recovery opportunities.

Opportunities

The following opportunities would support and accelerate a transition towards a circular economy in the built environment:

- **Government policy:** A strong policy on sustainable development can establish a framework providing a clear direction. Supporting innovation towards a more circular economy is key. Planning and building regulations could actively encourage development to maximise resource use, supporting the use of recycled/secondary materials and by products. Tax raising powers could be used to apply levies to virgin raw material to favour recycled alternatives. Lower VAT could be applied to products containing recycled content to incentivise their use.
- **Role of the public sector:** The public sector usually spends a large proportion of its budget on construction. This makes procurement to consider circular economy principles a significant opportunity. The education of the public sector client is key to bringing about change within the economic approach.
- **Resource availability:** Current research indicates that resource costs are likely to increase due to volatile markets and demand pressures. Within many parts of the EU there is a large volume of secondary materials and by-products, generated in large part from metal refining and power generation activities. The utilisation of these materials would provide volume aggregate materials bringing a positive environmental impact, reducing the carbon footprint and addressing material legacies.
- **Economics:** Adopting circular economy practices makes economic sense. Achieving Growth Within identifies a total economic benefit of up to €135 billion by 2030 in reduced utility, repair and maintenance cost, in addition to a €105 billion investment opportunity between now and 2025. Arup have identified that designing steel for reuse could generate high potential value for building owners, estimating savings of 6-7% for a warehouse, 9-43% for an office, and 2-10% for a whole building, with up to an additional 25% savings on materials.
- **Changing the way we use our built environment:** We need to change the way we think about how we use our built environment. We currently under occupy our buildings, typically 35-40% of offices in Europe are occupied, the same report identified that within UK homes 49% are under occupied.

Recommendations/actions

Developing a whole circular economy narrative, with collaboration across the entire supply chain and the ability to design for the whole life, including the end of life is necessary to fully realise an economic return. To truly evolve into a circular industry there will be a need to bring together the process start and end, aligning design and demolition to remove the current disconnect. Design

practices will need to consider what and how materials are used, are extracted and reused within the built environment, with demolition removing materials to protect the reuse value.

The following actions are considered key elements:

- **Materials selection**: Materials will need to be selected with consideration given to their end of life, there are numerous commonly used building materials that have no alternative recovery option other than landfill.
- **Standardised components**: There is a need to look towards manufacturing principles, such as component standardisation to deliver efficiencies including enhanced time in use, extended life, facility to repair/refurbish.
- **Design for circularity**, including:

    - Design for flexibility/adaptability to extend life;
    - Design for deconstruction – requirement to consider end of life in current design including reuse of asset/elements/components.

- **Product design**

    - Design for longevity – eliminate current practice to design planned obsolescence within asset and products.
    - Design for separation/on site management/demolition.
    - Design for reuse/site management/demolition.

- **Buildings as materials banks**
- **Building core competencies**: to facilitate product reuse, recycling, cascading - requires advanced skills sets/information sets/working methods.

Policy focus

The following are considered key areas for government policy development:

- **Market development**: Quality supply and demand: There is much to be done to support the development of markets for the large quantities of by-products, secondary materials and waste, such as IBA, PFA and steel slags. Many of these legacy materials need assistance to develop markets and routes to market for the type and volumes of these high quality by-products/secondary materials and recyclates.
- **Sector support**: The construction sector is fragmented, this is true across the industry and government. This does not provide a solid basis for end of life material extraction. There is a need for a cohesive construction strategy to be developed to provide clear direction and remove barriers to scalability and applicability.
- **Development of infrastructure**: The sector consumes and generates large volumes of materials. There will be a need to develop cost efficient, better quality collection and treatment systems and effective segmentation of end of life. Without this investment the leakage of materials out of the system will continue, undermining development towards circular economy.
- **Role of the public sector client**: The development of consistent approaches to the design, build and deconstruction of public funded construction with consideration of circular economy principles would provide clear direction creating stable investment and development platform for green growth.

Conclusions

It is important to ensure that the necessary policies and appropriate interventions are in place to deliver the necessary transition to make the most of the opportunity presented.

Key to the application of the approach will be design, influencing at the earliest possible opportunity. Adopting circular design will require the sector to embrace new ways of working, collaborating at earliest possible stages across the supply chain, thinking for the long term and embracing innovation in product and process.

2.1.2 Textiles

Current status

The legitimacy of companies have been challenged in recent years due to globalization which makes it difficult for companies to control every step in the value chain. This is particular a factor in the textile industry as the production process is spread across the globe and across desciplines. There is a need to bridge academic research and industrial development, western consumption and eastern production, first-world demand and third-world supply. Because of the geographical disconnect, Europeans generally find it difficult to recognise the full impact of their purchases.

Fashion textiles

The fashion industry is represented by fast consumer goods, but still the fashion industry is also a way for indivuals to brand their personal believe and an active position in life. Today, the pressure from consumers is a driving demand for more environmentally sustainable production processes. Use of textiles has important ressource implications. Processing raw materials into finished products results in one-third of the waste and over three quaters of the carbon and water footprint produced by the sector.

This demand has led to the fact that companies have increasingly taken over the political responsibility to lead the proces of ensuring that products do not contain toxins and that the textile industry waste is handled properly. Furthermore, resources are becoming more scarce as the world is running out of land for growing food. Agricultural land cannot be used for fibres when it is needed for food. Keeping textiles and fibres endless circulating makes good business sense. There is some possibilities for more circularity within the fashion industry, such as:

Increasing the lifetime of clothes through design and innovation technologies

1. Increasing the usage of clothes through renting or leasing
2. Increasig the re-use, repair and recycling of clothes

1) Lifetime extension through design and innovation technologies

Increasing the lifetime of clothes through enhanced design, innovative materials (e.g. nano coating) and consumer behavioural change reduces consumption of virgin resources.

2) Renting and leasing of clothes as service business models

Increased use of clothes during their lifetime, including renting and leasing of clothes, customised mass production and customer awarenes can deliver massive global savings.

3) Re-use, repair and recycling via incentivised return schemes

Improvements in clothing re-use, repair and recycling through take-back schemes and seperate collection of unwanted garments can lead to substantial global savings.

Furniture textiles

Textiles for furnitures are in a different category as these textiles need to last longer as in the fashion industry. Furthermore, the textiles often need to fulfill a long list of qualities such as being non-flamable, not fading in the sun, etc. These qualities need to be included in the environmentally friendly material. There is not yet a mature technology that can ensure the exact same quality of an environmentally friendly textile than a traditional material.

Producing an environmentally friendly furniture textile leads to a much more expensive product that most customers are not willing to pay for. Branding may be a solution to lead the way and pull the development in this direction as the manufacturers puts money in producing the environmentally friendly products at this moment.

Companies as well as academic research is still looking for the solution where price and quality equals traditional textile production. However, at this moment, demand has not yet come to furniture textiles in this regard. Furthermore, there is a huge pressure from China who during the past years have started to produce good quality at a much cheaper price. This does not encourage further investments in environmentally friendly production methods in which there is no demand. In return, the industry has started to use the residues and waste products in isolation as well as for second use in third-world countries.

Policy tecommendations

It is possible to improve the sustainability of clothing and textiles across its lifecycle by looking at:

1) Procurement and specification of lower impact fibres

Textile production has been moving steadily towards blended fibres in order to produce new functionalities, which has been a serious barrier to recycling levels.

2) Access to funding for supply chain partners to increase efficiency

SMEs has an advantage by being more flexible. While SMEs do not benefit from the funds of large companies, they are also not subject to their ’old ways’, which might be particular hard to change. Small business have the opportunity to build a brand from scratch without compromising on their values. In short it is much easier to create a green SME than to make an already existing company greener. Therefore, there is a need for policy makers to ease the proces for SMEs to access funding for product development in order to enter the circular economy.

2.1.3 Packaging

Introduction

Europe currently recycles around 40% of the waste produced by households in its area with recycling rates as high as 80% in some areas and lower than 5% in others. The proposal reflects on a high level of ambition while taking into account the different realities and performance levels across the EU. In other words, EU loses around 600 million tonnes of waste materials, which could potentially be recycled or reused. Resource efficiency could only be achieved by turning waste into a resource,

which helps closing the loop in a circular economy.

In general, packaging is a product constructed by using raw or used materials aiming to include other products (single or a group) in order to protect them during the transportation as well as to wrap the products targeted the consumers. Packaging products are constructed for single or multiple uses (reuse). Furthermore, a packaging manufacturer refers to a person or a legal company that wraps products or imports packaging products. This entity operates under the concept of 'Polluter Pays' having, in other words, the responsibility to promote the recycling of these products. For this reason, a specific and well known logo is included in the product wrap to indicate the necessity of its recycling. In particular, packaging products may include boxes, cases, folders, flower pots, hangers, capsules, membranes and bags.

The concept of circular economy is based on good practices regarding waste management which include the promotion of recycling, the innovation in materials management as well as limiting the use of landfilling. In order to achieve the above, the circular economy package includes specific proposals to amend the EU's waste legislation. These proposals will provide a stable ground for long-term investment strategies focusing on prevention, reuse and recycling (EC, 2016).

In this frame, the targets set by EU in terms of packaging waste management are listed as following:

- A common EU target for recycling municipal waste of 65% by 2030;
- A common EU target for recycling packaging waste of 75% by 2030;
- Material-specific targets for different packaging materials;
- A binding landfill reduction target of 10% by 2030

In addition, specific measurements were proposed to achieve these targets:

- Simplification and harmonisation of definitions and calculation methods in order to ensure comparable, high quality statistics across the EU;
- Adoption of special rules for Member States facing the biggest implementation challenges;
- Simplification of reporting obligations and alleviating obligations faced by SMEs;
- Introduction of an Early Warning System for monitoring compliance with targets;
- Encouraging Member States towards greater use of economic instruments (such as a landfill tax) to incentivise the application of waste hierarchy, to prioritise prevention, reuse and recycling, with disposal as the last resort.

Furthermore, a set of incentives were introduced to promote these alternative waste management strategies as listed below:

- Adoption of concrete measures to boost reuse activities (a clearer definition and rules were included as well to expand the scope of reuse activities rewarded under the EU targets);
- List of general requirements for the operation of Extended Producer Responsibility (EPR) schemes (producer's responsibility for a product is extended to the post-consumer stage of a product's life cycle-improve their performance and transparency, including direct financial incentives for greener product design);
- Set of clearer rules on by-products and end-of-waste criteria (stimulates the sharing of by-product resources among industries and markets for recycled materials);
- Adoption of new measures to promote prevention (e.g. food waste, marine litter) and reuse;
- Provisions to improve the traceability of hazardous waste.

The transition to a circular economy will secure access to high quality and affordable raw materials for European citizens, leading to a more competitive economy in the context of volatile resource prices,

political instability, resource scarcity as well as increasing global competition concerning the access to raw materials.

The prerequisite step for the optimal results is the minimization of landfilling and the recovery of materials through the implementation of alternative waste management schemes. Furthermore, a market development for the products derived from the recovery process is needed to take place for the viability of circular economy.

On the other hand, no such scheme could be implemented without citizens' participation. Citizens should have a more energetic role in the circle of consumption being able to separate their waste into the well known categories (e.g. packaging, organic, metals, etc.). The results from previous research on this issue have indicated the necessity of information campaigns in order to sensitize the community as well as training seminars for the participants (Vicente and Reis, 2007).

Taking into account the waste composition, the amount of packaging waste that can be recovered through the recycling system is significant. Packaging waste recycling strongly contribute in environmental protection and the improvement of quality of life (Banar et al., 2009; EEA, 2007; Anquilar-virgen et al., 2010). In particular packaging waste recycling:

- Helps in reducing the volume of waste for final disposal in landfills. In this way, the lifetime of landfills is increased.
- Contributes in resources and energy efficiency
- Develops new markets for products derived from recycled materials
- Creates new jobs
- Helps citizens to develop environmental consciousness

Packaging waste are separated into different categories including plastics, paper, metals, glass and wood. With regard to their short period of use, packaging materials become waste relatively quickly after they have entered the market.

Several opportunities are provided in order to increase the recycling rate of packaging waste. Such opportunities include a better packaging design, higher collection rates and improved segregation technology. The key barriers in promoting packaging waste recycling include the profitability that depends on the unpriced externalities and price volatility, the collection and segregation technology as well as the split incentives. Finally, the proposed policy options at national or regional level may include a mandated improvement of collection infrastructure, increased national recycling rates, standardised collection/segregation systems as well as increased incineration taxes.

In the context of circular economy a number of sectors face several challenges, derived from the specificities of their products or value-chains, their environmental footprint or the dependency on material imported from outside Europe. These sectors need to be addressed in a way which ensures that the interactions between the various phases of the cycle are fully taken into account along the whole value chain.

Packaging waste management in the EU

EU countries implement different methods for collecting packaging waste. These methods include a) collection from bins for recyclable waste and further separation to different waste categories in recycling units, b) collection from separate bins for the different packaging waste categories (paper, glass, metals, plastics) and c) collection of plastic bags where citizens dispose their packaging waste.

There exist several recycling units addressed to the different packaging waste categories operating at EU countries. The majority of the EU Member States manage their packaging waste in their territory.

However, in some cases there exist no technology or operate no such units in EU countries to manage specific waste streams (e.g. plastics, expanded polystyrene).

Table 1: Management of packaging waste in the EU.

	Greece	Denmark	Italy	Bulgaria	Finland	UK
Plastic	•	•	•	•	•	•
Paper	•	•	•	•	•	•
Metals	•	•	•	•	•	•
Glass	•	•	•	•	•	•
EPS		•	•		•	•
Wood	•	•	•	•	•	•

Plastics

Plastic packaging plays a key role in circular economy having an annual growth of ~3–5% globally for the next few years at the expense of other materials. The use of plastics in the EU has grown steadily, whereas less than 25% of collected plastic waste is recycled and more than 50% of the total collected material goes for final disposal in landfill. In addition, large quantities of plastics end up in the oceans which led to the 2030 Sustainable Development Goals including a specific target to prevent and minimise marine pollution of all kinds, such as marine litter.

The first phase of the value chain of plastic packaging is the design and production of plastic material, while the second phase is the after-use of collection, waste segregation and reprocessing. On the other hand, the after-use phase is more localized and open to individual national policy makers. In any case, all the phases of value chain are interrelated, while the after-use measures need to be made according to design and production standards (Ellen McArthur Foundation, 2015).

In terms of plastic waste stream, the collected material is disposed at recycling units where plastic scrap is separated and washed in order to remove the unwanted items. The next step of the recycling procedure is the compression of the scrap and the formation of plastic packs. The final stage that closes the loop is the heating of the plastic packs at 200°C that transforms them to a fluid material which can be used as raw material for plastic production.

Paper

Paper waste stream is considered of high importance in the EU. Today, numerous products use recycling paper as raw material including kitchen and toilet paper as well as cardboard. The vast majority of paper waste derived from big producers such as super markets, while a small percentage comes from households and offices.

The first stage of the recycling process includes the separation of the collected waste depending on their quality. During the next stage, the scrap is compressed and formed into packs after removing the unwanted material. Next, the packs are disposed into large containers where they mix with water through agitation and transformed into pulp (95% water and 5% paper). Thereinafter, the pulp passes through sieves, where any other material than paper is removed. During the final stage, the pulp is drained and the transformation into paper begins.

Metals

Concerning the metals, these are considered to be mostly aluminum and tinplates. In terms of the aluminum, the collected waste are first cut into small pieces. After a thorough screening, the scrap is melted, while materials such as coatings and ink are removed. The melted aluminum is then transferred into moulds formatting large rods. During the next stage, the aluminum rods undergo specific treatments in order to acquire elasticity and strength. In general, the same procedure is followed for tinplate waste.

Glass

Packaging waste consists also of glass mostly derived from bottles. At first, several materials that come with the glass bottles such as stickers and caps need to be removed by humans themselves. Then, magnets distract metal material from bottles. During the next stage of recycling, glass waste is separated based on its color (brown, green and transparent). The cullet is produced after breaking the glass is lead for melting, which transferred to moulds formatting new bottles or other packaging material.

Wood

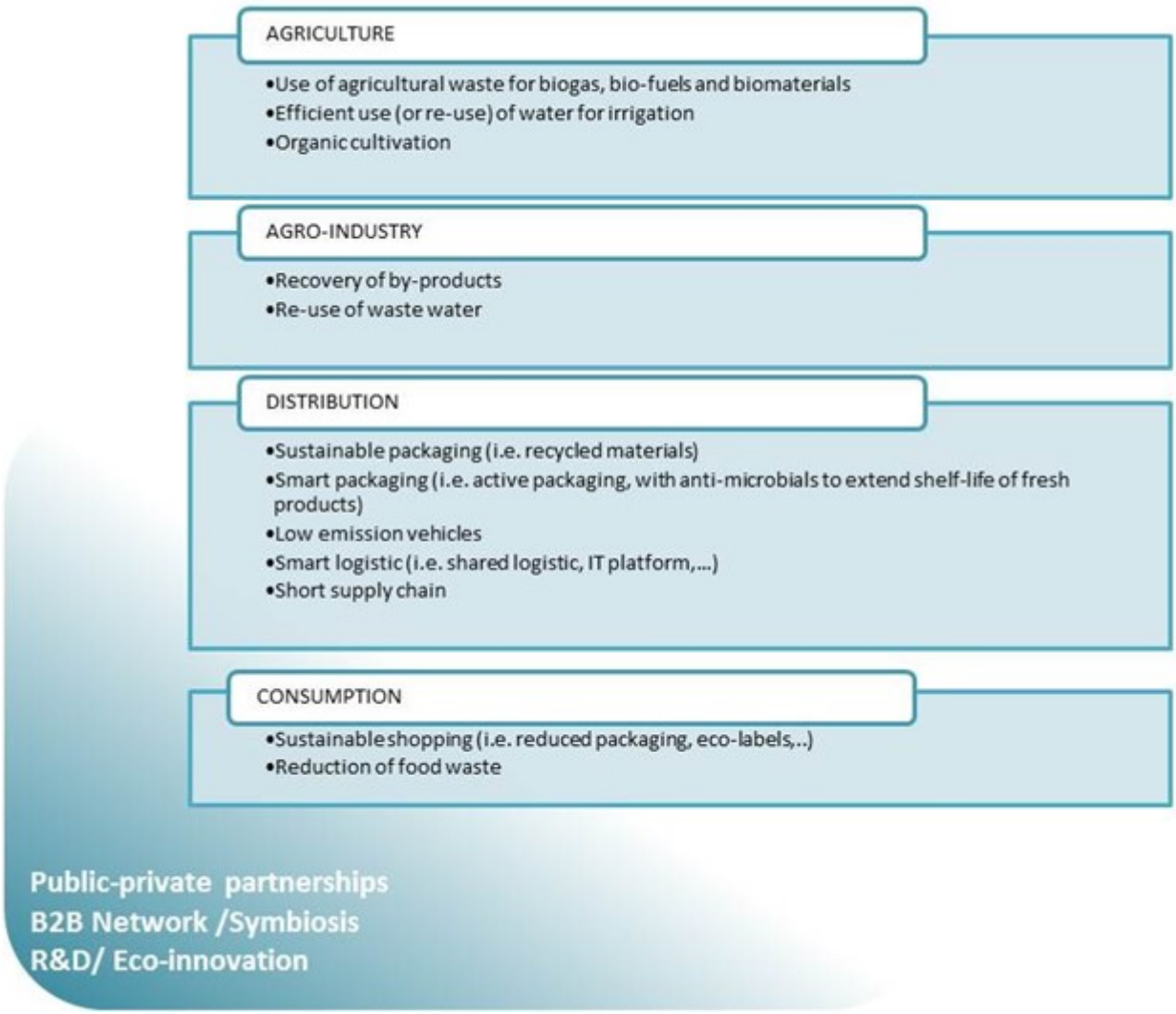
Another category of packaging waste consists of wood material. Waste from wood is transferred to recycling units and is mostly transformed to Refused Derived Fuels. The management process consists of the phase of the wood shredding in order to produce sawdust that are used afterwards as raw material for heat and power production.

Expanded polysterene

Expanded polystyrene (EPS) is another packaging waste that can be recycled. At first, EPS is compressed and transferred to recycling units. The EPS packs are then lead for melting and concrete polystyrene is produced. This product is considered as raw material for new products including flower pots, hangers, signs and toys.

2.1.4 Food and Beverages

Opportunities within “circularity” in the food and beverage sector have been analyzed by considering the entire circular economy loop, from the field to the table: each stage, starting from the agricultural models, through the productive process of food industry, the packaging of products until the consumers behavior at home could give a positive contribution to a circular model. These contributions could have a positive impact for example in waste prevention, resource efficiency (water and energy included) or extension of life-cycle products, as shown in the image below. Some factors such as partnerships, applied research or innovation could act as key-factors at any step of the cycle.

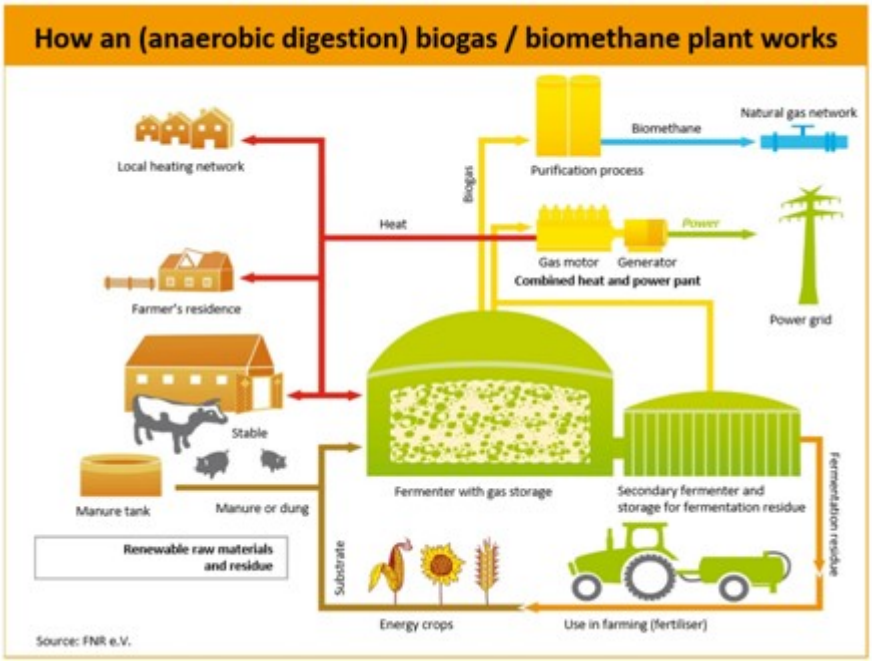


First stage: Agriculture

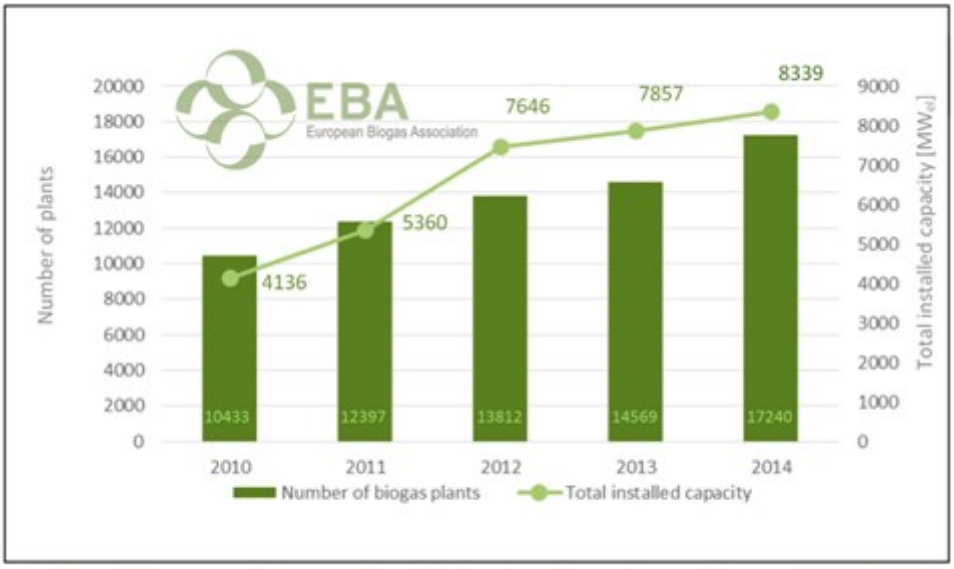
Nowadays, more and more companies from the agricultural sector (including the smallest ones) are trying to enhance the potential of their waste with the aim of getting both economic and environmental benefits: in fact, the recovery of waste could represent a supplementary income for farmers and a way to diversify the production. Depending on the type of waste, farmers can recover material or energy - or both.

Biogas plants represent the “win-win” solution to integrate the management of waste with the production of digestate and biogas, both economically profitable *(see the Italian best practice Agribioenergia).*

1. The digestate is the treated effluent from the Anaerobic Digestion process that takes place inside the biogas plant and can be used for fertilizing the fields, replacing chemical fertilizer, and increasing also the organic matter percentage in the soil
2. The biogas is the gas deriving from the digestion; it has a high content of methane (CH4) and therefore can be treated in order to be sent to the grid or used as biofuel for transport, replacing methane deriving from fossil energy sources (European Biogas Association, 2013).

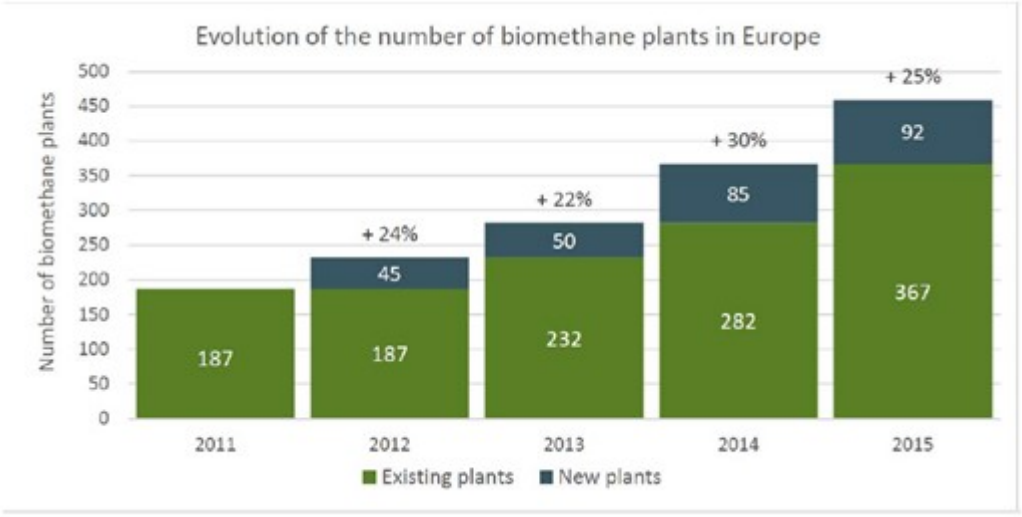


Statistics (from European Biogas Association) show a growing trend of the number of biogas plants all around Europe, therefore showing the promising potential of this technology:



Number of biogas plants and total installed capacity in Europe 2010 -2014

The evolution of the number of biomethane plants in Europe shows an even more increasing trend (source: EBA)



Type of waste

With regard to biogas plants, different types of waste could represent an incoming resource: for instance, animal manure and slurries, crop residues, organic waste from dairy production, food industries and agroindustries, wastewater sludge and organic fraction of municipal solid waste.

There is another relevant waste stream towards the agricultural sector: all organic waste (also from separated collection) that are treated and composted will be used for improving the quality of the agricultural soil.

Second stage: Agro-food industry

The food industry and the agro-industry are sectors where the industrial symbiosis and circular economy can express their full potential thanks to the great amount of organic residues generated throughout the productive process. Finding an alternative way to waste disposal means reducing both environmental impact and costs related to the treatment; but it also means saving resources, as they can be replaced by recovered materials.

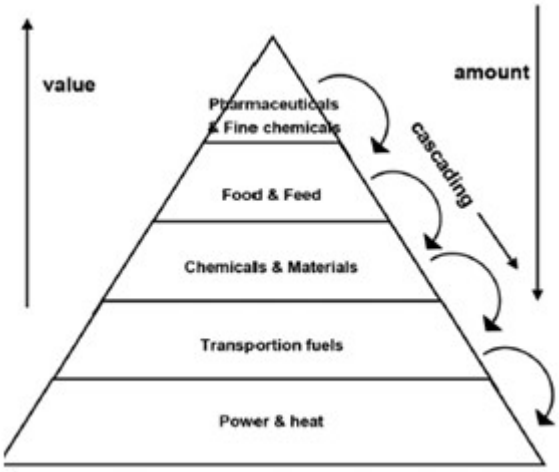
The whey (by-product that is produced in large amounts within the dairy industry) is the most popular example of a recovered by-product, given the huge amount produced and its nutritional composition. Whey is used for the production of feed (in particular for the nutrition of pigs and beefs), but also for the production of several derived substances (such as lactose and proteins). Whey is also used for human food (i.e. milk powder for baby food) and for other food industry processes (chocolate, ice-cream, confectionery product, etc.).

Nowadays, researchers are more and more focused on how to produce high value products from bio-based residues, with a growing interest from the pharmaceutics and cosmetics sectors. These sectors are in fact looking for natural ingredients that are suitable for replacing synthetic substances. As a matter of fact, food by-products are still very rich of active substances (sugar, minerals, organic acids, dietary fibers and bioactive compounds, as polyphenols and carotenoids, analogously to their edible counterparts) and they are produced in large amounts as shown in the following table (Barbulova et al., 2015):

Plant	By-Products	Edible Part
Agave	40% (rind and pith)	60%
Apple	11% (pulp and seed core)	89%
Artichoke	60% (outer bracts, receptacles and stems)	40%
Asparagus	Up to 40%–50% (spear)	50%–60%
Banana	Up to 30% (peel)	70%
Cactus cladodes	20% (spines, glochids and peel)	80%
Carrot	30%–40% (pomace)	60%–70%
Mandarin	16% (peels)	84%
Mango	42% (seeds, peels, unusable pulp)	58%
Citrus fruits	66% (peel)	44%
Papaya	47% (seeds, peels, unusable pulp)	53%
Passion fruit	75% (rind and seeds)	25%
Pineapple	52% (core, peels, top, pulp)	48%
Potato	15%–40% (peel)	60%–85%
Tomato	3%–7% (peel and seeds)	93%–97%

Another forefront kind of recovery of agricultural by-products or waste is the production of bio-polymers: those bio-chemicals derived from biomass can partially replace chemicals from fossil raw materials, traditionally used in petrochemical industry, thus providing economic and environmental benefits. Lastly, as previously described, agricultural waste can be valorized though the production of bioenergy.

All the above mentioned enhancements of agricultural biomass have not the same added value, as shown in the biomass pyramid below that suggests the preferred uses of biomass (European Union, 2013):



Besides waste recovery, the food and beverage industry can give a relevant contribution to a circular model in terms of water efficiency. Sustainability in the use of water can be represented both by:

1. Reduction of water use for processing food or beverage
2. Recovery of waste water.

In both cases, the contribution of technology and innovation is crucial. Reusing water, even if properly treated, is very complicated in the food and beverage industry due to very strict legislative requirements for products intended for human consumption. So, the reuse of water is mostly dedicated to parts of the production plant such as power systems or cooling systems *(see the Italian best practice Granarolo).*

Type of waste

Basically every kind of activities in the agro-industry sector provide a large set of waste and byproduct that belong to the family of biomass.

Third stage: Distribution

A circular approach at the distribution stage may include: sustainable transport and sustainable packaging. About transport, sustainability refers mainly to low emission vehicles but circularity needs a wider perspective in order to be carried out: for instance, there are some promising experiences in the "sharing" approach, which is one of the business activities of the RESOLVE model, created by Ellen Mac Arthur Foundation (). Business can overcome the idea of ownership and benefit from goods and services, thanks to the sharing approach with other business and the rental service. This option leads to cost savings and environmental benefits.

An interesting opportunity is the sharing among different logistic service companies: thanks to an IT platform, the logistic needs of different companies can be matched and compared, thus finding the best travel option for moving pallets more efficiently (NolPal example: minimizing the trips of empty pallets). With regards to packaging, the challenge is finding a balance between food storage (to keep safety and nutritional proprieties of the product) and the environmental impact of the packaging waste.

Packaging can be reduced both in weight and volume in order to reduce the final waste but also to make the transport of products efficient. Packaging can be produced by using recovered and recycled materials, with a particular attention to food contact. In addition to that, the more forefront and performing packaging can contribute to extend the shelf-life of food products: they are the so-called "ActivePackaging", which release substances that enhance the performance of the packaging itself. This system helps to reduce food losses *(see the Italian best pracice AMP recycling).*

Type of waste

All separated fractions of waste (in particular plastic, but also aluminum, glass and paper) can contribute to generate secondary raw materials for the packaging industry, thus allowing to save finite resources.

Fourth stage: consumption

At the consumption level, the most important activity from a circular point of view is the reduction of food waste, which represents a big ethical, economic and environmental issue (FUSIONS EU project, 2016). Retailers can give their contribution by donating surplus stock of products that cannot be sold anymore but are still edible (damaged packaging, proximity of expiration date, etc.). The same strategy can be followed by school canteens and hospital kitchens in relation to cooked yet uneaten meals. In both cases, retailers and caterings, the food is donated to charity organizations that distribute it among the people most in need, thus achieving both a social and an environmental aim (*see the Italian best practice Last Minute Market).*

On the consumption level, the demand for ecological/green/organic products from the consumers must be considered. The awareness towards the environmental aspects related to the food consumption is growing in the society, making people more conscious and demanding for "healthy food". This demand is satisfied for example by the environmental certifications and labeling, which certify the *green profile* of the product and/or of the process while making the consumer aware of the origin of the product and its circularity. The EPD (environmental product declaration) is a verified and registered document that informs transparent and comparable information about the life-cycle environmental impact of the products. It is used a lot also for food products, in which a very good

example from Italy is the Barilla group, which has 61 food products certified, covering the 69% of its whole production.

Another solution for reducing food waste is the collection and composting of organic waste from households. This second activity is a recovery action, while the above mentioned action (retailers and caterings) can be labelled as a prevention. The compost produced then comes back to the first stage of the circular economy loop of the food and beverage sector: agriculture.

Type of waste

At this stage, waste is basically food waste: as already explained, organic waste, if correctly collected and properly treated can be transformed into compost, useful for agriculture activities.

1. If the biogas is upgraded to biomethane and injected to the gas grid the efficiency will raise up to more than 80 % (European Biogas Association)
2. BarbulovaA., ColucciG.,AponeF."New Trends in Cosmetics: By-Products of Plant Origin and Their Potential Use as Cosmetic Active Ingredients"Cosmetics (ISSN 2079-9284; CODEN: COSMCC) n.2/2015
3. The report entitled De Ecopyramide – Biomassabeterbenutten (Derksen et al 2008) and the English language summary "The Ecopyramid – better biomass efficiency" http://www.innovatienetwerk.org/en/bibliotheek/rapporten/342/DeEcopyramide
4. "Growth within: a Circular Economy vision for a competitive Europe", McKinsey, MacArthur foundation, 2015
5. See the project Sharepal, promoted by the green start-up "NolPal" http://www.nolpal.it/
6. http://ec.europa.eu/food/safety/food_waste_en

2.1.5 Machinery

It has been estimated that the long-term benefits of the circular economy is within materials - intensive automotive, machinery and equipment industries (Ellen MacArthur Foundation, 2014). The automotive and machinery sectors along with the railway sector are examples of steel-intensive sectors. Together they represent around 45 % of the global steel demand (Ellen MacArthur Foundation, 2012).

Moreover, steel metal scrap from machinery and equipment along with vehicles and big household appliances produce approximately 30% of steel scrap globally, representing 10% of all steel produced. The typical lifespan of machinery, equipment and components in customer use is 5-25 years where maintenance plays a central role accounting for 30-50% of many companies' total turnover (Sitra, 2015).

It is estimated that the circular economy improves competitiveness in the machinery and equipment industry, as it creates a major opportunity for companies to boost their growth and to better meet customer needs. The circular economy is expected to bring a growth potential of EUR 300–450 million for the industry, which is based on additional sales generated by new business models using the circular economy approach. Such a change can already be seen in companies such as Caterpillar, Rolls-Royce, Renault and Kingfisher (Sitra, 2015).

The main input of the machinery and equipment sector mainly consist of labour, mostly engineers, as well as components, services and steel. In terms of resources the key raw material is steel. The market for steel material is well-developed, thus the cycle is almost closed. In the circular economy,

the most important issue is leading back to the OEM (original equipment manufacturer). In addition, it is important to remember the potential role of subcontractors in the refurbishing of components or in scrap metal flows (Sitra, 2015).

The machinery and equipment industry focuses on capital assets, i.e., the manufacture of production equipment. Such assets have longer service lives and innovation cycles than consumable products, which lead to a much lower volume of products and materials, also posing a challenge to the creation of tighter loops. However, a longer service life would increase the opportunities offered by modularity and leasing. At the end-of-life stage, there is still plenty of value to capture by selling machinery and equipment, but currently only few companies have started to benefit from this opportunity. One reason for this is the lack of existing platforms for second hand machinery.

Circular design is the first step towards closing the loop

The decisions taken in the product design phase are crucial, as they set the foundation for the possibilities of circularity of a product. Material that otherwise would be wasted is maintained or even improved through remanufacturing, repairing, upgrading or re-marketing. By extending the lifespan of the product for as long as possible, companies can keep material out of the landfill and discover new sources of revenue.

Circular design includes enabling the recovery of materials and products, e.g. by the choice of materials or a design for disassembly, as well as improving the modularity of a product to enhance the efficiency of remanufacturing. Other areas important for economically successful circular design are standardised components, designed-to-last products, design for easy end-of-life sorting, separation or reuse of products and materials and design-for-manufacturing criteria that take into account possible useful applications of by-products and wastes. Products need to be recycled as efficiently and safely as possible at the end of life, and therefore the circular economy will require user-centred service and product design, from raw materials to service concepts and from use to disposal. This will require new core competencies in circular design to facilitate product reuse, recycling and cascading in companies. However, it needs to be emphasised that remanufacturing is possible only if the equipment in question returns to the OEM (Ellen MacArthur Foundation, 2013; Antikainen et al., 2016).

Case example: Caterpillar
Over the past 40 years, Caterpillar's remanufacturing activity, Reman process, return products at the end of their lives to same-as-new condition and helps reduce owning and operating costs by providing its customers same-as-new quality at a fraction of the cost of a new pair. Through this process, Caterpillar reduces costs, waste, greenhouse gas emissions and need for raw inputs (Caterpillar, 2017a; Caterpillar, 2017b).

Case example - Valtra:
Valtra develops and manufactures tractors with its European-wide service concept. Since 2013, Valtra launched Valtra Reman concept focused on collecting used gearboxes and restoring them for reuse. The used gearboxes are dismantled, cleaned and refitted with new parts to replace worn or damaged ones. Gearboxes are then assembled, tested and painted.
The sales of remanufactured gearboxes is a very profitable business. Refurbishing makes the life cycle of the product longer, and helps cut manufacturing costs as well as material and energy consumption when compared to manufacturing of new gearboxes: remanufacturing uses approximately 95 % less energy than manufacturing a new product. Since 2012, the turnover for Reman gearboxes has increased by an annual rate of 25-30 %. For customer, a remanufactured gearbox costs 30-40 % less than a new gearbox.
Customers are committed to return used gearboxes by a deposit scheme, i.e., when ordering a Reman gearbox, they pay a deposit which is approximately 50% of the gearbox price. The deposit is returned when the customer returns the used gearbox. For a customer the Reman service is carefree as Valtra covers the delivery costs and also offers a warranty for the proper function of the remanufactured gearboxes (Sitra, 2017).

Case example – Valmet:
Valmet, developer and supplier of technologies, automation and services for the pulp, paper and energy industries, offers its customers technology and maintenance solutions, i.e. intelligent machines and advanced automation, with which they can improve and optimize their resource efficiency. Resource efficiency can be boosted by:
• Energy boilers and gasification technologies that enable the flexible use of a wide range of renewable fuel sources for energy production, reducing the need for renewable fuels, including efficient energy recovery from various waste streams.
• Pulp production solutions that are built on efficient and sustainable extraction of fibers from wood, while focusing on chemical and energy recovery in the processes, allowing materials to circulate within production processes for longer.
• Machinery design and services that enable flexible reuse and conversions; lifetime of equipment can be significantly prolonged with well-planned maintenance and partial replacements of production assets. Modular design and smart engineering enable using the same equipment for other purposes, making it possible to modernize production equipment and maximize their efficiency with the latest solutions, with only having to upgrade part of the machinery (Valmet, 2017).

Increasing the use utilisation rate by sharing

Related concepts with the circular economy are a sharing economy and collaborative consumption defined as the peer-to-peer-based activity of obtaining, giving, or sharing the access to goods and services, coordinated through community-based online services (Sundararajan, 2016; Albinsson & Perera, 2012; Botsman & Rogers, 2010). In manufacturing industry the benefits can be related to sharing of production capacity, resources, knowledge and logistic networks. As we look at micro companies sharing human resources might enable the flexibility and cost-efficient way for growth with motivated and committed people. Furthermore, sharing the logistic solutions with other companies might offer remarkable savings for example to small producers who often take their products by themselves to the retailers which is very time-consuming. As we look at the current news, such as “EquipmentShare, the Airbnb of construction, raises $26 million” (Kolodny, 2017) we see that B2B companies have already started to pursue new business models based on sharing economy ideology.

Case example – the Cargomatic app:
With the app, a company can reach a truck driver that has extra cargo space, to take care of both pre-arranged and on-demand pickups. The Southern California app has raised more than $10 million from investors.

The sharing platform model is centered on the sharing of products and assets that have a low ownership or use rate. With the model, companies can maximize the use of the products they sell, enhance productivity and value creation. Examples of the sharing economy abound, including transportation (Lyft, RelayRides, BlaBlaCar), lodging (Airbnb), and neighbors helping neighbors (TaskRabbit, NeighborGoods), among many others.

With IoT towards services in manufacturing

Digitalisation is boosting and accelerating the circular economy. Internet of Things (IoT) solutions are being used to track raw materials, products and equipment, optimise their utilisation rate and monitor their conditions. This is increasing the interest of companies in switching to services based on improved opportunities to gather data across product life cycles. Companies in possession of data and competencies to process it will be able to develop their own operations and discover new business opportunities. Various service platforms are connecting service producers with users.

Correspondingly, digital platforms are creating new business opportunities in inter-company operations for skilled combiners of data, but success requires openness of boundary resources.

IoT solutions will enable the smooth use of such services. Furthermore, data analytics, simulation and modelling will create new opportunities for, e.g., monitoring, preventive maintenance and optimisation throughout the value chain, as well as the evaluation of user needs and approval. Traditional operating models can therefore be disrupted on the basis of better and proactive understanding of service users.

In addition, the rapidly developing blockchain technology is creating cost-effective, global and secure solutions for payment, sharing, making contracts and the optimisation of resource use both between companies and consumers, which is helping to create new business models for the circular economy. (Antikainen et al., 2016)

Case example – Azure IoT Suite and Sandvik Coromant:
Sandvik Coromant has developed extensive know-how within tooling and the manufacturing industry. With digital solutions, Sandvik has been able to transfer the knowledge to the "digital manufacturing". In practice, this means the service model of Sandvik Coromant was developed with a predictive analytics solution that ties the elements of the supply chain and fabrication process together. The new tool collects all the information, such as machine data, tool data, sends it forward for real-time analysis to optimize the process, set up predictive maintenance schedules and set alarms so that machines can be taken offline before a failure occurs (Edson, 2016).

The opportunities of servitisation and digitalisation for the circular economy

In the 'product as a service' business model, customers use products through a lease or pay-for-use arrangement, in contrast to the conventional buy-to-own approach. This model is attractive for companies that have high operational costs and ability to manage maintenance of that service and recapture residual value at the end of life. Through services, broader ecosystems can be built through which both companies and consumers can be offered more comprehensive solutions. This way, the circular economy will be both global and local.

Servitisation and digitalisation will support circular economy concepts along the entire production and the product life cycle. Under the service model, the user will shift towards paying for the right to use, which will motivate the service provider and service user to jointly optimise resource use. The transition from product seller to service provider will require a change in company cultures, processes and business models. Process adjustment and a change in mind-set will also be needed on the buyer's side. A successful service model will create a closer collaboration relationship from which all parties benefit. In some sectors such as the car industry, leasing and rental agreements are already everyday occurrences, whereas they are only just emerging in other areas such as in the chemicals industry.

Case Example – Rolls Royce:
Rolls Royce has made the decision to go from manufacturing and selling engines to extending comprehensive maintenance services to the airlines that use its engines. The TotalCare Services employ a "power by the hour" model in which customers pay based on engine flying hours. Rolls-Royce is responsible for the reliability and maintenance of an engine, and utilises and analyses engine data for maintenance management and for maximizing the availability of aircraft (Microsoft, 2016).

***Case example – KONE*:**
KONE, a global leader in the elevator and escalator industry, bases its business model on a life cycle approach. KONE's R&D process seeks to optimize material use, avoid the use of hazardous substances, maximize material durability and recycled content, and minimize water consumption. 90 % of the materials used in elevators and escalators are metals that can be recycled at the end of the product life cycle.
KONE services over 1.1 million elevators and escalators, and maintenance and modernization are tailored to maximize equipment performance. Services are designed to help customers achieve their eco-efficiency goals in every phase of their buildings' life cycle. In 2016, the service business accounted for 45 % of KONE's revenue; maintenance accounted for 31 % and modernization for 14 % (KONE, 2016).

2.1.6 Energy (including Biomass and Bio-based Products)

Introduction

The combustion of fossil fuels increases the level of CO_2 in the atmosphere, which is directly associated with global heating. The adverse impact by greenhouse gas emissions on the environment along with declining petroleum reserves and future energy security have been realized as well. Therefore, there is renewed interest in the production and use of fuels originated from plant or organic waste for sustainable development of economy and society in an eco-friendly primary energy resource that can provide alternative transportation fuels in the short-term (Chandra et al., 2011).

Bioenergy will play an important part in the global energy composition in the next decades. Transitioning to a low-carbon energy economy while meeting increasing future energy demands will therefore require the rapid development of a large global bioenergy sector. At this level, all available sources of biomass, dedicated energy crops, harvest and process residues as well as organic waste materials, need to be exploited at a large scale (Beringer et al., 2011).

Globally traded biomass could add to energy security by reducing the dependency of oil, coal and gas imports from limited regions. Bioenergy could also create employment in struggling rural economies in the developed world and provide new income opportunities for farmers in the developing countries and thus help alleviate poverty. Private businesses have entered this developing market, anticipating large commercial potentials, scaling up their investments in biofuels and other processing technologies (WBGU, 2009; Beringer et al., 2011)

Sources of biomass

Different sources of biomass are available for energy production. Three main categories are residues from agriculture and forestry, organic waste, surplus forestry and energy crops. Dedicated energy crops are generally assumed to make up most of the total potential, although their large-scale cultivation is also one of the most controversial aspects of bioenergy. By contrast, residues and waste materials are considered to be more sustainable because they entail fewer direct impacts on land use (WBGU, 2009, Beringer et al., 2011). In addition to the agriculture and forestry residues, industrial by-products and residues are used as sources of energy e.g. in plants for heat and electricity production.

Differences between biofuels

Biofuel is energy made usually from plants. Bioethanol, biodiesel, and biogas are types of biofuels. Biofuels are considered renewable energies, emit less than fossil fuels, and have received increasing attention in the transition to a low-carbon economy (DeMates, 2013).

Biofuels may be classified under the categories of first or second generation biofuels. First generation biofuels are generally made from carbohydrates, lipids and oils or agro-industrial wastes using conventional technologies. Second generation biofuels are generally derived from lignocellulosic biomass including cellulosic plant biomass such as the stalks, stems and wood. Many second generation biofuels such as biohydrogen, biomethanol and mixed alcohols are under development (Ingale, 2014).

Recent analyses of energy crops have shown that current practices to convert food-product carbohydrates or plant oils into ethanol and biodiesel have only limited, if any capabilities to curb emissions. They also compete directly with food production for the most fertile lands. High hopes rest on the development of second-generation bioenergy technologies based on the conversion of lignocellulosic plant materials from fast growing tree and grass species. These energy crops, such as poplar, willow, Miscanthus and Panicum (switchgrass) are less dependent on favorable climatic and soil conditions and require fewer inputs of agrochemicals, thus reducing their direct competition with food production. Although technologies required to process cellulosic feedstocks into electricity, heat, biofuels or biomaterials are not yet commercially competitive, they are expected to mature within the next 10–20 years (Beringer et al., 2011).

Bioethanol

Bioethanol is the most well know biofuel and is an alcohol produced from corn, sorghum, potatoes, wheat, sugar cane, even cornstalks and vegetable waste. Bioethanol is alcohol that is produced during the fermentation of sugars. As in brewing, yeasts covert the sugars into alcohol, which is then distilled and purified before it is ready to use in the petrol tank (DeMates, 2013; Kotrbo, 2016). It is commonly blended with gasoline. However, plants grown specifically for any type of biofuel are not ideal due to the energy required, environmental impacts, and emissions associated with harvest and transport. Ethanol is a complicated issue, but overall is helping ease demand on fossil fuels (DeMates, 2013).

Biodiesel

Biodiesel is oil from plants or animals used as an alternative to or blended with petroleum diesel in automobiles and industrial fleets with diesel engines.Grease or oil from cooking can also be converted to biodiesel and is more sustainable because it is a by-product of another process (DeMates, 2013).Biodiesel is similar to fossil diesel. It is made by purifying and esterizing the oil. This involves removing glycerine to make the oil less viscous. Pure vegetable oil is so thick that it can only be used in specially adapted diesel engines (Kotrbo, 2016).

Diesel engines can automatically run off blends with 20% or less biodiesel. Using more than 20% biodiesel or vegetable oil from cooking requires some infrastructure adjustments. Local and regional recycling centers have also been working to make biodiesel more accessible, but challenges in scalability hold biodiesel back as well as concerns over food prices if using raw material. Alternative fuel vehicles such as hybrids and electric cars can alsopartly displace demand for biodiesel (DeMates, 2013), but not in trucks because of the high energy need.

Biogas

Biogas is created as a by-product of decomposing plant and animal waste in environments with low levels of oxygen. Biogas is made by fermenting organic material in an airtight container. Anaerobic bacteria break down the material, releasing methane (CH_4) and CO_2. Methane is the principal gas in biogas. Methane is also the main component in natural gas, a fossil fuel. Biogas can be used to replace natural gas in many applications including: cooking, heating, steam production, electrical

generation, vehicular fuel, and as a pipeline gas. With just a few engine modifications, LPG cars can run on compressed methane (DeMates, 2013, Kotrbo, 2016).

Until recently, the low cost of fossil fuels has hindered implementation of biogas production. There is a limited awareness of the potential and advantages of biogas production by citizens, government officials, and in the business sector that has limited interest in biogas production. More education, demonstration and investment in biogas technology would help overcome these barriers.

Biohydrogen

Biohydrogen is defined as hydrogen produced biologically, most commonly by algae, bacteria and archaea. Biohydrogen is a potential biofuel obtainable from both cultivation and from waste organic materials.Dark fermentation of organic biomass, i.e. agricultural residues, agro-industrial wastes and organic municipal waste is a promising technology for producing renewable biohydrogen. In spite of its potential, this technology needs further research and development to improve the biohydrogen yield by optimizing substrate utilization, microbial community enrichment and bioreactor operational parameters such as pH, temperature and H_2 partial pressure (Ghimire et al., 2015)

Biofuel production

Bioethanol

Bioethanol is widely produced on an industrial scale today. The available sources are plant biomass which is an abundant and which can be efficiently converted by microbes into biofuels. The pretreatment of lignocelluloses is known to be a key to the fast enzymatic hydrolysis of cellulose. In the past few years, a significant attention has been paid to the new sources of vegetable fibers, alternative to wood raw materials, for the pulp and paper applications and biocomposites (Ingale et al., 2014).

Biodiesel

The process to make *biodiesel* involves a chemical reaction. This means that the biodiesel industry is a chemical industry. Those involved in making biodiesel must have a good understanding of the underlying chemistry to ensure they are making quality fuel in a safe manner. Biodiesel is an alternative fuel for diesel engines that is produced by chemically reacting a vegetable oil or animal fat with an alcohol such as methanol or ethanol. In words, the reaction is:*Oil + alcohol → biodiesel + glycerin*

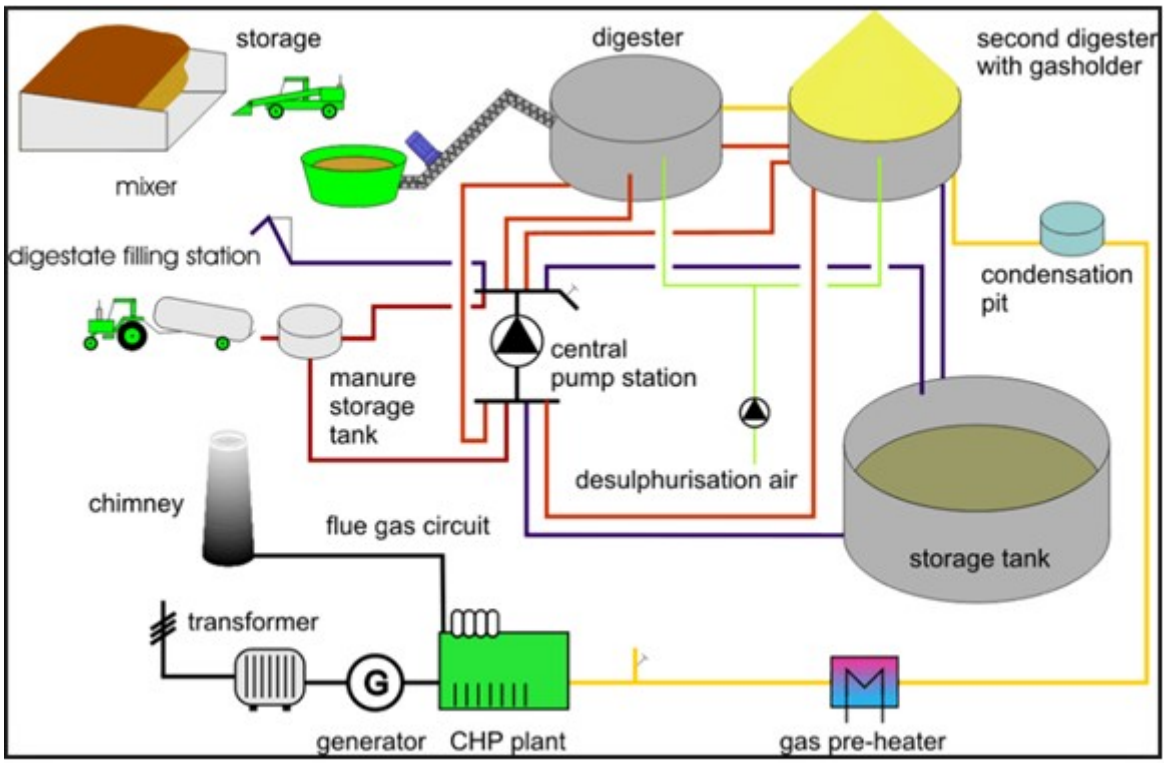
Biogas

In industrial biogas plants, industrial residues are used as a source of energy. Where possible, liquid manure from surrounding farms is delivered by trucks or pumped to the biogas plant. In order to reduce odor emissions, industrial residues are stored in closed containers or even within an enclosed hall. Depending on consistency, the substrates are pretreated, and where necessary impurities need to be removed. Powerful agitators in the mixing tank are essential for the subsequent homogenisation. If hygienisation is required, this is usually carried out at a temperature of 70° C. Subject to consistency, substrates are delivered into the digester by pump, mixed with liquid manure or process water or with a solid input device. Digesters in large plants are usually made of coated steel. Digester volumes vary, ranging from 500 m^3 up to several thousand m^3. The digesters are equipped with agitators for homogenisation. The biogas produced is collected in gas holders. These are usually constructed in the form of a double-membrane gas holder roof on the secondary digester and the digestate storage tanks. A large storage volume for biogas makes for greater gas

consumption flexibility[5].

Agricultural biogas plant

Agricultural biogas plants operated with liquid manure, dung, crop residues or energy crops. The spectrum ranges from simple biogas plants for using liquid manure to plants that are used exclusively for the digestion of energy crops. The liquid manure is collected in a pit near the digester and from there it is loaded intermittently by pump. Due to the mostly high water content of pure liquid manure, the energy yield is relatively small in relation to the digester volume. Adding other substrates therefore significantly increases the energy yield, and thus the efficiency. In agricultural biogas plants, crop or feed residues or specifically cultivated energy crops are used as substrates (Pfeifer and Obernberger, 2007).



Biogas plants are usually situated in rural or peripheral regions due to availability of raw materials and odor emissions. Because the transport of gas is expensive and difficult it limits the use of biogas. It is also difficult to utilize the thermal energy generated in the process. Therefore, the business profitability of biogas production depends on the amount of aid paid on different countries.

The stages of circular economy loop

Different sources of biomass are available for energy production: residues from agriculture and forestry, organic waste and industrial by-products and residues. Biofuels such as bioethanol, biodiesel, and biogas are produced from these biomasses. The digestate e.g from biogas production contains considerable amounts of nutrients and can be used as a fertilizer on agricultural fields and parks, which closes the circular economy loop.

2.1.7 Waste Water

Water management

There are great opportunities in using waste water as a resource; for irrigation and groundwater. Waste water management could provide an accessible and sustainable source of water, energy, nutrients and other materials fit for reuse.

The main documents regulating the rational use of water and in particular the use of waste water as a resource in Bulgaria are: the Water Act and the National Strategic Plan for Sludge Management from WWTPs. The basic principles set out in these documents are:

- Water Law: Reducing Water Pollution, Improving the Condition of Aquatic Ecosystems, Prevention of Pollution - polluter pays.
- National Strategic Plan for Sewage Sludge Management focusing on sludge recovery and sludge utilization;

Bulgaria generally shows a very low degree of compliance with the Urban Waste Water Treatment Directive (this also applies to the compliance rate of 11.6% and 11.2% for sewerage and secondary treatment respectively[6,7].

The Strategy for Development and Management of the Water Supply and Sanitation Sector (WSS) in the Republic of Bulgaria 2014 – 2023 is the main “roadmap” for the development of the water and sanitation sector till 2023. It updates and sets out for consideration by the Council of Ministers the main objectives and priorities for the WSS sector in the Republic of Bulgaria. It also gives proposals for the implementation and financing of policies to achieve targeted objectives within a ten-year horizon. The strategy integrates the findings of consultations and intermediate analyses, including a regulatory review, public expenditure review, and strategic financing plan, produced and discussed with stakeholders since September 2012. Considering that many WSS capital investments have a long life time, both the expenditure needs assessment and the strategic financing plan were prepared for a 25- year time horizon. This provides assurance that the measures proposed in the ten-year strategy are in fact compatible with a sustainable WSS sector in the long term.

Main outline of the Strategy for Development and Management of the Water Supply and Sanitation Sector in the Republic of Bulgaria 2014 - 2023 is that water supply services largely meet standards, but water losses are high and water supply systems maintenance is insufficient.

Coverage of the water-supply system in Bulgaria is very high, and drinking water quality typically meets standards. More than 5,000 towns and villages have central water-supply systems. This represents 99 percent of the overall population. Drinking water quality meets standards more than 95 percent of the time in all large water supply zones. Problems remain with regard to compliance with standards, especially in the smaller water-supply zones.

The forecasted investment needs to achieve full compliance with the Directive in Bulgaria amount of 2.969 million euros. A major policy task recognized by the government is to ensure adequate urban waste water treatment and to establish a water pricing policy covering a wide range of services in the water sector and is based on a measure of consumption that stimulates the efficient use of water.

Introduction to water and waste water in circular economy

Using the water and waste water in the circular economy aspect is to promote greater resource productivity aiming to reduce waste water and avoid pollution. The material flows are of two types: biological nutrients, designed to re-enter the biosphere safely and technical nutrients, which are designed to circulate at high quality in the production system without entering the biosphere as well as being restorative and regenerative by design. This is a contrast to the linear economy which is a 'take, make, dispose' model of production. So the purified wastewater can be used again, but as a

result of wastewater treatment are formed –sludge and wastes from coarse and fine screens; grease and grit removal; sludge dewatering etc[8].

The utilization of the sludge and wastes from WWTP's is often a challenge. The reuse of sludge is depending and limited from the content of hazardous substances such as heavy metals in the sludge. To prevent entry of hazardous substances in WWTP sludge it is very important to control industrial wastewater before discharge in sewerage network.

The water and waste water sector have the potential to save more than 80 million Euro/yearly in Bulgaria by implementing different measures to reach 20% reduction of NRW.

The sector's situation clearly justifies the need for a reliable financial plan for the short, mid and long term. The implementation of such a plan could only be ensured by carrying out deep reforms – a combination of measures and practices – which would result in specific amendments to the legislative and institutional framework and would enable the WWS operators to be direct beneficiaries of EU grants.

These would also improve the WSS operator's possibilities for co-funding capital investment, including investment in WSS infrastructure, which is a public state and public municipal property. Review of the current policy and legislation (organization) is needed in order to allow profit to remain in the companies and be used for re-investing, increased tariff revenues and developing the regulator's capacity.

The reform's leading principles are:

- Financial sustainability: providing sufficient and timely resources for the funding of the sector's investment plan.
- Efficiency: optimization policies and practices to achieve compliance and cost-effective achievement of the objectives.
- Affordability: resolving the issues related to tariff affordability through suitable social policies.
- Predictability: WSS operators and the water regulator working together to achieve the sector's main objectives.
- Transparency: publishing data about the condition of the WSS sector and a comparative analysis of the WSS operators' activity in order to encourage sustainable WSS practices.
- Competitiveness and economies of scale: consolidation of, and introducing benchmarking of, WSS operators to enhance efficiency and service quality.

Below several opportunities are categorised and assessments have been made of these opportunities:

Opportunity 1/ Save and reuse potable water and high-value recycling of components and materials. This opportunity may bring the following benefits:

1. Save new water resources and money for research and development of new water sources
2. Save operation and maintenance expenses to produce water, transport of water, purification of water, treatment of waste water and sludge
3. Healthy environment

Water companies can save water in other scales through reduction of NRW (non-revenue water), equivalent of "total water loss", margined between produced and supplied water; reduction of physical loses; reduction of leakages from water supply network etc. here the management of water companies is responsible and a pressure with the "public opinion" is possible.

Opportunity 2/ Utilization of Sludge from WWTP: Reuse and high-value recycling of components and

materials in sludge.

Benefits of implementing measures in that aspect:

1. Use of valuable materials contained in the sludge (for fertilization. Rich on N, P.); save money for fertilization;
2. Save O&M expenses for disposal in landfills;
3. Healthy environment
4. Return recovered bio resource to biosphere

Opportunity 3/ Using anaerobic digesters + CHP units (**C**ombined Heat and Power) = Production of power energy during wastewater and sludge treatment.

1. Save costs for power energy and for fuel for heating;
2. Sell excess energy
3. Increase effectiveness for using the methane for example selling power by top price periods.

Opportunity 3+/Using anaerobic digesters = Combined treatment of wastewater with other organic wastes with production of energy.

Benefits: Minimize expenses for separate treatment of waste and wastewater (Note: Legislation currently does not allow to treat waste und waste water together, because the financial rules for the two types of waste fall into two different regimes for funding.

Opportunity 4/Using of treated wastewater for recreation, fish- production, sport activities, tourism, restore health of ecosystem.

Opportunity 5/ Floodwater management; Storm-water management; (the precipitation has to be absorbed where it fell to the ground).

Benefits

1. Prevention of flooding damages;
2. Save construction cost for Storm water drain/sewerage;
3. Save Operation costs for treatment of storm water;
4. Save construction cost – the WWTP for separate sewerage (only domestic wastewater)

Different instruments for POLICY INTERVENTION could be applied in Bulgaria:

1. EDUCATION, INFORMATION and AWARENESS rising campaigns
2. COLLABORATION PLATFORMS – like Green Industrial Symbiosis programme
3. BUSINESS SUPPORT SCHEMES - to support innovation and new business models
4. PUBLIC PROCUREMENT and INFRASTRUCTURE - initiatives to support circular procurement practices
5. REGULATORY FRAMEWORKS - reduce NRW below 40%
6. FISCAL FRAMEWORKS

Existing critical situations and vicious circles.

Opportunity 1: Save potable water in households and public sectors by reduction of NRW and honest pricing of water. For the new constructed WWTP and sewerage systems, the funds for depreciation have to be enough to rebuild a new infrastructure after the end of life. An effective way for monitoring the depreciations from water companies is missing. Most of the water companies do

not increase the price of water services as planned during their application for financing.

Opportunity 2: Many WWTPs in the past years were rehabilitated or newly constructed with EU funding and mainly the projects have been implemented as a result of tenders and public procurement bids. But the disposal of WWTP's sludge is still a problem, which needs to be solved. On the paper all new WWTP have a Sludge Management Plan (SMP), but very often the SMP is unrealistic and the sludge is an unsolved problem. WWTP's sludge from big cities are polluted with heavy metals and cannot be used in agriculture. There are not enough landfills to dispose polluted sludge. The incineration of sludge is an option but it is expensive and not an environmentally friendly approach as well.

Opportunity 3: There are existing regulatory barriers to sell electric power produced from WWTP using CHP for small facilities. Electricity power sellers/distributors impose additional barriers for the smaller facilities. The expenses for separate treatment of wastes and wastewater could be optimized, but again legal regulations do not allow to combine treatment of wastes and wastewater.

Opportunity 4: Many WWTPs during the past years have been rehabilitated or newly constructed with EU funding. Mainly there is a usage of only "intensive methods for wastewater treatment and sanitation" and the "natural methods" as wet zones are excluded from the tenders. It is much more efficient for small towns and villages not to construct long sewerage systems and collectors and expensive WWTPs container types. In many cases the "Wet zones treatment plants" can be more suitable, because they have lower operation and maintenance costs, though a bigger area (construction site) is needed.

The rain water being streamed to soil absorption can be a more efficient solution instead of rain water being streamed to sewerage and combined sewerage system. The "Wet zones WWTPs" and absorption of Rain water into the soil are methods not included in the regulatory documents and difficult to be used in tenders and public procurement, thus being prevented from implementation.

2.1.8 Green Public Procurement

Introduction

This paper summarises the interventions implemented by the Welsh Government in relation to public sector procurement activities and resource/waste management to achieve better environmental, economic and social outcomes for Wales in the context of the circular economy approach.

The high level interventions past and present are listed along with opportunities identified to support the Welsh Government's objective of one planet living, contributions towards the well-being goals of the Well-being of Future Generations (Wales) Act 2015 and, more recently, emphasising the commitment to move towards a more circular economy for Wales. Policy interventions that are transferable across regions are also identified in this paper.

Background

Wales has had a waste plan in place since 2002, the latest iteration of the plan being Towards Zero Waste' published in 2010. This has been adopted by the Welsh Government's Cabinet Secretary for Environment and Rural Affairs as the current plan to deliver resource efficient outcomes through a more circular economy.

A circular economy is one where materials can be productively used again and again, creating added value and associated multiple benefits. More value should be placed on the resources often taken for granted, through reducing what we use, and wherever possible keeping materials and goods in use for longer. The approach moves away from the throwaway culture and encourages behaviours that will help protect our environment.

Recent studies by the Ellen MacArthur Foundation, WRAP and the Green Alliance have identified potential savings and income of more than £2 billion each year to the Welsh economy and up to 30,000 new jobs through the development of a more circular economy.

Wales' recycling rate has increased from just under 7% in 2002 to 64% in 2017 - the third best recycling nation in the world. The success seen in Wales is largely due to the clarity and direction of the national waste strategy for Wales, Towards Zero Waste.

The importance of public sector procurement

The public sector as a whole is a significant employer in Wales, and a major procurer of goods and services from private sector businesses and social enterprises. Annual Welsh public sector procurement expenditure amounts to approximately £5.5bn, representing over a third of the entire Welsh Government budget settlement from the UK Government.

Since the publication of 'Towards Zero Waste' (TZW) in 2010 and the Waste Prevention Programme in 2012 there has been a clear commitment by the Welsh Government to improve the efficacy of resource management practice in the public sector and also for the sector to lead by example through sustainable procurement activities. Procurement can play an important transformative role in helping to deliver circular economy outcomes for Wales, particularly in the public sector given its budget.

Public procurement can be resouce efficient generally by focussing on products procured directly, and those used in service contracts. There needs to be a hierachy checklist for resource effiency in procurement which could be along the lines of the folowing:

- Why buy this item, and why buy so much? Are there unused stocks already available in another part of the estate.
- Buy second hand/reused.
- Buy remanufactured
- Can the product be leased?

- If it has to be bought, consider (not in priority order):
    - Minimise/eliminate hazardous components in the product, and generated as hazardous waste in the production procress
    - Make sure the product has a long life/high durability, and is easily upgradeable, repairable (with a repair/dissassembly manual/inventory of parts/materials made compulsory – including for new buildings)
    - Buy with a high recycled content.
    - Buy products with the lowest carbon, water, material and land use footprints.
    - How to maximise the social impacts / community benefits?
    - How will it have to be disposed of? Wil, the supplier take it back for recycling or diposal

Interventions

- Plans and Programmes Towards Zero Waste – Waste Strategy for Wales

TZW recognised the important role of the public sector as a significant employer and its ability to influence procurement activity in relation to supply chains. TZW also identified the importance of leading by example through the promotion of sustainable consumption and production and by our aspirational 'one Wales: one planet' goal.

A key policy priority of TZW is to use public sector procurement to help to create a market for recyclate by buying products with a high reyccled content, ideally sourced from Wales.

- Adopting a behaviour change approach – using the 4 Es approach:

The Welsh Government has adopted an effective model for creating an approach to drive long term change, called the "4Es" approach. This is simply a way of working through the interventions which need to act together in order to catalyse change.

The 4Es approach is explained in the Sustainable Lifestyles Framework published by the UK Government's Department of Environment, Food and Rural Affairs (Defra, 2008). The Framework outlines a set of key behaviours that constitute a sustainable lifestyle, identifies best practice to influence behaviour and key insights on why some people act, all informed by a robust evidence base.

The 4Es approach is a series of interventions under the following four behaviour change categories:

- Encourage
- Exemplify
- Engage
- Enable

The section below identifies the 4Es approach adopted by the Welsh Government is respect of achieving greater resource efficiency through public procurement.

What we have done

Encouraging

The Welsh Government encourages the public sector to adopt waste prevention and resource efficiency measures in order to demonstrate public sector commitment to sustainability, and also to send a clear signal to the public sector workforce and its suppliers through exemplifying practices.

Specifically the Welsh Government encourages public bodies in Wales to achieve a sustainable approach with public sector procurement activities by ensuring that the power of Welsh public procurement drives cost effective sustainable outcomes in Welsh businesses in the supply chain, so that they develop more sustainable products and services, using resources more efficiently, including using higher recycled content (including compost in topsoil used in landscaping), and designed for reuse, ease of repair and ease of disassembly and recycling.

The Welsh Government also encourages the public sector to act as an exemplar in its working practices in relation to waste and resource efficiency management and in particular, in relation to its procurement activities.

Exemplifying - High level Governmental (Cabinet Secretary) commitment

There is clear leadership on the circular economy agenda by Welsh Ministers, for example the Minister for Environment and Rural Affairs published an oral statement on 14 June 2016 'Building on our recycling success for a Circular Economy'. In the statement the Minister made a commitment to

‘explore all necessary mechanisms, including legislation, to require a high content of recycled materials in products procured by the Welsh public sector.

In September 2017 the Wales Cabinet Secretary for Environment and Rural Affairs published a written statement on Extended Producer Responsibility which included a commitment to the circular economy approach whereby keeping materials and goods in use for longer. Moving away from the throw away culture and encourage behaviours which will help protect our environment.

In October 2017, the Cabinet Secretary led a government debate on the Circular Economy. She identified that achieving a more circular economy is a challenging task involving all parts of the supply and waste management chain. To help achieve this collaborative approach WRAP Cymru has set up a circular economy taskforce for Wales, involving representatives from manufacturers, retailers, Local Authorities and the waste industry. Their initial focus has been on plastics, where in Wales there is a significant number of diverse manufacturing companies producing moulded plastic products and components.

WRAP is working with stakeholders to produce a plastics route-map with the aim of creating a better market for recycled plastic in products made in Wales. This will help create jobs in Wales and reduce reliance on overseas markets for waste plastic. This work will include examining the plastic products procured by the public sector in Wales, and the scope to increase recycled content, possibly by requiring it in public sector contracts.

The Cabinet Secretary also emphasised the need for more circular economy business models to be developed in Wales. Through procurement activities, the Welsh Government and the public sector can lead by example by saving money as a result of sustainable product selection, waste prevention, reuse and recycling. The Welsh Government is working with public sector bodies to drive cost-effective, sustainable outcomes in Welsh businesses in the public sector supply chain, so they can develop more sustainable products and services, using resources more efficiently, including products using high recycled content, designed for reuse, ease of repair, disassembly and recycling.

Exemplifying - through use of procurement case studies

An excellent example of the power of public sector procurement can be seen in the case study[9] published by WRAP Cymru on the use of remanufactured furniture by Public Health Wales when they moved to a single central office in Cardiff. The bulk of the furniture used for the new office was either re-used and re-manufactured from existing furniture or sourced from elsewhere, many of these items, had they not been re-used, would have been destined for landfill.

In the refit, 1,143 individual items were re-used; these items were cleaned, repaired and reupholstered. A further 1,270 items were re-manufactured, which involved taking the long life elements of high quality used furniture (like metal frames), checking and resurfacing them, and rebuilding the rest of the item around them. Items reused or remanufactured included:

- Office chairs, canteen and meeting chairs
- Carpet tiles
- Office pedestals
- Desk high storage cabinets
- Sofas, white boards and coat stands.

In total, the project saved around 134 tonnes of C02e and 41 tonnes of waste has been diverted from landfill.

Encourage - Legislation Well-being Future Generations Wales Act 2015

The Well-being of Future Generations (Wales) Act 2015 (WFGA) strengthens existing governance arrangements for improving the well-being of Wales to ensure that present needs are met without compromising the ability of future generations to meet their own needs. It is about improving the social, economic, environmental and cultural well-being of Wales. The Act will ensure that public bodies in Wales carry out their activities in a sustainable way so that we can achieve a sustainable Wales, now and in the future.

To make sure that in Wales we are all working towards the same vision, the Act puts in place seven well-being goals. They are for *a prosperous; resilient; healthier; more equal and globally responsible Wales; with cohesive communities; a Wales of vibrant culture and thriving Welsh language*. The goals show the kind of Wales we want to see. Together they provide a shared vision for the public bodies listed in the Act to work towards.

All public sector procurement needs to comply with the WFGA requirements including to maximise the contribution to the well-being goals and the 5 ways of working. In particular 'A Prosperous Wales' requires the efficient use of resources.

Engaging

The Welsh public sector will seek collaboration through its supply chain to reduce waste arisings and achieve more sustainable business models. Opportunities are being explored to trial new circular economy approaches through Welsh Government public sector procurement initiatives such as 'Better Jobs, Closer to Home' and the Small Business Research Initiative (SBRI)[10].

Enabling through Delivery Partner funding

To help embed circular economy and sustainability into procurement policies and practice into public sector organisations, the Welsh Government has funded WRAP Cymru to deliver support programmes to help the sector rethink the way it procures goods and services, delivering a step change in its approach to waste and resource efficiency.

Components of the support programme to the public sector by WRAP Cymru includes:

- *Organisational Support:* Provision of consultancy support to individual public sector organisations and influential bodies such as the National Procurement Service to implement resource efficiency (materials & waste) activities.
- *Supportive Case Study Evidence:* Development of viable pilot projects (this includes looking at cost-effective decarbonisation initiatives and assessing the role of low carbon supply options, and exploring opportunities for procuring more recycled and/or reused materials). Publishing case studies to demonstrate best practice will enable these to act as exemplars for other public sector organisations.
- *Networking Events:* Organising events to showcase organisations that deliver services/ products that work towards meeting the needs of a circular economy and sustainable practices to provide inspiration/example to others.
- *Procurement Frameworks:* Development of frameworks that enable public sector organisations to identify and employ alternative procurement practices embedding principles of circular economy and sustainability.

Opportunities

The evaluation of the Wales Waste strategy is due to complete in the autumn of 2017 – the findings

from the evaluation along with consultation with stakeholders, shared learning from interregional partners and other administrations will help to inform the development of the updated strategy and new resource efficiency route map for Wales. The updated strategy will have an even stronger focus on circular economy principles and the opportunities for Wales to make a greater contribution towards the Well-being goals of the WFGA. Resource efficient practices including circular economy business models in public sector procurement will feature strongly in the route map.

2.1.9 Green Raw Materials

Introduction

This section describes how circular economy principles are vital for improving resilience in the supply of critical raw materials upon which the economy of most European countries and regions depend.

Why the concern about critical raw materials?

As stated by the European Commission, “raw materials are crucial to Europe’s economy and essential to maintaining and improving our quality of life. Securing reliable and unhindered access to certain raw materials is a growing [economic] concern within the EU and across the globe”[11]. These ‘critical raw materials’ (CRMs) are chemicals and/or materials that have both a high economic importance and a high risk associated with their supply, either in terms of cost or availability. Examples of CRMs include rare earth elements, cobalt and niobium. Many are used in the electronics industry and some are vital for renewable energy technologies, including batteries for electric motors.

It is generally accepted that physical scarcity in the Earth’s crust is not currently an issue for the majority of the materials considered ‘critical’. In some cases current reserve estimates are small but these recognised “reserves” only represent material resources that are currently economic and legal to extract; this does not mean that materials will actually run out. However, new mineral exploration and mining operations can take 10-20 years to develop, hence there can be a supply risk until these new sources are developed.

There is also the significant environmental impact of the mining and refining of CRMs to consider. In many cases very low grade ores are mined, with high amounts of waste and significant emissions associated with the refining. In addition, future extraction may occur from lower-grade and deeper deposits with potentially greater environmental impact.

The European Environment Agency’s 2014 report (EEA, 2014) on materials resources and waste identifies that the EU has the world's highest net imports of resources per person, and its open economy relies heavily on imported raw materials. In 2010 the share of imports in the EU-27’s consumption of metals ranges from 50 % for copper, 65 % for zinc and about 85 % for tin, bauxite and iron ores, to 100 % for a wide range of hi-tech metals. The EU is responsible for only 3% of world production of metallic mineralsand is almost wholly dependent on imports for the 14 materials labelled critical by the EC. The biggest share of reserves, and therefore worldwide production of those 14 materials comes from a limited number of countries of which China, Russia and Brazil are of particular significance.

Increases and large fluctuations in commodity prices are a major challenge for industries in the EU. International competition for access to materials has intensified due to increasing demand and, in some cases, the limited sources of supply of key materials. The 2008 EU Raw Materials Initiative and the 2011 EU Communication on tackling the challenges in commodity markets and on raw materials

sought to address these concerns. More recently, these issues were acknowledged in EUROPE 2020, the European strategy for smart, sustainable and inclusive growth, adopted in March 2010.

The UK Department of Environment, Food and Rural Affairs (Defra) 2010 report 'Review of the Future Resource Risks Faced by Business and an Assessment of Future Viability' identified that in the medium (5 – 20 years) to long term (20+ years) the overall trend in the UK is one of increasing resource demand. This will be due to population growth, increasing global economic development and the drive towards a low carbon economy. UK businesses were advised to plan for the future, including how to secure supplies, reduce use or reliance on particular resources or look at potential alternatives.

The UK's EEF (The Manufacturers' Organisation) has identified in a 2014 report that raw materials represent around 40 percent of manufacturers' costs in the UK[12]. They highlighted increasing raw material costs, price instability, and lack of security of supply of key materials as a threat to growth in manufacturing. The economy of a region such as Wales usually relies on inputs of raw materials, either directly in the manufacturing of components and/or final products, or in terms of imported products that are sold by retailers, and which are used in service industries.

A 2013 report[13] identified that CRM issues are potentially significant for Wales' Advanced Materials and Manufacturing Sector, and may also be significant for the Energy and Environment Sector and the Welsh Government's ambition to create a sustainable low-carbon economy, particularly if price rises occur in imported finished products such as wind turbines, solar PV cells, electric vehicles and energy efficient lighting (i.e. LEDs), due to the use of rare earths in their production.

The potential benefits of adopting the circular economy approach for critical raw materials

Since most CRMs are contained in electrical products, this is the area that needs the most focus in terms of ensuring resilience in how CRMs are used. The traditional 'linear economy' of 'take, make, use and lose' (to landfill or incineration) results in the loss of CRMs in electrical products from the economic cycle into landfill or incineration. Even a partial circular approach where end of life equipment waste is exported for recycling in a different part of the world is a concern given it results effectively in the loss of valuable CRMs, especially those contained in cars and electric and electronic appliances.

The EU's Raw Materials Initiative suggested reducing the EU's consumption of primary raw materials by increasing resource efficiency, improving eco-efficiency, the wider use of recycled materials, the prevention of leakage of valuable resources through exports of end-of-life products and increased use of renewable materials – all of which form part of a circular economy approach. Increasing product longevity, durability, ease of repair, remanufacture and disassembly and increasing reuse are also key options under a circular economy approach that will result in greater resilience in the use of CRMs.

Challenges

The eco-design of electrical products in terms of materials efficiency is not as progressed as eco-design in respect of energy efficiency. Using as little CRM as possible in products and designing products so that CRMs are in active 'live' use for as long as possible in a given product are part of the challenge that needs to be addressed. High demand for many CRMs is maintained because there are few or no substitutes currently available that will offer the same level of performance in a product for the same price. This is particularly true for rare earths such as neodymium used to make high power magnets for use in electric cars and wind turbines.

For many CRMs and the products that contain them, reuse and recycling operations are poorly

established in EU member states and regions, despite the best endeavours under the WEEE Directive. The recycling rate of rare earths in Europe for example is less than 1%[14]. The main barriers to recycling come from the dispersal of the materials, where very small quantities exist in large numbers of products, making concentration low and separation of the materials expensive. This is particularly the case for small electrical devices used by the general public that are discarded in the household waste stream. WRAP research has shown that nearly 40% of electrical products in the UK go to landfill when they are disposed of.

Every year in Europe, around 9 million tonnes of WEEE and 7-8M tonnes of ELVs are generated, and over 1 million tonnes batteries are sold. These products are a rich source of secondary critical raw materials (CRMs) in the urban mine. For example, 99% of world Gallium consumption is in integrated circuits and optoelectronic devices, 74% of Indium in flat panel displays and 27% of cobalt in rechargeable batteries.

Currently, CRM 'rich' waste streams are insufficient partly due to the fact that many products that use critical materials are relatively new and still in use. There is also a lack of information on the amounts of CRMs present in components and products produced in or entering the UK and Wales. Until now, the data on CRMs has been produced by a variety of institutions including government agencies, universities, NGOs and industry and lies scattered in different databases, formats and reports which is difficult to compare or aggregate.

The current approaches to extracting CRMs from WEEE need to be improved. There is too much reliance on a mixed WEEE shredding approach, often carried out outside of the EU, with potential environmental harm. It also involves the economic loss of the CRMs from the EU. New approaches are needed to extract the CRMs within the EU.

Opportunities

For countries and nations/regions such as the UK and Wales that have very little mining or refining capabilities for CRMs, policies aimed at improving resource efficiency of, improving recovery rates of and the development of substitutes for CRMs are important. Resource efficiency measures such as reducing usage of materials are commonly cited by studies as an opportunity for businesses to reduce costs and environmental impacts.

By reducing material usage through eco-design, eco-innovation or similar actions, businesses can also reduce their exposure to material risk, potentially leading to unrealised financial and environmental benefits. Opportunities may also exist for collaboration between industry and academia in the development of new or improved recycling and recovery processes with the aim of extracting critical materials from waste, as well as initiatives aimed at the development of direct substitutes for critical materials, or the eco-design of new products that are less reliant on critical materials.

In the long term, the most effective strategies to deal with uncertain supply from key primary supply countries are to look for alternative supply chains and to reduce the need for critical materials in renewable technologies[15]. The EU is promoting research (e.g. Replacement and Original Magnet Engineering Options (ROMEO), Suprapower project, INNWIND.EU and EcoSwing to develop renewable-energy technologies that do not depend on critical raw materials.

Recycling of waste products containing CRMs is one way to mitigate against supply risks for these materials. Recycling is currently more promising for indium and gallium than for tellurium and is currently not feasible for neodymium and dysprosium. There is already some good practice guidance available, for example the 2014 WRAP report - 'Techniques for Recovering Printed Circuit Boards (PCBs)'[16]. WRAP has also published the results of five case studies of waste electrical and electronic

equipment (WEEE) collection trials[17]. These tested options to increase the collection of WEEE for re-use and gain maximum value from it.

Some examples of work currently underway

Critical Raw Material Closed Loop Recovery

There is a €2.1 million EU LIFE funded Critical Raw Material Closed Loop Recovery ('CRM Recovery') project to map out effective recovery of raw materials from electrical products involving a partnership of WRAP, the UK Knowledge Transfer Network (KTN), Wuppertal Institute, ERP UK Ltd, and EARN[18]. The project is exploring new and commercial opportunities for harvesting critical raw materials and precious metals including gold, silver and platinum group metals, from everyday unwanted electronic products and is believed to be the first-of-its-kind to link collection methods with recovery success. (See www.criticalrawmaterialrecovery.eu)

Over the course of the three and a half year project, the CRM Recovery project aims to increase the recovery of a range of CRMs by 5% from products such as consumer electronics, ICT equipment and small household appliances. The project will link collection methods, such as kerbside collections, retailer take-back schemes or postal returns, to how the material components of these products can be efficiently dismantled, recovered and returned to the market. This will present environmental benefits by keeping materials in the loop for longer, and by demonstrating the potential to economically recover these materials from Waste Electrical and Electronic Equipment (WEEE). Findings will be fed back to the European Commission in the form of policy recommendations and proposals for infrastructure development for the cost effective recovery of these precious and critical raw materials. Four countries are participating – UK, Germany, Italy and Czech Republic, with each country representing varying maturity stages of recovery development, allowing cross-comparison so that a European-wide framework can be developed.

Wales based electronics recycler E3 Recycling is a partner in one of the UK trials in the CRM Recovery project. Non-reusable electrical items collected from in-store collection trials in British Heart Foundation and Dixons stores across Greater Manchester are sent to E3 Recycling for dismantling. Data has been collected from this activity that will feed into the evaluation of the trials and this evidence will allow a greater understanding of the considerations required for dismantling as part of any CRM recovery solution.

ProSUM

The ProSUM project[19], funded by the European Union (€3.051m) and the Swiss Government (€0.63m), will deliver the First Urban Mine Knowledge Data Platform, a centralised database of all available data and information on arisings, stocks, flows and treatment of WEEE, ELVs, batteries and mining wastes. The availability of primary and secondary raw materials data, easily accessible in one platform, will provide the foundation for improving Europe's position on raw material supply, with the ability to accommodate more wastes and resources in future. ProSUM will provide data for improving the management of these wastes and enhancing the resource efficiency of collection, treatment and recycling. The project includes the development of a centralised database of all available data and information on arisings, stocks, flows and treatment of waste electrical and electronic equipment (WEEE), end-of-life vehicles (ELVs), batteries and mining wastes.

Recommendations/actions

It is important to regularly review the 'criticality' of the CRMs. Many materials now considered critical may be in relatively plentiful supply in the near future due to the discovery of new reserves or the

development of substitutes. A course of action needs to be carefully planned and implemented that is appropriate for each country and region. The Commission is committed to updating the CRM list every 3 years. So far this has been 2011 (14 CRMs) and 2014 (20 CRMs).

More work is needed to reduce the use of CRMs in products, and ensure greater durability/longevity of products containing CRMs. New business models need developing to move towards servitisation whereby more products contained CRMs are leased rather than sold/bought, enabling the manufacturer/retailer to retain ownership of the CRMs.

A better understanding is needed of products rich in CRMs and how these can be accessed at end of life – hopefully utilising the results of the ProSUM project identified above. The ability to disassemble WEEE to extract CRM rich components may require the production of disassembly manuals – potentially increasing opportunities for robotics to play a part in extracting CRM components, eg. from circuit boards. Designing cost effective systems for CRM rich waste products (especially small WEEE) that make it economically viable to collect, extract, refine and reuse the CRMs within EU members states needs addressing.

Policy focus

Potential policy options for members states/regions to ensure greater resilience in CRMs include:

- Consideration of full extended producer responsibility for CRM rich products - including differentiated charges/taxes, take back etc.
- Introduce legislation to ensure that small WEEE is collected separately and not sent to EfW or landfill.
- Provide support and advice to businesses (manufacturers and retailers), especially with an innovation focus.
- Provide funding support for new infrastructure for preparation for reuse, reuse and recycling of CRM rich waste materials.
- Fund research into innovation (including eco-design) to support businesses, including a strong focus on innovation for material substitution to reduce the reliance on and use of CRMs.

Conclusions

The challenge of CRMs can be addressed through applying circular economy principles ensuring a strong focus on reducing the use of CRMs, and then focussing first on the ‘inner’ circles of the circular economy such as increasing longevity, reuse and remanufacture. The ‘outer’ recycling circle is important, but remains a significant challenge that needs addressing.

2.2 Barriers of Implementation

As CESME project addresses SME inclusion in the circular economy, an overview of the barriers for the implementation of circular economy mechanisms seemed necessary. On the basis of the debates risen from project meetings and from Local support groups activities, 4 main barriers have been identified:

1. Regulations and bureaucracy
2. Lack of economic resources
3. Lack of culture and knowledge
4. Lack of collaboration

Regulations and bureaucracy

These are considered the main obstacle from business, institutions and the research sector. Companies pointed out how regulations are often too unclear and inhomogeneous; regulations are too difficult to understand and to apply, in particular legislation on waste and by-products. It even lacks an adequate control over their observance. Same critics came also from institutions, especially about inconsistency and fragmentation at different territorial levels. Bureaucracy can be considered as a consequence of the legislative framework: bureaucracy makes processes much slower (thus, more expensive) and more confusing.

The lack of economic resources

The economic issue is a real obstacle to the development and realization of projects. R&D, industrial scale-up and innovation of processes and products require financings that are hard to get (i.e. difficult access to loans). Moreover, investments on technology have long payback times, making them financially unsustainable for SMEs and therefore in competition with other projects with a more immediate return on investments. Another economic issue is the fall in prices of raw materials that undermines the market of secondary raw materials and in general the whole recovery industry.

The lack of culture and knowledge

This is one of the main obstacle to circular economy since it makes even its concept hard to understand. Companies point out a lack of competence and knowledge from the public administration on topics that should be often updated, public procedures are indeed considered too rigid and out of date. The little awareness on this topic and the little knowledge of its benefits are given by a bad communication which causes a stiffness of implementation, of change and of development of new visions. People’s perception and awareness is also of greatest importance for they must understand the benefits in order to change their consumption habits thus helping the development of green products markets.

The lack of collaboration

Companies need to collaborate and to create networks and agreements in order to guarantee an efficient flow of material and its exchange. The lack of collaboration comes from a lack of mutual knowledge and this makes the identification of potential partners (as well as, for instance, authorized plants to receive certain types of waste) quite difficult. Another factor that undermines collaboration is data protection and industrial secrecy: intellectual property is seen as a barrier for sharing information. The same problem can rise if different companies compete on the same final product: in that case collaboration becomes more and more difficult. In order to have a first, quick glance over the identified barriers, every partner of CESME project has evaluated their relevance within their region, using the following value system (from 0 to 2):

0 = in my region, this issue does not represent an obstacle to a transition towards circular economy

1= this is a critical issue also in my region, however we have found solutions to successfully overcome it

2 = this is a real obstacle to the transition towards circular economy in my country, it has never been overcome yet

	0 Absent	**1** Present but not critical	**2** Present and critical
BULGARY			
Regulations and bureaucracy			x
Lack of economic resources			x
Lack of culture and knowledge		x	
Lack of collaboration		x	
DANEMARK			
Regulations and bureaucracy		x	
Lack of economic resources			x
Lack of culture and knowledge		x	
Lack of collaboration			x
FINLAND			
Regulations and bureaucracy		x	
Lack of economic resources			x
Lack of culture and knowledge			x
Lack of collaboration		x	
GREECE			
Regulations and bureaucracy			x
Lack of economic resources			x
Lack of culture and knowledge			x
Lack of collaboration	x		
ITALY			
Regulations and bureaucracy			x
Lack of economic resources			x
Lack of culture and knowledge			x
Lack of collaboration			x
WALES			
Regulations and bureaucracy			x
Lack of economic resources			x
Lack of culture and knowledge			x
Lack of collaboration			x

Barriers description

In the following paragraphs, every country/region participating in CESME has provided examples of critical situations related to some of the obstacles that they have rated 1 or 2, in order to get a deeper understanding of the local mechanisms (in some cases, related to specific economic sectors)

and for a better comparison among different countries/regions.

Bulgaria

Regulations and bureaucracy: From a policy perspective, Bulgaria's legal system as a whole does not currently create a unified platform for promoting the circular economy. The fragmented regulation systems are often challenged by such leads. For example, some of Bulgaria's current tax regulations discourage enterprises and the public from reusing or recycling resources. In many cases the primary raw materials are so cheap that industries prefer to purchase virgin raw materials rather than recycled alternatives that sometimes require additional, sometimes costly, processing. Such a reality does not provide an economic incentive for companies to purchase secondary raw materials. It might be that relevant tax reductions or measures stimulating the use of recycled materials in certain productions could provide an improvement in this aspect.

The lack of incentives to separate waste collection as well as the lack of sanctions doesn't contribute to the circular economy. There is space for improving the recycling rates. In addition, the enforcement of environmental regulations is not very efficient due to lack of qualified personnel and budget to monitor and control the ones avoiding the laws enforced so far. Public procurement procedures do not help very much either e.g. in light of green public procurement as well as lack of capacity of the companies to bid for such tenders if any.

Lack of economic resources Without the application of state-of-the-art technologies, it is unlikely that enterprises will be able to improve their eco-efficiency and reduce their negative environmental impact, becoming part of the circular economy concept. Demand for environmentally friendly technologies is still weak, and both technical capabilities and financial resources are inadequate for most of the Bulgarian enterprises, although it should be admitted that the number of successfully implemented technologies is increasing. The lack of support from supply and demand doesn't facilitate the economic conditions of the value chain. There is lack of appropriate training and financial resources to overcome these gaps. Small companies usually don't have the capacity to improve technology and the big companies often lack incentives. Lack of finance in many cases refer to lack of initial capital, lack of financial opportunities or other adequate alternatives. Nevertheless many start-ups are looking into environmental innovations raising funds through alternative sources and try to compete on the international markets.

Lack of culture and knowledge. In particular, when developing the circular economy, knowledge is needed for effective planning and management, including the creation of scenarios for optimal reduction, reuse and recycling. Every corporate enterprise, from a small business to a large multinational corporation, is part of a larger system. Companies are interlinked via increasingly complex supply chains. Therefore, an information system spreading the knowledge about possibilities for circular economy is required if decision-makers are to find more environmentally and financially beneficial ways to plan and manage their resources. In most cases, accurate information is not available to decision-makers, or is not conveyed in a timely manner. The corporate culture in many companies is still not focusing on environmental performance which does not support establishing a mindset among the employees that supports the process.

Public participation is very important for implementing a circular economy, due to both the complex nature of the concept. Full support of all stakeholders (i.e. industrial managers, government officials, staff of research institutions and financial organisations) is needed. Without a broad public involvement, it will be difficult to coordinate contributions towards the circular economy. Currently, Bulgaria has to increase the administrative, human and institutional capacities to encourage public participation in a circular economy. Some governmental and municipal officials lack an understanding of environmental principles. Also, awareness-raising activities related to the circular economy concept

(including TV promotions, newsletters and workshops) should be carried out periodically in order to build awareness, since such initiatives can provide the basis for debates and exchange of experiences from lessons learned. These activities could create opportunities for stakeholders to strengthen their mutual understanding and trust, which could be a sound foundation for further collaboration on promoting the circular economy concept.

Lack of collaboration The major obstacle to a better collaboration is the lack of appropriate information. Again the lack of information results in less efficient collaboration. There is no well-organized data platform recording available secondary raw materials and resources, repaired products, etc. to potential buyers and sellers. Moreover, due to fragmented management frameworks, different kinds of information often belong to different agencies. For example, environmental protection agencies maintain control over emissions data while economic development agencies usually collect and control data related to economic performance. Often such agencies do not interact with each other and cross-agency collaboration is still rare, with the result that none of them can play a leading role nor collaborate in providing such information to the corporate world.

Greece

Regulations and bureaucracy: on the administrative side, it is an often repeated complaint that Greece's complex bureaucratic stipulations (despite the progress achieved in the last years) dissuade if they do not prevent actors and investors from developing eco-innovations. Moreover, the regulatory framework changes frequently, thus limiting the ability of involved actors to plan and organize investments.

Until April 2016, all directives related to Circular Economy have been typically implemented in Greece, however it is indicative that no directive was implemented within the required deadline. Delays in some cases exceeded the period of one or two years following the implementation deadline. Actual implementation seems to have been delayed even more, until the required derivative legislative acts have been issued. And finally there is a lack of law enforcement, absence of sufficient audit mechanisms and subsequent delays in the imposition of administrative fines.

Lack of economic resources: an issue that needs to be mentioned has to do with the impact of economic crisis, since 2010 and the imposition of capital controls that have been imposed since July 2015 in Greece. In the context of the resulting economic volatility, this affected the private and public investments as well as the finance initiatives from banks to the private sector. The only money available comes from the EU structural and cohesion funds. As regards the EU structural and cohesion funds for the programming period 2014-2020, Greece has foreseen the allocation of significant amounts for waste management projects.

However, by the time of the Operational Programs the country had not fulfilled the relevant ex-ante conditionality. Although the new national Waste Management Plan and a Waste Prevention Program are in force in line with the requirements of the Waste Framework Directive, there is a need to prioritize the Circular Economy and formulate clear links with the financial instruments available in Greece.

Lack of culture and knowledge: social barriers towards eco-innovation remain, mostly related to public attitudes and ignorance of the benefits of innovation (especially in the area of energy efficiency in the built environment). There is a lack of programs aiming at changing current linear consumer habits, and understanding the value of circular products and business models might require education, take back schemes, consumer incentives, pricing policies, labelling of products and other.

In the early stages of the transition to a Circular Economy and until its core principles and benefits

have started to become clearer to the public, it would be beneficial to focus on raising the awareness on more established ideas like environmental benefits and cost savings, rather than the concept of the Circular Economy per se. Furthermore, the local society appears to be hesitant about the quality and the way of use and sometimes this fear is well founded (first application, potential failure of environmental control).

Lack of collaboration: there is a lack of systematic approach to the Circular Economy, including cross-sector collaboration, which is imperative in order for the applied circular models to reach their potential.

Italy

Regulations and bureaucracy. In Italy a slow and complex bureaucracy is widely considered as an obstacle to development and competitiveness in general, therefore an obstacle also for the innovation needed for the transition toward a circular economy. On the basis of a review from the association of foreign banks in Italy (AIBE, 2014), 58% of foreign investors point out that legislative and bureaucratic burdens undermine the attractiveness of the country and 41% highlight the uncertainty of the legislative framework.

Three issues can be considered as the main obstacles: the complexity of procedures; the overlapping of different legislations; the long time needed to get authorizations and licenses. These issues lead to an economic burden too, not only because of the direct costs (taxes, stamp duties, fares,…) but also because of the human resources needed: Italian small and micro enterprises are estimated to use more than 30 man-days/year for bureaucratic requirements (Report PROMO PA, 2013).

Even the regional structural funds calls (that represent a good opportunity to get financial support for investments) are considered from companies too complex from the bureaucratic point of view (for the submission but even more for the reporting phase); this complexity represents a highly discouraging factor for those SMEs needing a financial support.

Lack of culture and knowledge. This barrier is seen from companies at different levels:

- companies complain for the lack of knowledge of public administrators on fast growing topics (such as green technologies), which would need permanent training; therefore, the administrative procedures seem often anachronistic if compared to best available technologies and the state-of-the-art innovation;
- companies point out that a higher knowledge and awareness is needed also within suppliers; without the involvement of the suppliers, it would be difficult to set up a sustainable value chain;
- the perception of citizens could also be an obstacle: if they don’t know the technology and are not fully aware of impacts and benefits, they can oppose to the realization of new plants. For example, one of the most contested type of plant in Italy is the biomass plant. On the other hand, citizens may have a positive impact on green companies activities: public environmental awareness leads to a more sustainable consumption and a higher demand for green products.

Denmark

Lack of culture and knowledge: The social factor barriers of capabilities and skills and custom and habit are widespread, as the behavioural changes needed to realise many of the opportunities go against ingrained patterns of behaviour and skill-set on the part of consumers and businesses. Imperfect information is also a barrier: businesses is often unaware of potentially profitable new opportunities, or the information necessary to realise them is unevenly distributed.

Technology can be a critical barrier as well, especially for the more technology-dependent opportunities such as cascading bio-refineries, 3D printing of building components and bio-based packaging.

Lack of collaboration: The key barriers include unintended consequences of existing regulations (e.g. definitions of waste that hinder trade and transport of products for remanufacturing), social factors such as lack of experience among companies and policy makers to detect and capture circular economy opportunities, and market failures such as imperfect information (e.g. for businesses to repair, disassemble and remanufacture products) and unaccounted, negative externalities (e.g. carbon emissions). In addition to creating enabling conditions, policy makers can, as appropriate, set direction for a transition to circular economy.

The barrier of unintended consequences from existing legislation limiting circular economy opportunities is present for example in bio-refining where food safety regulations prevent the use of certain certain animal products as feedstock. Such barriers can be in the complexity and cost adhering to regulations as well as in actual prohibition of certain activities.

As businesses are already starting the transition, the circular economy offers an opportunity for policy makers to collaborate with businesses. In Denmark there is a need for cooperation between different government departments (including business/industry, finance and environment) so that no new unintended policy barriers are created and – like the business solution – the policy response is designed to maximise system effectiveness. Other society stakeholders, including citizens and consumers, labour unions, environmental organisations and the scientific and educational community should also be engaged.

Finland

Lack of economic resources. Companies in South Ostrobothnia are very small in size. It is estimated that about 98% of all companies are micro-companies employing less than 10 people. In small-sized companies the material flows are usually small too. In addition to this, companies are widely spread throughout the area, and sometimes in challenging locations. This means that the transportation costs for small amounts of material flows might rise too much and be unprofitable. This doesn’t encourage small companies to seek solutions for their by-products (at least in collaborative way) and would probably need more incentives from the public sector.

Small size often means small resources both in time and money. If the circular economy solutions demand big investments, most of the companies don’t have the financial capacity to make them. In small companies there is also less knowledge.

Lack of culture and knowledge. Circular economy is not a completely familiar concept within all the companies and the general public. It is a broad concept that are often misunderstood or simplified in to recycling. The attitude towards recycled materials should also be improved. Consumers are being more and more conscious in their choices so the companies might follow them. These sceptic attitudes lead to the fact that there are not that many companies that use recycled materials yet. The market is still too small. The sceptic or ignorant attitudes towards circular economy are relevant especially in the Finnish building habits, when building the new instead of renovating and repairing the old ones is highly preferred. When considering the smallest companies the lack of technological knowledge is also relevant.

Lack of collaboration. The lack of collaboration is present in South Ostrobothnia. There are probably various reasons for this, varying from business to business and industry to industry. In some areas such as food production, there is a high competition that makes the collaboration and sharing of good

practices between competing companies very difficult. Long distances between the companies might also affect to the lack of collaboration. There are not that many good examples of collaboration networks that are built on the logic of circular economy.

United Kingdom (Wales)

Lack of culture and knowledge.

1.Potential ambiguity: circular economy seen as a cost. Traditional perspectives such as the 'polluter pays' principle may be considered to have contributed to an antagonistic relationship between businesses and environmental lobbies. The externalities such as pollution that companies all around the world produce have led policymakers to impose disincentives (e.g. taxes) in order to compensate society for damage to environment and health. Waste products are viewed as a burden, for society which must dispose of them when they are no longer required, and for business which must pay financially for them to be treated.

Thus the scene is set for a standoff between the 'money makers' and the 'planet savers', and when government or another body sees fit to introduce 'green' or 'eco' framed initiatives for businesses, the common perception is that these are costly programmes to mitigate negative impacts or token measures that don't take the reality of business into account.

The circular economy invites a new vision, based on a unified systems perspective: just as growth is the only common attribute of life, so growth is vital to a living and functioning society. In closely mirroring natural systems, the circular economy presents waste as a resource or a 'food' rather than a burden, and as such something to be valued and maintained at the highest possible quality, rather than disposed of at the lowest possible cost.

The understanding and assimilation of this circular economy vision at government and business levels is vital, since this directs the communication and implementation that follows. It is therefore crucially important that key decision makers understand the relative costs and benefits of innovative approaches and so they can then provide the necessary support and encouragement for their operational staff.

2. Danger of polarising language and framing – from the research (Ellen MacArthur Foundation /Wrap Wales report) it is reported that several interviewees stressed the fact that terms such as 'green', 'eco' or 'sustainable' have a tendency to exacerbate existing divisions by playing into the assumptions of many business leaders that any initiatives that are environmentally beneficial are automatically deleterious to business. Thus policies such as 'green 'growth' and 'sustainable development', whilst trying to promote a positive message, may unwittingly be inviting the cynicism of the status quo.

Centred on economic activity and on opportunity, the circular economy framework goes beyond traditional "end of pipe" solutions and the inevitable tension they create when presented to companies. Rather than offering more schemes and more efficient ways to "clean up", the circular model embodies a system redesign based on generating positive outcomes from the outset.

The framing and dissemination of circular economy at a localised level can prove a further barrier: in several instances, both business and policymaker interviewees reverted to a discussion of 'recycling', which ultimately negates the increased value brought by circular economy practices such as reuse, repair, remanufacturing and pure materials flows, and implies a cost to business which managers may equate to dumping, or landfilling.

The lack of clarity in language used around recycling and the waste hierarchy exacerbates this

problem, leading to poor understanding and valorisation of resource flows. For example, although Wales's major waste policy document describes 'high levels of clean, high quality, source-separated recyclates' and the 'right kind of recycling', it is the target of 70% 'recycling' that stakeholders and local authorities recognise and work towards; the alternative here is to capitalise on the greater opportunities for reuse and longer cycling.

The confusion that exists around the EU's Waste Framework Directive and the conflation of reuse with preparation for reuse and recycling also exemplifies this issue, and it is likely that by classifying reusable materials as waste, policy has contributed to the lack of uptake of reuse over recycling. The classification of hazardous waste materials, moreover, can prove a barrier to industrial symbiosis activities for certain companies.

For example, it affects the speciality chemicals manufacturer Dow Corning (Wales) in that businesses which could otherwise be interested in using its silica waste streams are put off by the 'hazardous' label and neither party releases the potential valorisation. Of course, such labels have been applied by the regulator for good reason, but there may be cases in which better coordination of the intentions of both parties is useful.

Lack of collaboration. Inconsistency of approach it is evident from speaking to a number of stakeholders that differences in understanding and motivation within an organisation can contribute to fragmentation and ineffectual action. The two core sustainable development principles of policymaking in Wales are Involvement and Integration, an approach that 'makes the connections between, and effectively integrates economic, social and environmental challenges'.

It appears that there is an opportunity for increased collaboration among and between government departments – for instance Economy, Science and Transport and Natural Resources and Food (Welsh Government). The importance of replacing 'silo' mentalities, which focus almost exclusively on given targets and lack practical recognition of the interrelated nature of environment, economy and society, with 'systems' thinking as a tool for circular economy is very apparent here.

Several businesses place huge importance on the coordination and consistency of Local Authority collections, and government insiders acknowledge this as an area for improvement. Separate materials streams and effective reverse logistics are a key aspect of a circular economy, and the Welsh Government's Collaborative Change Programme provides support to local authorities looking to provide higher quality recycling services. However, consensus between local and central government is yet to be reached, particularly with regards to the desirability of a 'one size fits all' approach, whether kerbside separation or comingled recycling should be instigated and who should bear the related costs.

Price differentials play a significant part here, and according to a spoke person of the 'Welsh Local Government Association', waste reprocessors sometimes offer local authorities similar prices for certain mixed and separated waste materials (e.g. clear and coloured glass), which then makes it hard for the authorities to justify the additional costs of separation. Some businesses also suggest that reuse credits should be paid consistently by Local Authorities in Wales, and at a higher price than recycling credits – thereby incentivising reuse as of higher value than recycling.

Varying motivations between business, government, or the regulator also make for differences in interpretation and implementation of the same legislation, in some cases leading to potential waste of resource. In some cases where the letter of the law may conflict with the spirit it is vital that a whole-systems perspective is taken by businesses and regulators alike.

1. Business as Usual lock-in **-**In order to reap the benefits of a circular economy, companies will need

to innovate and collaborate along supply chains, apportioning the rewards of innovative product redesign or takeback systems. However, some businesses are anxious about collaborating when for so many years they have acted on a competitive instinct alone. Barriers around competition legislation mean that organisations have to be careful with the manner of collaboration and the information that they disclose, and for some this is a disincentive to circular innovation.

The remit of sales and marketing teams is traditionally to increase the number of units sold as a means to grow the business, but this approach fails to take into account the opportunities for growth and valorisation through repair and remanufacturing of existing materials. At a purchasing level, 'business as usual' practices support the custom of over-buying and then disposing of unwanted items, for instance in the clothing industry. This creates needless waste as superfluous stock clogs up the system, bringing down prices to levels that fail to reflect costs of production and discouraging reuse.

Bias towards the status quo is a key challenge for transition to circular economy, and when businesses are struggling to stay afloat in a difficult economic climate there is inevitably a reluctance to risk bold innovations that are perceived as risky to the bottom line, compared with more traditional approaches.

2.Limited take up of public procurement drivers -Following the work of the UK Sustainable Procurement Task Force in 2005 Welsh Government, with the assistance of the Environment Agency Wales developed the Sustainability Risk Assessment (SRA), to promote consideration of life cycle thinking in contract planning. The SRAs encourage consideration of the potential economic, social and environmental impacts linked to specific procurements.

For example in the last all-Wales Print Framework awarded by Welsh Government, the opportunity to move to vegetable based inks and dyes was identified which were less environmentally hazardous and consequently also less costly for contractors to use, manage and dispose of. The collaborative approach to procurement not only saved 25% but also enabled the move to vegetable dye to be made across all the print work procured.

The SRA templates also prompt consideration of options such as reused or leased products, and take-back options. In a survey of SRA usage undertaken by Value Wales in 2012, 85% of respondents confirmed that the SRAs are specified in their organisations procurement strategy and or, policy documentation or in procurement desk instruction or standing orders. However, only 49% of respondents stated that in their experience the SRAs were widely used.

Existing critical situations and vicious circles

Starting from the categories of obstacles examined above, every region reports one case of "failure" considered as the most characteristic, at local level, or some kind of dynamic that happens regularly.

Bulgaria

Regarding waste collection a common practice is the existence in parallel to the extended producer's responsibility scheme, another scheme which allows scavengers sell the recyclable fractions of the waste to be collected by the packaging recovery organizations and get some income. This dualistic approach needs to be monitored and controlled, or even redesigned, because it makes the process of collection of recyclables very controversial – from one side the packaging recovery organization are drained from substantial amount of recyclables, on the other it demotivates the households and the companies to separate waste at the source.

Greece

Regarding regulations and bureaucracy and the lack of economic resources, there is a delay in licensing and financing business to start operation. The process is long and complex as many entities are involved. Collection and recycling systems as applications on circular economy are not always easy to develop. There is a delay in the development of entrepreneurial initiatives from the public and the private sector for their utilization. It is of great importance the licensing process to be simplified in order to give motives for the construction and operation of new plants.

Regarding the lack of culture, knowledge and collaboration, there is lack of information about the benefits of implementing circular economy in order to facilitate industrial symbiosis. The economic crisis has reduced economic activity and this can lead to a shortage of recycled raw materials. Stakeholders such as farmers and livestock farmers do not believe in the benefits of circular economy, they are hesitant to use products derived from recycled materials.

Moreover, there is need for well experienced staff, technologically advanced machinery and the development of networks to ensure continuous operation of the system. The lack of expertise and qualified staff means that the company should provide an investment amount in its annual budget.

Some kind of dynamic that happens regularly tends to be the utilization of waste generated from constructions and are used for asphalt construction. The major problem that would break this circular utilization of recovered product would be the lack of this material, but this problem does not exist. The efficiency of raw materials is 30%, as it is the reclaimed asphalt which is used for preparing new. Furthermore, in the tourism industry there are remarkable application examples of circular economy, as exploiting seawater, reusing water, recycling wastewater, managing waste and provide the sustainable procurement.

Italy

An example of failure deriving both from the lack of knowledge and an unclear legislation comes from the building sector (from the report “Circular Economy in the building sector”, 2017, Legambiente): nowadays a great opportunity of this sector is represented by the use of recycled aggregates deriving from construction and demolition waste, that are available in great amounts (25-30% of the total amount of waste in Europe is represented by this kind of waste); environmental benefit will be great considering the amount of saved virgin material.

The lack of knowledge is a real obstacle: the specification criteria for public works often restrict or even forbid the use of this kind of recycled material because public administrators who don’t know this material are skeptical about it and don’t consider it as performing as the virgin one. The technicians who have to coordinate their works are often concerned about the administrative or criminal liability for the misuse of recovered material, because of the strict legislation on waste and consequences for those who manage waste without permits.

Legislation could provide a clear framework for the use of recycled aggregates, defining the requirements for the end-of-waste and all the technical and environmental characteristics the material must have in order to be reused; this would provide awareness and certainty for all actors of the value chain.

Denmark

Denmark has many leading companies pioneering circular solutions, a long an rich tradition of innovative policies that stimulate the circular economy, as well as a long-term strategic commitment to energy efficiency and renewable energy. Denmark outperforms EU28 on a majority of selected resource and innovation metrics, such as share of renewable energy og eco-innovation.

Still, significant value is left on the table across the economy, which could be unlocked by e.g. improved utilisation of assets and better use of waste or by-products as a resource. For example, one third of all waste is incinerated for heat and power generation before extracting its full potential value as a resource, and the materials that are looped back into the value chains are predominantly recycled for material value instead of being usedin higher-value cycles, such as reuse or remanifacturing.

Finland

When thinking about the problems of implementing the Circular Economy particularly within SMEs, probably the most vicious obstacle in South Ostrobothnia is the small size of the companies and the widely spread infrastructure between them. When the companies are small usually the amounts of their by-product flows are small. Transporting only small amounts of by-products long ways is felt logistically difficult and expensive and therefore the small companies are sometimes hard to introduce to Circular Economy.

For example there are small quantities of different kind of plastic products and –packages in almost all SME companies, shops and farms, which are difficult to sort, collect and circulate. In bigger industrial and commercial units there is no problem to properly sort, collect and circulate plastic and other packaging material etc.

United Kingdom (Wales)

The Public Sector framework for the procurement of office furniture for the public sector did not prioritize furniture for reuse or remanufacture. Public sector continuing to procure new furniture and at best recycling old furniture.

A way out – virtuous examples and initiatives

Some existing case studies (as the ones described in chapter D) could represent a solution to the barriers examined above; where possible, every region has provide a good practice that can represent a practical solution to overcome the above mentioned obstacles.

Bulgaria

The transformation of transport shipping containers into social houses appeared to be a successful best practice example because due to the knowledge, enthusiasm, the proper communication and solid financial justification in terms of value for money the founders of the company running this project succeeded to overcome all of the barriers for implementation of the concept behind these project and make it sustainable in terms of economic, social and environmental perspective by:

- Effective and efficient collaboration with municipal and state authorities to fix administrative and regulatory issues in the process of building and maintaining the social houses;
- By explaining accordingly the benefits of transforming a marine transport container into a “house”, a lot of business undertakings declared readiness and supported the initial stages the project and thus the lack of financial resources was overcome. Consequently everybody realized the economic efficiency of such a project;
- The lack of culture and knowledge was overcome the same way – proper, adequate communication and conveying the right messages to the public and the stakeholders concerned;
- As a result of the above mentioned the collaboration among parties was very effective and efficient;

Greece

The application of the model of circular economy in Greece is seen as a challenge and an opportunity. The recycling and recovery of waste before final disposal is the solution to one of our biggest problems, which is their management. Businesses contribute to environmental protection, using waste as alternative raw materials in the production process while improving competitiveness by reducing the raw material costs. This solution contributes to sustainable development by reducing the environmental footprint of human activity, increasing the level of quality of life, while offering new jobs in the waste management sector and provides solutions to local communities on the critical issue of the waste management, reducing costs for their management. Furthermore it helps the quality of life and resource efficiency.

Businesses aiming for economic benefit by implementation of circular economy have an incentive to overcome the obstacles. So indirectly they offer knowledge, expertise and experience. Furthermore, they promote the implementation of the goals that the European Directives set within circular economy as wel as the simplification of national legislation. The society directly benefits by the integrated, safe and low cost waste management.

There is a positive impact at the local and regional level regarding the reduction of materials disposed to landfills, the saving of natural non-renewable resources (fossil fuels), the impact on climate change and pollution of natural resources. Through good business practices, environmental consciousness is created. Businesses enhance the information regarding the benefits of applying CE and disseminate the necessity and usefulness of good environmental practices through their employees, the local community, their visitors and the Internet.

Italy

One of the best practices described in chapter D, even if not related to the building sector described above, is a good example of how to use recycled materials without obstacles.

ILPA is a group of 3 companies which all together manage the whole supply chain of r-PET: from post-consumer plastic to a new thermoformed food packaging; the 3 companies belonging to ILPA are:

- ILIP – business units: fresh products packaging; foodservice packaging; fresh food packaging
- MP3 – business units: semi-finished products; thermoformable and FF&S reels; cut sheets
- AMP Recycling – business units: PCW PET recycling; R-PET films extrusion; horticultural packaging

ILPA’s three main commitments are: (1) REDUCE packaging weight without compromising the safety and shelf life of the packaged products by promoting a more sustainable and innovative packaging system, like heat sealing; (2) RECYCLING: as part of the vertical integration of the r-PET supply chain, ILPA creates a closed loop system from post-consumer water bottles for food packaging; (3) RENEWABLE RESOURCES: I.L.P.A. is the only European manufacturer with complete ranges of disposable tableware, food service packaging and fresh produce packaging made in PLA. ILIP represents the final stage of ILPA recycled -PET vertical integration converting r-PET in food trays and securing its origin and traceability:

- washing, sorting and grinding post-consumer water bottles (the water bottles supply is in accordance with COREPLA standards, the Italian consortium for the collectinon, the recycling and recovery of the plastic packings)
- extruding r-PET flakes
- thermoforming r-PET sheets

The E.F.S.A. (European Food Safety Authority) approved the food grade r-PET flakes, therefore ILPA is entitled to manufacture 100% r-PET punnets. In compliance with the Reg. EC 1935/2004 and the Reg. EU 10/2011 ILPA is now producing multi-layer sheets made of 20% virgin pet layer and 80% r-PET layer, and its next step will be the production of monolayer sheets made of 100% r-PET layer, in compliance with the Reg. EC 282/2008. The current recycling capability of ILPA group is 15.000t and by recycling 15.000t of waste into secondary raw material ILPA contributes to avoid the production of the same amount of virgin PET which, in terms of Global Warming Potential (carbon footprint), is equal to 25.800.000KgCO2eq.

ILPA is a virtuous example of a company which managed to close the loop of its production by collaborating with the three companies belonging to the group and by respecting European regulations, getting also the due approvals from the competent authorities.

Denmark

Denmark is internationally recognised as a front runner in the circular economy. As such Denmark is one of the world leaders in the domains of energy efficiency and the adoption of renewable energy. Yet, even Denmark has significant opportunities to further transition towards circular economy. The Ellen MacArthur Foundation has identified 10 circular economy opportunities in five focus sectors in Denmark:

Food and beverage:

1. Value capture in cascading bio-refineries

2. Reduction of avoidable food waste

Construction and real estate:

3. Industrialised production and 3D printing of building modules

4. Reuse of high-value recycling of components and materials

5. Sharing and multi-purposing of buildings

Mashinery:

6. Remanufacturing and new business models

Plastic packaging:

7. Increased recycling of plastic packaging

8. Bio-based packaging where beneficial

Hospitals:

9. Performance models in procurement

10. Waste reduction and and recycling

These ten identified opportunities are already being pursued to some extent today, inside or outside Denmark. There is however significant potential to scale up. Doing so could bring Denmark to an advanced transitioning and in some areasalmost fully circular economy by 2035.

Finland

Lapuan Peruna is a company that makes potato starch for the use of paper industry. During the recent years they have actively developed new ways to use the waste material flows from the extracting process and been successful in this. Through new technology and methods they have been able to produce more enriched and versatile fruit juice that can be used as a protein feed for animals and a fertilizer for soils.

Lapuan Peruna is a good example in many ways and they have overcome many of the earlier mentioned obstacles. Firstly, they have managed to get financing for their new process of using the by-products from the starching process. This has been done through the European Fund for Strategic Investment (EFSI).

Secondly, one could say that Lapuan Peruna has overcome the obstacle of lacking knowledge and culture. They have been actively seeking ways to use their by-product flows more efficiently and sought and found opportunities from the circular economy. In addition to the EFSI funding they have successfully received funding from a program to enhance nutrients recycling run by the Finnish Ministry of Environment for a research project. Thirdly, they have been collaborating with their potato suppliers very well and thus have been able to test their new products with them. So in other words their company works in a good circular economy system where they buy potatoes from local contract farmers and also make products from by-product-flows for local farmers.

In another case example Kohiwood Ltd is producing wooden glulam panels for furniture industry and construction material. In Kohiwood the material flow is so enough, that all side products of the main production are able to be sorted and used according to sustainable circular economy principles. The wood material which is not going to the main products is chipped and sold to the pulp- and paper industry as raw material. Wood bark is used in bioenergy production and all kind of packaging and handling material used in production chain is sorted and circulated.

Wales

Working collaboratively Public Health Wales were able to appoint a consortium to deliver the office furniture solutions for their organization. The consortium included an SME and social enterprise that were able to deliver a local solution remanufacturing the majority of the equipment and avoiding unnecessary waste to landfill (41 tonnes). Public Health Wales decided not to use the office furniture framework and took a bespoke approach with a tender specification designed to promote reuse and remanufacture. The tender was put out through OJEU, the Official Journal of the European Community (http://www.wrapcymru.org.uk/sites/files/wrap/Public%20Health%20Wales%20Sustainable%20Workplace%20(4).pdf).

Conclusions

By looking at the partners contributions on the barriers of implementation, it is clear how the circular economy is an already well-known yet controversial concept. The barrier that results to be the hardest to overcome by all partners is “lack of economic resources”, followed by “regulation and bureaucracy” together with “lack of knowledge” and lastly by “lack of collaboration”.

Economic resources are obviously fundamental for developing circular economy models and their lack makes it impossible for companies to switch to new business models. New models often require new technologies, new know-how which require both big investments, that SMEs cannot always afford, and human resources. Although the demand for green technology may still be weak and green investments may not be seen as profitable, more incentives and dedicated financing opportunities are

desired if not necessary. In the same way, regulations should also facilitate the access to the circular economy, whereas they are often considered too confusing, complex, fragmented and subject to frequent changes.

Moreover, if regulations are complicated and do not always make it easier for companies to implement new circular models, bureaucracy complicate the framework even more by making the process longer thus representing an even more discouraging factor. As for the lack of culture and knowledge, it emerged quite clearly how the circular economy concept has not yet been understood by many within the most important actors. In fact, companies point out how the public administration is not enough prepared, so the lack of knowledge is a big problem not only within the general public, but also within the civil servants. Lastly, collaboration seems to be not as urgent as the other barriers, demonstrating that there is a general interest towards the circular economy and thus a general desire to implement it, however the essential starting points (such as economic resources, regulations and knowledge) are sometimes still missing.

Although the barriers of implementation are clear there in every country, each partner also described virtuous examples of implemented circular models that were able to overcome the above mentioned barriers. The circular economy is a relatively new concept but for sure one of the most relevant and definitely something at which companies want to aim; of course it needs to be improved, society as well as business need time to adapt but nevertheless circular economy is already giving very good results. For this reason, information and awareness need to be boosted on all levels, for culture and knowledge represent the ground on which circular economy can actually grow.

2.3 Identify Relevant Stakeholders

To identify relevant stakeholders for circular Eeonomy the Triple Helix model must be reffered to.

The concept of Triple Helix of university-industry-government relationships initiated in the 1990s by Etzkowitz (1993) and Etzkowitz and Leydesdorff (1995), encompassing elements of precursor works by Lowe (1982) and Sábato and Mackenzi (1982), interprets the shift from a dominating industry-government dyad in the Industrial Society to a growing triadic relationship between university-industry-government in the Knowledge Society.

The Triple Helix thesis is that the potential for innovation and economic development in a Knowledge Society lies in a more prominent role for the university and in the hybridisation of elements from university, industry and government to generate new institutional and social formats for the production, transfer and application of knowledge. This vision encompasses not only the creative destruction that appears as natural innovation dynamics (Schumpeter, 1942), but also the creative renewal that arises within each of the three institutional spheres of university, industry and government, as well as at their intersections.

Through subsequent development, a significant body of Triple Helix theoretical and empirical research has grown over the last two decades that provides a general framework for exploring complex innovation dynamics and for informing national, regional and international innovation and development policy-making[20].

The first workshop of the Triple Helix movement, launched by Prof. Henry Etzkowitz and Prof. Loet Leydesdorff, was organized in Amsterdam to discuss the Triple Helix model. It brought together 90 researchers and attracted participation from Latin America, Europe, North America, Australia and Asia. The workshop was subsequently referred to as the first international conference on the Triple

Helix.

The London event in 2012 brought the issue of open innovation and invited participants to challenge the Triple Helix model, while extending and deepening the application of the conceptual apparatus, created as part of the evolution of the Triple Helix academic community. The considerable number of participants (over 300) from 35 countries indicated the emergence of a Triple Helix movement, anchored by the TH Association and spinning into numerous academic and practitioner domains[21].

The Triple Helix innovation model focuses on university-industry-government relations. The Quadruple Helix embeds the Triple Helix by adding as a fourth helix the 'media-based and culture-based public' and 'civil society'. The Quintuple Helix innovation model is even broader and more comprehensive by contextualizing the Quadruple Helix and by additionally adding the helix (and perspective) of the 'natural environments of society'. The Triple Helix acknowledges explicitly the importance of higher education for innovation. However, in one line of interpretation it could be argued that the Triple Helix places the emphasis on knowledge production and innovation in the economy so it is compatible with the knowledge economy.

The Quadruple Helix already encourages the perspective of the knowledge society, and of knowledge democracy for knowledge production and innovation. In a Quadruple Helix understanding, the sustainable development of a knowledge economy requires a coevolution with the knowledge society. The Quintuple Helix stresses the necessary socioecological transition of society and economy in the twenty-first century; therefore, the Quintuple Helix is ecologically sensitive. Within the framework of the Quintuple Helix innovation model, the natural environments of society and the economy also should be seen as drivers for knowledge production and innovation, therefore defining opportunities for the knowledge economy.

The European Commission in 2009 identified the socioecological transition as a major challenge for the future roadmap of development. The Quintuple Helix supports here the formation of a win-win situation between ecology, knowledge and innovation, creating synergies between economy, society, and democracy. Global warming represents an area of ecological concern, to which the Quintuple Helix innovation model can be applied with greater potential (Carayannis et al., 2012).

Main stakeholders

Universities and research centres

Universities and research centres are very important for the development and growth of circular economy. For instance, Pioneer Universities are an international network of higher education institutions developing truly pioneering and innovative circular economy-orientated research or teaching programmes. Ellen MacArthur Foundation work with them to have a vision of a global network of higher education institutions that explore, develop and critique key ideas and priorities in a transition to a circular economy.

To bring this about, the Foundation is working with leading universities around the world, as they themselves work with business to find solutions and to educate and inspire future leaders, to address emerging economic realities. As non-fee paying members of the CE100 programme they have a formal agreement with the Foundation and commit to drive and support relevant and beneficial knowledge exchanges between business and HE (https://www.ellenmacarthurfoundation.org/assets/downloads/higher-education/HE-programme-overview_10-04-15_2.pdf) furthering the collective understanding of the circular economy through insights and skills development.

Many of these research and teaching programmes focus on Ellen MacArthur Foundation target disciplines - business, education, design and engineering. The Pioneer University programme offers bespoke input from the Ellen MacArthur Foundation's team and facilitated links with regional networks around the world[22].

Government

Government plays a key role in advancing the circular economy. By setting legislative agendas, developing strategic programs and public services, and making smart decisions regarding internal agency operations, government can drive the demand for circular products and influence the way businesses operate. Large municipalities especially, have considerable influence over the public and commerce, far-reaching purchasing power, and the ability to impact millions of stakeholders through policies and programs. For example, it's interesting to analyse the five ways Government drives the Circular Economy in New York City (NYC), the city is shaping the circular economy through its waste policy and practices.

1. Public Commitments

Two of Mayor De Blasio's biggest public commitments impacting the circular economy are 0x30 and 80×50. 0x30 aims to achieve zero waste by 2030 and 80×50 calls for the reduction of GHG emissions by 80% by 2050. Ambitious public policy commitments set the stage for shifts in collective thinking around waste, resources and sustainability and open the floor for business to invent new and unique solutions.

2. Regulations

NYC has several laws that lay the foundation for closed loop material systems. Recycling has been a legal mandate since 1989 here, and was expanded over the past decade to include a wide variety of materials (most recently rigid plastics). The next innovation in convenience is single stream recycling, which is slated to occur within the next few years. Second, several state laws govern extended producer responsibility (EPR) for various products, some of which are accompanied by disposal bans.

For example, manufacturers are required to take financial responsibility for the collection and reuse/recycling of their electronic products at the end of the product's useful life. But not all product stewardship is mandated; companies are increasingly offering stewardship options for their products to customers on their own accord. Voluntary product stewardship allows companies to define the terms themselves – at times by collaborating with their competitors – and find the best business model for doing so.

Third, in his vision for the city, One New York, Mayor de Blasio calls for the development of "an equitable blueprint for a Save-As-You-Throw program to reduce waste." While EPR programs incentivize producers to make products that are longer-lasting, higher quality, and made from recovered/recoverable materials, a Save-As-You-Throw program might incentivize consumers to buy longer lasting products to offset disposal costs.

3. Collection programs

In addition to curbside recycling, collection program that target specific materials, like organics, electronics (e-cycleNYC), textiles (re-fashioNYC), reuse programs (ReuseNYC), and household hazardous waste (SAFE Events) help to recover materials that might otherwise follow the linear path to the landfill. Together, these programs provide a systemized way to reintroduce unwanted "waste" materials back into markets as renewed products or raw commodities.

4. Procurement

Environmentally preferable purchasing (EPP) sets minimum environmental standards for the products that agencies, companies, and organizations can buy. Like many EPP rules, purchasing standards in NYC government address energy and water efficiency, hazardous materials, and recycled content. Any purchase or contract meeting minimum price thresholds must abide by a precise set of environmental rules. EPP policies are a simple tool that any entity can implement. With examples like reprocessed latex paint, minimum recycled content for paper and plastic goods, energy efficient appliances, and minimum warranties, EPP provides a direct demand for closed loop systems and products.

5. Long-term processing contracts

NYC leads a 20-year contract with Sims Municipal Recycling for the processing of recyclables collected from NYC's residents, agencies, and institutions. While specific and not feasible in all situations, the tactic of entering into a long-term contract with a materials processor can guarantee the viability of a recycling or recovery program by bringing financial stability to a marketplace notoriously characterized by fluctuating commodity prices and market volatility.

As we have seen of late, recycling is not a self-sufficient business with the luxury of relying on the revenue from commodity sales alone. Instead, recycling programs are a public service that must be treated and funded as such. Long-term contracts that pre-define cost and revenue sharing agreements serve to mitigate financial risk while also providing the industry with the material supply assurance it needs to invest significant upfront capital into infrastructure development[23].

Enterprises

Social and green entrepreneurship is considered as one of the main engines playing a relevant role within the complex systemic process enabling a more Circular Economy. Its key drivers, the social and green entrepreneurs, accelerate the transition anytime they convert their ideas into feasible and viable enterprises. The core business of their enterprises is mostly environmentally and socially oriented rather than purely economic. They offer products or services to reduce environmental impacts and create social values using innovative, effective and efficient business models and natural resources. Their work concentrates on sustainable sectors such as renewable energy, waste management, recycling, organic food or eco-tourism[24].

In general, circular economy is a great opportunity for SMEs. However numerous barriers can hamper the implementation of 'circular' and 'green' economy practices by SMEs that can originate, for example, from the SME enabling environment, such as culture and policy-making, from the market chain in which the SME operates, such as behaviour of suppliers, and from lack of technical skills and finance. One key barrier was found to be a lack of technical and managerial knowledge, skills and information, including on the usability of new business models. This limits the options for SMEs to adjust to a circular economy as new or adopted ways of doing business may not be known or staff may not be able to (easily) pursue new activities.

In addition, a lack of long term scenarios in the top management's mind-set – which may result from a lack of time, lack of awareness of the relevance of a circular economy or aversion to change – may also hinder the implementation of a circular business model, including insufficient retirement planning for succession among business executives. Furthermore, the organisational structure and culture of an SME may limit the exchange of information between different departments, e.g. between accounting, marketing and engineering. Thus, relevant opportunities may go untapped or the SMEs response mechanisms may be too slow to exploit opportunities. Furthermore, lacking access to funding and high up-front investments costs vs. long-term pay-back times puts a brake on SMEs'

ability to ‘greenovate’ (Rizos et al., 2015).

Civil society

The development of a circular economy allows citizen-consumers to have access to better quality eco-designed products. Sustainable sourcing and local distribution channels lead to better traceability of products, especially food, with significant environmental and social benefits (local economy, jobs, health, etc.).

In addition to environmental benefits, extending the life of products makes it possible to limit citizens' expenses and benefit from additional sources of income by selling their goods second-hand. Social economy structures specialized in reuse and donation platforms help optimize the use of resources while generating significant economic and social gains.

The functional economy proposes reforming the dominant sales model by disconnecting consumption from ownership. Such a model allows citizens to break away from the purchasing process and all its related imperatives such as maintenance, storage, repair and end-of-life. Providing use as an integrated service is a win-win situation: the producer obtains consumer loyalty and saves on resources; the consumer no longer buys the product but pays only for its function and performance.

Setting up local collaborative consumption networks reduces the costs of acquisition and use of the products while encouraging social cohesion among citizens[25]. But the main lever to move citizens to the circular economy is education, starting with schools. So, new generations can apply good practices in the circular economy as naturally as possible.

The role of financial/economic system

The Quintuple Helix Innovation Model should consider also financial/economic system as Carayannis and Kaloudis write. This area requires ‘sustained action’, political and economic leadership’ or ‘empowerment’, and ‘intelligent use of technology’. The area of financial and economic system refers to financial and economic aspects of the effects of climate. The following question arises: how should the two systems effectively change or adapt with-each-other in order to reduce or exclude crises in consequence of climate change (see for example: Barbier 2009; Barth 2011a; Green New Deal Group 2008; Hufbauer et al. 2009; Meyer 2008; OECD 2010; Sen 2007)?

The economic system comprises industry, banks and services and the political system represents the public authorities and their plans, laws, ideas and so on. The five helices work as “subsystems” in which knowledge moves from subsystem to subsystem in a circular manner. If knowledge is input into one subsystem, a process of knowledge creation leads to new knowledge or innovations. That does not mean that the fifth helix is an actual actor but rather a driver for new knowledge and innovations in response to environmental challenges (Carayannis et al., 2012).

Business models to make SME’s circular businesses a reality

The stakeholders work together, each with its role in the application of the circular economy. To do this, however, requires business models. Below we list five business models that allow SME’s circular economy to become reality.

1: products as services

In products as services, goods vendors embrace the idea of themselves as service providers: leasing access to and not selling ownership of a service. In some cases, this has led not only to an effective hedge against cost volatility but also to a stickier customer relationship and increased upsell.

Vodafone’s Red-Hot plan is a good example. You can rent the latest phone for a year and keep on exchanging it for a newer version. Assuming Vodafone is engaged in collecting the old phone, not only does this act as material collection and pooling but from a business standpoint also creates deeper customer relationships.

2: next life sales

Next life materials and products work when a company can efficiently recover and re-condition its products after use and then put the same products into the market to earn a second or third income. Tata Motors Assured is a good example here. It’s more than a second-hand car dealership. Cars are handpicked and refurbished in Tata workshops and then undergo a certification process. Customers are even offered financing options and warranty.

3: product transformation

Not all products can be reconditioned in their entirety but most products have certain components that carry a high value. Not just products, but often materials themselves have an embedded energy component that makes them even move valuable then their virgin source. With the right design and remanufacturing capabilities, they can be put together to form new products. This is product transformation. For BMW, it can mean a 50% cost saving for customers buying remanufactured parts as compared to new ones. You get exactly the same quality specifications as a new BMW part subject to the same 24-month warranty.

4: recycling 2.0

Not to be forgotten is that innovation in recycling technology (Recycling 2.0) is rapidly evolving and enabling production of high-quality products with fantastic sustainability performance. Starbucks, for example, is actually aiming to turn thousands of tons of its waste coffee grounds and food into everyday products by using bacteria to generate succinic acid which can then be used in a range of products from detergents to bio-plastics and medicines.

5: collaborative consumption

Lastly, social media exchange platforms are rapidly transforming industries by collaborative consumption. Airbnb (the online service that matches people seeking vacation rentals with hosts who have space) now has over 200,000 listings in 26,000 cities. Check out ThredUP the next time you need new clothes for your kids, you can browse like-new clothing at significant reductions from families whose children have outgrown their old clothes. Of course, moving to a truly circular economy could require a mixture of all these five business models and a great deal of product and service innovation. Consumers and policymakers have a significant role too. But what these business models demonstrate is that it is possible to rethink how we make and use things. The companies that are starting now may well define the future of sustainable business, enabling global prosperity on a crowded planet with finite resources[26].

3.1 Bulgaria

3.1.1 Perpetuum Mobile Albena

In 2012 the company started the construction of an installation for biogas. It is an aerobic digester for agricultural and kitchen wastes. It also produces energy with cogeneration - electric and heat. The heat is used for greenhouse (and district heating which is in progress). The digested material is used as liquid fertilizer in the agricultural fields of the company and for the parks and gardens of the resort. The production goes directly to the hotels. A new biogas installation is under construction. The company has eco-policy implemented in all hotels and daughter companies which contains transport (buses and air transport, a construction company, etc)[27].

At the beginning, they had problems using kitchen waste and started by using just agricultural residues. But after adjustments and improvements of the technology process, they are able to use both types of wastes, even though they use predominantly agricultural waste[28].

3.1.2 Utilization of Marine Transport Containers

The project demonstrates the possibility to use marine transport containers for building a hostel for students. This is the first of this type of building in Bulgaria which is tailor-made for the needs of a specialized sport school in Sofia to provide optimal living conditions to some of the youngsters studying there. Twelve colored marine transport containers were used for the building which after processing and transformation resulted in 8 fully equipped apartments. The project has taken into consideration the needs of handicapped as one of the apartments is designed completely to serve students with disabilities. The idea was born as a result of the negative trade balance between Asia and Europe, which resulted in piles of unused containers, stored and not used anymore once they reached Europe.

It is important to be careful when picking up the containers from the harbours, so they are kept as undamaged containers, because the system to construct such a building is using the ”click” modules and everthing should fit precisely.

The buildings made out of colored containers are covering the requirements and providing the comfort of a standard apartment. They are extremely energy efficient and can be made much faster than the traditional ones. Furthermore, they are not affected by the weather conditions and the investment costs are lower. They are also mobile and much more solid in case of an earthquake.

The constucting modules allow a very quick assembling in case of necessity such as force majeure or red cross actions as the containers are prepared, equipped and designed for this purpose from the plant. They come from the plant with a 90% readiness to be installed on the spot. The concrete foundation can be used as a foundation for the building, as the construction system is light and solid at the same time.

This approach/technology can be used to build kinder gardens, homes for elderly people, low budget hotels, bungalows, bazars, office buildings, etc.

3.1.3 Save potable water Project

The project is about saving potable water in households and public facilities by installing: water

saving showers and wash basins with aerators and sprinklers, which use smaller amounts of water and locks massive water stream. Toilets with 2 flushing water volumes; the classic water flushing toilet has a volume of 8-12 liters, but to flush after a slash doesn't require a big volume as only 3-4,5 liters are needed. By installing toilets with 2 flushing volumes – a small volume of 3-4,5 liters and a big volume 6-9 liters a big amount of potable water can be saved. In general, 1 person visits the toilet 1 time daily for pooping and 3 times for slash. By using classic toilet cisterns with 12 liter volumes, the daily amount will be 4*12=48 liters/day/person.

By using a WC with 2 flushing water volumes; 4 liters and 8 liters, the used water amount will be 1*8+3*4=20 liters per day per person, which is 28 liters less and will save 58% of potable water.

By using such WC in public facilities the saved potable water will be multiplied, as well as it may save 50-60% of water, as 28 liters/person/day times 7,5 million people in Bulgaria = 210 000 m3/day saved potable water.

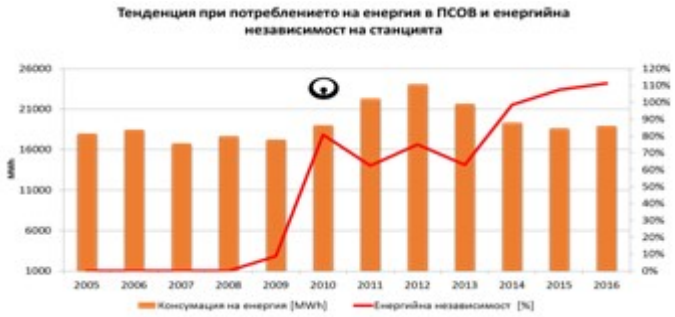
3.1.4 Utilization of Sewage Sludge

The example describes combined heat and power (CHP) production as well as compost production facility using the sewage sludge of the WWTP, who is in charge of the exploitation, maintenance and management of the water supply, sewerage system and purification of the waste water of the municipality of Sofia.

The plant uses a technology for mechanical and biological purification of the waste water and a technology for sludge treatment that ensures dewatering and energy production. The CHP installation has 3 co-generators producing: 1063 kWt electricity per co-generator and 1088 KWT heating power per co-generator. The daily capacity is 35 000 – 39 000m^3 biogas. The sludge of the plant is used as fertilizer in agriculture.

It occurs that sometimes there are contaminations (substances) in the waste water (as its quality varies) that make the purification process more difficult and challenge the production of fertilizer with high quality and high level of safety. A very close monitoring and control system is exerted giving input on the sludge treatment process as a whole to prevent dangerous substances being present in the produced fertilizer. A special legislation regulates all processes of using sludge as fertilizers.

The WWTP is fully satisfying its own needs and provides energy independency by the plant. The graph below shows the tendency in energy consumption and energy independence. The produced fertilizer is used for re-cultivation of areas around Sofia and its neighborhood.



Tracking the quality of the sewage sludge at every stage; Energy independency of the plant contributes to cost efficiency and a greener city while protecting the environment by recycling smartly waste water and reducing carbon emissions.

In case the legislation develops further in the field of using fertilizers from sludge treatment, there could be much more incentives for their utilization in the agriculture. Social, ecological and environmental aspects of this project should be more exposed and become more visible to the population[29].

3.2 Greece (Region of Central Macedonia)

3.2.1 Sani Resort

Sani Resort's Corporate Social Responsibility program pursues three strategic objectives with a well-defined set of policies, initiatives and measurable targets.

1. Sustainable hotel operations
2. Protection and enhancement of local biodiversity
3. Local community support and human capital development

Circular economy practices are relevant to the first and third strategic objective and regard the following:

1. Recycling of wastewater to cover the peripheral garden's irrigational needs. According to the EU Action Plan for Circular Economy, water scarcity has worsened in some parts of EU in recent decades with damaging effects on our environment and economy. In addition to water-efficiency measures, the reuse of treated wastewater in safe and cost effective conditions is a valuable but under-used means of increasing water supply and alleviating pressure on over-exploited water resources in the EU. Specifically, Sani Resort uses recycled wastewater to cover the peripheral garden's irrigational needs in accordance with the national legislation. Waste water is treated in a three stage biological treatment plant. The resort managed to reduce the water consumption over the years. Just between 2014 and 2015 water consumption has decreased by 7%.

2. Waste management. According to the EU Action Plan for Circular Economy, waste management plays a central role in the circular economy. Sani Resort is considered a pioneer in the waste management. The resort implements an integrated recycling program for all waste streams. In total, it managed to recycle almost 42% of the waste produced during 2015. In cooperation with recycling companies, Sani Resort recycles glass, paper, plastics, cans, batteries, electrical and electronic equipment, lighting bulbs, toners, candles and coffee capsules. As "large quantities of plastics also end up in the oceans and the 2030 sustainable development goals include a target to prevent and significantly reduce marine pollution of all kinds, including marine litter" (see EU Action Plan for Circular Economy: 13), it is of great significance that the resort has banned the use of plastic bags in all owned operations and suppliers are encouraged to use reusable paper or other bags.

Moreover, used cooking oil is collected by the resort's processor and the relevant revenue of each year is invested on the needed equipment or training of the employees for the recycling program (see further below). At 2016 Sani Resort started a pilot composting program. The green waste produced by all green spaces of the resort are collected to a compost bin. The compost produced is used as fertilizer in the resort's gardens. This is also in line with the interest of the EU for the promotion of organic and waste-based fertilizers.

3. Sustainable procurement. The company community policy is to support local suppliers and local products as well as to reduce waste and chemical use. Sani evaluates all suppliers on the basis of

sustainability criteria focusing on quality, locality, environmental protection and business ethics as set out in the sustainability procurement policy. This is in accordance with the potentials of green procurement for extending the durability and reparability of products and hence, promoting circular economy[30].

3.2.2 Biogas Lagada

Biogas Lagada SA is a power generation plant (power 1 MW) from the biogas combustion, which is produced by the anaerobic digestion of organic raw materials. The majority of the raw materials consist of farm waste such as liquid and solid cattle and poultry manure. As raw materials are also used cheese, whey waste and mill waste. Additionally, but in a smaller rate the AD uses, as a resource, silage from various crops such as corn, wheat, rye, etc.

All the above mentioned raw materials are stored in digestion tanks with the appropriate conditions and the required quantity. This digestion tank, within a suitable temperature conditions and with the absence of air, produces the required amount of biogas for the continuous operation of the biogas combustion engine, which operates the power generator. Besides electricity, the whole process produces heat, which is used to cover the heating needs of digestion tanks. The digestate of anaerobic digestion is stored in tanks and used as fertilizer in agricultural crops in the region.

At a daily bases 240 tons of waste are collected and treated. Otherwise all these produced livestock waste would end up at agricultural crops without following the quality standards, as the digestate derived from the AD plant. The dairy and mill waste would have been illegally disposed in a natural recipient or in a wastewater treatment plant creating further treatment costs. Additionally the AD plant constitutes the only RES technologies with negative CO_2 balance.

The construction and operation of AD plants bring a great environmental benefit and contributes to the implementation of CE goals. It is of great importance that the licensing process is simplified in order to give motives for the construction and operation of new AD plants[31].

3.2.3 Kaisidis ABTE

This good practice involves the use of recovered asphalt mix in a new production. The reclaimed asphalt mixture is the result of the asphalt or scraping asphalt. Demolition is carried out using road machinery such as the excavator while scraping is done using an asphalt cutter. After the material is transferred to the worksite, this material is processed to separate the material containing the highest percentage of asphalt and graded in grain size.

This treatment is done by using the granulator containing special shredders that do not polish the recovered bitumen but repel it. With this technology, the asphalt contained retains all its properties while the sieves give the material the correct grading required. The recycled asphalt mixture then goes into the production process of the new asphalt mixture. There in special mechanical equipment it is heated and then mixed with the raw materials, asphalt and aggregates.

The most important challenge that would prevent this cyclical recovery of the recovered asphalt mix would be the lack of this material. Today this challenge does not exist because the percentage of road rebuilding and therefore the acquisition of recovered asphalt mix is much higher than the construction of new roads that do not offer reclaimed asphalt mix. This practice improves the quality

characteristics of the final asphalt mixture as well as the envionmental benefits from the recovery of waste.

Tests have shown that the use of 30% recycled asphalt mix increases up to 150% the properties and mechanical strengths of the new asphalt mixture. The primary raw material savings are 30% as well as the recycled bituminous mixture used in the manufacture of new ones. The use of recycled materials ensure the reduction of the use of primary sources of materials as well as reduction of waste deposits in the environment.

The reclaimed asphalt mixture ceases to be a waste, but it is a precious commodity with rich properties and mechanical strengths that offer economy and reduce the pollution of the natural environment In order to properly evaluate the properties of the recovered asphalt mixture, the material to be used in the production should be controlled for both its primary asphalt content and its granulometric grading[32].

3.2.4 Mirragio Hotel

Mediterranean luxury resort hotels reach their peak occupancy during the summer months, when the air temperature is high and the availability and quality of potable water is low. The competitive advantage of Mirragio’s Hotel will result from a system capable of addressing all cooling, heating and water needs at the same time:

1. has a very low energy consumption
2. has low building costs
3. requires minimum or zero roof space
4. is reliable and corrosion proof

Design and implementation of a ’combined energy and water system’ for 5* hotels and spa by SYCHEM SA. The combined system uses sea water and electrical energy to provide:

1. Space cooling and heating
2. Underfloor heating
3. Domestic water heating
4. Pool & spa heating and cooling
5. Domestic water production (reverse osmosis desalination)
6. Sea water supply for Thalassotherapy Center
7. Sea water and brackish water supply for pools re-filling
8. Heat rejection for hotel’s centralized refrigeration systems

The innovation of the system lies in the joint use of the mechanical equipment and resources (sea water, electrical energy, reclaimed heat) for several combined users, under the control of a sophisticated Building Energy Management System (BEMS).

The main synergies of the combined system are:

1. Extensive in-series reuse of the sea water by water-source schillers, water-source heat pumps, desalination plant, centralised refrigeration, thalassotherapy and pools. The route of the sea water is controlled according to the specific temperature requirements of each sub-system. The result of sea water reuse is the substantial reduction of sea water intake infrastructure and pumping energy.

2. Reclaim of waste heat by water-source chillers for the heating of the pool and underfloor heating
3. Reclaim of waste cool by water-source heat pumps for space cooling
4. Use of thermal springs for heating of the pool

Moreover, all the equipment used follow the highest energy efficiency standards and is dynamically regulated to further enhance the already very high efficiency of the innovative combined design[33].

3.2.5 Porto Carras Resort

Porto Carras is a resort in Halkidiki Greece, eight times awarded by Conde Nast Traveller. Porto Carras features two 5 star hotels, a world-class villa, a luxurious casino and two thalassotherapy & spa centers. Furthermore, it contains an 18-hole golf course, a conference hall, a horse riding academy, a tennis club with 9 courts, a diving center, a nautical club, 3 helipads, 2 waterways and a 315-berth marina.

Porto Carras has been awarded with the Green Key Eco label[31].

Circular economy practices already applied by the hotel management are the following:

1. Recycling wastewater to cover the golf course' irrigational needs. The resort uses a tertiary biological waste treatment plant (UV-clorination). The treated water is transferred to 3 reservoirs with a total capacity of 40.000 m^3 after which the treated water is used to cover the irrigation needs of the golf course. This practice is in line with the provision for combating water scarcity, as mentioned in EU Action Plan for Circular Economy.

2. Sustainable use of sewage sludge in agriculture. Porto Carras has the largest vineyard in Greece which covers 475 ha. In its tertiary biological waste treatement plant, the sewage sludge passes from a filter press and then sorted and dried in order to be used as an organic fertiliser for the vineyards as long a quality standards allow it.

The evidence of succes is reduced waste, reduced arrigational water consu,ption and increased capacity of produced fertiliser.

The specific waste treatment plant treats 80% of phosphates and nitrates. The remaining percentage of nitrates and phosphates (20%) which is overlaid in the bottom of the reservoirs, creates the eutrophication phenomenon. The eutrophication is evident from the bright green water, caused by a dense bloom of cyanobacteria. In the event that eutrophication appears in the reservoirs, the water has to be discharged and the sewage sludge must be removed. The phenomenon appears approximately every 5 years[34].

4.1 Bulgaria

The background

The Action Plan targets an entirely practical approach – a show case/ demonstration project for SMEs (as a beginning hotels) to enable them to increase the rate of recycling as a first step using a digital application by sending a real-time request to a waste collection company to pick-up separately

collected packaging waste (plastic, paper, glass). In addition, it involves SMEs via the digital App to exchange information about the waste accumulated which could be used as a resource among them and to third parties.

The reason for the development of the Action Plan is the lack of efficient policy tools and mechanisms to stimulate sustainable usage of the waste as a resource. There is a clear need to improve tools for B2B communication and improve business models, which will enable more SMEs to increase awareness of the possibilities and benefits of using the waste as a resource.

Our further development of the Action Plan strengthens and encourages the B2B communication via the development of the platform to be accessed on the following website: **http://cesme.bamee.org/**

Actions

Our Action Plan extented further from the idea of hotels and guest houses, which would normally generate packaging waste to further offer the possibility to the SMEs in Bulgaria to exchange information among each other having the below mentioned functionalities:

- There will be the possibility of a SME to select the type of waste either prouced or needed and to make a dedicted search. We have assigned different code numbers for the differnt kinds of waste. These are administratively defined codes according to the Bulgarian legistation. The platform will allow the SME to exchange in real time informtion, e.g. if a comapny produces a certain kind of building waste and another company could include it in other production, using the waste as a resource. We have to further eleaborate the aspect with the control and tracability about the materials to be exchanged and we are considering options.

- Further on the platform has covered the bigger part of the Bulgarian towns and cities, so that the user could select the geographic location, which bests suits its logistics.

- After selecting the parameters for the kind of waste needed or to be offered and the approximate location, the B2B platform generates data for the available kinds of waste, where, what amount currently is available, what could be the maximal amount to be expected; time of the information is submitted and if it is to be sold, given for free or export oriented.

Important to mention is that at the beginning each user of the platform has to make a registration, which clearly identifies the legal entitiy, the company itself, ID, address, contact details, so that the participants are transperent and visible. The access to the system is possible via valid e-mail and password registration.

Our approach was inspired as a result mainly of the visit to Greece, where the hotel Sunny Day in Halkidiki was attended. It was demonstrted how the whole hotel could function almost as an Ecosytemn, closing the cycled and use efficiently resources. So we started with the investigation of the possibilties for hotels and then decided to spread over this opportunity, to create a platform created for a huge range of SMEs. For this fact a significant role was played the chance to visit a construction company in Greece producing asphalt to be used in roads construction and the companies, which were visited in Finland showing a very efficient use of wood, closing the loop in a certain company.

Our B2B to be communication platform will allow companies from different fields to communicate with each other, being able to establish relationships, which would be an example for an industrial symbiosis. Thus the platform will ensure a considerable environmental impact, providing usage of

unused till now resources, which are considered waste.

Development

- Select the SMEs (hotels) organizations to test the digital platform which will allow for real time requests to pick-up waste;
- Introduce them to the digital platform and provide a link to it;
- Involve relevant stakeholders and carry out an informatin compaign;
- Encourage and facilitate the necessary infrastructure in order to speed up the process; provide publicity and taining of the staff of selected SMEs; (a show-case);

It was necessary to carry out a waste management study at the local level among the SMEs to identify the possibilities to apply the principles of the Circular Economy through the active participation of the municipalities in the creation of preconditions for industrial symbiosis among those small and medium enterprises on the territory of a municipality.

Further on a huge effort was put to systematize, structure and analyzing data in order to be used by B2B (business to business) communication platform between small and medium-sized enterprises to promote resource efficiency. This analysis became the basis of the Action Plan.

- Further develop and test the digital platform, which could be used as an App in case it gethers critical mass of users and requests from the companies are in place according to the following timeframe:

- April 2018 - finalisation of the concept & setting up of a team to further eleborate on the platform and then establish a team for its promotion;

- June 2018 - concept validation & testing

- September 2018 - a promotion campaign;

- December 2018 – tracability and overview to analyse the participation of the companies using the platform;

- January – December 2019 – potentially in case needed an App is up and running and the results of the increased recycling rates of the organisations involved are measured;

Involvement of stakeholders:

- Local Authorities (responsible for the implementation of policies at local level), Municipalities;
- The members of the Local Support Group
- Hotels/ SMEs
- Ministry of Environment and Waters
- The Regional Environmental Inspectorates

Expected impact on the policy instrument addressed:

Through the successful implementation of the project, it will be demonstrated that the waste could be

an effective tool for different industries to increase the recycling rates and provide incentives for industial symbiosis and improved resource efficiancy.

The aim is Influencing decisions makers to change policies and legislation related to the field;

Financial or other resources available:

The foreseen by the project funds under “External expertise” are be used for the development of the Action Plan and in case of necessity additional funding, it will be provided by BAMEE (including in-kind contribution) or other related to the topic funding bodies.

4.2 Central Macedonia Region

The background

The Action Plan took into account:

- the European policies for the promotion of circular economy (as they were incorporated in the White Book),

- the national policies that are directly or indirectly related to circular economy,

- the priorities / areas of high regional interest, as reflected in the Regional Innovation Strategy (RIS3) of Central Macedonia,

- the Priority Axis / Thematic Objectives, Investment Priorities and Specific Objectives of the Regional Operation Programme (ROP) of Central Macedonia for the period 2014-2020, which constitutes the main funding instrument,

[The above form the framework of the Region’s development policy and contribute to the identification and prioritization of sectors, branches and business activities of high regional interest, based on the special characteristics of the Region, in combination with the investment priorities of the NSRF 2014-2020.]

- The analysis of strengths and weaknesses of the ROP 2014-2020, which led to the conclusion that there are currently no funding opportunities for circular economy actions,

- the analysis of strengths and weaknesses of RIS3, which led to the need for further "specialization" and targeting towards circular economy,

- the study of good practices applied to other countries within the consortium, giving input to exploring opportunities for exploiting and improving the specific funding tool (as for example the case for the industrial symbiosis database developed in Denmark),

- the lack of mechanisms to promote the idea of circular economy in the Region and the need to create a networking and promotion structure,

- the results of a survey (questionnaires) conducted during the preliminary stage of the action plan’s development, where the members of the LSG and additional SMEs were given the opportunity

to express their views on circular economy status and prospects as well as on the possibilities offered for funding. This survey aimed at capturing the specific needs and desires of the potential beneficiaries (i.e. SMEs) and constituted an additional participation process / process of ‘co-creation’.

Actions

The central objective of the Action Plan is to influence the available policy tools towards circular economy, with special focus on the Regional Operational Programme (ROP) of Central Macedonia. This will be supported by actions that will increase the awareness of potential SMEs beneficiaries, in order to include the benficeries/SMEs in actions funded by the ROP. The overall goal is 80 SMEs in the Region to improve their resource efficiency through circular economy actions.

The Action Plan for the promotion of circular economy in the Region of Central Macedonia consists of three (3) main axes:

1. "Specialization" of the RIS3 Strategy

The Region of Central Macedonia seeks to influence the Strategy's specialization with actions in the field of circular economy. Indicative relevant actions are included in the Plan, concerning ‘champions’ and ‘horizontal support’ sectors, as identified in RIS3.

2. Incorporation of circular economy actions into the ROP of Central Macedonia 2014-2020

The Region will seek to incorporate actions in the ROP 2014-2020, through which the Region’s SMEs can be funded in order to move towards a more circular economy. "Circularity" is intended to be seen primarily as a key factor for improving competitiveness and secondarily as a factor for reducing the environmental impact of the SME.

The above objective, i.e. the influence of this particular policy tool, is proposed to take place in three dimensions:

A. Introduction of the "circular economy" criterion in the funding procedures stemming from the ROP 2014-2020. Focusing on Priority Axis 3 "Enhancing the competitiveness of small and medium-sized enterprises" favors this approach.

B. Development of a ‘structure’ to promote the idea and good practices in the field of circular economy *(one-stop-shop).*

C. Innovation coupons for SMEs (aiming to strengthen the Region's SMEs and the improvement of their production processes through the purchase of knowledge and expertise from innovation institutions).

3. Implicit incorporation of the issues of circular economy into the ROP of the next programming period (2021-2027) and its funding priorities.

Players involved

Axis	Action	Players involved

1. "Specialization" of the RIS3 Strategy	1.1. "Specialization" of the RIS3 Strategy	Region of Central Macedonia (RCM)
2. Incorporation of circular economy actions into the ROP of Central Macedonia 2014-2020	2.1. Introduction of the "circular economy" criterion in the funding procedures stemming from the ROP 2014-2020	RCM, Managing Authority RCM, Thessaloniki Chamber of Commerce and Industry, Thessaloniki Chamber of Commerce, Technical Chamber of Greece
	2.2. Development of a ‘structure’ to promote the idea and good practices in the field of circular economy (one-stop-shop)	RCM
	2.3. Innovation coupons for SMEs	RCM, Managing Authority of RCM, HEIs/TEIs and Research Institutes, Thessaloniki Chamber of Commerce and Industry, Thessaloniki Chamber of Commerce, Technical Chamber of Greece
3. Incorporation of the issues of circular economy into the ROP of the next programming period (2021-2027)	3.1. Incorporation of the issues of circular economy into the ROP of the next programming period (2021-2027)	RCM, Managing Authority of RCM, Ministry of Economy and Development

Timeframe

Indicative timeframe

Proposed actions	**2018**			**2019**				**2020**				**2021**			
1.1. "Specialization" of the RIS3 Strategy	x	x	x												
2.1. Introduction of the "circular economy" criterion in the funding procedures stemming from the ROP 2014-2020	x	x	x	x	x	x	x	x	x	x	x				
2.2. Development of a ‘structure’ to promote the idea and good practices in the field of circular economy *(one-stop-shop)*			x	x	x	x	x	x	x	x	x	x	x	x	x
2.3. Innovation coupons for SMEs			x	x	x	x	x	x	x	x	x				
3.1. Incorporation of the issues of circular economy into the ROP of the next programming period (2021-2027)								x	x	x	x	x	x		

4.3 Emilia Romagna Region

The background

The following actions have been selected considering the topics arisen from the discussions with project partners and local stakeholders. In particular, thanks to the creation of the Local Support Groups and its activities, it had been learnt that circular economy has different interpretations and as such policy makers must keep this in mind while implementing policies which can be really effective for SMEs and their transition towards circularity (**action 1**). Furthermore, SMEs confirmed during meetings that energy consumption and energy costs are within their main concerns, and topics like energy efficiency or renewable energy from waste or biomass make Circular Economy be seen as a key factor for competitiveness (**action 2**). Some of CESME case studies have also inspired policies: Orangebox (UK) showed a great experience in Green Public Procurementindicating that local public institutions sometimes lack in understanding what is really green (**action 3**). On the other hand, Danish Industrial Database proved to be an indispensable basis to increase circular economy, whereas Italian companies consider the lack of mutual relationship as an obstacle to access Circular Economy, thus the creation of a green database is proposed (**action 4**). As registered during the local stakeholders meetings, many local SMEs still have difficulty understanding "circular economy" and the considerable growth and development opportunities linked to the transition from a linear economic model to the “doughnut economy" . Therefore the need to raise awareness and organize targeted information activities (**action 5**) is a priority for the Metropolitan City of Bologna. Finally, Bologna plan to deepen the link between circular economy and nature-based-solutions to foster new business opportunities, developing a materplan **(action 6**).

Actions

ACTION 1 - GREEN\CIRCULAR MONITORING SYSTEM ON ERDF CALLS

ACTION 2 - FOCUS ON ENERGY CALLS

ACTION 3 - INFORMATION AND TRAINING ACTIVITIES TARGETED TO PUBLIC INSTITUTIONS

ACTION 4 - DATABASE OF GREEN ENTERPRISES & INFORMATION ACTIVITIES TARGETED TO COMPANIES

ACTION 5 - RAISING-AWARENESS AND INFORMATION ACTIVITIES TARGETED AT LOCAL SMEs

ACTION 6 - CIRCULAR ECONOMY AND NATURE BASED SOLUTIONS TO CREATE NEW BUSINESSES

ACTION 1 - GREEN\CIRCULAR MONITORING SYSTEM ON ERDF CALLS

ERVET will provide to the Managing Authority a specific monitoring system of structural funds, focused on green projects. The monitoring system for ERDF calls on which ERVET is currently working aims at assessing their ability and their potential to foster eco-innovation and sustainability/circularity among enterprises. A questionnaire about eco-innovation and other environmental topics related to the financed projects has been created and its results are used to adapt the questionnaire itself in order to use it in other calls with the aim of setting up a permanent monitoring system. This system will assess the environmental quality of the financed projects and the potential of eco-innovation as a key-factor for competitiveness. On the basis of the results of monitoring system, ERVET will produce a memorandum targeted to Managing Authority on how to embed environmental sustainability (green and circular topics) in future ERDF calls.

ACTION 2 FOCUS ON ENERGY CALLS

ERVET will analyses the results of some specific regional calls targeted to enterprises (energy audits) with the aim of understand if (and how) energy efficiency could act as a key-factor for competitiveness. ERVET will produce a memorandum targeted to companies in order to push them to consider ERDF energy calls as an opportunity to increase both their competitiveness and their circularity.

ACTION 3 INFORMATION AND TRAINING ACTIVITIES TARGETED TO PUBLIC INSTITUTIONS

ERVET is involved in the programming and the implementation of the GPP regional plan; the Plan will include, as the previous one, information and training activities targeted to local institutions and to companies; ERVET will add to the discussed topics the circular economy and how the GPP could push the transition towards a circular model.

ACTION 4 DATABASE OF GREEN ENTERPRISES & INFORMATION ACTIVITIES TARGETED TO COMPANIES

ERVET is currently building a database of regional green enterprises, economic data included, and will collect as many best practice as possible, in order to disseminate a culture on circular and green economy. All the information related to te competitiveness and resiliency of green companies will be used to show them the economic benefits of the transition towards circular business models and to persuade them to adopt circularity as a competitiveness factor.

ACTION 5 RAISING-AWARENESS AND INFORMATION ACTIVITIES TARGETED AT LOCAL SMEs

The Metropolitan City of Bologna will organize raising-awareness and information activities targeted at SMEs within the metropolitan area of Bologna, aimed at increasing and improving their information and knowledge on circular economy, green growth, related development opportunities and possible concrete solutions to promote eco-sustainable business models. This action is strictly related to the new *Metropolitan Strategic Plan (PSM 2.0)* – Priority 4, *Manufacturing, new industry and training*, aiming at boost green and circular business models among local SMEs.

ACTION 6

The Metropolitan City of Bologna will develop a masterplan, and funding application, for roll out of nature based solutions. It will stimulate the innovation potential of nature-based solutions and community potentials by developing communities-of-practices within authorities, communities and businesses. Moreover it will promote raising-awareness and information activities targeted at future entrepreneurs within the metropolitan area of Bologna. The activities developed will contribute to pursue the Priority 4 of the PSM 2.0.

Timeframe of the actions

Action	2017	2018	2019	2020
1	X	X	X	
2	X	X	X	
3		X	X	
4		X		
5		X	X	X
6		X	X	X

4.4 North Denmark Region

The background

During the CESME project we have learnt that:

- No SME is an idealist meaning that ‘money talks’ when they want to take action in this direction
- The low-hanging fruits have already been picked. Product innovation and business models will be the next big thing, but also requires a lot more effort and knowledge to succeed
- Scalability is important as the investments are big
- Bringing the SMEs together in order to share knowledge and experiences often strengthens the learning experience (Go n’see tours)
- In order to make the final and right decision, ROI (Return on Investment) may be the key.

Actions

The toolkit and the green mindset will become a natural part of the business counselling in North Denmark Region

- The toolkit (or parts of it) will be implemented in already existing business programmes giving advice to SMEs
- The Business Development Centre North Denmark will train other business counsellors in the region within this area
- The Business Development Centre North Denmark will become a knowledge hub within circular economy in the region

Players involved

- Local Business Service in each municipality (they will help to identify the green potentials in the SMEs)
- Universities and regional educational institutions (they will provide expert knowledge to keep us updated within the field)
- National and regional clusters and network (they will identify common challenges and barriers as well as solutions to them and It will help strengthen the cooperation between Business Development Centre North Denmark and the relevant clusters)
- Private consultants and experts (they will act as the extended arm for the Business

Development Centre North Denmark)
- SMEs (they are the target group)

Timeframe

The timeframe will be from 2018-2019

Costs

Costs related to these actions will be around 250.000 EUR structural funds.

They will be spread among

- 100 SMEs for individual counselling
- Camps and after-work meeting for around 100 SMEs

Funding sources

The funding source will primarily be the European Structural Funds, which have already been approved for these actions.

4.5 South Ostrobothnia Region

The background

The Circular Economy Action Plan of South Ostrobothnia has been a joint development of the two Finnish partners, the Regional Council of South Ostrobothnia and the JPYP Business Development. In addition two expert organizations have taken part in the preparation process. The VTT Technical Research Centre of Finland has been actively involved in the development of the action plan in general from the vision-creation to the developing the actions. The Natural Resources Institute Finland was involved during spring 2017 in the workshops where possibilities of circularity of wood products were analyzed and recognized. During the fall 2017 another two workshops were held, where the VTT played a crucial role.

The Action Plan in general guides the ways how the region should systematically move towards Circular Economy. It starts with a general introduction to the thematic of Circular Economy in global, European, national and regional context, the most important European, national and regional policy frameworks and lastly, the most important funding opportunities. It then explains the circular economy vision for the region and after that presents the actions in three action groups. The first action group seeks to develop the general operational environment of the circular economy by enhancing co-operation, networking and information flows around the area. The second action group seeks to influence the knowledge-base and innovation environments and the third action group comprises of several sector-specific actions.

Circular Economy Vision for South Ostrobothnia

Circular economy vision for South Ostrobothnia was created together with local stakeholders in a workshop held in fall 2017. In the workshop several themes were raised that should guide the region's development towards circular economy. Firstly, the regions reliance on bioeconomy and food industry was seen important. Secondly, the new business potentials and innovations was recognized as core of CE. The shift towards CE needs also change in the mind-set and new ways of co-operation and networking. In addition, resource efficiency, sustainability, efficient material flows and smart use of technology were seen important. By combining these factors the vision was captured in the following sentence:

"Creating new business and sustainable well-being from circular economy with co-operation and south-ostrobothnian perseverance"

Regional policy context

The policy instrument for the project is the Regional Strategy of South Ostrobothnia for the years of 2018-2021. The new regional strategy recognizes the possibilities of circular economy in various ways. Firstly, the possibilities are recognized in the development of sustainable food systems, bioeconomy and bioenergy productions. Secondly, the new strategy comprises an own chapter for resource efficiency and the circular economy, where new business potentials and business models are highlighted.

In addition to the regional strategy the RIS3 strategy of South Ostrobothnia takes some of the principals of circular economy into account. The strategy focuses on sustainable food systems and new solutions for bioeconomy, smart and resource-efficient systems and regeneration of service and experience productions. From the other regional strategies the regional energy and climate strategy for 2014-2020 takes the circular economy principals strongly into account.

Actions

Action group 1: Promotion of advising, information sharing and business networking

One of the challenges of promoting the circular economy in South Ostrobothnia region has been identified the lack of knowledge, information-sharing and business networking. The region has a need for an organization or an expert who would centrally inform the circular economy possibilities, share the latest information and bring actors together to share their knowledge and new ideas.

Action 1

An advisory and information project on the circular economy will be launched to resolve the lack of knowledge. Through the project good practices and possibilities of CE will be informed widely in the region. This will be done by development of different information exchange and discussion platforms. Inspired by the Danish partners' Industrial Symbiosis Database, the project will also activate the regional actors to join the most important Industrial symbiosis databases relevant in Finland. JPYP Business Service will manage the project. The project cooperates with Leader groups and R&D organizations. Target groups are local municipalities and enterprises. The project will fund during 2018 and will implement during 2019 and 2020. The cost of the project is estimated at 100.000 € and funding is sought from The Rural Development Programme for Mainland Finland.

Action group 2: Developing the knowledge-base, education and innovation activities of the circular

economy

The workshops and interviews highlighted the need to increase the knowledge and to identify opportunities of circular economy at different levels. In order to achieve the objectives of the regional program it is also necessary to increase the level of knowhow and to develop the innovation activity around the circular economy. Two education projects to increase the knowhow of the circular economy will be launched in the Seinäjoki University of Applied Sciences.

Action 2

The first project aims at designing circulation economy to be a part of education of engineers of process and material technology. The project for engineer education includes all the Finnish universities of applied sciences providing process and material teaching and thus the Seinäjoki University of Applied Sciences is also involved in the project. The project has started in the fall 2017. The planning, piloting and development of the courses will take place in 2018 and the project will end in the early 2019. The budget of the project is 140 000 € and is partially funded by Sitra, the Finnish Innovation Fund.

The second project aims at developing, producing, testing and evaluating the new tools for the education in the food supply chain. The food chain project includes five different education institutes in Finland including the Seinäjoki University of Applied Sciences that manages the project. The project has started at the beginning of 2018 and will end in the early 2019. The budget for the whole project is 190 600€ and it is partially funded by the Sitra, the Finnish Innovation Fund.

Action group 3: Sector-specific actions

ENERGY

The need to develop the use of forestry and agriculture biomass was raised in the interviews with business developers in all parts of the region. According to the regional strategy, the South Ostrobothnia aims for energy self-sufficiency and various methods and technologies to produce bioenergy.

Action 3

The possibilities of biogas production will be clarified in a project launched in the Lake District of South Ostrobothnia. The project will investigate the necessary equipment, methods and financial calculations for biogas production. Stakeholders' needs to set up the biogas plant will also be investigated in the project. JPYP Business Service manages the project and key stakeholders are local industry and energy companies, local farms and forest industry. The biogas project will be implemented during 2018 and the planning of company investments will start during 2018 and 2019 and construction in 2020. The cost of the biogas project is 15.000 € and is funded by the Leader-fund. The cost estimate of an industrial size biogas plant investment is 6-8 M€ and the cost of farm size plant is 0.5-1 M€.

In addition, there are also several company-specific bioenergy plant plans in the area. For example, there are plans for CHP plants that would use the side products of wood product industry. Various parts of the region have also made plans to build a biogas plant e.g. Suupohja and Järviseutu regions.

WOOD PRODUCTS

The forest bioeconomy and wood product industry are important business sectors in South Ostrobothnia. The building and wood products industry needs new business models and methods to meet the challenges of the future. The wood product industry also produces large quantities of by-products that should be utilized better and with the principals of circular economy. The actions for wood products comprise of one certain project and few suggestions for future actions that were developed in the local workshops.

Action 4

Circular Economy – Game Changer for the Wood Building Industry. The project is launched to develop the circular economy of wood building industry and to introduce new methods and approaches for the industry. The overall goal for the project is to boost regional companies' competitiveness on the international market by initiating new networks and business ecosystems and introducing circular economy solutions based on previous recognized success factors. Novia University of Applied Sciences manages the project and Tampere University of Technology and Seinäjoki University of Applied Sciences take part in the project as South Ostrobothnian partners. Target group is the wood building industry. In addition R&D organisations are important stakeholders in the project. The project will take place from 2018 to 2020. The budget for the two South Ostrobothnian partners is 420 000 €. The project is financed by the Botnia-Atlantica program.

Suggestions for actions raised in the workshops. In the workshops of the project, new uses for the side products of the wood product industry were innovated. New ideas such as the separation of wood extracts and the production of fiberboard panels need further refinement. There is a need for a project to develop of further processing of wood side products. The responsible actor or funding opportunities for the actions are still unclear.

PLASTICS

According to EU circular strategy, all packages should be recyclable by 2030. The strategy will renew the way products containing plastic will be planned, produced, used and recycled. This will affect the whole plastics industry. It will create new challenges but also new possibilities to all industries. New solutions that take account circularity can boost competitiveness in the region and nationally. The developments of the collection and recycling of plastics as well as increasing the use of recycled plastic have been recognized important in the South Ostrobothnia area. There already is some collecting and granulating activity in the area, but in relation to the amount of plastic waste, this activity is still rather slight.

Action 5
Mapping and developing the plastics ecosystem in South Ostrobothnia. The aim of the project is to establish a plastics ecosystem in the South Ostrobothnia area, in which the locally formed secondary plastic waste can be effectively processed and reused in the area. The project will establish a collaboration platform / value chain, gather and formulate information on the properties of secondary plastic when being reused, offer companies possibility to pilot their ideas in VTT research environments, and tighten the interfaces between science, education, companies and public sector. The project will result in scientific understanding on the properties of recycled plastics, and demo products. The project will be implemented by Into Seinäjoki in collaboration with VTT. The target group is the plastic companies in the region. Partners will also include Seinäjoki University of Applied Sciences, waste management companies and trade business.Funding will be applied from AIKO

(Regional innovations and experimentations programme) during March 2018. The project budget will be approximately 100 000 euros.

TEXTILES

The utilization of textile waste is still small world-wide, and also in Finland. It has been estimated that in Finland in 2012 71,2 million kg of textile went out of use, out of 80 % ended up as waste and 20 % to separate collection and sorting. Majority of waste textile ended up being burned, only 1,5 % was recycled. However, the new waste directive will have a major effect on the way textile waste will be handled in the future. By 2025, all the EU countries need to organize a separate collection for textile waste. There are many challenges that need to be tackled before the material of textile waste is utilized in a larger scale, e.g. the lack of actors that utilize the material, the lack of waste that is sorted and meets certain demands, the need for more effective sorting processes etc. New kind of value creation is needed which may also mean new activities and roles.

Action 6

Project for analyzing the development steps for textile recycling. A project will be started to analyse the current state and development needs for textile recycling as well as the measures for activating actors. The aim is to recognize the actors and the needs of the textile ecosystem in the region, to analyse the investment needs for various recycling technologies in relation to cost-effective production capacity and to organize innovation workshops with a special aim to share good practices, support measures and bring actors together. The aim in the first project is to reach as many actors as possible - actors that already have a role in the textile ecosystem and that could be part of it. A coordinator, who will be responsible for the management of the project is still unclear. The actions should take place as soon as possible during the current year. The possible fundoung sources are Business Finland, ERDF and the EAFDR.

Starting a company project or taking part in a research project. Based on the findings and collaboration started in the previous, analysis project, preparations for a company project or for a research project will be started. One option for this collaboration is Telaketju project for which continuation is already planned. The responsible actor for the action is still unclear and there is no accurate schedule for the action yet. The preparations for Telaketju 2 project are expected to take place in the end of 2018, when also the preparations for joining the project should be underway. The costs for the projects have not been estimated at this point but the possible funding sources include Business Finland, ERDF and EAFDR.

4.6 Wales

5.1 Presentation of the Tools

Introduction

The Circular Economy - where waste is minimised, and the value of products and resources are kept in the system for as long as possible - offers a number of benefits to Europe. These include the

potential for economic growth and job creation, encouraging innovation, enhancing the security of supply chains and building economic and environmental resilience. It offers an opportunity to make the European economy more competitive and more sustainable - bringing benefits to industry, businesses and citizens.

According to the recent European barometer, focusing on circular economy and SMEs and published in June 2016 in Europe, nearly three quarters of SMEs (73%) have undertaken some activities related to the circular economy in the past 3 years. The most common activities include minimising waste by recycling, reusing or selling it to another company (55%) or re-planning energy use to reduce consumption (38%). Although the majority of the companies in the 25 Member States have undertaken some activities, there are still large variations across the EU. Looking for instance at some of the CESME project member countries, in the UK and Greece, two third of the companies are already taking actions (84% and 73% respectively). In Bulgaria, on the other hand, less than half of the SMEs are taking steps to become more circular (44%).

Amongst companies which have undertaken activities related to the circular economy, 61% say they have encountered at least one or several issues. The most mentioned potential obstacles are complex administrative or legal procedures (34%), the cost of meeting regulations or standards (32%) and the difficulties on accessing finance (27%).

Amongst companies that have not undertaken activities related to the circular economy, the most mentioned potential obstacles are the lack of clear idea about cost benefits or improved work processes (27%), the lack of or clear idea about investment required (27%) or the lack of expertise to implement these activities (26%). The CESME project offers some relevant solutions to meet some of these challenges.

Accessing the circularity of SMEs

In order to know if SMEs are fit for circular business models, it is important to know how to assess the level of their green profile. Do companies invest in renewable energy? How is waste recycled during the production process? Is the company promoting repair/reuse to keep their products in use for a longer period? This first set of questions may be of high relevance to already acknowledge the first efforts done by a company before starting its circular transformation. At the same time, it is essential to measure and track the progress in order to get a roadmap of possible future actions.

Several tools have been developed, tested and used in the recent years. Some are qualitative in essence, others focus on quantitative results. A number of organisations such as Ellen MacArthur and McKinsey, but also minor organisations have developed tools to score the green profile of a company. They all differ in terms of focus, level of details, output format, etc.

As there are several tools on the market already, there is no need to develop yet another tool. The CESME project has examined the different tools in order to identify one that is:

- Flexible (can be used by different types of companies in different branches)
- User friendly (can be managed by companies themselves)
- Leave valid and reliable results

In order to identify the existing tools on the market, different contacts were held with direct sources:

- Consultants active in SMEs and environmental management (for instance the Green Office consortium, EMAS helpdesk at the EU Commission, etc.)
- Circular economy associations/organisations (circle-economy in the Netherlands, Ellen MacArthur Foundation, etc.)

- Academics actively working with circular economy.

Some publicly founded projects have also been analysed to identify relevant tools: H2020, FP7, Erasmus+, Leonardo da Vinci, Interreg with deliverables including some green evaluation tools.

Based on the identification of the tools, they were all cross-evaluated according to the criteria mentioned above. In the framework of the CESME project, an online tool was favoured. A tool focusing exclusively on circular economy was also considered preferable. Following this first filtering exercise, two tools remain: 1) The Circular Economy Toolkit and 2) The Circle Assessment.

As the latter is currently be adapted to be made available in an open source version ready by summer 2017, it is the first advised to use The circular economy toolkit.

The Circular Economy Toolkit

The toolkit is developed by Cambridge University and is located on the link: www.circulareconomytoolkit.org

The toolkit is an online self assessment tool, free of charge where no qualitative data are needed. The challenge is broken down into seven key opportunities.

The Circular Economy Toolkit supports businesses in developing more environmentally sound decisions which will create new opportunities, save money and attract customers. With the vast number of possibilities for creating value out of circular economy and cradle-to-cradle thinking, it can be challenging to asses all the options. The Circular Economy Toolkit has consolidated all the opportunities and provided information on how companies can benefit from circular economy.

The website provides a '5 Minute Assessment Tool' which analyses the products and services sold by a company and gives guidance on potential improvement areas. The 'Workshops' section encourage companies involve themselves by downloading all the materials they need to run their own workshop and start finding opportunities for themselves.

The opportunity assessment tool has combined literature, survey results and observatios from workshops. The assessment tool provides an indicator of potential areas for business opportunities or improvements according to the product design and the business operations. Greater benefit may be seen according to industry, product, positioning in the value chain, relation with the customer, etc.

The tool provides a large set of dimensions related to circular economy. The toolkit offers relevant information and training material associated with the assessment tool.

The overall approach focuses mainly on manufacturing companies, whereas the tool is less relevant for companies with a strong service approach. It should be noted that the assessment tool considers the result against best practice e.g. using 100% fully recycled materials even though it might be technologically unachievable as the assessment tool is unable to assess the difficulty for the business to further stretch the product or service performance. This needs to be undertaken in a more thorough discussion and analysis.

The Circle Assessment Tool

The toolkit is developed in the Netherlands and is located on the link: www.circle-economy.com

The tool is available on request. An open source version will be available from September 2017. The full version approach comes against a fee. A lighter open source version is available free of charge.

It is an online tool to help businesses understand the different operational and organisational aspects of the circular economy, following the seven specific categories defined as key elements of the circular economy.

The Circle Assessment Tool enables investors to review the circularity of companies within their portfolio and collaborate with investees to improve their circular performance in order to reduce their risks, capitalize on new opportunities and enable long-term growth.

It is the first ever automated online tool designed to assess the circularity of a company through a set of six key indicators known as the C.I.R.C.L.E framework which allows the company to evaluate their performance through an online survey. Companies are evaluated based on the extent to which they are pursuing and implementing various circular business strategies and investors are able to review the circularity of their investees and identify areas in which they can improve the overall performance of their portfolio.

The results of the tool score the companies on their current circular thinking as well as educates companies on potential circular opportunities to explore further. The assessment can be completed for the entire organisation, completed across multiple business divisions as well as completed over time to track the progress.

The tool in its full version may also provide relevant information for business advisors who may get overall insights on strengths and weaknesses of SMEs at local level.

As the tool is focusing on a qualitative assessment, it may be relevant to combine it with a quantitative approach as well.

5.2 Presentation of the Tool Application per Country and Region

GREECE - Central Macedonia Region

In general

In total, within one month, the tool was applied to 4 SME’s in the Region of Central Macedonia belonging to 4 of the RIS3 of Central Macedonia "champion" sectors. Specifically, the enterprises according to their sector are:

1. Agro-Food Sector: KONVA SA - fish processing industry at the Industrial Area of Stavrochori, Kilkis
2. Tourism Sector: AVALON Hotel - 4-star hotel in the Airport Area in Thermi, Thessaloniki area
3. Textile Sector: MALLIACHOVAS & CO. - Textile printing company in N. Efkarpia, Thessaloniki area
4. Building Materials Sector: D. Tsavachidis OE - Production of PVC Compounds and plastic profiles for building use in N. Santa, Kilkis area

The companies participated actively and pleasantly in the implementation of the tool. The entrepreneurs were (some more than others) aware of the notion of Circular Economy and in many cases have incorporated relevant actions both in the production process and in the management of

their resources and waste. These meetings, they said, were particularly useful to them and they were interested in further updates on Circular Economy.

Specifically:

S(E)ROI

1. The tool is quite complicated and difficult to complete in its entirety. Templates require information that sometimes cannot be given by companies. In particular, the following categories, where qualitative data was required, could not be completed by all the SME's:

- Labor Productivity Improvements - In Greece improvement in productivity is not measured. Moreover this information could not be extracted from any other data provided by the enterprises.
- Number of days (total reductions); number of staff declaring increased 'positive functioning'. This indicator was abstract and incomprehensible by SME managers & owners. The consultants could not complete this section as all of them consider that their employees "*are happy as long as they are getting paid*".

Nevertheless, informing entrepreneurs with regard to social data that have financial return was considered particularly useful.

2. The data collected included certain assumptions to be made by the consultants on behalf of the SME managers/owners so that the tables could be completed. Specifically:

- in cases where "Material Costs" could not be given, data relating to specific resource or resource costs (for example, only transport fuel) were entered.
- In order to fill in the profit margin certain calculations that entailed the SME's balance sheets were necessary to be made by the consultants. In one out of the 4 cases the SME refused to provide financial data. The remaining 3 SME's had trouble in handing over the information because certain SME's do not have balance sheets (depending on the size of the enterprise) and others needed time to gather the information.
- Several calculations were made in order to fill in the "CO2 reduction" cells as companies do not record such data (e.g. CO2 released from oil burning, etc.).

- In the cases of expenditure, responses were easily obtained and data was collected for all the categories. Unfortunately, financial liquidity in the country leaves little room for predictions as most companies are unsure of their viability and revenue, so they find it difficult to think about buying machines, renovations, upgrades, changes and improvements.
- Further explanation on the effect of SR(E)OI is needed as the utility of the tool is not easily understandable by the entrepreneurs.

Templates 1-8:

The predefined templates were generally easily filled in during meetings with SME managers. Some more specific comments are:

1. The templates for stakeholders involved mainly general questions whose answers were not always related to the concept of circular economy.

2. The indicators refer to data that can easily be found.

3. In Template 3 the role and the objectives of stakeholders needed to be analyzed. In this template it was not possible to analyze 5 stakeholder personas from different categories.

ITALY - Emilia Romana Region

The tools created within CESME have been tested on an Italian company, located in Emilia-Romagna Region and belonging to the Local Support Group. EDILTECO operates in the building sector having 26 employees and meeting a sales revenue of 5.893.000 e in 2016. In particular, the company produces materials for insulation (thermal, acoustic, vibration, fire protection). The resources used during the production process include natural inert resources (sand, clays, waste), synthetic resources (polymers), labour and technological know-how.

Goals

Edilteco is a company strongly committed to environmental sustainability of products and process. Here are some of Edilteco initiatives targeted to increase sustainability, listed in an increasing order of innovativeness:

1. Life Cycle Assessment analysis (LCA) has been conducted to a “Ready to use, lightweight thermally-insulating base screed”, which can be considered as a “normal” product (i.e. not “green”), in order to be aware of its environmental impacts and to understand how improvements can be introduced
2. The company has created a “green” product by working on the content of recycled material: it is a lightweight substrate for thermal and acoustic insulation, containing recycled natural aggregates (olive kernels), with a total amount of recycled material up to 49%
3. The company is carrying out a disruptive green innovation for a new product (MAS.TER.PIECE project, co-financed by ERDF call on applied research): the aim is to study new screeds with a high content of recycled material (secondary raw material and waste from ceramic industry and foundry) but with the same performance as traditional concrete, in terms of thermal/acoustic insulation and fire/water resistance. Further innovative features of this new product are to keep the production cost low and to make the laying of the product easier for the final user. The percentage of recycled material in the final product is very high (85%) without undermining the resistance of the material.

It is interesting trying to understand why the company has decided to become “greener” (this part matches with “establish the company goal” phase of the tool). Edilteco has always paid attention to the reduction of its environmental impacts, it is within the company policy targets. Besides the commitment for environmental sustainability, the company is pursuing a green/circular business also because of profitability related to the following key-factors:

1. Environmental sustainability is relevant for all certifications related to building sector (i.e. international certification as Leed and national certifications as Itaca and Casaclima)
2. Recently, at national level, compulsory environmental criteria have been introduced within the Green Public Procurement legislation. GPP requirements for the building sector are listed below:

 -The use of recycled material has become compulsory for those who want to participate to public calls

 -Public authorities have now the possibility to assign higher scores to those offers including use of sustainable materials

 -At least 50% (in weight) of building components must be disassemblable

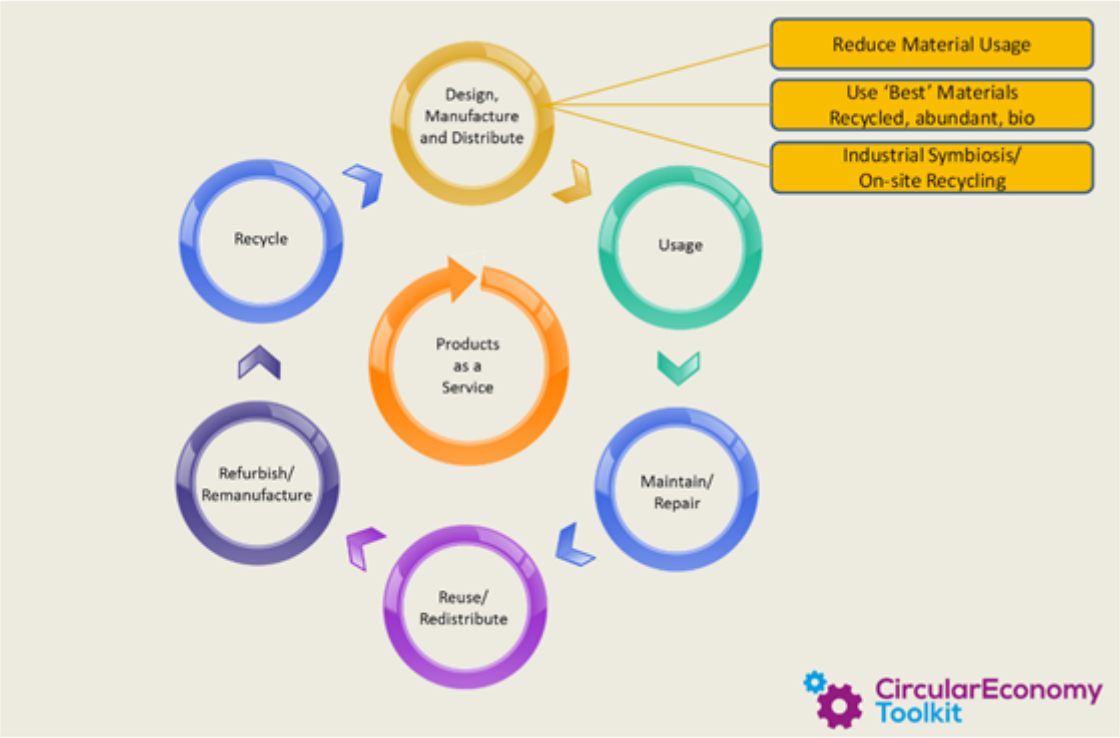
 Recovered or recycled material must be at least 15% (of the weight) of the total amount of the material used for the building.

3. A growing “green” awareness of the consumers turned the environmental aspects into a priority for the company, which wants to satisfy the requests coming from a more sustainable consumption model.

Tools application

Green Profile assessment tool

This tool could be very useful for those enterprises which can be considered “absolute beginners” for the Circular Economy and that need to be guided step by step. With a company like Edilteco, which has already a deep awareness of sustainability of products and process, some steps can be skipped and we can jump directly to the tools that are more useful. For example, we find the identifications of the business models very useful, by means of the cycle image of the web-tool (Circular Economy Toolkit):



Each business model has some peculiarity and it is very important to define the model a case study refers to. The cycle helps for categorizing all business models related to circularity, so it represents a good baseline for further reflections. The discussion with the company leaded to the following categorization of the 3 above-mentioned initiatives of sustainability:

 -LCA analysis could be considered similar to the target of the tool, as they can both be useful for the definition of the business model: LCA supports in the identification of those areas in which the

environmental impact must be decreased and sustainability must be improved; for instance, if the result of the LCA analysis shows that the lifecycle phase with the biggest environmental impact is transport, the company will choose “Distribute” as the business model to work on. Obviously, the LCA analysis is more detailed as it provides quantitative information whereas the web tool provides a qualitative overview; on the other hand, the web tool is free and doesn’t need a consultant to be carried out

 -both initiatives of the company for the introduction of recycled materials could be categorized in the business model “Design”.

Another interesting point arisen from the discussion with Edilteco is that a company could develop more than one business model. The business model is often connected to a specific product and not to the whole company; for example, the product design within the project MAS.TER.PIECE contains recycles materials (“Design” business model) but it has also been conceived for an easier and shorter laying from the users (“Use” business model).

Social and Environmental Return On Investments

For every business model it is very important to develop a return on investment model. When the ROI is from 3 to 5 years, we can label the situation as a “Win-win” situation, which is the best condition to foster and spread circular economy as the economic benefits are clear for enterprises. Environmental and social values are harder to express and insert in the model.

Some difficulties have been encountered during the application of the SEROI tool:

- Adding Environmental value to the ROI. From our case study the only possible ways to do this calculation are the following:

 - to find a shared and institutionally approved value for CO2 emissions

 - to add the resource value in the «use» phase during the life cycle (e.g. water and energy consumption)

 - to add the waste disposal cost (more difficult)

- Adding Social value to the ROI is possible only when the stakeholder engagement is strong and can affect some of the following aspects:

 - Employment

 - Local community

 - Customers/end users

In our case study, we have identified for each value category (economic value, social value, environmental value) the following Circular Impacts:

- In order to assess the Economic value, we needed to identify/quantify at least:

- Costs related to the management of waste (incoming recycled material)

- Increased sales for new “green” products

- In order to assess the Social value, we needed to identify/quantify at least:

- Ability to meet the need of all customers (building companies) that have to comply to new GPP requirements (in relation to the use of recycled material)

- Interest from the territorial industry of the olive oil, that can turn a waste into a resource

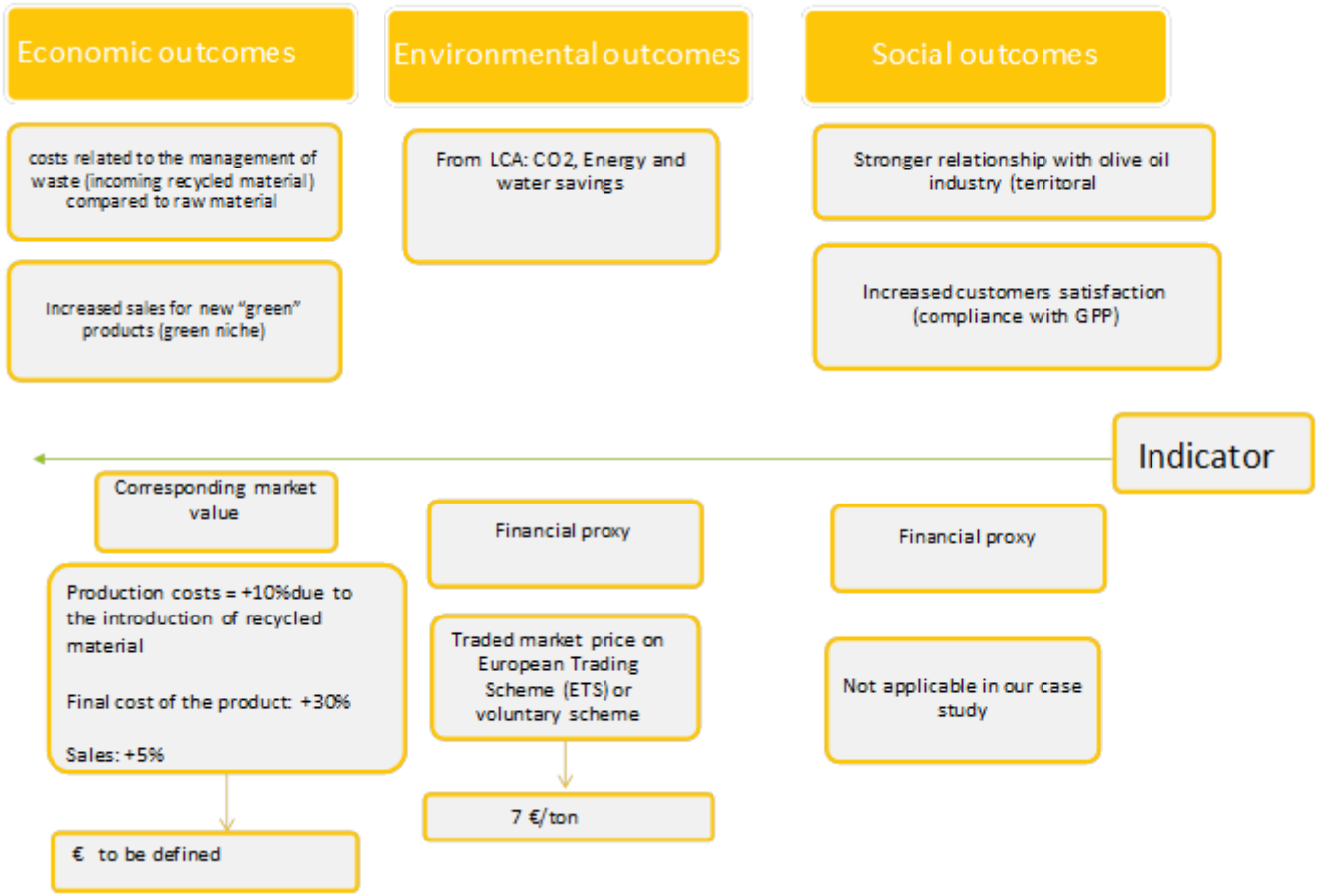
- In order to assess the Environmental value, we needed to identify/quantify at least:

- waste diverted from landfill

- virgin material savings

- energy and water savings.

We have then tried to identify appropriate indicators with a market value or ‘proxy’, enabling us to measure the impact that matters to each stakeholder and to compare social, environmental and economic outcomes and values, as requested from the tool. This image shows the result :



Lessons learned and follow-up activities

The application of the tools to the company has been very useful as we introduced the business models in the discussion about circular economy: we understood how much we need to discuss with

them about economic issues/benefits in order to foster circularity.

The tools should be used with an external support from a territorial/business agency as it is quite a long process and the language is very technical, therefore a sort of “translation” is needed.

Not all the phases have the same importance, it depends on the level of “maturity” of the company about circular economy. In our experience two steps are fundamental:

- *Definition of business models and comprehension of the advantages of the practices.*
- *Calculation of the ROI for every practice with the adding of economic value for: CO2 saved, energy saved, water saved, waste disposal (note that a correct evaluation of CO2 is possible only with a product carbon footprint).*

The other steps of the tools could be defined as secondary and filled out only when relevant (example: social issue, stakeholder definition).

For these reasons, we have revised the tools with the aim of making them more understandable and user friendly for local companies (translation to Italian included). We have kept the web assessment tool in order to have a support for the definition of the business model; we have then designed a working tool that will combine business models and companies’ business plans. The current version will be presented during the next Local Support Group meeting and it will then be tested on some companies.

DENMARK - North Denmark Region

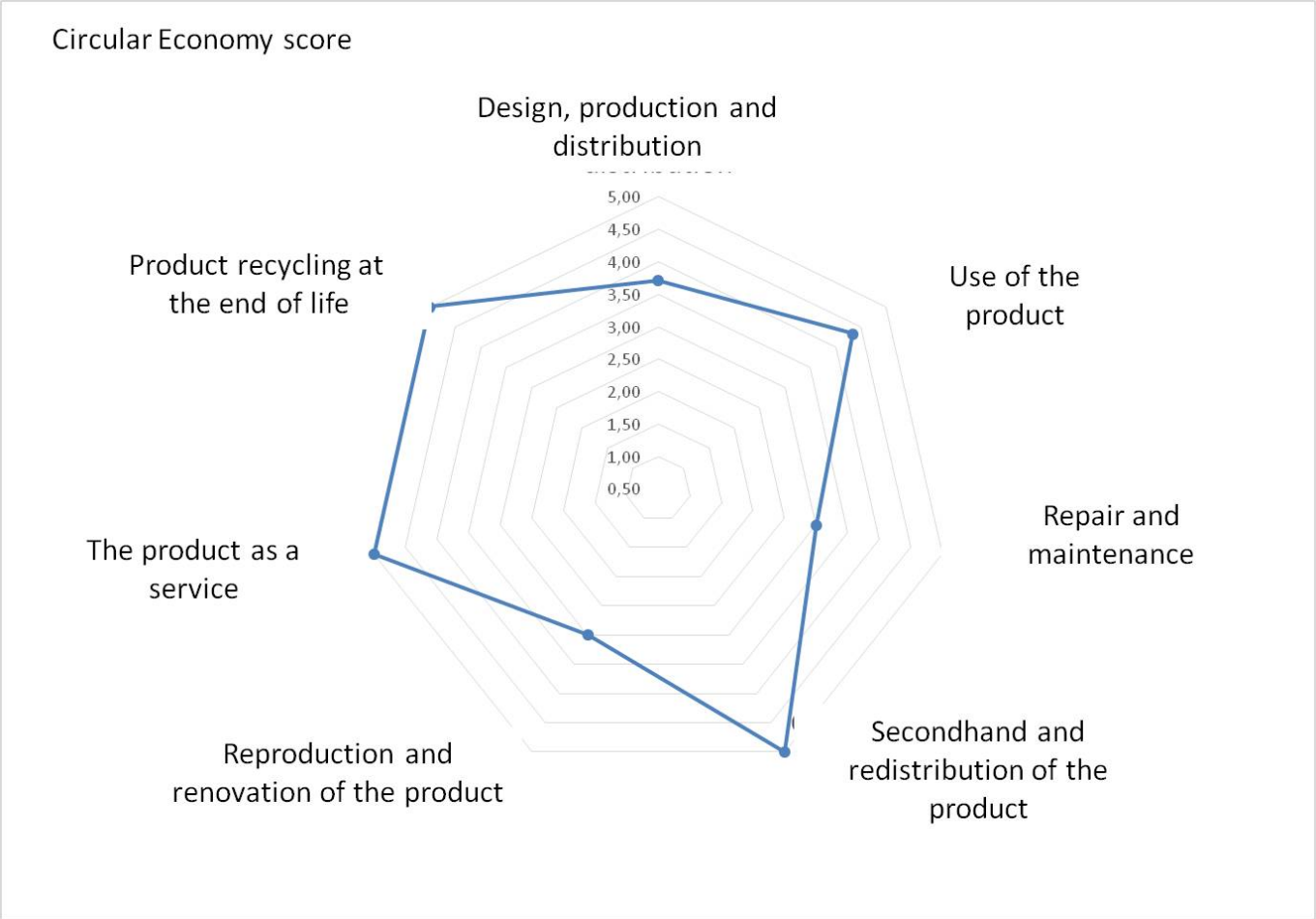
The use of the modified Cesme tool kit in Denmark took place in the 'RebuyBaby' company. The company provides a service concept where the customer subscribes to high branded children's clothing meaning that every month the customer receives a shipment with “new” clothing adjusted to the age of the child (currently supported is 0 to 2 years) and the season (summer, fall, winter, spring) and every month the customer returns the last months shipment of clothing back ReBuyBaby.

The returned clothing is washed, cleaned and checked for damages and are then shipped out to the next customer/subscriber. It is expected that the clothing can be re-used and re-shipped 3-4 times before the quality perception for high branded clothing runs out. After expiration the clothing are handed over to different charity organizations where the clothing typically is sold or auctioned away.

The findings based on the screening tool show that it would be useful to sort out waste from the “production” into plastic and paper and then reuse it and/or recycle it. In addition, one could appeal to the producers that they only deliver in bulk and no single wrapping in plastic bags. Besides the frequency of the shipment could be increased to reduce fuel and carbon footprint from the transportation forth and back to the customers.

The experience with the actual tool indicates that the different areas and subjects in the tools have different relevance depending of which type of product you produce and business model you are in like production, trade or service etc.

ReBuyBaby was open for recycle discussions and the tool turned out to be a good “ice-breaker” to fuel the discussion.



FINLAND - South Ostrobothnia Region

The Finnish partners (PP5 and PP6) have not tested the CESME toolkit with a local SME during the first phase although a lot of research and assessment for the tool have been done. As part of the development done with the regional action plan the external expert VTT has evaluated the usefulness of the toolkit and created a Finnish user guide for its use.

In the comments received from the external expert, the toolkit is highly an ambitious and complicated tool that still needs quite a lot of further development in order to be used in professional work. The pit falls of the tool lie especially in the ROI-method. Evaluating the sustainability impacts of new products or processes is not an easy task and therefore the abilities to find and choose the right indicators and especially evaluating the values for the indicators demands a great amount of expertise and background material. This means that there are quite a lot of requirements for expert who is applying the tool with the local SMEs. The first parts of the tool, however, seem to work better and have received more positive comments. The methods used to assess the green profile and to develop actions to enhance the sustainability and green profile of the companies are much simpler and straightforward to apply.

In order to test and apply the toolkit more thoroughly the Finnish partners have applied for a pilot project from the Interreg Europe programme. In the pilot the toolkit would be adjusted so that it could be used by the local business developers and other applicable actors. During the pilot the toolkit would be also tested in local SMEs.

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