



# ECOCITY FORUM

# CIRCULAR ECONOMY GUIDEBOOK

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## Foreword

A circular economy is a regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing energy and material loops; this can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, recycling, and upcycling. This is in contrast to a linear economy which is a 'take, make, dispose' model of production. Thus, circularity offers an alternative model based on the idea that circulating matter and energy will diminish the need for new input. Its concept lies in maintaining the value of products, materials and resources for as long as possible and on the same time, minimising or even eliminating the amount of waste produced. Circular economy is an alternative to a traditional linear economy (make, use, dispose) in which resources are in use, cascading for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life.

At European level, the circular economy has been developed relatively recently as a solution for achieving the European objectives of economic development under restrictive environmental conditions. In other words, the implementation of circular economy activities is essential to maintaining and increasing the competitiveness of the European Union. More specifically, the “Circular Economy Package” was composed of a revision of EU waste legislation and a Circular Economy Action Plan that focused on four key action areas (production, consumption, waste management, and secondary raw materials), and five priority sectors (biomass and bio-based products, plastics, food waste, critical raw materials, and construction and demolition). In other words, the European waste recycling policy has contributed to the development of the European circular economic model, in particular by promoting policy and legal measures to support waste recycling and re-use of waste materials in productive processes.

A circular economy is not something that any single institution or company can do alone. It thrives on connections, whether between business actors joined in an industrial symbiosis or cities exchanging knowledge and experience. The best way to make the first steps towards a circular economy is to join those that want to move in the same direction, or better yet, are already a few steps ahead.

The benefits deriving from circular economy are the following: (a) improved competitiveness by creating savings and reducing raw materials and energy dependency, (b) improved security of supply and control of rising costs, (c) contribution of EU climate policy by reducing greenhouse gas emissions, (d) employment opportunities, (e) reduction of environmental impact of resource extraction and waste disposal, and (f) opportunities for new business going from earning revenue by selling goods to offering services.

This Handbook presents much of the material presented in the 2018 Thessaloniki Ecocity Forum on the circular economy in a format that is intended to help local leaders implement their own vision and strategies for a circular economy. A series of seven steps is suggested that can guide an implementation team forward.

## Introduction

The effects of globalisation present one of the greatest challenges of the 21<sup>st</sup> century. Climate change, extreme social inequality and the rapid rise in global population are very serious problems that can only be solved by the international community on a global level. Combating climate change, which according to the UN secretary general António Guterres is “the most systemic threat to humankind”, is more than an ecological question: It is about security and freedom, potentially perhaps even about war and peace (Radermacher, 2017).

In close relation to climate change, resource scarcity is another major issue for the international community. The pressures of population growth, economic growth and climate change are placing incredible stress on finite, non-renewable resources such as fossil fuels and minerals. Demand for these resources is expected to intensify as efforts are underway to exploit the world’s remaining deposits, and protectionism efforts are the response of some countries. A transition to a more sustainable growth model is the only solution if access to these resources is to remain possible for future generations.

A key for achieving sustainability regarding the world supply of all necessary resources (including raw materials and energy) is the successful implementation of circular economy (i.e., an economy which is regenerative by design, with the aim to retain as much value as possible of products, parts and materials) combined with energy transition to renewable sources and the rise of the Internet of Things in the frame of the so-called 4<sup>th</sup> Industrial Revolution. The International Energy Agency predicts that renewable energy will comprise 40 percent of global power generation by 2040 (International Energy Agency, 2019).

The concept of a circular economy has been discussed since the 1970s. Yet, switching from the current linear model of economy to a circular one has only recently attracted increased attention from major global companies and policy-makers (Wautelet, 2019). In time for the World Economic Forum 2012 in Davos, the Ellen MacArthur Foundation and McKinsey Company published a report that evaluated the potential benefits of the transition to a circular economy: it could create an opportunity of 630 B\$ a year for only a subset of the EU manufacturing sectors (Ellen MacArthur Foundation, 2012). Next to the huge economic benefits, significant environmental and social benefits were predicted from a transition to a circular economy.

Although policymakers have a significant role in paving the way for circular economy implementation, mainly by preparing all necessary legislation and regulations and by providing meaningful incentives, it will be crucial to convince society that the collaboration of the citizen is essential for a rapid breakthrough of circular economy. Therefore, it is decisive to engage also NGOs in this transition process, as these organisations are appropriate mediators between governments (especially at the local and regional level), enterprises and the public.

The EU reacted rapidly considering circular economy a high priority issue. Already 2015 the European Commission adopted an ambitious “Circular Economy package” covering the whole cycle: production, consumption, waste management and secondary raw materials. EU’s view is that circular economy is a driver for a modernised economy with high environmental relevance while contributing to the UN Sustainable Development Goals (SDGs). New business models and innovative solutions are necessary for achieving a circular economy, and there is sufficient evidence that this process will be very beneficial for the labour

market. Different industrial sectors will be linked to enable industrial symbiosis with the support of public bodies, and the overall success will strongly depend on the availability of additional public and private investment (European Commission, 2017).

## Circular Economy for ecocities: A Handbook / Roadmap to help take first action steps at local level

In the last few years circular economy is receiving increasing attention worldwide as a way to overcome the current production and consumption model based on continuous growth and increasing resource throughput.

Cities could be uniquely positioned to drive a global transition towards a circular economy, with their high concentration of resources, capital, data, and talent over a small geographic territory, and could greatly benefit from the outcomes of such a transition, by closing-the-loop production patterns within an economic system which contribute to increase the efficiency of resource use, with special focus on urban and industrial waste and to achieve a better balance and harmony between economy, environment and society.

The process of the Circular Transition is a systemic process. The interdependence of the various fields, sectors, regions, countries and continents represents a challenge that we, as a civilization, have never had to face before. We require planetary perspective, global leadership and inclusive management. We also need clearly-outlined national priorities and goals, which should be easily measurable and internationally comparable. We are in a phase of discovery, exploration and innovation. This is why practice exchange is crucial – both good and bad, accompanied by dialogue, a dialogue in which we truly hear each other, and not merely listen. The process of creation of this Roadmap was aimed at opening up a space for this kind of involvement and bonding of circular stakeholders.

With the understanding that there is no one single formula, we have to trace the priority areas for Circular Transition, based in part on extant examples of good practice, put together recommendations and, most importantly, create a platform for constructive dialogue, starting forming connections between the various stakeholders, since a transition is only possible if we work together and in unison. Regional consultations and meetings with stakeholders are required in order to provide with the core information for the creation of a kind of Roadmap.

We have confirmed that, by collaborating, we can reconcile and connect the nodes that can accelerate this transition. This means that we must know the national and regional characteristics intimately, understand what competitive advantages are, what differentiates a region from another, etc.

In all this, the Government (national and regional) plays a crucial role – by taking concrete and effective cross-sectoral measures it has the potential to support the key points that represent the potential for a Circular society on local, regional and national levels, and by reinforcing its involvement in the Strategy of Smart Specialization and the established Strategic Research and Innovation Partnerships, as well as to continue actively working on a comprehensive circular transition in collaboration with Europe.

Circular economy is the only way to promote the principles of eco-cities and it is also the main method and effective mode of gaining sustainable development based on a systematic cities and building's planning, using natural resource in a viable way, respecting inhabitable ecological environment and strengthening buildings and cities against natural disasters etc.

Cities play a central role as motors of the global economy and they are at the heart of creativity, innovation and growth. 54% of the world's population live in urban areas, and cities account for 85% of global GDP generation. Cities are also aggregators of materials and nutrients, accounting for 75% of natural resource consumption, 50% of global waste production, and 60-80% of greenhouse gas emissions.

Cities and local communities play a crucial role in the transition. They are increasingly recognised as the central generators of circular change. Cities are operating within a global economic system that is based on the linear "take-make-dispose" model. In the coming decades, cities will be increasingly important as even greater rates of urbanisation are expected, and significant infrastructure investments and developments will be made. A growing global population, largely concentrated in cities, and a rising urban middle class, have led to an increase in the demands and pressures on urban infrastructure and government resources, and an increase in the consumption of resources in cities. Combined with the lack of a holistic approach to urban management, this is leading to economic losses as a result of structure waste and negative environmental impacts.

In a circular economy, the value of products and materials is maintained for as long as possible. Waste and resource use are minimised, and when a product reaches the end of its life, it is used again to create further value. This can bring major economic benefits, contributing to innovation, growth and job creation.

Circular economy origins are mainly rooted in ecological and environmental economics and industrial ecology having as ultimate goal the decoupling of environmental pressure from economic growth of finite raw materials and resources and in this way increasing societal welfare. This can be achieved by gradually designing out waste from economic activities, keeping products and materials in economic use and regenerating natural systems.

In this context, it is important to present the main challenges arising by the linear economy impact, such as the economic losses due to the waste (most of the value in materials we use is "lost" to landfills, and the things we make are consistently under-utilised) and also to some key sectors such as mobility, food, the built environment but also other negative externalities including air, water, noise pollution, the release of toxic substances, and greenhouse gas emissions.

Promoting a circular economy is a high priority on the EU policy agenda because of its potential to reduce our impact on the climate and the environment, foster sustainable economic growth, boost competitiveness and generate new jobs. The transition towards the circular economy is expected to generate multiple economic, social and environmental benefits by accelerating the financing and investing in circular business models.

In this light, a Handbook for Circular Economy is necessary to be produced and to be used as a Guide or as a Roadmap to assist take first action steps at local level, outlining some of the challenges cities are facing in today's linear economy, exploring the alternative of a "circular city" in a circular economy, and finally, enabling, stimulating and developing the key role finance can play in the transition towards a circular economy, having in mind that circular economy holds the promise of prosperity that is restorative and regenerative by design to benefit businesses, society, and the environment.

In this way this Guidebook offers circular economy advisory services, and is active in circular economy networking, sharing of best practices, connecting different circular economy stakeholders and facilitating access to circular economy finance. In light of this, this Guidebook aims to:

- a. promote a common understanding of the circular economy concept and related challenges and opportunities among our financial and project partners;
- b. raise awareness about and promote circular solutions among project promoters and other stakeholders;
- c. facilitate and harmonise due diligence of and reporting on circular economy projects by our financial and project partners;
- d. communicate the vision of the transition to a circular economy.
- e. Involve stakeholders to identify and connect circular practices
- f. create recommendations for the Government to facilitate a more efficient transition
- g. Identify circular opportunities for the strengthening of international

## **Assemble actors from at least four sectors: Government, science/academia, industry, residents**

A circular economy can be achieved by re-thinking and redesigning products, business processes, industrial processes and service models to ensure more sustainable natural resource and material management based on the principle of the 3 Rs – Reduce, Reuse and Recycle – and by encouraging more sustainable consumption patterns.

In a fully circular economy, the concept of waste is minimised to the extent possible so that resources are kept in use in a perpetual flow, and by ensuring that any unavoidable waste or residues are recycled or recovered.

The circular economy concept is gaining attention in light of increasing consumption and resource use by a fast-growing population with rising standards of living. Circularity refers to the circular flow and efficient (re)use of resources, materials and products. This is a new economic model that represents sustainable progress towards efficient green growth, moving from a consumption and disposal-based linear model to extending the life and use of products and materials and minimising wastage. Due to its expected environmental, climate, social and economic benefits, the circular economy is not only being strongly promoted by the European Commission and other EU institutions, as well as a growing number of EU Member States and cities, it is also attracting increasing attention from the business community and from public and private financiers. The circular economy clearly goes beyond resource efficiency and recycling and provides the framework to develop new business models aimed at increasing the value, use and life of materials, products and assets and designing out waste from production and consumption. To this end, the circular economy concerns all of us: It concerns Government, science/academia, industry and residents.

Governments and institutions have to work together in order to limit the excesses of unsustainable interests opening a dialogue on the methods to confront the mounting imbalance of power between organised economic interests and people at large, forcing to adapt to the changing market conditions and increased cost-based competition.

There is no chance that sustainable well-being for all can be achieved, unless citizens and their different associations regain strong civic and political influence through active participation not only at elections, but

also as part of decision-making and implementation throughout society, and by engagement with political representatives between elections on a continuous basis.

To empower people, forceful action is necessary at three levels:

- Democracy must be vigorous, and collective action in different forms must flourish
- Trade unions need to become robust again, and all social partners must be strongly engaged
- Civil society organisations must play a strong role in a vivid and broad civic space

Re-empowering people as citizens, as employees and as consumers must be a central axis for a sustainable society. We cannot hope to address the complex challenges of environmental and social sustainability without more and wider participatory democracy beyond the ballot box. This requires a range of policies all conducive to this re-empowerment.

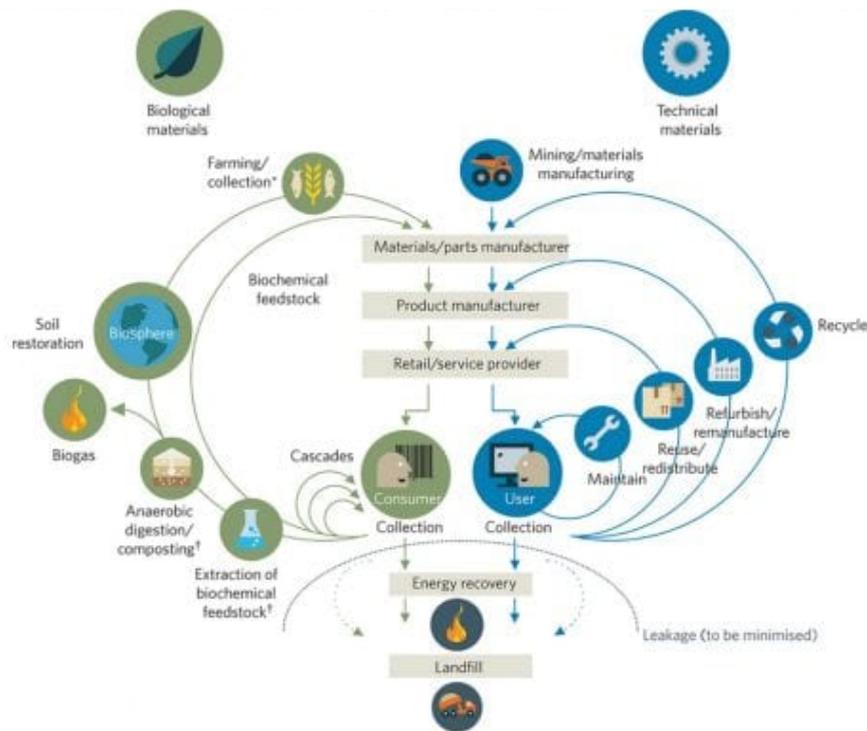
It is the pooling of a number of approaches that will generate a critical democratic mass, reinforced by horizontal approaches aiming directly at invigorating democracy.

In this context three principles are important to keep in mind:

- a. We have to reveal and design out the negative externalities of economic activity that cause damage to human health and natural systems.
- b. We have to design for re-use, remanufacturing, and recycling to keep components and materials circulating in and contributing to the economy (keep products, components, and materials at their highest value and in use)
- c. We have to regenerate natural systems. A circular economy enhances natural capital by encouraging flows of nutrients within the system and creating the conditions for regeneration of, for example, soil.

We also need to keep in mind that:

Circular economy comprises two material cycles: a biological cycle, in which residues are returned to nature after use, and a technical cycle, where products, components or materials are designed and marketed to minimise wastage, as is presented in Figure 1 (Ellen MacArthur Foundation, 2012). Such a circular system aims at maximising the use of pure, non-toxic materials and products designed to be easily maintained, reused, repaired or refurbished to extend their useful life, and later to be easily disassembled and recycled into new products, with minimisation of wastage at all stages of the extraction-production-consumption cycle (European Investment Bank, 2019).



(source: Ellen MacArthur Foundation, 2012)

**Figure 1:** Material cycles in the circular economy concept

## Local Action Plan for the Circular Economy

A Local Circular Economy Strategy is necessary to help businesses and consumers to make the transition to a stronger and more circular economy where resources are used in a more sustainable way, covering the full lifecycle: from production and consumption to waste management and the market for secondary raw materials. The strategy should focus on;

- "closing the loop" of product lifecycles through greater recycling and re-use and bring benefits for both the environment and the economy,
- extracting the maximum value and use from all raw materials, products and waste, fostering energy savings and reducing Green House Gas emissions.

The way and methods to develop and adopt an ambitious Local Circular Economy Plan in Municipal or/and regional level can be achieved in the following steps

- a. **Raising political priorities** by tackling climate change and the environment while boosting job creation, economic growth, investment and social fairness following national and regional targets.
- b. **Establishing a new decision-making process** by; (i) raising information and dissemination campaigns on circular economy challenges, (ii) developing information / training workshops and opening the dialogue

between interested bodies and citizens, (iii) debating, evaluating and assessing political priorities, (iv) taking decisions, and (v) developing an Action Plan

- c. **Funding:** Using the EU funding programme for research and innovation, such as the European Fund for Strategic Investments (EFSI) funding, 650 M€ from Horizon 2020, 5.5 B€ from structural funds for waste management, and investments in the circular economy at national level, etc.
- d. **Working on sectoral measures and quality standards for secondary raw materials,** adopting actions to reduce food waste, to use quality standards for secondary raw materials increasing the confidence of operators in the single market; to adopt Ecodesign working plan for 2015-2017 (promoting reparability, durability and recyclability of products, in addition to energy efficiency); to facilitate the recognition of organic and waste-based fertilisers in the single market and support the role of bio-nutrients; to adopt the strategy on plastics, addressing issues of recyclability, biodegradability, the presence of hazardous substances in plastics, and the Sustainable Development Goals target for significantly reducing marine litter; to adopt a series of actions on water reuse including a legislative proposal on minimum requirements for the reuse of wastewater, etc.

## Revised Legislative Proposals on Waste

The revised legislative proposal on waste sets clear targets for reduction of waste and establishes an ambitious and credible long-term path for waste management and recycling. To ensure effective implementation, the waste reduction targets in the new proposal are accompanied by concrete measures to address obstacles on the ground and the different situations across Member States. 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 (e.g. for packaging, batteries, electric and electronic equipment, vehicles).

## Review generic roadmap

### What is a circular economy?

A circular economy is an industrial system that is restorative or regenerative by intention and design. It replaces the “end-of-life” concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models.

Such an economy is based on few simple principles. First, at its core, a circular economy aims to “design out” waste. Waste does not exist—products are designed and optimised for a cycle of disassembly and reuse. These tight component and product cycles define the circular economy and set it apart from disposal and even recycling where large amounts of embedded energy and labour are lost. Secondly, circularity introduces a strict differentiation between consumable and durable components of a product. Unlike today, consumables in the circular economy are largely made of biological ingredients or ‘nutrients’ that are at least non-toxic and possibly even beneficial, and can be safely returned to the biosphere—directly or in a cascade of consecutive uses. Durables such as engines or computers, on the other hand, are made of technical nutrients unsuitable for the biosphere, like metals and most plastics. These are designed from the start for reuse. Thirdly, the energy required to fuel this cycle should be renewable by nature, again to decrease resource dependence and increase system resilience (e.g., to oil shocks).

### Creating a roadmap on circular economy

"Closing the loop" of product lifecycles through greater recycling and reuse, and bring benefits for both the environment and the economy is the most important challenge of the EU Action Plan for the Circular Economy. In this context the associated plans and measures have to extract the maximum value and use from all raw materials, products and waste, fostering energy savings and reducing greenhouse gas emissions, covering in any situation the full lifecycle: from production and consumption to waste management and the market for secondary raw materials.

The Circular Economy Package gives a clear signal to economic operators that the EU is using all the tools available to transform its economy, opening the way to new business opportunities and boosting competitiveness. The broad measures for changing the full product lifecycle go beyond a narrow focus on the end-of-life stage and underline the European Commission's clear ambition to transform the EU economy and deliver results. Innovative and more efficient ways of producing and consuming should increasingly emerge as a result of the incentives we are putting in place. The circular economy has the potential to create many jobs in Europe, while preserving precious and increasingly scarce resources, reducing the environmental impacts of resource use and injecting new value into waste products. Sectoral measures are also set out, as well as quality standards for secondary raw materials.

The Circular Economy Finance Support Platform will enhance the link between existing instruments, such as the European Fund for Strategic Investments (EFSI) and the InnovFin - EU Finance for Innovators initiative backed by Horizon 2020, and potentially develop new financial instruments for circular economy projects. The Platform will bring together the European Commission, the EIB, National Promotional Banks, institutional investors and other stakeholders, raising awareness of circular economy investment opportunities and promoting best practices amongst potential promoters, analysing projects and their financial needs, and providing advice on structuring and bankability.

The main objective is to support the Local Authorities to produce an Action Plan on Circular Economy concerning first of all the Urban Environment involving as a big priority the principles of a “**Circular City Governance**” (CCG) with the identification, analysis and elaboration of actions in support of Circular Governance in Cities, particularly through better knowledge and better funding, starting from an empirical approach primarily focussed on the identification of:

- a. the most common barriers and challenges that are encountered by cities seeking to promote the circular economy, and
- b. the most important governance interventions cities have taken to initiate and advance in the transition to a circular city.

This information drawing from the analysis of selected case studies of circular economy projects in urban environments, various publicly available circular economy strategies, etc. will be very useful. Action Plans should be prepared by cities based on interviews with experts, officials and citizens contributing to improve the general knowledge basis on the promotion of the circular economy in cities by presenting the experiences and main lessons learnt by cities at the forefront of the circular economy agenda.

**A circular city** embeds the principles of a circular economy across all its functions, establishing an urban system that is regenerative, accessible and abundant by design. These cities aim to eliminate the concept of waste, keep assets at their highest value at all times, and are enabled by digital technology. A circular city seeks to generate prosperity, increase liveability, and improve resilience for the city and its citizens, while aiming to decouple the creation of value from the consumption of finite resources. A circular city will likely include the following elements:

- A built environment that is designed in a modular and flexible manner, sourcing healthy materials that improve the life quality of the residents, and minimise virgin material use
- A built environment that is built using efficient construction techniques, and is highly utilised thanks to shared, flexible and modular office spaces and housing.
- Components of buildings are maintained and renewed when needed, while buildings are used where possible to generate, rather than consume, power and food by facilitating closed loops of water, nutrients, materials, and energy, to mimic natural cycles.
- Energy systems are resilient, renewable, localised, distributed and allow effective energy use, reducing costs and having a positive impact on the environment.

- The urban mobility system is accessible, affordable, and effective incorporating public transportation with on-demand cars as a flexible last-mile solution, electric-powered, shared, and automated.
- Air pollution and congestion will belong in the past, and excessive road infrastructure is converted to serve other needs of citizens. Central to vehicle design will be remanufacturing, durability, efficiency and easy maintenance.
- An urban bioeconomy where nutrients are returned to the soil in an appropriate manner, while generating value and minimising food waste. Nutrients could be captured within the organic fraction of municipal solid waste and wastewater streams, and processed to be returned to the soil in forms such as organic fertiliser – used for both urban and rural agriculture.
- Through urban farming, the city is able to supply some of its own food, reusing food waste and sewage in closed and local loops to produce vegetables, fruit, and fish. Such a system could also provide a more resilient, diversified and cost-effective energy system in the city through the generation of electricity from wastewater, biofuels and biorefineries. These offer additional revenue streams to the city, capitalising on the utilisation of material and nutrients that are already in use.

That means that production systems encourage the creation of “local value loops” and more local production by increasing the value of local economies, of local production, by repairing and distributive manufacturing, collective resource banks and digital applications would feature in these local, circular production systems. A key focus area for local policy-makers will be boosting job creation and encouraging economic development within their constituencies. Initial research suggests that the circular economy could lead to more jobs and entrepreneurial activity within the areas of remanufacturing, repair, logistics and services.

Moreover, carbon emissions are considered a major strategic focus area for local governments, and though high-level results exist on the impact of circular economy activities on carbon emissions, cities need a greater evidence base and more nuanced narrative on the link between the two topics. This could strengthen the arguments and strategic decisions of local policy-makers. As cities commit to moving towards a low carbon economy, a circular economy framework could offer a cohesive model for change.

The “liveability” of cities is also of great importance to local policy-makers for attracting people and remaining competitive. It is often measured by factors as varied as stability, infrastructure, education, healthcare, and the environment. Initial indications suggest that a circular economy will influence liveability positively, through the reduction of congestion, improved air quality, and the reduction of other forms of pollution. However, a more thorough and holistic analysis on the impact of a circular economy on liveability in cities is required, supported by the creation of a narrative on the citizen experience of a circular city. The resilience of cities, as defined by organisations such as 100 Resilient Cities, is the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow, no matter what kinds of chronic stresses and acute shocks they experience. While circular economy activity has been seen to increase the resilience of business’ to external shocks, an exploration of how circular economy activity could increase urban resilience to both shocks and stresses could offer insights into the role a circular economy plays in influencing the fabric of urban environments.

Delivering a roadmap on circular economy is a big challenge for every city. It could be a kind of toolkit for policy-makers - for governments who wish to embark on a circular economy transition. Building on this work, there is an expressed need from local governments to get access to even more specific tools and methodologies that will enable them to begin their city-level transitions. As with any circular economy challenge, a broad collaboration of actors across the board will be needed in order to develop a comprehensive understanding of the pathway towards the circular economy transition.

## **What do good examples look like on the ground?**

In response to a linear economy ripe for disruption, a circular economy holds the promise of prosperity that is restorative and regenerative by design. It is an approach to economic development designed to benefit businesses, society, and the environment. In contrast to the current linear model, the circular economy aims to decouple growth from finite resource consumption.

Today's European Commission Communication on the role of waste-to-energy processes in the circular economy will maximise the benefits of this small but innovative part of the national energy mix. It provides guidance for Member States to achieve the right balance of waste-to-energy capacity, highlighting the role of the waste hierarchy which ranks waste management options according to their sustainability and gives top priority to preventing and recycling of waste. It helps optimising their contribution to the Energy Union and exploiting the opportunities for cross-border partnerships where this is appropriate and in line with our environmental goals.

The package adopted by the European Commission today also contains a proposal to update legislation to restrict the use of certain hazardous substances in electrical and electronic equipment (RoHS Directive). The proposal promotes substitution of hazardous materials to make the recycling of components more profitable. The proposed changes will further facilitate second-hand market operations (e.g. reselling) and repair of electrical and electronic equipment. It is estimated that the measures will prevent more than 3,000 tonnes of hazardous waste per year in the EU, and enable savings of energy and raw materials. In the health sector alone, an estimated 170 M€ in healthcare costs could be saved.

Finally, in its report on progress since last year, the European Commission lists the key measures taken in areas such as waste, eco-design, food waste, organic fertilisers, guarantees for consumer goods, and innovation and investment. Circular economy principles have 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. To make the transition to the circular economy happen on the ground, the European Commission also calls on the European Parliament and Council to progress with the adoption of the waste legislation proposals, in line with the Joint Declaration on the EU's legislative priorities for 2017. In the coming year, the European Commission is committed to deliver further on the Circular Economy Action Plan, i.e. with a strategy on plastics, a monitoring framework for the circular economy and a proposal for promoting water re-use.

The EU Circular Economy Package, including the EU Action Plan for the Circular Economy gives a clear signal to economic operators that the EU is using all the tools available to transform its economy, opening the way to new business opportunities and boosting competitiveness.

The broad measures for changing the full product lifecycle go beyond a narrow focus on the end-of-life stage and underline the European Commission's clear ambition to transform the EU economy and deliver results. Innovative and more efficient ways of producing and consuming should increasingly emerge as a result of the incentives we are putting in place. The circular economy has the potential to create many jobs in Europe, while preserving precious and increasingly scarce resources, reducing environmental impacts of resource use and injecting new value into waste products.

## **Tools needed to create a Circular Economy Plan for municipalities**

The main prerequisites for the effective implementation and transition towards a circular economy model are summarized below:

- Establish common understanding on circular economy concept and gain citizens' acceptance[
- Explanation on how challenges and opportunities can lead to measurable benefits
- Raising awareness about and promoting circular solutions through stakeholders commitment
- Communication of the vision on how the municipal authorities can support the transmission
- Focus and commitment on priorities and practices. Regular monitoring of progress and constant review and revision.

Managerial, organizational and communications structural changes are necessary in order to develop an efficient Circular Economy implementation Plan. Municipal organisations structure and human resources need to be modified and allocate areas of responsibilities. Changes and adjustments according to priorities set, knowhow and skills from the inside or outside working environment are prerequisites for accuracy and effectiveness.

The ECOCITY team explains and supports the municipalities to understand and be prepared to choose the appropriate implementation model according to short-term, mid-term and long-term aspects, taking into account the demands, constraints and needs of each geographical area. Interaction of variables and time limits are also considered, while project evaluation, reporting, liaison with UN SDGs necessary to access financing, Product Environmental Footprint (PEF) and Organization Environmental Footprint (OEF) methods and other factors and variables are included and liaised with society's benefits.

Towards this direction, the following steps are necessary to develop a concrete strategy:

- Development of a SWOT analysis of municipal organization to map the existing facilities and resources including human capital (resource constrains, technological development, socioeconomic development) and determine the priorities and select cooperatives.
- A National Strategic Plan and related framework should be considered to conduct consulting report on the necessary adaptation steps and the models to be followed.

- Allies, subcontractors and experts on issues and subjects related to circular economy should be carefully selected and proposed for collaboration.
- Financing tools and support platforms for circular economy transmission need to be identified and connected with priorities transmission with UN SDGs.

The areas of actions that need to be designed and coordinated/implemented are summarised in the following:

- Training – workshops should be organised with the aim to explain and support the understanding of different implementation models to municipal staff members, executives and municipal counsellors (e.g. cost-effective waste collection, value recovery, waste prevention, behavioural change, circular use).
- Conference – convention event/s should be organised in order to present and support the understanding and benefits of circular economy to stakeholders and citizens – motives and problem solutions are promoted in order to acquire acceptance of the plan.
- Organising and moderating deliberation with stakeholders and citizens on subjects/areas of interests and priorities will assist on explaining the potential business models alternatives according to sectors and particularities of developments to be chosen (recovery, use or manufacturing).
- Integrated communication plans will be required so as to educate and cultivate new perceptions on circular economy benefits and opportunities for citizens, business and the environment. Dissemination and persuasion are critical and thus media, social media, events and material may be designed and produced for different targets.
- Pro-active crisis communication plans should be designed and activated in order to avoid manifestations, social objections and contradictions.

### Prioritisation of issues

Three to five critical issues among those the local society faces, are in question to prioritise, according to data (survey) or experience. Information, criteria, legal framework and financing tools are on the table via educational and training methods in order to include aspects urgently needed, ensure future acceptance and involvement. Resistance to possible changes is also minimised. Priorities differ as issues and societies' needs do also.

In this light, a public dialogue with citizens is required. Circular economy can be promoted at local level in two steps:

- a. Training – moral enhancing team courses are organised for municipal staff and executives. Main objective is to help cities, municipalities and regions to modernise their municipal waste management and adapt it to EU standards. Municipal waste experts from similar cities from other EU Member States can share their experiences on advanced municipal waste management, reducing adverse environmental impacts and waste disposal, increasing waste recycling and promoting waste prevention, improving services for citizens and developing circular economy opportunities for local businesses. These experts will preferably come from other European cities with a similar background, but with more advanced practices and

experience in municipal waste management. Based on the presentations, participants will explore how good practices from these similar cities can be transferred to their cities. The workshop will provide an opportunity for the participants to discuss and work on the practical challenges of modernizing municipal waste management with their peers from cities of other EU Member States.

- b. Suggested plan and options are presented along with benefits resulting from the targets. Opportunities via cooperation, collective forces engaged, and technological means applied are the main tools to serve the above-mentioned scopes.

### **Strategies to attack each priority**

Considerable factors and issues to be taken into account are the individual municipality characteristics (geology, climate, local economy structure, demographics etc.). Moreover, Logistics and Municipality Code operational rules are also analysed and evaluated when conducting realistic time schedules and holistic circular economy implementation plan.

Confronting issues, such as public perceptions based on former cases, and/or evaluating modern priorities are tasks that need to be included in all interactive plans. Furthermore, a crisis prevention plan should be prepared together with a relevant crisis communication plan.

Financing tools and options should be also carefully examined and opportunities for co-actions with neighbouring municipalities or regions developments are invited.

The Circular Economy Implementation Plan per priority (Project management plan) involves the following concrete actions:

- Describe - announce the task and methods to be used
- Set the information screen and feedback - select key messages to communicate
- Develop a common understanding and strong commitment of all parties
- Control and re-evaluate tangible and intangible assets that refer to the priority selected
- Monitoring progress - report according to KPIs
- Identify possible changes - administrative adjustments
- Audit - cooperate with internal municipality services
- Prepare project completion documents
- Assess the plan's sustainability and prepare a proposal for future projects and continuation

### **Agreement for partnership to succeed**

ECOCITY expert's team per specific area consults and guides the city council and municipal authority executives and staff. The municipal representatives act also as links and facilitator for the internal communications with different – relevant departments, thru all processes and as long as the design and implementation plan lasts. Action Plan per project require a series of actions such as

- Introductory meetings with Municipality authority representatives in order to agree on the project content, cooperation, fees and payment conditions. A 3 hour seminar/presentation on CO is offered as an introduction for the Municipalities decision makers in order to fully understand relevant principles to imply.
- Partners select their representatives and assign project coordinator
- Work on MoU text. Sample – MoU among Municipality, ECOCITY, Scientific expert (according to projects to be developed) is prepared by ECOCITY law experts
- MoU agreed & signed by partners
- Prepare the Circular Economy implementation plan
- Circular Economy implementation plan and time schedule agreed and signed
- Project coordinator determines benefits deriving from expert NGO cooperation – ECOCITY Scientific Committee, CE forum, bridging with EC

### **Establish timeline, mileposts and resourcing**

Circular Economy implementation plan develops in phases according to specific areas of interest and the audit results. It differs per case and according to priorities set and partnerships agreed.

Time schedules apply to experts team work, to municipal representatives' responses and also to public consultation, management of messages and handling of targets' arguments. Financing tools timelines do influence the projects development.

Time lines are set to deliver data and reports on internal municipal authority level.

Meetings, interim reports, measurement of achievements are part of the time plan.

Identification and selection of info and data resources, surveys, previous disaster cases or success stories are included.

When necessary, support is derived from the Ministry of Environment – National Plan for Circular Economy, other institutions or organizations related to the areas of interest selected as well as European Commission corresponded

### **Priority communications between meetings**

Communications policies are important and several factors are considered according to the project to be implemented:

- Invitation and meeting with the municipality head / mayor to better understanding about the benefits of cooperation and partnership scheme.
- Key persons and communications logistics agreed according to municipality management grid and project's complexity.
- Potential areas to be developed according to Circular Economy model – benefits to derive from it. Consider targets public opinion.
- Estimate total duration of implementation plan.
- Presentation of credentials (ECOCITY and team members/experts) to targets involved directly and to multipliers (media).
- Experts link with municipality personnel. New priorities set among daily duties.
- Organize introductory seminar on Circular Economy concept and principles for Municipality representatives & executives. May be extended to targets involved.
- Publicity plan to be designed and implemented by ECOCITY team (social media campaign included)
- Reporting and evaluation methods proposed and accepted.

### **Modify roadmap with local reality**

Citizens' acceptance is crucial for everything new. This is accomplished by

- Education on environmental and economic benefits
- Increase citizen's knowledge on opportunities derived from Circular Economy.
- Motivate and positively influence young citizens on the areas of Circular Economy to be developed in the city.
- Educate public opinion on environmental issues costs and explain macro and micro positive effects from Circular Economy implementation model (with success cases). Explain and present funding according to local characteristics and preventions. Mobilize active and leading members of the local community to act and participate to Circular Economy initiatives

### **What are ways ECOCITY can help? (contact information)**

ECOCITY network of Municipality Authorities in Greece since 2008 focusing on consulting services concerning development of friendly environment strategies and projects.

Distinguished Scientists and specialized professionals are listed among members of ECOCITY covering all areas of expertise concerning multilateral environmental development and circular economy implementation model.

Services to Cities ECOCITY members also include coordination of public consultation, conducting environmental strategic plans, co-organize events and press events on special areas of interest (with environmental content).

ECOCITY annual programs and campaigns aim to advocate positive attitudes and behaviors on environmental issues, to motivate citizens on participating to debates and to support and educate local communities on benefits and opportunities to be accomplished by the **integrated circular economy plans**.

The Organizing Committees of the above mentioned programs and campaigns invite Municipal Authorities to co-action in order to expand results in local and national level.

For more information contact ECOCITY Secretariat, tel.: +3(0) 6974476855 , e-mail: [info@ecocity.gr](mailto:info@ecocity.gr)

## Learn from Forum 2018 presentations

### Trends in Energy, Industry, Agriculture and the Management of Wastes

#### Decarbonisation and renewable energy strategies

Developing strategies for renewable energy exploitation serves the basic objectives of Circular Economy and it is one of the pillars of the overall strategy for decarbonisation. Such strategies are implicit in the Paris Agreement (Article 4.19) which calls on all signatories/parties to develop long-term strategies for low emissions; further, Decision 1/CP21 invites Parties to present such strategies ahead of 2020. To implement these provisions across all 28 EU countries, the European Union is preparing minimum requirements and guidelines, under a new governance regulation, for the EU Energy Union project. Prominent in such policy measures are considerations on the exploitation of renewable energy sources (RES).

General issues to be addressed in developing strategies for decarbonisation (that also impact on development of renewable energy strategies) include the need to develop innovative industrial technologies, as well as promote systemic changes to business models and to product markets. However, in strategy development at the country level, additional economic, environmental and social issues/particularities have to be carefully addressed. Therefore, both the approach to develop a strategy for renewables and its contents should be significantly affected by local/country conditions.

#### *Activities and experience*

There is rather intensive activity worldwide to address the various issues (i.e. political, legislative, technical, R&D). Progress has been made in developing strategies for RES exploitation in several European countries of the North; e.g. Germany, Denmark, Sweden. In these countries, significant experience has been gained on the above issues that will enable them to formulate in time a national strategy, in response to the Paris Agreement provisions and the related *EU Energy Union* requirements.

In Greece, fair progress has been made on RES exploitation. In particular, there is significant long-time experience with, and exploitation of, hydropower. Moreover, in recent years, notable progress has been made in harnessing solar energy (through PV cells) and wind power that contribute significantly to the national energy budget. Yet, considering the rich RES resources of the country, much remains to be done to improve their exploitation and meet the targets set by EU. Characteristic is the case of Geothermal Energy and Biomass that have a rather insignificant contribution to RES energy/power production at present, although significant projects are in the development stage.

The presentations in ECOCITY FORUM's relevant session suggested that technical issues do not impede progress in planning and implementing RE exploitation. For instance, the Public Power Corporation - Renewables (PPC-Renewables) is planning/pursuing the Aegean complex, which is a major undertaking (of capacity 3600 MW). This project will involve installations, in islands of the Aegean, harnessing several types of RES, alone or in hybrid form. However, significant impediments to RES development are mainly due to legislative, social and political issues. Legislative steps have been taken in recent years (in conformity with EU policies) that have facilitated development of solar- and wind-power production; regarding the latter, the total installed capacity is over 4580 MW at present (data from ΑΑΓΗΕ S.A. – Operator of Electricity Market in Greece, August 2018). In parallel, a new draft law aims to render geothermal energy in Greece more accessible to all interested parties and to facilitate exploitation. This draft law includes provisions for geological research, renting and management of geothermal fields, issues of granting permits for exploitation, the role of Regional Governments, etc. A related recent law (4513/2018) on Energy Communities is expected to facilitate the active involvement of local communities in geothermal and other RES exploitation plans.

### *Examples of best practices*

Of particular significance are RES installations in the Greek islands, especially those not connected to the national grid. In fact, the first wind park in Europe (5 × 20kW) was installed in Kythnos island in the Aegean in 1982. Further developments on such wind parks have followed.

Relevant legislation and plans by PPC-Renewables that promote water desalination by RES, particularly in remote areas, is a good example of novel/hybrid forms of RES utilisation that are expected to improve public acceptability of such projects of social significance.

Planned projects (by PPC) for power production, through solar/PV-cells in abandoned lignite mines (280 MW), are a welcome manifestation of the transition from conventional/fossil to RES utilisation.

Another area worth noting is the integrated utilisation of heavily polluted effluents/wastes that involves novel technologies, including anaerobic digestion for biogas production and recycling of the treated water; this is a typical example of good practices in the context of Circular Economy (see next section). However, it should be noted that such examples are still relatively limited in Greece, as compared to those in several other European countries. It is hoped that EC-supported policies/initiatives and structural funds (involving subsidies and other measures), that have intensified in recent years, will bear fruits.

### *Knowledge gaps, next steps, actions, proposals*

In the development of RES strategies, consideration should be given to several barriers that have to be overcome and issues to be addressed, which may be categorised as follows.

- i) *Technical and economic barriers.* An effective RES development strategy in any country should address some well-recognised barriers, that include:
  - *Capital investment.* The relatively high capital investment (compared to conventional energy sources) is a widely publicised and over-stressed “barrier” to renewable energy exploitation at large scale. It should be noted, however, that in most RE types/ installations (particularly solar/PV and wind), the very low operating cost and the rather long amortisation period, can lead to total specific energy-production cost (in \$/kWh) smaller than that of conventional power-production sources.
  - *Siting and transmission.* A relatively limited number of high-output power plants characterises power generation by fossil fuels (i.e. coal, natural gas). However, development of power production by RES (notably solar and wind), according to a decentralised model, necessitates spreading across a large area. Although RES decentralisation offers some advantages (mainly grid resilience), it also presents significant barriers such as siting and transmission. In particular, issues related to land use for RES-power installations (siting, transmission lines), including contracts, permits, community relations, tend to be impediments to RES project development.
- ii) *Optimal/sustainable utilisation of RES.* There is a need to develop *overall sustainable* projects of RES utilisation. From this stand-point, the significant case of *biomass* utilisation appears to require particular attention, as the selection of an optimal bio-energy production scheme may not be the only concern. Indeed, one has to consider (in addition to bio-energy) the possible need for (alternative) production of bio-based materials to closed resource loops. Furthermore, carbon sequestration and soil-quality improvement coupled with bio-energy generation are important issues to be addressed, in pursuing mitigation of global climate change. Finally, in biomass utilisation plans, public health issues, resilience of communities and other socio-environmental concerns should be also considered.
- iii) *Social acceptability of RES exploitation projects.* This is a significant potential barrier to RES exploitation, particularly in Greece, where local communities have often taken a negative position and essentially have stopped RES-utilisation projects; geothermal energy exploitation in islands is one such case. Thus, educating the public, ensuring citizens’ support, and actively involving all stakeholders in designing RES-utilisation projects are important issues in the RES-promotion strategy.
- iv) *Innovative technologies.* The development of innovative technologies for all types of RES is pursued internationally, on all aspects of RES utilisation with a view to improved sustainability. The ongoing rather intensive R&D, in a very broad range of topics, is expected to yield disruptive technologies and related break-through that would facilitate optimal RES utilisation. Significant R&D activities in this direction are also ongoing in Greece.

## *Perspectives*

In general, it appears that developing strategies for decarbonisation of the economy, through renewable energies and novel approaches, requires a lot of effort at several levels (R&D, technology development, legislation, social awareness, etc.) and above all citizens education and active support. A well-designed RES development strategy, at the country level, should address all the aforementioned potential barriers, thus facilitating progress toward meeting the targets of Circular Economy.

### **Energy recovery from bioeconomy and waste-to-energy options**

Organic waste and forest residues and are two biological waste fractions whose management is promoted among others in the newly published (October 2018) EU Bioeconomy Strategy. Sustainable bioeconomy is the renewable segment of the circular economy. All biowaste, residues and discards may be transformed into valuable resources and towards this direction incentives are developing, in view of the potential to increase innovation and to promote rural development.

EU Bioeconomy Strategy contributes to both Circular Economy and Energy Union, and its scope is in line with the overall European priorities in order to maximise impact on the priorities also set out in the renewed 'Industrial Policy' (COM(2017)479), the 'Circular Economy Action' Plan (COM(2015)614), and the 'Clean Energy for All Europeans' (COM(2016)860) package. Apart from investments to utilise those potentials, there is a need to develop strategies and implement systemic changes that cut across different sectors where those waste/residues are generated. In addition, it will be essential to work together with various stakeholders.

### *Activities and experience*

Organic waste is the core element of most countries' bioeconomy strategies worldwide due to the limited capacity of existing landfills, the need to minimize greenhouse gas emissions, but most importantly because of the fines imposed by European Union due to the low diversion factor from landfills. In addition, food waste minimisation is one of the UN Sustainable Development Goals (SDG 2). The proposed EU Circular Economy Package 2030 targets for MSW landfilling to be less than 10%, while in Greece that percentage was 81% in 2012. Meanwhile, the overall biological waste (in municipal waste only) is approximately 50-60%, offering a great opportunity for their biological or thermal treatment with regard to EU "Sustainable and optimal use of biomass for energy" report.

Inadequate management of *forest residues* leads to wildfires (due to the failure to collect forest and harvest residues) or road accidents from reduced visibility. In Greece, from 1940 to 1998 the number of fires incidents was below 20 thousand/year on average and human losses were as low as one every two years. After 1988, the number of fires increased to more than 100 thousand/year and human lives losses increased to over 17/year. Fires destroy any potential for circular economy strategies' application, transforming biomass into quality waste. Currently in Greece (2018) only 36% of the existing forests are managed and overall production is only 50% of the corresponding 1988 production. The rest is not harvested and according to the inviolable nature's law, will be lost through fire in the near future destroying nature in the way. The Lower Heating Value of forest residues in the Region of Central Macedonia (northern Greece) is of the order of 20 MJ/kg depending

on the residue type and according to recent studies these residues could be utilised to cover approximately 55% of thermal power needs or approximately 15% of electrical power needs of the area.

Overall both Forest Residues and Organic Wastes may be anaerobically digested to produce fertilizer and incinerated to generate thermal or electrical energy as well as solid, liquid or gaseous fuels (e.g. biochar). Wood chips from traditional plantations, harvest residues and controlled deforestation residues have been used as raw material in CHP plants to supply hot water to schools and hospitals and at the same time electricity. In addition, hundreds of projects exist where organic waste is stabilised and turned into useful compost product, while biogas may be utilised for energy recovery.

Waste-to-energy in the circular economy could ensure that energy recovery from waste in the EU is consistent with the objectives pursued in the Circular Economy Action Plan, when it comes to progressing towards higher levels of the waste hierarchy (prevention, reuse and recycling). Waste-to-energy plants (waste incineration with energy recovery) thermally treat household and similar waste that remains after waste prevention and recycling.

The objectives and expectations from waste-to-energy concern mainly the building of synergies between environment and business agendas and economic and environmental resilience. Circular economy has been characterised as a new growth model because the competitiveness of the EU, growth and job creation can be increased up to +7 % GDP through its implementation. A good example is co-processing, for instance via the use of alternative fuels by the cement industry. This globally tested safe technique is recognised as a suitable solution in the relevant EU legal frameworks and could significantly contribute to circular economy and sustainable development.

Important constituents of a circular economy business model are circular supply chain, product life, materials and energy recovery, sharing platform, and product as a service. Relevant funding at EU level originates from structural & investment funds (ESIF) and the Horizon 2020 programme. For the implementation of circular economy in a country like Greece, a national roadmap should foresee the adoption of given EU legislation, necessary investments, an industrial symbiosis national plan, quality standards for secondary materials, de-characterisation of waste, and green public procurement. Financial incentives consistent with circular economy criteria should include a landfill tax, Pay-As-You-Throw and measures following from the Polluter-Pays Principle and based on total externality cost.

### *Examples of best practices*

An example of implementing circular economy, the BIOREGIO Project (<https://www.interregeurope.eu/bioregio>), boosts bio-based circular economy through transfer of expertise about best available technologies and cooperation models and has already demonstrated an example of best practice in Circular Bioeconomy. The Bioeconomy encompasses those parts of the economy that use renewable biological resources from land and sea to produce food, bio-materials, bio-energy and bio-products. EU countries will now be required to recycle at least 55% of their municipal waste by 2025, 60% by 2030 and 65% by 2035. Other approved measures include a 10% cap on landfill by 2035 and mandatory separate collection of biowaste, which now takes place in ten EU member states. BIOREGIO network offers quick access to municipal biowaste management in the EU available for local companies in Päijät-Häme.

In another example (Munich), the biowaste management was feasible since the implementation of the bio bin as a part of the 3-bin-system was successful. The annual cost of the necessary integrated marketing campaign at the beginning was 0,50 €/inhabitant. It was also observed that bio bin had a high amount of garden waste (about 50%) and that more and cleaner biowaste was collected in low-density areas, whilst low level of impurities was recorded in the bio bin (was 5,5% in total). The content of biowaste in Munich's residual waste was high (30-40%) and thus, the amount of bio bins should be sufficient for increase of quantity. The key lesson learnt was that citizens had meanwhile little knowledge about biowaste separation and recycling.

There is also considerable potential for expansion of biowaste management, which will have a positive impact on the labour market. Assuming that an additional 60 million tonnes of municipal biowaste could be collected and composted/anaerobically digested across Europe, up to 50,000 new jobs could be created. This is particularly relevant in areas of high unemployment, such as southern Europe, where bio-waste treatment capacity is currently small and the potential significant. Sustainable bio-waste management could also be used to strengthen rural areas, regardless of whether agricultural anaerobic digestion or composting plants are built. The Standing Committee on Agricultural Research became a source of advice on European agricultural and wider bioeconomy research, along with being a catalyst for the coordination of national research programmes, where it has helped shape the beginnings of an integrated European Research Area. The bioeconomy covers all sectors and systems that rely on biological resources. It is one of the EU's largest and most important sectors encompassing agriculture, forestry, fisheries, food, bio-energy and bio-based products with an annual turnover of around €2 trillion and around 18 million people employed. It is also a key area for boosting growth in rural and coastal areas.

As far as the waste-to-energy in Europe is concerned, the total incineration capacity was estimated at 88,6 million tonnes in 2014, whilst the municipal waste treatment trends were 18% for recycling, 11% for waste-to-energy and -30% for landfilling during 2001 – 2015 for EU 28. As far as the role of waste-to-energy in the circular economy is concerned, first it was stated that at global level, over the next 10 years, EUR 6 trillion will be invested in clean technologies in developing countries, with some EUR 1,6 trillion accessible to SMEs. Furthermore, waste-to-energy processes can play a role in the transition to a circular economy provided that the EU waste hierarchy is used as a guiding principle and that choices made do not prevent higher levels of prevention, reuse and recycling. In 2014, 1,5% of the EU's total final energy consumption was met by recovering energy from waste through incineration, co-incineration in cement kilns and anaerobic digestion (i.e. around 676 PJ/year). Diverting one tonne of biodegradable waste from landfill towards anaerobic digestion to produce biogas and fertilizers could prevent up to 2 tonnes of CO<sub>2</sub> equivalent emissions. Finally, Member States have some flexibility in the application of the hierarchy, as the ultimate goal is to encourage those waste management options that deliver the best environmental outcome.

### *Perspectives*

Circular economy is both a necessity and opportunity for Europe. Maximising the value get out of products, materials and resources, and minimising waste generation are essential to the EU's efforts to develop a sustainable, low-carbon, and resource-efficient economy.

As the circular economy is at the top of the EU agenda, the EU Member States (including the EEA countries) should move away from the old-fashioned disposal of waste to more intelligent waste treatment

encompassing the circular economy approach in their waste policies. Furthermore, waste-to-energy has been outlined in government reports as part of the waste hierarchy after waste prevention, reuse, and recovery steps. The EU calls for waste management to be transformed into sustainable material management which embeds the principles of Circular Economy, enhances the diffusion of renewable energy, increases energy efficiency, reduces the dependence of the Union on imported resources and provides economic opportunities and long-term competitiveness. As part of its Action Plan, the European Commission proposes to revise the key EU waste regulations: The Waste Framework Directive, the Landfill Directive, the Packaging Directive, and the Directives on end-of-life vehicles, batteries and accumulators, and waste electrical and electronic equipment (WEEE). Even though municipal waste represents less than 10% of the total waste generated in the Union (measured by weight), this waste stream is amongst the most complex ones to manage. The EU considers that countries which have developed efficient municipal waste management systems generally perform better in overall waste management.

Today's challenges are the annual municipal waste generation of 475 kg per person, the 600 Mt of recyclable materials that are thrown away or "wasted" annually, the 48% of total treated waste that is sent to landfill, the relatively low 44% of municipal waste in EU that is composted or recycled and the 50% of plastics that go to landfill (< 25% are recycled). Tomorrow's opportunities are, among others, the 50% less food waste, the 100% ban of landfilling of separated waste, and the maximum 10% landfilling of municipal waste. The effective door-to-door collection of separated waste, the re-design of products and the elimination of superfluous waste are three principles of Zero Waste for the success of a Pay-As-You-Throw programme. In accordance with Eurostat (2016), there is not any energy recovery in Greece, while the mean value for EU is 27%, whilst the landfilling in Greece is 82% (instead of the mean value of 25% in EU).

Waste management in the Union should be improved, with a view to protecting, preserving and improving the quality of the environment, protecting human health, ensuring prudent and efficient utilisation of natural resources and promoting the principle of the circular economy, enhancing the spread of renewable energy, increasing energy efficiency, reducing the dependence of the Union on imported resources providing new economic opportunities and long-term competitiveness. Co-processing is a technology that has been developed more than 40 years ago in Europe; its application continues to improve and expand. Co-processing in the cement industry is the simultaneous energy recovery and material recycling through the use of alternative fuels and raw materials in clinker production i.e. belongs to 'recycle' and 'energy recovery' of EU waste management hierarchy. In other words, co-processing is an optimal solution for materials that cannot be recycled. There are strict specifications during the selection and use of alternative fuels, which must comply with Health and Safety, Quality Production and Environment (WBCSD-CSI Guidelines for Co-Processing Fuels and Raw Materials in Cement Manufacturing, EN 15359:2011 Solid Recovered Fuels Specifications and Classes, and Joint Ministerial Decision 56366/4351 12/12/2017 – Official Journal 339 – RDF Specifications from Municipal Solid Waste). Furthermore, the co-processing in cement production contributes to climate change mitigation because pre-processed waste is utilised, and thus conventional fuels are replaced, while the ash is incorporated in the cement. The environmental investments going beyond compliance for the use of alternative fuels in cement production are closed storage and feeding systems, bag filters, selective non-catalytic reduction, low NOx burners, online analysers, quality control equipment, automating sampling and by-pass for chlorine.

The environmental benefits from co-processing are the non-renewable natural resources conservation, the reduction of greenhouse emissions, the reduction of landfilling and the zero-ash production. Improved competitiveness will lead to low carbon dioxide and low fuel cost, while the import of fuels will be reduced. The benefits for the society will be the safe, low cost waste management solution, the creation of jobs and the increase of GDP.

Unfortunately, Greece had the lower co-processing rate (7%) in cement industry of EU (mean value 41%). The main barrier appears to be the fact that the National and Local Waste Management Plans have not been yet in effect. Furthermore, there are limited streams of high-quality alternative fuels, whilst the landfill tax is not being imposed. Next, there are not any criteria in place to assess investments contributing to circular economy and a trust deficit has been created among citizens, business and authorities.

The conclusions of ECOCITY FORUM's relevant session could be summarised as follows: The European Union has set up priorities for countries with high landfilling rates and with non-existent dedicated incineration capacity, such as to develop separate collection schemes and recycling, to reduce the landfilling of biodegradable waste by anaerobic digestion and to assess the need for additional waste-to-energy capacity for the treatment of non-recyclable waste. The following points should be taken into consideration: the impact of existing and proposed separate collection obligations and recycling targets on the availability of feedstock to sustain the operation of new incineration plants over their lifespan (20-30 years), the available capacity for co-incineration in combustion plants and in cement and lime kilns or in other suitable industrial processes and planned or existing capacity in neighbouring countries. Especially for Greek cement industry, the use of alternative fuels will contribute to climate change mitigation. Greece is lagging in recycling and that is a business opportunity for energy recovery because landfilling should be reduced through recovery and recycling.

### **Industrial symbiosis, closed loop systems and eco-industrial parks**

In brief, industrial Symbiosis fosters the sharing of resources between different processes of a single company or between multiple companies of the same sector or cross-sectoral. In the context of Circular Economy, Industrial Parks are being transformed into Eco-industrial Parks, where companies are encouraged to collaborate and efficiently share resources (information, materials, water, energy, infrastructure and natural habitat). An eco-industrial park is a community of manufacturing and service businesses seeking enhanced environmental and economic performance through collaboration in managing environmental and resource issues, including energy, water, and materials. By working together, the community of businesses seeks a collective benefit that is greater than the sum of the individual benefits each company would realise if it optimised its individual performance only. The goal of an eco-industrial park is to improve the economic performance of the participating companies while minimising their environmental impact. In this context, such a practice is expected to result into substantial economic and environmental quality gains. Moving from a linear to a more circular economy calls for new business models and new solutions for turning waste into resources.

The benefits from Industrial Symbiosis can be multiple at all levels of sustainability, namely economic, environmental and social, including:

- Financial benefits: Industrial Symbiosis turns a disposal cost and waste treatment into a profit centre by reducing the cost of required raw materials for production, maximising the use of under-utilised resources and facilities, spreading costs of new infrastructure and investing in collaboration with stakeholders within their industrial sector or cross-sectoral. Moreover, management of resources is converted into innovation, adding value to “useless” or “non-exploitable” resources and opening up new business opportunities. Compliance with regulations can also save companies significant amounts of money from relevant penalties.
- Environmental benefits: Industrial Symbiosis reduces virgin resource use and net waste generation without compromising economic activity. Through Industrial Symbiosis, waste is diverted from landfills and carbon emissions are reduced. It is considered as a major step towards a more sustainable society.
- Social benefits: In addition to the aforementioned economic and environmental gains, Industrial Symbiosis can play a significant role in improved public relations and also on safeguarding and creating employment.

### *Activities and experience*

At European level, the circular economy is an alternative to the linear development model and is a concept that has been developed relatively recently as a solution for achieving the European objectives of economic development under restrictive environmental conditions. In other words, the implementation of circular economy activities is essential to maintaining and increasing the competitiveness of the European Union. More specifically, the European waste recycling policy has contributed to the development of the European circular economic model, in particular by promoting policy and legal measures to support waste recycling and re-use of waste materials in productive processes. A circular economy is not something that any single institution or company can do alone. It thrives on connections, whether between business actors joined in an industrial symbiosis or cities exchanging knowledge and experience. The best way to make the first steps towards a circular economy is to join those that want to move in the same direction, or better yet, are already a few steps ahead.

### *Examples of best practices*

A circular economy needs to be tailored to the local and regional needs and resources. It is evident that copy-pasting solutions from elsewhere will not be effective, however there is a wide range of good practices already available that can be adapted to suit the local context. The most well-known and widely discussed such good practice that can be further elaborated to match specific local needs is the case of Kalundborg, Denmark. At Kalundborg Symbiosis, public and private companies buy and sell waste from each other in a closed cycle of industrial production. Driven by increased costs of materials and energy demand for businesses, exchanges between companies are initially assessed based on economic gains in saving of resources or money. The partnership of the Kalundborg Symbiosis dates back to 1961 and includes some of the largest industrial enterprises in Denmark. More specifically, at Kalundborg Symbiosis six (6) private enterprises collaborate with three (3) public organisations, with over 5,000 employees being involved and twenty-five (25) different

resource streams exchanged between the various actors. Kalundborg Symbiosis is the Winner of Gothenburg Sustainability Award 2018.

### *Knowledge gaps, next steps, actions, proposals*

Due to the high share of the costs associated with the consumption of raw materials and energy, the European Commission has initiated actions to closely monitor the difficulties that companies encounter in the process of transforming the challenges of environmental pollution into opportunities.

Some of the actions to be taken towards enabling the prevention of pollution created at source include:

- Incentives to transform the operational practices and undertake new innovative technologies.
- Investments in environmental infrastructure and green businesses.
- Strengthening environmental management practices and establishing sustainability criteria to reduce the impact of industry on the environment. Widespread adoption of the European system eco - management (EMAS) and eco - management of the ISO14001 standard.

Some main barriers encountered by the firms in the implementation of circular economy includes:

- Organisational culture and the management values and attitude towards the environmental issues.
- Substantial financial investments related to the implementation of sustainable solutions, from this perspective, access to funds to support sustainable performance and innovation being important.
- Lack of adequate government support and/or appropriate legislation (public funding opportunities, training, appropriate tax policies, etc.).
- Lack of information on the benefits of implementing a circular economy.
- High level of bureaucracy in monitoring and reporting data on SMEs performance in the field of circular economy.
- Lack of internal technical competencies facilitating the transition to business models that allow for the implementation of sustainable production and consumption technologies.
- Insufficient support from suppliers and consumers due to their low interest in environmental issues.

Developing Industrial Symbiosis networks is a knowledge-intensive practice. Information is necessary to discover the potential of symbiotic connections between industrial material and/or energy flows. Therefore, the efficiency of ICT solutions for facilitating Industrial Symbiosis depends heavily on collecting, analysing and integrating highly-diverse quantitative and qualitative data. Such includes, but is not limited, the following; materials / waste quality and quantity data, location data, national statistics, data from questionnaires, national waste registry data, pre-treatment / upgrade processes data, end of waste criteria data, road network and geodata data, iso or other standards, cost parameters data, legal framework, etc.

### *Perspectives*

Clear responsibilities for Member States are already established in terms of advising and supporting enterprises in moving to a more sustainable green economy. However, being sustainable implies costs and

evidence suggests that the decision to be a sustainable entrepreneur is not a frequent one among enterprises. The main motivations affecting the decisions of firms towards this movement in favour of sustainability are obeying the law, increasing profits, and making use of existing opportunities in the market.

A data-driven approach for the facilitation of Industrial Symbiosis is being adopted through the proposition of a significant tool presented during the forum session. The specific tool could facilitate an Industrial Symbiosis scheme at a local/national level is the development of a digital platform which maps and analyses the industrial activity, identifies symbiotic links, measures the link intensity and identifies the symbiotic potential. The above platform is currently developed by the Athena Research Centre (<https://www.athena-innovation.gr>). The next steps of the tool before it presents a market-solution (TRL9) includes the following steps; enrich the registry of industrial facilities, track existing connections, add material substitutions and pre-treatment processes, utilise data from the National Waste Registry and add open data on regional waste streams available from Eurostat.

### **Importance of innovations in product design**

To design products using the principles of Circular Economy requires the application of cross-sectoral collaborative product-development processes. To be effective these processes need to span the entire value chain from material sourcing and design to production and distribution, and from consumption to material reduction and reuse, and from the recycling sector back to production. In practice, there are three hierarchical levels of design sustainability enabled by digital technologies, namely:

- Design Level: Sustainable Design, Computational Design, Optimisation.
- Manufacturing Level: 3D printing, CNC, Robotic in-situ manufacturing.
- Material Level: New materials, Smart materials, Recycled materials.

A wide variety of energy-using products which are utilised daily, ranging from domestic appliances and electronics, to commercial and industrial applications, have a significant impact on the environment, resource depletion and energy bills.

With more than 80% of a product's environmental impact determined during its design, the product policies of Eco-design and Energy Labelling constitute an essential mechanism for achieving the environmental and energy goals of the European Union. This framework has so far been very successful in delivering gains regarding energy savings, consumer empowerment and industry competitiveness.

### *Examples of best practices*

Design plays a vital role not only in product innovation, in general, but also in the transition to a Circular Economic system. Regardless of whether operating in Circular Economy or not, the focus of "Innovation" is on releasing trapped or introducing new value that is both distinctive and central to customers lives, quoting Geoffrey Moore, the author of "Crossing the Chasm" as saying: *"In a world in which supply exceeds demand, efficient suppliers are much less interesting than effective demand fulfillers. Organising around the demand*

*chain will be the new system's focus, and leading that shift in perspective will challenge executives everywhere."*

An impressive number of examples of products and business cases from a global perspective can be identified, ranging from various conceptual designs to design software and hardware including 3D printing, to consumer goods and to industrial symbiosis, some of which are outlined below:

- The Kalundborg Eco-Industrial Park described as the first full realisation of an industrial symbiosis network located in Kalundborg, Denmark, in which companies in the region collaborate to use each other's by-products and shared resources (<http://www.symbiosis.dk/en/>).
- The Green Guru Gear, a sustainable gear producer, based in Colorado that upcycles outdoor gear waste, like tires and fabric scraps, into new products. Thus, reformulating something at the end of its life into new value (<https://www.greengurugear.com/>).
- The Adidas-Parley shoes, made from plastic waste collected from the world's oceans. This Circular product strategy is gradually affecting the entire Adidas product range, with the company planning its apparel line for the spring and summer of 2019 to contain around 41% recycled polyester (<https://www.adidas.com.au/parley>).
- Eco Birdy, a "Good Design Award" winning sustainable Children's furniture manufacturer that creates furniture from 100% recycled plastic waste. The project was Co-funded by the COSME programme of the European Union. (<https://www.ecobirdy.com/>).
- The H&M - I:CO partnership that showcases the power of Cascaded Use. Specifically, the I:CO take-back system makes it possible to collect used clothing and shoes at a retailer's point of sale and give them a new life through reuse or recycling (<https://www.ico-spirit.com/en/>).
- The application of the principles of circular economy in building facades. The main problem in building facades is that the materials are inseparable and might include non-recyclable substances. Preferable are façade systems with parts that can be easily disassembled, with materials that are separable and recyclable. Thus, the facade can be upgraded during its life, and it can be disassembled instead of demolished. This approach facilitates the recovery of materials.

### *Knowledge gaps, next steps, actions, proposals*

One of the critical emergent thematic areas in product innovation is the enabling conditions that can facilitate the transit from the dominant linear "take – make – dispose" model to a circular one. Undoubtedly, this transit requires the reconfiguration of our societies, economies, legislation and design-thinking processes. Product designers, however, face the additional challenge, to enable through their designs, cycles of material reuse, reduction of resource consumption, refurbishment and recycle while designing for potential multiple product life cycles.

Social sustainability is characterised as under-investigated in comparison to environmental and economic aspects. Social sustainability occurs when there is the capacity of current and future generations to create healthy and liveable communities. Socially sustainable communities are equitable, diverse, connected and democratic and provide a good quality of life. Most tools and methodologies, however, are directly linked

more with the economic and environmental pillar of sustainability. Thus, social sustainability has often been neglected as social issues are underrepresented in many cases. From the product design point of view, there is a need for development of tools and methodologies to be directly linked with the social pillar of sustainability. Embracing Social Centred Design (SCD) entails the belief in the notion that all problems, even the seemingly intractable ones like poverty, gender equality, and clean water, are solvable. Additional research is also required for the recovery and recycling of materials as well as on the education of the involved members (architects, engineers, material manufacturers, contractors, demolishers, clients).

The social sector is ripe for innovation. Focused on this target, two “design for X” methodologies are proposed; (a) Design for Promoting Sustainable Principles through user education (D.f.P.S.P.), and (b) Design for Green Usability (D.f.G.U) following the guidelines of the proposed User Assessment Tool.

The potential beneficial role of conceptual design as culture generator for Circular Economy has also been identified. The role of conceptual designers is to stimulate discussion and debate about the social, cultural and ethical future implications of decisions made today. Design concepts that raise public awareness and propose new ways to slow the loops, close the loops or create bio-based and bio-inspired loops are critical and need to be promoted. Such conceptual designs imagine alternative possibilities and different ways of “being” and give a tangible form to new values and priorities towards a Circular Economy.

### *Perspectives*

Success in Circular Economy requires design and systems thinking and a highly collaborative product-development process that involves the entire value chain and spans from design to materials, to business operations, to cross-sectoral collaboration and existing as well as upcoming legislation. Through measures, such as introducing minimum lifetime, designing components which are easy to disassemble and providing repair information, tools and spare parts, the Eco-design and Energy labelling framework offer a wide range of opportunities.

How can digital media for design and manufacturing, facilitate a new creative approach to the Circular Economy? We can all engage to this change of mentality through the eyes of the “digital tinkerer”, a new-age designer, thinker and maker, who is frequently found “tinkering” at a local FABLAB, a Fabrication Laboratory where people are inspired to turn their ideas into products.

A FABLAB gives people access to a range of advanced digital fabrication equipment such as Laser cutters, CNC mills, 3D printers, 3D scanners, cultivating the mentality of turning data into things and things into data, therefore providing a space where anyone can create anything, anywhere; therefore, producing locally and reducing CO<sub>2</sub> emissions.

Considering the role of digital media, the following categories can be distinguished:

- Design that optimises/reduces material, through digital tools for Topological Optimisation, Genetic Algorithms, and Form-finding.
- Design that reuses material, through Upcycling, Repairing, Reusing existing parts.
- Manufacturing with recycled or eco materials, through 3D printing with recycled plastics, eco-materials and new materials. Durability and easy access to worn components.

As far as the construction sector is concerned (also in building facades, in particular), information has to be maintained and communicated through the life of the project, such as the material contents of a product, the details about disassembly and recycling, disposal and handling. The Building Information Modelling (BIM) technology should be utilised for that task. The ventilated façade system could be a solution, especially when realised with aluminium composite panels as the cladding of material and aluminium substructure. The functions are separate (insulation, aesthetics, rain protection) upgradable, fire safe and recyclable. Mechanical fixings should be applied. This solution can be applied to existing structures and extend their usability. The ideal cladding product is lightweight and made of recyclable materials, for easy handling and minimised additional loads. Indicatively, such an example is the aluminium composite panel, which can have a coated surface that lasts longer or even have upgraded characteristics like high reflectivity or easy clean properties.

### **Role of digital technologies – Industry 4.0**

Digital technologies enable the management of data which in turn will result in smarter use of resources. With real-time data on the status of products, such as elevators and other machinery, companies are able to identify possible failures and plan for maintenance and repairs, accordingly, thus enabling predictive maintenance and lengthening the product's lifetime. Companies may also provide products as a service by utilising sensors to oversee their usage. Consumers can then pay fees according to their consumption, while companies remain as the product owners. Such a strategy has benefits for both sides, as companies accomplish a continuous revenue flow and thus allowing them to keep their products in use for larger periods of time, while recipients are only obliged to pay for what they actually use (Pardo, 2018).

#### *Activities and experience*

Digital technologies may stimulate sustainable consumption paradigms. For example, smartphone applications could be used to retrieve information on a product, such as source materials and details about its durability and recyclability among others. Digitalisation can assist in overcoming barriers that nowadays hinder the recycling and recovery of materials. While the ability to trace hazardous materials is a barrier to the increase of recycling, the web-based tool "Chemycal" uses blockchain open-source software to track information so that its users may monitor these materials throughout.

Circular economy, however, has the potential to create some dependencies and rigidities that are not easy to manage. Specifically:

- Quantities are handled, and products are created for traditional markets according to variable market needs.
- Markets are imperfect, thus leading to the frequent emergence and disappearance of companies from the field.

Companies often ignore the above and the relevant impact on gains. Financing projects is another tricky venture, since business tend to lack the required capital to implement a more circular business model. Furthermore, access to information and its free flow is hindered by inadequate digital infrastructure, occasional lack of interoperability between systems, geo-blocking and a hesitance from both industry and the

people to share data. The EU policy framework might be useful for the promotion of digital technologies and for reaching circular economy goals. Stakeholders should manage and share information in a secure environment. Some of the initiatives of the European Commission's Digital Single Market mid-term review are therefore considered relevant to the subject of circular economy.

The free flow of non-personal data across the EU could enable companies to evaluate and transmit data and scale up new inventive business models. To this end, various regulations have been established lately: The "Building a European data economy" Strategy, whose goal is to optimise the potential of digital data in a manner that benefits the economy and society along with the proposal for the regulation of free flow of non-personal data, as issued on September of 2017; The potential impact of such regulations should be further studied in terms of their results on circular economy. Trust is also extremely important. For effective circular economy practices, stakeholders require a secure environment to share data. It is thus crucial to identify the circumstances of accessing and using of this data. The terms for liability, confidentiality and interoperability should be known to all stakeholders. In addition, the European Commission's Cybersecurity Package that aims to ensure the security of connections, and the General Data Protection Regulation that became active since May of 2018 could also prove to be beneficial to circular economy. Regardless, further legal and technological guarantees are needed to persuade industry and society that their data is safe from cyber threats and that they can safely create and use digital tools.

Block chain technology should be further explored as it can help to gain more knowledge on material cycles and processes through the value chain and enable sharing of data in a secure environment. The Blockchain Observatory and Forum operates since 2018 and examines the potential of this technology. It would be useful to further explore its impact on the environment. The European Commission has set aside a budget of 340 million euros for projects that use blockchain technology by 2020, focusing on projects that aim to achieve circular economy goals. Online platforms assist in the creation of cooperative economy models where end-users may share, trade, buy and sell used or new products and services. This way, unused products are being repurposed instead of becoming waste, while end users might earn or save money. The European Commission recognises the connection between online platforms and the cooperative economy by linking its "European Agenda for the Collaborative Economy" with its Communication on "Online Platforms and the Digital Single Market". Both refer to the need to gain the end users' trust in these platforms, through the introduction of stricter measures. Raising awareness on the advantages of these solutions could also enhance their adoption by society and industry. Upgrading digital skills requires additional investments as suggested by the Digital Single Market mid-term review. Further work is required towards ensuring that businesses that express interest in developing circular business models may achieve the necessary digital skills.

In short, the evolution towards a smarter resource use can only be achieved if digitalisation is exploited. This includes understanding the connections and making use of the synergies between the digital and the circular economy plans. The EU needs to advertise the smart use of data and digital solutions in an attempt to encourage the transition, otherwise opportunities to close loops and improve practices will be missed. Other initiatives could come up, but a real holistic change will not be achieved.

## *Perspectives*

The size and complexity of a circular economy system are determined by the scope of circular area, the industry and products specific characteristics and circular level. Companies mainly experience complexity in the following two ways; (a) they are too big and diverse to have a meaningful link to all elements, (b) the dynamic adjustments of such a system are not predictable due to aforementioned size and diversity.

Digital technologies may offer solutions in different topics. Indicatively:

- Flexibility and competitiveness: Circularity could address various challenges such as higher volatility, client loyalty, and the costly issue of waste disposal. This implies much closer cooperation between participants. End-users also get more included because the value chain does not end when the consumption stage is reached.
- Reduced unpredictability and greater security of supply: Due to requiring the use of fewer “virgin” resources, and the increased use of recycled goods with a higher share of labour costs, lower exposure of a company to volatile raw prices is achieved, increasing its resilience.
- Improved client interaction and loyalty: Circular solutions provide new ways to creatively engage customers. Companies can thus establish more intimate service relationships with their customer base.
- Optimisation of recycling systems: There are already some recycling and composting systems that are considered well established.
- Greater utility: The consumer benefits may be complemented by the additional choices and quality that circular economy offers. Choices increase due to the tailoring of products or services to better suit client needs.

Lower total cost of ownership: Frequently changing trends will no longer procure high costs of ownership for end-users. Consumers may also benefit from the longer-term reduction of waste disposal expenses along with other related environmental costs stemming from the old linear system.

## **Digital transformation of farming with the use of robotics and big data**

Technology is changing the world, and farming is catching up. In recent years, technology in agriculture has rapidly changed the industry. However, our population is continuing to grow, which has the potential to affect resource availability going forward. In recent studies, it was found that the industry’s output must increase by 60% by 2030. The introduction of everything from automated farm equipment to a wide array of Internet of Things (IoT) sensors that measure soil moisture and drones that keep track of crops have changed the business of agriculture. Some experts even call this movement "Agriculture 4.0" (a term used by the World Government Summit). A digital farm is more efficient and sustainable than its counterparts of the past. On a smart, digital farm, crops are likely grown using precision agriculture, tractors might be self-driving, the harvest could be determined by digital imagery of the fields, and the farmer is typically working with an agronomist to provide technology know-how.

Agriculture 4.0, the coming agricultural revolution, must be a green one, with science and technology at its heart. Agriculture 4.0 will need to look at both the demand side and the value chain/supply side of the food-scarcity equation, using technology not simply for the sake of innovation but to improve and address the real needs of consumers and reengineer the value chain. Modern farms and agricultural operations will work differently, primarily because of advancements in technology, including sensors, devices, machines, and information technology. Future agriculture will use sophisticated technologies such as robots, temperature and moisture sensors, aerial images, and GPS technology, to list a few. These advances will let businesses be more profitable, efficient, safer, and environmentally friendly.

The top six digital transformation trends in Agriculture are: **(i) IoT and Sensors in the Field:** Sensors placed strategically around fields along with image recognition technologies are allowing farmers to view their crops from anywhere in the world. **(ii) IoT and Sensors in Equipment:** Using the term “precision agriculture” tractors and other farming equipment are being manufactured with navigation systems and a variety of sensors. **(iii) Drones and Crop Monitoring:** Drone technology is giving agriculture a high-tech makeover. The six ways drones will be used throughout the crop cycle are the following: a. Soil and field analysis, b. Planting, c. Crop spraying, d. Crop monitoring, e. Irrigation, f. Health assessment. **(iv) Farming and Robotics:** Robotic unmanned ground vehicles, unmanned aerial vehicles, modern digital platforms for environmental and agricultural production systems monitoring, decision support systems and production management based on AI are some of the novel and ground-breaking technologies. **(v) RFID Sensors and Tracking:** RFID sensors can be used to track food from the field to the store. The end user, or the consumer, will be able to follow a detailed trail about the food they consume from the farm it came to the location where it was purchased. **(vi) Machine Learning and Analytics:** One of the most innovative pieces of the digital transformation is the ability to use machine learning and advanced analytics to mine data for trends.

## Urban and Regional Level Developments

### City planning to promote circularity

More than 55% of the global population lives in cities, a percentage that is expected to increase in the next few decades. Increase of global population leads to increase of consumption of materials with severe impacts on the environment. For instance, approximately 50% of CO<sub>2</sub> emitted into the atmosphere is directly related to the construction and use of buildings, while another 25% comes from emissions from public and private transport. Cities per se are uncircular entities and they accumulate a great amount of resources within their territory. Therefore, societies are in the need of alternative urban development approaches that will contribute to a more circular and sustainable urban ecosystem.

### *Activities and experience*

Circular economy presents a contemporary approach of production and consumption, friendlier towards the environment. The circular model alternates the classic approach of production and consumption circle by maximising the exploitation of the existing resources along with reduction of loss during their usage. In specific, urban development determines and is determined by parameters such as urban (trunk) infrastructure, transportation networks and waste management together with resources management and economic competitiveness functioning as a whole. Nowadays, we are gradually discovering that through incorporating the principles of circular economy one city can acquire a circularity character concerning all its functions, producing in this way, a system that rejuvenates and is accessible and abundant by construction.

The transition from a linear economic model to something more circular that applies in city scale is not straightforward. An interesting framework in helping this transition is provided by “biomimicry”, a science that explores the ideas of nature and imitates them concerning their planning and procedures. For instance, inspiration could come from the function of a tree. One single tree produces several nutrients; these nutrients are being incorporated in the same tree through a process. Once the blossoms fall off and might not have been pollinated, they become new nutrients for the same tree. Other than that, the tree provides additional services like shade, fresh air, wind breaker, clean water etc. So, it is not only the circularity aspects per se but also the services provided.

The simple example of the tree indicates that trees function in closed loops and most importantly they do not think in pollutants but in nutrients. Even though cities are complex entities, the closed loop approach could help the transition of cities from a linear economic model to something more circular by adding several functional loops. The smaller the loops the more environmentally friendly they are, because they are closer to the territory and economy, meaning for instance that local job creation will have the less environmental impact.

The vision for a circular sustainable city is essential part of the wider notion of sustainable development that has been a global concern for several decades now. The idea of sustainability in urban models involves the interplay of territorial actions on the city configuration combined with environmental and landscaping elements and the optimal management of natural resources, while promoting social cohesion and the participation of citizens (Perry, 2013; Perry and May, 2010). In this context, adopted environmental policies

and spatial plans ensured, in a way, resource savings and improved quality of life in cities. Furthermore, ecological and social friendly solutions that have been recently introduced allowed the development of open, alive cities and cities that protect public health.

Recently, the European Commission enhanced the adoption of circular practices within the context of sustainability by announcing, in December 2015, the approval of an ambitious set of laws on circular economy. This initiative is considered to be very significant as it targets at reinforcing the competitiveness, the creation of workplaces and the promotion of sustainable development. Significant financial packages that support the implementation of the above-mentioned framework are already in application, while a series of laws have been approved and transferred into national legislation systems of several EU Member States. Furthermore, the McArthur foundation initiative is profound since it promoted an integrated approach aiming at waste elimination, diversity, non-homogeneity, reusable sources of energy and incorporation of real cost in the market price of resources and products. Many municipalities have adopted this approach mainly on the issue of waste management that incorporates recycling and sorting at the source. In this light, the concept of circular economy is already included in most national strategies across Europe, while the rest are in the process of updating their strategies towards the same direction. However, the bio-based circular economy is, at present, rarely mentioned on a strategy level, even if the importance of circulating nutrients is notified. The bio-based circular economy is currently addressed mainly through biowaste management, which limits the full potential of the multi-disciplinary circular economy approach. In this light, biowaste management is currently the most common approach linked to circular economy, limiting the full potential of the multidisciplinary model. The bio-based circular economy is more than separating, collecting and processing biowaste and the role of authorities at macro-level is essential in providing financial incentives and setting up practicable and functional frameworks.

As far as economy is concerned, relevant to the circular approach are those of green economy and social entrepreneurship. The relevant legislation formulates a three-sector scheme, including; (a) the state, (b) the profit-driven sector and (c) social economy (governmental and non-governmental sector) that aims to promote social entrepreneurship at local and regional level.

Besides the institutional changes, it is important to refer to several changes in the prevalent production and consumption model. It is now generally accepted that the current production-consumption-rejection (waste) model is not working and new ways of minimising waste and reusing products need to be found. The acceptance of the new, limited waste consumption model by the industry has brought radical modifications on the whole production system alongside with the life cycle of the products.

Urban planning is a multidisciplinary scientific and political process for regulating urban development considering other components of the urban environment (transport, green spaces, etc.). On this basis, urban planning addresses the real needs and capacities of a city and enables stakeholders to visualise alternative future scenarios that are more sustainable, economically productive and responsive to trends and challenges, and facilitate decision-making and mobilisation and empowerment of communities (Feleki et al., 2016). In terms of the urban environment and city functionality, intermodality has been introduced as a new mobility approach. Instead of the use of car, intermodality promotes the use of a combination of alternative and low energy means of transport like walking, cycling and public transport. Moreover, in support of intermodality

many European countries promoted accompanying measures like issuing a speed limit of 30 km/hour in inhabited city areas. It should be noted that until recently transportation policies were automobile-centred with their main concern focusing on the improvement of transportation times from origin to destination. Approximately half of the population in big cities use private vehicles daily, a practice with a strong impact on the environment. The new intramodality notion is based on a human-centred approach as it aims to create inclusive urban environments for the excluded users i.e. cyclists, pedestrians, children etc., and to ensure qualitative environmental characteristics and a more pleasant transportation experience.

Finally, it seems that biomimicry could provide modern societies with nature-based solutions and circularity aspects at city-level. Cities can be considered as evolutionary ecosystems with smaller individual ecosystems lying and developing within. Supportive infrastructure that includes a combination of green, grey and blue infrastructure could help towards this bio-inspired concept.

### *Examples of best practices*

An interesting example of wise use of space comes from the ancient times. Spatially, Athens remained the same for centuries and it started to expand in the 19<sup>th</sup> century. Today, there are worthy examples of reconstruction concerning building and mixed-use practices, vertically on tall buildings. The specific practice, however, isolates inhabitants from road/public space and, thus, social life.

In terms of the function of the city we meet, nowadays, interesting good practices and contemporary technology with the potential of further improvement. For instance:

- Green walls that may be used to clean air and decontaminate water to be reused as service water in the same building. The quality of the water exceeded the targets of the related guidelines. With the use of a filter it can become drinking water.
- Green house structures which is made of recyclable and construction demolition materials and it is used to clean waste-water, so it can be used for urban food production.
- Plant based public toilet, cheaper than conventional ones, self-sufficient, using no water, producing no waste, consuming no energy.

It would be a real challenge to close the full water cycle in isolated areas (e.g. the Greek islands), proving that it is possible to close and recirculate new business models with just incorporating waste water and capturing all kinds of non-conventional water resources.

"Green supplies" presents an approach closer to the notion of circular economy which is gradually being developed in most European countries. A remaining problem has to do with the small size of the enterprises which produce such products and it does not contribute at all to cost reduction.

A broader strategy concerning circular economy can be a useful tool. The paradigm of Brussels 2016-2020 Strategic Circular Plan is noteworthy, and it includes 111 actions subdivided into logistics, construction, food and cross sectorial measures. A budget of 1-2 million per year to finance companies to experiment and develop circular projects is available. The related initiatives need to be more systemic and bigger companies should be engaged.

The private sector may also provide a wide series of paradigms just like the construction of cars from biodegradable and recyclable materials. Incorporating businesses to our circularities will promote cycling economy as people are usually more sensitive in generating wealth.

### *Knowledge gaps, next steps, actions, proposals*

The transition towards circularity has already begun. In terms of spatial planning the main challenge is to find the link between spatial planning and the circular economy model. In general, the notion of planning relies on the idea of keeping the products, components and materials at their highest value and usefulness. Therefore, spatial planning is consistent and compatible with the notion of circularity, but there is a need for better integration of the several aspects of circularity into the planning philosophy and practice.

Climate change discussion has assisted towards this direction since it brought up issues like energy savings, emissions reduction of carbon dioxide, water scarcity etc. In this context, cities' response to climate change and achievement of sustainability could utilise the notions and practices of circularity.

The issue of physical space as the field of integration of circularity is critical for the successful transition to circular economy. Spatial planning along with smart city strategies could set the framework for better management of the urban environment, by developing dynamic links with economic and social aspects, strengthening environmental protection due to the associated economic benefits, creating blue and green infrastructure, enhancing equal access to knowledge and infrastructure, promoting wise management of natural and cultural heritage, embodying resilience into basic city functions and establishing an efficient and integrated waste management system.

In addition, the transforming process from the linear to the circular economy should start by linking economy to the goals of Agenda 21. In the current program period and through Horizon 2020, 650 million and 5.5 billion from the Structural Funds are allocated to fulfil Agenda 21's goals. Initiatives are related to food waste reduction in municipalities, review of fertilizer regulations, strategies for reusing plastics (e.g. reuse of straws, plastic glasses, etc.), re-use and increase the average life products, water reuse and finally spatial planning policies that will integrate all these sectoral policies.

By nature, spatial planning is a multidimensional notion. Therefore, following are the individual components and how each of them can contribute to the cyclical economy:

- *Urban Environment:* Cities can support the development of the circular economy in a variety of ways such as creating dense and diverse urban environments that would promote walking, enhancing protection and preserving natural ecosystems, managing impacts of climate change and promote active citizenship at all levels.

They can also be an active field of experimentation towards greener urban practices. For instance, in Greece there have been great advancements that include the transition from green buildings to green cities and from buildings with low energy consumption to almost zero-energy buildings. This includes the energy and water footprint of the building, the integrated energy of the building materials, the entire life cycle of building materials and of course the management of building waste. Reducing the environmental

impact and ensuring a vigorous economy and a just society is one of the basic goals of sustainable development.

Finally, investors should be aware that the city's competitiveness objective on the free global market is a central pillar of the rhetoric of urban renewal programs and other programs which are now integrated into the urban sustainability objective. There cannot be a competitive city if it does not incorporate the characteristics of urban sustainability. The quality of the urban environment, the attractiveness of the image of the city and all the green management strategies, are now emerging as significant elements of economic viability, and enhancement factors of their competitiveness. So, the traditional competitive relationship between the environment and urban development has ceased to exist.

- *Transportation and mobility:* Transportation infrastructure and mobility practices are connected to cities' spatial pattern and to citizens' behavioural patterns.

In terms of cities' spatial pattern, it seems that European cities with historic centres, are not vulnerable to traffic congestion since their urban tissue discourage extensive car usage. Contrariwise the layout and land use allocation in American cities favours car usage leading to extensive traffic congestion. At the same time high population growth rates will inevitably lead to an increase in car usage. It is estimated that by 2050 the number of cars will be doubled, and an additional 2.5 billion cars will be added into the road system while people will demand greater and better mobility opportunities than today.

So, the way we plan our cities is critical to the produced mobility patterns and habits. For instance, if more space in the outskirts of the city is allocated to serve circular activities, i.e. circular industrial uses, without the provision of mass transit this will intensify the use of car. As most urban planners highlight, we need to reduce urban expansion rates because this will induce longer journeys and car usage which in turn will cause pollution and higher rates of accident hazards. The issue land use allocation and associated travel demand does not have a straightforward answer since our cities are expanding with high rates while two thirds of global population will live in urban agglomerations by 2030.

The question is how the society deals with such rates of development. Some proposed to create smaller cities within large cities in which walking, and cycling could be a viable solution. This is not so simple because of the issue of jobs and housing allocation, real estate markets and other variables that come into play and complicate a seemingly simple and applicable solution.

The solution may be twofold, and it is related to policy and behavioural changes. In terms of policy and in order to integrate circular economy aspects and principles into mobility then we will have to start thinking in multimodality terms meaning to integrate different means of transportation in our daily trips i.e. mass transportation, cycling, walking and maybe car. It is worth noting that conventional approaches to the issue of decongestion and depollution of cities promote the solution of electric cars or autonomous cars without drivers. Despite that this option seems attractive, it is not a sustainable solution since the main mean of transport is still the car that consumes the same space as conventional cars and congestion will eventually occur, even in higher rates.

In terms of behavioural changes, it seems that the solution lies in each one of us and it is connected to citizens' everyday mobility choices. For instance, a conventional diesel car is polluting the environment, but this car is

polluting less if it is transporting four people meaning that the “pollution rate per person” is less than the pollution that causes a “clean” car that transports only one person (the driver). The point here is that each individual citizen has a pollutant footprint, depending on transport choices, the speed he/she is moving etc. So, it becomes very important how lifestyles and behaviours are organised. Under this notion, car-pooling is a growing trend (especially in Europe) and could be part of the solution for modern congested cities. Car-pooling entails the notion of “sharing” but in order for carsharing to succeed, there is a need for change in citizens’ behavioural patterns.

Finally, what is very optimistic today is that many cities are preparing Sustainable Urban Mobility Plans, aiming to reduce vehicle use, move with lower speeds, increase the use of mass transportation and finally increase walking and cycling. This approach could be revolutionary for most countries internationally due to the citizens’ behaviour and habits, with the EU offering both excellent ideas, practices and funding that might have a positive behavioural change in mobility patterns.

- *Consuming patterns:* Citizens can be a catalyst or a bottleneck in the transition process of a linear economy towards circularity. Therefore, mobilising local stakeholders and citizens is crucial.

In terms of consuming patterns, changing them is the key to the widespread adoption of cycling economy. The change has to do with renting the service or renting the use of a product rather than buying it. When change in consumer patterns occurs, then industry will follow by changing production patterns that will eventually provide a more complete form of service that will focus on the reuse and sharing of products. It is anticipated that the change in both consuming and producing patterns will have impacts on local development and employment.

- *Circular economy and social entrepreneurship:* Emergence of small and medium-sized business is a direct consequence of linking the circular economy with entrepreneurship. Enhancing entrepreneurship will have a very important social dimension in the circular economy.
- *Political support and strong political vision:* The form of economy that will eventually lead us to resource efficient production practices and new production, consumer and employment patterns needs to have strong political support. Therefore, central administration and local governments have to adopt a new political vision by incorporating into their agenda policies towards circular practices.

This new political vision has to be reflected into the strategic spatial plans. For instance, future municipal authorities have to integrate circular economy in both their long and medium-term business plans, as well as their strategic spatial plans. Local production processes need to be integrated for a more holistic approach and to study new employment opportunities. In terms of the areas of intervention, although not adequate if fragmentally implemented, waste management with more reuse and recycling could be a good way to start.

- *Cities’ organisational and managerial structure:* In order to promote circular economy, it is essential to change the organisational and managerial structure of the local governments (municipalities) so that new revenues can be created for the municipality itself. For instance, the cleaning department could reinvent itself as “circular economy service” department, that will be responsible for planning and contracting with all the alternative waste management bodies in order to reduce the waste which goes for burial which in

turn means reducing the volume of waste, thus lowering municipal fees. Other actions might include collection and exploitation of organic material in cooperation with certified bodies for management of special waste, integration into programs for special types of recycling like life jackets, fishing nets etc.

Necessary condition for this to happen is to create an autonomous office of cyclic economy and social entrepreneurship. Furthermore, we need to have a strategic plan for establishing contracts with social economy bodies, circular economies bodies and social enterprises, supporting social enterprises, enhancing the citizen communication through the website of the Municipality as a reference point, organising information events and utilising all kinds of financing opportunities. Finally, a modern city needs to move from "me" to "you" to "we", to "us".

The most important aspect of the circular economy however is changing citizen's behavioural patterns. Circular economy is an unknown concept to the average person, as well as to the local government. The state should adopt different approaches that in addition to the promotion of circular economy to the local governments it should include; (a) engagement of citizens in all stages of the transformation process starting from the greater vision of circular economy and the city to the shaping of the final strategic plan and solutions, and (b) special school education programs because children are the future and they will help us to consciously and responsibly look at the future.

### *Perspectives*

Today the challenges for cities are consolidated within the 17 "Sustainable Development Goals" which constitutes a framework to coordinate global efforts for ending poverty and hunger, combating inequality and disease, slowing climate change and building peace. At the same time, it sets more specific goals for cities such as clean air, preserve biodiversity, coastal hazards protection, control land consumption, restrain tourism overexploitation, manage water scarcity etc.

In this context, urban development strategies should promote coherent, densely populated, multifunctional, mixed use and diverse urban environments that focus on the quality of life and human relations and have strong social dimensions. Despite that this city development model has been part of the planning discourse for several decades it has been partly applied due to prevalent city planning practices that focused on the functional performance of cities rather than the social or environmental one.

The new urban development perspectives are in accordance to the philosophy of smart cities that rely on technological innovations and, moreover, to the philosophy of the circular city that ties them together in economic terms. It is important to note that within cyclic economy environment acquires a measurable economic value and only when there is an economic estimation about the environment then there could be countermeasures.

Space is the most critical component for the spatial integration of circular economy. The integration could happen in two different planning scales; the strategic and the local. On the strategic level there must be provisions for space that would enable circular economy to flourish. This presupposes that we do not view cities as astatic accumulation of buildings (i.e. green buildings as part of green cities), but as an integrated, living and ever evolving entity. For instance, cities can be considered as urban living laboratories in terms of reusing materials while current underused industrial areas could be the receptors of new type industries.

Therefore, several critical to urban development components should reinvent themselves. For instance, cities need to get away from the classical perception of industry that includes heavy industries usually located in the periphery of the cities. Instead new types of industries i.e. urban industries that are need-based and for which there is added value should be promoted.

In addition, transportation infrastructure is essential part of cities and therefore an essential part of circular economy. New ideas on transportation practices are heavily related to the concepts of “sharing” and “slowing down”. These emerging concepts will shape transport policies in the future that will focus on making roads friendlier to the pedestrian and a place “of” and “for” social interaction. Everyday movement ceases to be one-dimensional experience, meaning to move from “origin” to “destination” as fast as possible. In contrast it becomes a pleasurable and interesting experience and even more a socialising opportunity. A necessary condition for this to happen is to be able share the road with safety among its users, the pedestrians, the bikers and the drivers.

Another important aspect of urban development strategy is to promote resource efficient urban forms. Urban form has been highly associated to energy consumption patterns and CO<sub>2</sub> emissions. The spatial allocation of specific socio-economic activities i.e. industry, education, commerce, services, recreation and housing are crucial in respect to the mobility patterns within city scale. Critical factor in producing resource efficient urban forms are high density, increased diversity and interesting urban design. In addition, the change mentality in mobility, as presented above, could create urban environments that can contribute to the protection of environment by ensuring the minimum use of natural resources and energy consumption.

On the local level, urban planning must provide a well-organised system for all social infrastructure and create or reserve space to allocate circular activities. For instance, in the case of waste collection allocation of the “Green Spots” should be a citywide policy that would serve equally all the parts of city.

Finally, circularity is about social inclusion and social justice in all its forms. Providing jobs which require low expertise or make provision for enhancing the skills of unemployed make circular economy for everyone and not for thinkers and machines

### **Waste prevention and effective recycling**

In essence, Circular Economy is sustainable, meaning it has the ability to regenerate resources according to its needs, while also being a multidisciplinary approach, which focuses on both technical and biological streams. The technical approach focuses on the recycling, reuse and prolongation of a product’s life span, whilst biological streams mainly undergo the regeneration or conversion through natural cycles.

Linking Circular Economy with the operation of a “smart city” may include a list of actions to improve waste management and recycling rates, offering a better environment and significant revenue to the city's funds:

- i) Main Wi Fi network in cities, in co-operation with the relevant public authorities.
- ii) Placement of 4 coloured bins in schools, Public Services, audience gatherings. At the same time in the Schools, Education, let's talk about Environment, Waste Management, Contribute to Effective Recycling, according to Ministry of Education mandate.

- iii) Placement of underground bins in squares and places of concentration of stores of health interest, operation with a Key Card and chip. All shops will be obliged to throw the waste to be recycled, into these bins and they will be controlled.
- iv) Chip buckets and Wi Fi system to check the bucket completeness and the correct collection time from a sufficient number of bins.
- v) Keeping the citizens informed about the need to sort waste at source, i.e. at home, store, service, school. This makes it easy to select the corresponding coloured bin. The separation of food from packaging is considered particularly important for the management and recycling process.
- vi) In the context of reducing disposable plastic, particularly in island or coastal areas, municipalities could make obligatory the use of reusable plastics compulsory and the collection and washing of those used, as a condition of renting space.
- vii) The creation of "green" points in selected parts of the city
- viii) Consult with the other cities involved in a Solid Waste Management Facility so that the separation, sorting, processing of the Waste to be recycled, is done properly. This will produce Recycled High Purity with a good resale price in the Recycled Manufacturing Plastic Industry.

One of the main areas of intervention for achieving sustainability and circularity in EU is the plastics sector. In January 2018, the European Commission adopted a new set of measures, including a Europe-wide EU Strategy for Plastics in the Circular Economy and annex to transform the way plastics and plastics products are designed, produced, used and recycled. By 2030, all plastics packaging should be recyclable. The Strategy also highlights the need for specific measures, possibly a legislative instrument, to reduce the impact of single-use plastics, particularly in our seas and oceans. On October 2018 a large majority in the European Parliament voted to strengthen the European Commission's plan to cut pollution from single-use plastic items. The Parliament voted to ban some of the most problematic throwaway products, such as expanded polystyrene food containers and very lightweight plastic bags, and to ensure producers are held accountable for the costs of single-use plastic pollution. For fishing gear, one of the largest contributors to marine litter, harmonised standards will be developed, and minimum collection and recycling targets will be set at the EU level. The measures adopted include:

- An EU-wide ban of single-use plastic cotton buds, straws, plates and cutlery (with exemptions until 2023), beverage stirrers, balloon sticks, oxo-degradable plastics and expanded polystyrene food containers and cups
- An obligation for EU countries to adopt measures to achieve a 25% reduction of the consumption of food containers and cups for beverages
- An obligation for EU countries to reduce post-consumption waste from tobacco product filters containing plastic by 50 % by 2025 and 80 % by 2030,
- Extended Producer Responsibility (EPR) schemes that include the cost of clean-up and awareness raising measures

- Harmonised standards and an Extended Producer Responsibility (EPR) scheme for fishing gear, as well as a 50% collection target and a 15% recycling target for fishing gear by 2025
- An obligation to separately collect 90% of beverage containers and ensure they are produced from 35% recycled content by 2025
- An obligation to prevent the use of hazardous chemicals in the composition of sanitary items
- An obligation to label products to inform consumers about the presence of chemicals of concern in certain single-use plastic products

Regions or regional waste management authorities play a significant role in the support and implementation of good practices for the promotion of circular economy. National strategies use several different keywords to indicate the move towards circular economy. Overall, even if the bio-based circular economy is not mentioned as such, most countries address it through bioeconomy, waste management or circular economy approaches. Multidisciplinary approaches are hindered by waste management focus in many cases limiting the potential of circular economy from biological streams. Most likely, this will change in the near future with upcoming national strategies as the comprehensive understanding of bio-based circularity spreads in the EU.

### **Urban mining**

The passage from a linear to a circular approach has characterised waste management strategies over the last few decades. Attention is currently moving from the limited and fixed stocks of raw materials to the increasing anthropogenic stocks of materials. Urban Mining activities operate in this context, representing actions and technologies finalised towards the recovery of secondary raw materials and energy from products of the urban catabolism. Urban Mining therefore provides a systematic management of anthropogenic resources stocks (products and buildings) and waste, in the view of long-term environmental protection, resource conservation and economic benefits.

The term Urban Mining refers to the process of reclaiming compounds and elements from any kind of human inventory, including buildings, infrastructure, industries etc., extending landfill mining to a wider meaning, by using what we consider as a “mine” like a resource that can be exploited.

According to recent research, urban mining maximises the resource and economic value of the waste streams generated in urban spaces and will be a significant concept in the planning and designing of sustainable cities, making the process consistent with the sustainable development goals. Also, in planning sustainable cities, it is essential to connect local material and energy loops, which are adapted to local circumstances to reduce the pressure on virgin resources in production.

Waste Electrical and Electronic Equipment (WEEE) represent a very good example. An average gold mine produces 5 grams of gold per ton of ore, while a ton of printed circuit boards from old computers can contain up to 450 grams of gold. Furthermore, for some very rare-earth elements, urban mining can potentially become the only source. Research suggests that recovering gold, copper and other metals from WEEE is cheaper than obtaining these metals from mines.

The value of metals alone in Germany's anthropogenic deposit is estimated at €650 billion.

Issues discussed further during this session include landfill mining, WEEE management, and cooperation using a bottom up approach to tackle the challenges of circular economy, at a local level.

Landfill mining can be used to recover valuable materials from historic landfills, an estimated 150,000 to 500,000 in Europe, therefore a huge potential. The Enhanced Landfill Mining concept was adopted by the European Parliament on 14.3.2017 as amendment 34 in the Circular Economy Package proposal for a new landfill directive.

The enhanced landfill mining's contributions to circular economy targets are the following: (a) material and energy recovery from wasted resources, (b) moves waste from disposal to recycling and energy recovery; potential to reduce the amount of existing landfills, (c) provides secondary materials for production from consumption waste; replacing the use of fossil fuels with waste fuel, (d) introduces secondary materials into the economy; provides energy from historic waste streams, (e) enhanced landfill mining can possibly lower emissions in some cases: decrease mining of primary ores and by replacing fossil fuels with waste fuel (debate in academia), and (f) with the platform of up to 500,000 landfills in the EU, enhanced landfill mining could provide jobs for decades.

Recent research work dealt with using maps in Geographic Information Systems with former uncontrolled landfills in Greece for assessing the perspectives for landfill mining in the frame of circular economy. An example of the simulation system was given for two prefectural units (Chalkidiki and Serres) in the Region of Central Macedonia, Greece. For 581 t (1,280 m<sup>3</sup>) of mined waste, the profit varied from 383 – 4,603 €. By dividing profit by the mining mass, the eventual revenues index was given from 0.66 – 7,92 €/t. Since the mining and treatment cost was 35 €/t, the net mining cost was determined from 27.1 to 34.3 €/t. Considering that the year of the start-up of the waste disposal sites was the 1994, it was assumed that at least 168,000 t of waste were disposed. From the disposed mass of 168,000 t, the recyclable waste was calculated to 16,800 t (= 10% x 16,800 t). Based on statistical data, the average Greek citizen produces 0.51 t/y and thus, the index giving the cost for mining waste per citizen and year was calculated from 13.82 to 17.49 €.

One of the fastest growing waste streams is WEEE. More and more people have access to electrical and electronic equipment, which means more and more waste are being produced. By 2021 it is estimated more than 50 million tonnes WEEE will be produced per year (Baldé et al., 2017) with a yearly growth rate of 3-4%.

Electronic and Electrical Equipment (EEE) by default contain a lot of different and valuable materials, such as metals (iron, aluminium, copper, precious metals, etc.), plastics (PP, PE, ABS, PS, PC etc.), glass, wood, paper, also rare earth metals, critical resources for the economy. On the other hand, EEE also contain many hazardous and toxic substances.

To separate and sort the “enclosed” materials in a way that they can be recovered, WEEE must be collected and transported to the treatment facility. There they will be sorted in categories, manually dismantled, depolluted and then treated. WEEE disassembly is a labour-intensive process because they must be depolluted, which means the selective removal of specific components which are potentially hazardous, like batteries, toners, capacitors, etc. and are treated in licensed facilities as hazardous. All these are thoroughly described in the WEEE Directive (2012/19/EU) and must be implemented. Treatment usually means

mechanical shredding and separating through magnet, air, density and eddy current separators. In all stages, from collecting to treatment, health and safety conditions must also be monitored and issues be addressed according to the relevant legislation and standards. The final stage of precious metals and rare earths recovery includes complex pyro- and hydro-metallurgical processes. Capacity for treatment has been developed, but capacity for reuse and preparing for reuse is still lacking and must be a priority for further research and implementation.

Excerpting from a final presentation, learning from the city's historical projects and best practices across the world, an innovative cooperation tool to tackle the challenges of circular economy, at a local level is been developed. A bottom up approach of the traditional top to down strategies is imperative. The main idea is the supply chain cooperation across the entire lifetime of a public construction project in the urban fabric from the design phase to the end-of-life. It is essential to involve all parties from the initiation stage, including the associated information to achieve closed loop supply chains and sustainable partnerships.

The tool is based on the concepts of recycle and reuse, and it receives the perspective of the end users. Stakeholders are using collective intelligence tools and questionnaires to shape the goals for the project and the process. In that way the tool utilises the knowledge and the resources from all the parties and creates a multidisciplinary team. Trust is formed between the supply chain parties, leading to 4P business models. The engagement of all parties, gained from the tool, ensures that with the constant implementation of the process, material value is maintained via reuse, recovery and recycling.

Overall, there has been up to now, significant experience, in research as well as in practice, in the fields of WEEE management and C&D waste management, although implementation of reuse is still lacking. There is experience in landfill mining, on the research level, less so in practice. However, on the level of urban infrastructure mining capacity and practices/processes, there is a clear lack of data, especially for Greece, which is one of the conclusions of this session and thus a need for further research.

### **Transport sustainable mobility and air quality aspects**

The adoption of a circular economy model in transport sector could substantially contribute to the achievement of the objectives posed by EU concerning the reduction of the consumption of natural resources, to the reduction of GHG emissions, to the increase of energy efficiency and to the increase of use of renewable energy sources.

Sustainable mobility through circular economy can certainly be achieved, given that the challenge in circular economy is to find ways to maximise the value of products and materials (hence reduce the usage of natural resources) and to create positive societal and environmental impact, while sustainability means "meeting the needs of the present, without compromising meeting the needs of tomorrow".

More specifically, sustainable mobility is a major issue due to several issues, such as; production of Greenhouse Gases (GHGs), dependence mainly on non-renewable fuels, increase in financial requirements, increase in raw material requirements, demand in huge amount of source energy, traffic congestion, urban

sprawl, increased mobility needs, and noise pollution. In this light, there is definitely a need – and a chance at the same time – to implement circular economy principles in the transport sector.

### *Activities and experience*

Undoubtedly, ports can play a really important role concerning circular economy in transport sector. The European Sea Ports Organisation (ESPO) was established in 1993, aiming at ameliorating the performance of ports. Members of the Organisation are port authorities, port associations and port administrations from EU and Norway, while there are observers from Iceland, Israel and Ukraine. Moreover, the EcoPort network, was initiated by a number of proactive ports in 1997 and has been fully integrated into the ESPO since 2011. It consists of 90 port – members and is able to define the “environmental profile” of a port, by means of Self Diagnosis Method (SDM) and Port Environmental Review System (PERS, certificate assessed by Lloyds register).

The International Maritime Organisation (IMO) has set a global limit for Sulphur in fuel oil used on board ships of 0.50% m/m (mass by mass) from 1 January 2020. Moreover, IMO has set a target to cut the shipping sector's overall CO<sub>2</sub> output by 50% by 2050, to begin emissions reduction as soon as possible, and to pursue efforts to phase out carbon emissions entirely. In general, there are significant regulations which refer to measures towards the reduction of air pollution due to shipping, with respect to the following top ten environmental priorities of European ports: Air quality, Energy consumption, Noise, Water quality, Dredging operations, Garbage/ port waste, Port development (land related), Relationship with local community, Ship waste, Climate change.

Apart from the ports, Municipalities can also contribute to the achievement of the objectives posed in the context of circular economy. The cooperation agreement signed between Municipalities, among which the Municipality of Thessaloniki, constitutes a representative example, aiming at the reduction of consumption of natural resources, the reduction of pollutant emissions and the increase of energy efficiency, especially by means of the adoption of relevant measures referring to the public buildings and vehicles owned by the municipality.

### *Examples of best practices*

There are several examples of good practices in the transport sector which are promoting the circular economy concept. Indicatively, the following could be referred;

- Uber (the most famous peer-to-peer ride-sharing economy).
- BMW DriveNow car-sharing service (operating in 9 European countries).
- CIVITAS (a network of cities, co-financed by the EU, that promote car and bicycle sharing and pooling).

An excellent example to demonstrate how waste management based on the principles of circular economy and industrial symbiosis can be an optimal solution is the “FAB LAB” network of laboratories that help spreading digital and computing industry research, first started by the MIT’s University Centre for Bits and Atoms. It is a technological platform for research and innovation, providing incentives for local entrepreneurship.

In Greece, circular economy principles are promoted thanks to FAB LAB located at HIT/ CERTH (Thessaloniki) in the following ways:

- It allows research and development of transportation system parts based on secondary materials. This is achieved through 3D printing of parts with the use of recycled filaments, while efficient recovery of secondary resources will enable the reverse loop in the supply chain.
- Users can share knowledge and get actively involved in value co-creation.
- It can support dematerialisation.
- It has a significant influence concerning consumer education and behaviour change.
- It can contribute to the digitisation of the automobile manufacturing industry.
- Products can meet both customers and the industry present and future needs.

### *Knowledge gaps, next steps, actions, proposals*

The key issues for circular economy application in the transport sector can be summarised in the following:

- Matchmaking of FAB LAB(s) and other relevant premises/infrastructure with customers and especially with SMEs.
- Finding ways to create critical mass for MaaS (Mobility as a Service) in municipalities and development of relevant business models.
- Recycling of EV batteries.

Furthermore, new vehicle technologies (autonomous, electric, shared) can contribute to a great extent to the adoption of circular economy principles concerning sustainable urban mobility, with the minimum social, environmental and financial cost. Undoubtedly, the benefit will be maximum in case of vehicles that are shared, electric and autonomous at the same time.

A shift to “green” ways of mobility (e.g. cycling) by constructing relevant infrastructure (e.g. bicycle lanes) is considered to be also important, in the context of sustainable urban mobility, adopting a circular economy model.

As for maritime transport, Onshore Power Supply (OPS) is one of the strategies recommended by the World Port Climate Initiative for reducing the environmental impact of seagoing vessels in ports. It replaces the use of auxiliary engines at berth and can reduce environmental impact of vessels, harmful air emissions and noise. The electrification of specific segments of maritime transport could become commercially viable for specific vessel types and route. As a result, OPS can really contribute to the solution of problems concerning air quality, noise and climate change, thus to the promotion of circular economy.

Last, the provision of knowledge, as well as of EU financial support, to all those organisations that wish to pass from traditional to circular economy is important, as well as the cooperation between research centres, Universities, Technological Institutions, NGO, EU and all the stakeholders.

## Innovative logistics solutions and hubs

According to the European Commission “in a circular economy the value of products and materials is maintained for as long as possible; waste and resource use are minimised, and resources are kept within the economy when a product has reached the end of its life, to be used again and again to create further value”. Circular economy is a contemporary subject with many extensions to the international financial being as well as to the globalised commerce, affecting all areas of business activity. Within this frame, there is a huge interaction of circular economy with logistics and the supply chain management. Nowadays, enterprises, not only need to optimise their forward logistics processes, but at the same time they need to invest in managing the reverse flows, thus creating a holistic approach of managing closed supply chain loops. The management of closed loops must approach in depth all issues related to the environment and the society. Circular economy greatly maintains the products' chain value by reducing waste creation and hence the negative impact of business activities to the environment.

### *Activities and experience*

Global commodities flows are increasing the last 20 years with an average growth rate of over 6%. This constant increase of global commodities flow has highlighted the important role of supply chains. During the last years, transportation is the activity with the largest increase of GHG emissions in Europe. As an indication, according to the European Environment Agency, within the EU-15 countries (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom), during the 1990 - 2008 period, a 20% increase of the total GHG emissions from transportation has been recorded. As a result, supply chain engagement is already present in many EU and member state policies. Indicative are the strict targets set by the 28 Member States of the EU concerning the GHG emissions (million tonnes CO<sub>2</sub>-equivalent) from transportation. Specifically, the goals for GHG emissions from International Maritime Transport are 100 million tonnes CO<sub>2</sub>-equivalent, while these emissions in 2012 reached the number of 146 million tonnes. Respectively, for GHG emissions from Transport incl. Aviation, the goal for 2030 is 888 million tonnes, while in 2012 they reached 1,028 million tonnes.

Tackling freight transports in urban areas is critical for several reasons. Indicatively:

- 70% - 80% of the European population will live in urban areas by 2020.
- 3% - 5% of urban land is devoted to freight transport and logistics.
- A city not only receives goods, but also ships them. Outgoing freight represents 20% - 25% of truck-km in urban areas, incoming freight 40% - 50%, and the rest originates from and is delivered within the city.
- Transport companies providing urban freight services are generally very small. In Europe, 85% of short distance truck companies have less than five employees.
- Every year 100 billion euros, or 1% of the EU GDP, are lost to the European economy as a result of delays and pollution related to urban traffic.
- Urban traffic is responsible for 40% of CO<sub>2</sub> emissions and 70% of other pollutants.

### *Examples of best practices*

There are some examples of good practices within the urban freight transports sector. These have been strategic choices of companies or have been imposed at legislation level. Indicatively:

- Urban consolidation centres: Consolidation of shipments in centre's terminals (suburban hub) and last mile distribution coordinated and carried out by the terminal operator.
- City logistics mobile depots: Using a mobile depot in combination with the tricycles and electric vehicle.
- Remote "bring-site" monitoring for reactive and sustainable logistics depots: A subset of textile banks will be equipped with remote monitoring technology to observe daily fill rates and develop more dynamic collection schedules.
- Container (cargo) tracking to inform the warehouse / distribution centre on freight arrival by the use of GPS: Organising accordingly the warehouse operations for the last mile distribution.
- Smart urban transport solution: Optimising retail supply chain management and "last mile" distribution networks by sharing standardised information collected by RFID technology between involved companies and use of common shippers and transport operations.
- Night-time distributions: Night -time distribution for the retail sector.
- Municipal regulation of loading and unloading of freight: Promoting improvement in loading and unloading operations management and parking regulations supported by the municipality.
- Pack-station systems: Located in popular city positions offering to consumers and professionals the possibility of access to their parcels 7 days per week, 24 hours per day
- Delivery plan / optimal routing: The vehicle allocation and delivery plan support system and optimal delivery routing system.

### *Knowledge gaps, next steps, actions, proposals*

The limitations of applying an optimum management of urban freight transports can be summarised into the following:

- Many freight and logistics issues depend on long-term national policies that cannot be properly addressed at the local level.
- Lack of strategy by policy makers in local and national level.
- 80% of urban freight today is carried out by companies on own account and not by professional logistics service providers.
- Even today, more companies are organising last mile deliveries in house
- Transport companies providing urban freight services are generally very small. In Europe, 85% of short distance truck companies have less than five employees.

On the other hand, there are opportunities / possibilities for the development of urban freight transports. Indicatively:

- Development of co-modality schemes: Co-modality involves combining the range of services offered by transport modes that can include using public transport vehicles such as trains, trams, buses or taxis for transporting goods as well as passengers.
- Autonomous City Logistics: Urban logistics could also have connected autonomous fleets. Concepts such as autonomous trucks are set to be functional within 10 years. Another area that is emerging is the use of autonomy for urban last-mile deliveries.
- Big data and analysis: Collection of “big data” of pickup-delivery truck or goods movements in urban areas. The analysis of big data of truck movements in urban areas allows us to gain insights into the traffic, behaviour of drivers, market behaviour, road pricing, etc.

### *Perspectives*

For the urban freight transports to be feasible, the public and private sector synergy is necessary. Public private partnerships initiatives are particularly attractive in those situations that require large investments and simultaneously have high risks. Public authorities and private investors agree on the share of risks and level of investment of each party.

Future research areas and streams towards the development of urban logistics and the achievement of circular economy goals are twofold. On one hand, research needs to emphasise on the development of techniques for collection of data and environmental performance on urban logistics activities, while on the other hand focus should be given on the development of models for the analysis of urban freight flows and the evaluation of possible solutions taking into consideration environmental and social aspects.

### **Sustainability in ports**

Our expansive economic system is putting enormous stress on the planet's carrying capacity. Environmental problems, such as biodiversity loss, water, air, and soil pollution, resource depletion, and excessive land use are increasingly jeopardising the earth's life-support systems. Global environmental concerns have led to the emergence of the green economy, which extrapolates to the concept of circular economy. So, there is a pressing need to a transition to more sustainable socio-technical systems.

Ports are an important player in the world, due to their role in global production and distribution systems, by trading over 10.3 billion metric tons annually (UNCTAD, 2017). Around 90% of world trade in terms of volume is transported by sea, which is why port cities can be considered the gateway to globalisation. Ports are therefore key drivers in the world economy as shipping and industrial hubs. They are therefore also key to addressing many of the wider global issues the world faces in relation to planetary boundaries, including climate change and chemical pollution. In addition, ports offer access to large quantities of waste and biomass resources that can be utilised in a circular economy value chain. Globally, in 2012, 36 out of the 50 most competitive cities were port cities, while of the top 20 cities ranked according to Human Capital Indicators, 14 were port cities (Girard, 2013). More than 75% of Europe's external trade and 37% of internal trade is seaborne. Ports in European Union (EU) Member States play a vital role in the movement of goods and passengers both within the EU and globally, with more than 90% of goods imported into the EU entering

through such ports (Saxe and Larsen 2004). Port activities frequently dominate local and regional economies, providing a source of economic wellbeing and instilling a sense of place and identity for local and wider communities. In addition, ports are under increasing pressure to become more environmentally and socially conscious. A myriad of environmental impacts of port related industrial activities have long been recognised, as well as social issues including loss of jobs. These phenomena have forced ports to comply with ever stricter regulatory requirements for environmental protection, and they are increasingly being held responsible for their sustainability performance to ensure community support. These developments pose great challenges to ports' current business models and their competitive advantage, with ports facing challenges to find new ways to use their assets, for example their waterfront zones, as efficiently and productively as possible in economic, environmental, and social terms, including legal, organisational, and technical.

### *Activities and experience*

The port industry is facing many challenges globally including: The need to accommodate very large ships; competition from new ports; environmental issues such as air, land and water pollution from ships; and transport bottlenecks for the movement of goods, raw materials and people between the land and the sea; and the need of ports and the companies operating them to remain viable, competitive and profitable. Circular Economy can assist ports to respond to such challenges and ensure their competitiveness in a resource-constrained world, while fostering innovation, and reducing environmental impacts.

Circular Economy in ports mostly focusses on; (a) minimising the use of inputs and the elimination of waste and pollution; (b) maximising the value created at each stage; (c) managing flows of bio-based resources and recovery of flows of non-renewable resources in a closed loop; and (d) establishing mutually beneficial relationships between companies within each circular chain. Circular Economy within ports is, therefore, a synergistic approach which combines economic, logistic and industrial activities with the cultural heritage of the port and the creativity of its wider community, resulting in a dynamic, complex and sustainable system.

Many initiatives at ports go beyond legal requirements (e.g. Directive 2008/98/EC on establishing a legal framework for the treatment of waste within the Community; and Directive 2000/59/EC on port reception facilities for ship generated waste and cargo residues). These initiatives include cases of industrial symbiosis, circular economy research, and innovation centres. Port authorities have been the main drivers of these developments. As hubs of global resource flows, hosts to large industrial complexes, and inter-modal platforms with strong connections with their hinterland and urban areas, ports can be ascribed a unique and highly important role in stimulating Circular Economy practice, with their influence transcending far beyond their own industrial complexes. Existing Circular Economy initiatives at ports have ranged from the micro-level, such as reusing waste streams within a single company, to the a meso-level, i.e. industrial symbiosis between two or more companies at the port (e.g. the Industrial Ecology Approach of the Port of Bristol (GreenPort, 2009)), to interregional port-industry networks for exchange of secondary resources at the macro-level (e.g. the Bioport of Europe project of the Port of Rotterdam) (Carpenter et al., 2018).

The circular economy is important for ports because of several reasons, the most important being:

- Ports function as “matchmakers” that bring both the producing and recycling industries in contact with each other in order to re-use the energy in the chain.

- Ports accommodate industries that are active in the treatment, collection and shipment of waste and stimulate the emergence of innovation circles.
- Ports are important crossing-points for all kind of waste and industrial flows and act as logistical hubs for the import/export of waste materials. Therefore, they are ideal locations to further develop the circular economy.
- The presence of industrial clusters in ports help to facilitate the circular and more sustainable use of waste and resources because they offer the benefit of existing synergies between industries (Port of Rotterdam 2018).

### *Examples of best practices*

Circular economy is an increasingly popular proposition for ports, since it can be a viable way in keeping securing a port's future and contributing to its sustainability and that of the city/region where it operates circular economy extensive dredging that would have been (Carpenter et al. 2018). By managing and recycling waste for fuel or chemicals, and supporting specific recycling facilities, ports from all over the world are embracing this notion. For example, the Dutch government has set a target of moving to a circular system by the year 2050, benefitting its ports (Bensalhia, 2018). In recent years numerous ports world wide make efforts to implement circular economy, but every port authority has its own policy to implement the circular economy in the port.

Seaports throughout Europe are realising their potential, and several have set out visions for their transition to the circular economy. The bio-based economy is already emerging in a number of ports, and the many initiatives to support this development include the introduction of wind and solar power and the production of biomass and waste-based energy production. Several European ports have already engaged in the circular economy process through regional initiatives and strategies.

The Port of Antwerp is investing heavily in the circular economy. With so many companies in different sectors operating in such proximity to each other, there are plenty of opportunities for jointly using sites or reusing a company's by-products and waste as raw materials in another company. Residual heat is transformed into heating, wood chips into biomass (Port of Antwerp, 2018). The port has active waste management since 1996. There are three waste parks where inland vessels can drop their waste, as well as they collect floating waste which will contribute to a safer and more sustainable port. As far as the reduce of CO<sub>2</sub> emissions is concerned, the port authority has set up nine shore power installations for inland vessels. Therefore, there will be invested more in infrastructure of the railway. Environmentally friendly cars, trucks and vessels will be more promoted, while there will be a limitation on the use of cars. The port authority also uses financial incentives to increase the attractiveness of the use of environmentally friendly vessels (Vermeulen, 2016).

The Port of Gavle example shows that using circular economy principles, contaminated dredge material can be used to create new land, thus fulfilling two purposes; expanding the port to be ready for more and bigger ships and encapsulating polluted material that would otherwise be too costly to manage or treat (Carpenter et al., 2018).

The Port of Rotterdam is involved in several circular economy-related projects, including the recycling process known as “Ioniqa”. The latter involves the recycling of plastic PET bottles (made from polyethylene terephthalate) and various other items of PET waste. This results in a pure chemical raw material which can be used for future products (Bensalhia, 2018). One of the port’s goals is being the number one port in the new energy commodity CO<sub>2</sub>. The port authority will reserve space for carbon capture and storage facilities, furthermore new pipelines will be constructed (Port of Rotterdam, 2011). Furthermore, the port of Rotterdam has a generator ban for inland vessels, which obligates them to use shore power, fact that could also lead to a further decline in CO<sub>2</sub>. Also, the port authority is stimulating recycling by reserving spots for innovative ideas and develops business cases to create awareness. Additionally, the port of Rotterdam has a few financial incentives to reward environmentally friendly vessels (Vermeulen, 2016).

The Port of Amsterdam has also set ambitious goals in respect to circular economy. Known for its strong position in fossil fuels, the port area already has an existing cluster of circular companies, including one of the largest bio-based ecosystems within Europe, where organic waste is converted into renewable energy, fuels, fertilizers and chemical compounds. Already, 6% of its turnover is circular based, with an aim to grow to 10% by 2021 (Bensalhia, 2018). The residual heat of the only coal-fired plant is currently transported into the city Amsterdam. There are 18,000 households which are using this heat and the residual heat will also be used to make. Additionally, the port of Amsterdam is investing in vapor recovery systems and a launder emission system to reduce emissions. They even have a platform where companies can exchange ideas and residual products. The port authority uses active management on closing loops of companies and gives various training sessions regarding recycling. They have an active waste management plan and a lot of recycling companies are located in the port. The port of Amsterdam has even an energy plant which can convert waste into energy (Vermeulen, 2016).

### *Knowledge gaps, next steps, actions, proposals*

The transition towards a circular economy requires a marathon, not a sprint. Ports cannot stop from one to another day the import of fossil raw materials such as coal and phosphate as it is still important for the energy production by coal power plants or to produce fertilizers used in the agriculture sector. The development and implementation of circular economy strategies requires a renewed cooperation between the various stakeholders (ports, authorities, companies, etc.) including the role of citizens associations.

Furthermore, ports are neither exploiting the circular economy nor a producer of sustainable energy. As landlord and match-maker, they have the commercial assets to only stimulate the industries within the port area. The development of the circular economy heavily depends on the final market uptake and initiatives of individual companies. There are clear opportunities for ports in terms of collecting waste and transport it through inland waterways to valorisation centres in a sustainable way. A challenge is to reach enough critical mass in the circular economy business model for certain waste to obtain economic profitability. The development of waste units/plants is hindered by the overall negative public opinion about waste; waste should be equal to value, this also limits the development of business cases regarding waste valorisation. With the recycling (down cycling) of plastics a second quality raw material is being created. The quality of this type of waste should be increased in the next phase. Waste should be separated and collected in a good way in

order to create a strong business case and companies and consumers should be made sensible. Last but not least, what is extremely challenging is the lack of space to install collection and treatment units on their sites.

Although the transition to a circular economy is currently high on the policy agenda in Europe, the linear model of producing and consuming goods and services in Europe continues to prevail. One of the reasons is the complexity of the circular-economy concept, which eventually will affect all sectors of the economy. Policy-making based on political, thematic or sectoral “silos” will not be effective for fostering this transition. In the case of recycling, the potential benefits of improving the circular economy are the market value of recycled materials, reduced waste disposal (incineration or landfill) and the decreased extraction of natural resources. The lack of societal pressure, by not knowing the benefits of sustainable products, or circular economy, is a barrier to the implementation of new policies by business and government. One of the challenges facing societies in the pursuit of sustainability is to find viable strategies and initiatives capable of decoupling economic growth from environmental pressure, within the limits of the available resources. The barriers that appear most frequently in the literature are technological, policy and regulatory, financial and economic, managerial barriers, performance indicators, customer (interest in the environment issues or lack of information on environmental impacts) and social. Many challenges and actions have been taken to overcome these circular economy implementation barriers. However, support from governmental and non-governmental entities is needed, as well as organisations that help promote, regulate and monitor circular economy implementation. Effective performance evaluation is another barrier, found as it can aid in recognising the key barriers on industrial symbiosis of industrial parks, so that more appropriate policies can be raised by considering local realities. The circular economy barriers to eco-parks were also identified divided into two main categories, as follows; (a) external (capital support barrier, policy support barrier and information support barrier) and (ii) internal (Araujo Galvao et al., 2018).

### *Perspectives*

First, it is crucial to recognise the value of waste and residual products. Waste has to be seen as a resource and a raw material, without harming public health and the environment. The EU should also promote innovations and help to create a stable investment climate for businesses in the circular economy by harmonising waste legislation and safety requirements and reducing regulatory inconsistencies. The transition to a circular economy is a lengthy process that will require legislative perseverance, as well as some level of predictability and consistency from European institutions so that industry and, in this case, ports can make long-term investments. The benefits of the circular economy go well beyond the costs of investing in it. Going circular means contributing to our climate and environmental goals while thinking rationally about the economics behind our actions. Already there are industrial symbioses. What used to be waste for one industry is now a product and raw material for another. It is also imperative the recovery of materials and especially minerals that are becoming scarce more efficiently and put them back into production instead of shipping them to landfills, where they traditionally have been and to some extent still are polluting our soils. The possibilities are huge but so are the expectations for new products and job creation. In the line, to make the circular vision more straightforward and shared by decision-makers, including policy-makers as well as industrial practitioners, efforts must be done on: the appropriate level of intelligibility of circular indicators in accordance to their main recipients. Also, communication on best practices or successful examples of how

circular indicators have helped managerial activities to orientate actions in circular economy projects, as well as new experimentations of circular indicators for steering circular strategies, should be foster to lead and inspire this shift towards a more circular economy. Finally, making circular indicators more transparent and trustworthy e.g. in anticipating the environmental or economic performance and thus enlightening decision-making, will make them certainly more applicable in return. As it is identified generally for circular economy, the successful implementation of circular economy models relies on the synergy between key building blocks including product design, new business models, reverse logistics, enablers and systems conditions. From that standpoint, circular indicators can be considered as interesting enablers of the move to a more circular economy. Yet, the information provided by those indicators has to be translated into suitable actions for managing the circular economy transition. As such, other methods, tools and resources can complementary help the implementation of circular economy. Circular Economy Package and Symbiotic Bio-Energy Port Integration with Cities constitute two milestones towards this direction. Specifically:

- Circular Economy Package: The Circular Economy Package consists of an EU Action Plan for the Circular Economy that establishes a concrete and ambitious program of action, with measures covering the whole cycle: from production and consumption to waste management and the market for secondary raw materials. The proposed actions will contribute to "closing the loop" of product lifecycles through greater recycling and re-use and bring benefits for both the environment and the economy (Ballini, 2017).
- Symbiotic bio-Energy Port Integration with Cities by 2020 (EPIC 2020): EPIC 2020 builds capacity and know-how to promote the most efficient use of available bioenergy resources within ports and port regions and generates sustainable urban economic growth for Cities, ports and regional businesses based on bioenergy resources and environmental and social values EPIC 2020 targets the unused bioenergy resource potential. Also, EPIC 2020 supports the transformation of port areas into efficient and carbon-neutral, urban-integrated energy systems by applying the industrial symbiosis approach (Ballini, 2017).

## Quality of Life – Economic, Social and Governance Aspects

### Social well-being & health benefits with emphasis on the urban population

It is often taken for granted by those promoting Circular Economy that policies aiming at sustainability of the environment will be equally beneficial to human health and well-being. Even though health effects and benefits from specific policies are important criteria for evaluating these policies, to date coverage of health implications from policies promoting circular economy has been limited and, if anything, more concrete information is available about potential adverse health effects stemming from various practices especially associated with recycling, use of new chemicals and re-use of water. It is therefore very relevant and timely that health benefits and risks from policies related to the promotion of circular economy should be addressed and emphasized. On the potential benefits side, the way in which each policy is expected to decrease harmful exposures (e.g. to chemicals, air pollution or noise) or mitigate climate change should be quantified and its benefits for health estimated (clearly stating the associated uncertainty) and for the risks, it is better to face them directly, quantify and identify ways in which to prevent them.

### *Activities and experience*

The World Health Organization, European Center for Environment and Health (WHO-ECEH), which is located in Bonn, Germany, convened a meeting on "Circular Economy meets Environment and Health – Opportunities and Risks" in October 2017, with representatives of major policy making institutions, International Organizations, funding bodies, researchers, think tanks, civil society and private sector. In July 2018 the WHO Report "Circular Economy and Health: Opportunities and Risks" was published. In November 2018 another meeting was convened by WHO ECEH "From Linear to Circular Economy: Health Implications of Sustainable Consumption and Production (SDG 12)".

The 2018 WHO Report identifies the gaps in assessing human health effects when plans and actions related to circular economy are presented or implemented. The Report refers to all the initiatives taken towards circular economy, either as integrated policy actions (such as those initiated from alliances formed by public Institutions, NGOs or private sector companies) or as initiatives that present the totality of policies directly or indirectly related to circular economy. The latter type includes older WHO initiatives referring to Green Economy, the 2015 EU Action plan for Circular Economy, food safety and waste regulations- including e-waste-etc. Several EU countries are at the forefront of such efforts but there are also Global initiatives (such as from the UNEP). However, until today, in spite of the obvious association of the initiatives with human health, there are few instances in which this issue is systematically addressed. The WHO report is the first effort to present today's state-of-the-art overview and analysis concerning the interdependence between human health and circular economy policies and concrete action plans. The main conclusions are that 1. Reduced use of primary resources, greater use of renewable energy and energy efficiency may have direct (from reducing costs for households and the health sector) and indirect health benefits. 2. Changing utilization patterns will lead to indirect health benefits related to e.g. decreased emissions of air pollutants. 3. In contrast concerns are raised related to negative health impacts related to recycling practices, e.g. increased exposure to chemicals found in recycled materials, or from unregulated recycling practices. 4. A particular concern, which should be

evaluated at local, regional, national and global scale, is that adverse effects may fall disproportionately on vulnerable groups.

Therefore, the general conclusion is that circular economy as a concept and framework for action may have overall positive direct and indirect health benefits, especially reducing the impacts of climate change and the level of air pollution. However, although the overall effect of circular economy is expected to be positive, there are some critical issues to be observed when implementing policy changes. That suggests strongly that the study of health impacts can be one of the key drivers of change from linear to circular economy and therefore should be brought to the forefront of the policies planned and implemented.

### *Examples of best practices*

Policies towards circular economy have been undertaken at local, national and international level as described in the 2018 WHO Report (Annexes 3,4). However, these do not emphasize or integrate the health aspect in all policies and actions and the health stakeholders are often not integral part of the planning processes and their expertise is not sought. In the ECOCITY FORUM a plenary presentation focused on an independent Provincial Government Institution in Austria "The Vienna Ombuds Office for Environmental Protection and its role in promoting circular economy". The Ombuds Office participates in administrative procedures, gives opinion on City planning ordinances, assesses draft acts, takes part in Environmental Impact Assessments and strategic Environmental Assessments, provides advice and information for citizens and citizens initiatives, government, administration and NGOs, in close cooperation with scientists, and develops programs for awareness in environmental matters. Several Programmes are implemented in the City of Vienna, such as ÖkoKauf Wien (Ecobuy Vienna - Programme for Green Public Procurement), for which an impact calculation has indicated ecological, social and economic impacts and even though health impacts have not been directly assessed, they can easily be inferred in one further step as a result e.g. of the reduction in air pollution or of the improvement of living/working conditions. Additionally, the programme Smart City Vienna aims at "the best quality of life for all inhabitants of Vienna, while minimizing the consumption of resources ...", including innovation and climate goals and promoted distributional economy, efficient energy use and sustainable waste management. One project of the Ombuds Office and Ecobuy Vienna particularly relevant to health benefits is the development and distribution of the WIDES database ([www.wides.at/en](http://www.wides.at/en)), a database for disinfectants aiming at making the substitution of toxic agents in disinfectants easy and effective. The data base is industry independent and can be used without charge. Its effectiveness in reducing toxic agents has been demonstrated.

### *Knowledge gaps, next steps, actions and proposals.*

As mentioned, there are important potential benefits for health, but also non-negligible adverse health effects related to circular economy. The latter may be primarily identified in food safety from re-use or extended use of foods, pollutants emitted during composting processes, the presence of toxic chemicals in recycled materials, soil and water contamination from using sewage sludge and from unregulated and unprotected recycling processes. In the ECOCITY FORUM an important example of adverse health effects affecting primarily vulnerable groups was presented: health implications for recycling workers on electronic waste disposal sites in low income countries. Electronic waste includes all electrical and electronic equipment and their parts that

have been discarded. It is evident that this type of waste is sharply increasing and will continue to increase in volume. It is mainly exported for recycling in unregulated disposal sites in the developing World, whilst the workers in these sites are dependent on the income made out of this work, but are not informed and not instructed to take protective measures with direct consequences for their health. The workers include children and low education migrants from rural areas, living and working in extremely poor and unhealthy conditions. Although the preliminary and fragmentary evidence for the associated health effects can be shocking, there is no systematic approach to the study of health effects, the extent and nature of the exposures and no impact assessment. However, there are preventive steps that can be taken such as evaluating the extent of the problem; increasing the lifespan of electronic equipment; increase public awareness; promoting recycling with appropriate infrastructure; promoting education, information and the use of personal protective equipment; providing better health care and alternatives for workers.

Additionally, although the direct health benefits of circular economy practice in the health sector are often mentioned, little research has been done on the application of circular design in the healthcare industry. Aspects of safety for those working and for patients and the principles of designing circular medical products are emphasized in relation to this issue. Thus, introducing circular economy principles into the highly-risky field of the design of medical products is challenging and it is imperative to establish frameworks and guidelines for how products can be designed to be compatible with circular economy principles.

Using Health Impact Assessment (HIA) tools, which have been implemented extensively in some areas either focusing on specific exposures, such as in assessing the health impact of air pollution, or on specific health outcomes, such as was done in the Global Burden of Disease Study, can result in estimating the benefits and adverse effects of circular economy policies and calculating cost-benefit ratios. In the ECOCITY FORUM session a comprehensive presentation of such tools illustrated the purpose, usefulness and applicability of such tools. HIA is a combination of procedures, methods and tools by which a policy, programme or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population, whilst at the same time may identify appropriate actions to manage those effects. It is clear that population health is to a large extent determined by living conditions and other environmental, societal and economic factors and is not merely a product of health sector activities. Several HIA have been undertaken and need to be expanded to include the totality of effects from policies related to circular economy.

One example that was presented referred to the qualitative HIA aspects of the evaluation of the implementation of the Low Emission Zone for the centre of London. HIA of some circular economy policy may need to be qualitative but quantitative HIA is more powerful in providing prioritisation of circular economy policies. In quantitative HIA of air pollution reduction policies, assumptions about the change in the composition and size of the car fleet, emissions, dispersion of pollutants, the associated health benefits which depend on the underlying frequency of a specific health outcome and the associated exposure-response function known from the literature, and data on the affected population size, allowed the calculation of the life-years gained by the introduction of the low emission zone policy. Uncertainty was taken into account by introducing several scenarios for the above assumptions. Using these tools several different policies can be compared in quantitative terms and their advantages and disadvantages compared and used as input in a cost-

benefit analysis. Other aspects such as noise and physical activity changes can be quantified in terms of life years.

### *Perspectives*

Policies related to the promotion of circular economy have not taken into account potential health benefits or adverse health effects in a systematic way until today. The recent initiative of WHO steps in to provide a platform for improving this important gap. To achieve further progress in this respect, there is an urgent need for specific quantification of the consequences of each policy promoting circular economy, both in terms of direct and, more importantly, indirect effects, as in the latter lies the larger part of expected benefits. The indirect effects need to specify (with a level of uncertainty) the results of a policy on specific exposures (such as reduction in air pollution, improvement in supplying food etc) at local, national or international level, or a subset of these. These will be combined with the size of the population affected, concentration or exposure-response functions when these are available (or further research where needed), the underlying frequency of the health outcome addressed and a quantified HIA will provide invaluable information. Benefits and adverse effects should both be considered. The planning and impact in the health sector should be included within the priorities.

In order to achieve this change at the stage of proposing and planning an activity or legal framework related to circular economy, the awareness of all stakeholders is needed: policy/decision makers, business and industry players, NGOs and civil society and an informed public. Policy-makers and specifically (investment/change) planners at local, regional and national level should be knowledge-equipped and supported by other sectors, such as health, education and environment. Impact assessments, such as HIA and EIA should be carried out by default and should become “gold-standard” tools and ultimately become mandatory. The health sector should become one of the key drivers of change towards a sustainable and circular economy, promoting not just only GDP growth and full employment but the OECD supported framework and indicator set of well-being and the 17 UN sustainable development goals (SDGs) with the ultimate aim to “Leave No-One Behind”.

### **Customer behaviour and social interaction**

Citizen’s role is multilateral and affects circular economy implementation models though consumer’s behaviour has a long way to meet circular economy principles. Main issues that prevent consumers from adopting new behaviours according to the circular economy are linked with collective or individual attitudes and with lack of information or education. Also, lack of motivation is considered as barrier to behavioural change. Suggestions were made on the ways that we can contribute positively to the behaviour towards circular economy.

### *Activities and experience*

The following issues emerge in adopting and implementing the circular economy model:

- Poor culture in recycling attitude, combined with a lack of adequate infrastructure. There is no common culture on recycling across the country. Still, some municipal areas do not apply recycling systems when

harvesting garbage. Priority is on citizens training concerning recycling methods to be implemented and benefits to be collected. Circular Economy principles and practices follow.

- Advertising / Mass Media and Social Media effect. Advertising and, more generally, mass media promote the pattern of the successful and happy unsavoury consumer and ties emotions with material goods resulting to irrational consumer behaviour of all socio-economic classes and ages. It is worth noting that this issue was brought to the students by having received environmental education at school as an expression of their own perspective focusing on the effects of the projected lifestyle with emphasis on overconsumption.
- Initiatives to adopt behaviours favourable the circular economy models. Examples of good practices were reported but the results do not match with the expectations of the citizens who supported them. Indicatively, cases mentioned of recyclable and non-recyclable materials were collected together by the municipal services although sorted from the source. Citizens when separating their rubbish, they expect handling with positive effect. Differently, the authorities' behaviour eliminates citizens' attitude and acts as a cancellation for every effort.
- Inconsistency in policies' priorities and unreliability for the success of any other effort. Usually, when designing policies there is an intention to support the circular economy policies; for a variety of reasons (political, economic, etc.), finally priority is given to other areas or to the line model of economy. This prevents the systematic effort and results derived by the circular economy and keeps off the gradual maturation of situations aiming to adoption of its principles. The negative image obtained is a key element for the players' unreliability, and creates bias, considering any new effort or initiative unsuccessful.
- Technology achievements. Anarchic development of technology does not support circular economy neither principles of a consistent economic model. Often, technological advances considered as good examples of "technological innovations" are cut off from harmonised policies.
- Incomplete promotion and discontinuity in the implementation of good practices. Recently, good practices have been realised in the framework of funded pilot project; this method is scattered and there is no follow-up on the successful practices implemented. Usually, these practices are funded for a certain time period and cannot ensure sustainability after the funding is stopped.

### *Perspectives*

The Focus Group discussion concluded to proposals to strengthen circular economy behaviours, as follows:

- School education for Sustainable Development. Education of students is the most important investment for the future; same initiative is also a strong incentive for parents to adopt new behaviours. Educational Programs promoting the concept and practices of the circular economy can build on the already established environmental education and education for sustainable development. Specifically, sustainable development education should be based on the Mediterranean Strategy on ESD and the corresponding Action Plan adopted by Greece. It is worth mentioning that there is an Environmental Education Centre in each municipality of the country, frequently visited by schools. There should be a relevant to the circular economy educational program introduced systematically.

- Education of citizens through the Municipality and training of the Municipality's executives. Municipal Authorities can be a major factor in shaping the culture of the circular economy on a wider scale, playing a vital role in spreading new behaviours to citizens and supporting actions to promote the model of the circular economy. To achieve this goal, there is a need for targeted training/retraining for municipal officials to learn about the meaning and usefulness of the circular economy and thus to support with their decisions all respective actions.
- Experiential training. Experiential and interactive education is the most appropriate methodological approaches to adopt new behaviours. When applied, they enable the individual to actively participate and understand the concepts of the circular economy and contribute substantially and effectively to behavioural change.
- Traceability of recycled products. Technological development can support the development of traceability systems for recycled products. Authorities will be able to trace products on the stage of their production, consumption, recycling and conversion into raw materials. This will help us to identify with precision obstacles per stage and to propose and adopt specialised solutions for product flows in priority.
- Rewarding / Motivation. According to Greek and International studies rewards are strong motivates. Among best practices is recycling of glass bottles in the recycling centres that provide a discount for new buying or financial aid/donation to an NGO. This practice can be extended to other materials for recycling.
- The "polluter" pays / control system. Contrary to the principle of reward, the imposition of severe fines significantly affects the degree of compliance with the rules. Essential requirements are to create a stable regulatory framework, to monitor compliance systematically and to consistently impose fines to prevent inappropriate behaviour which do not contribute to recycling.
- Utilisation of local/domestic resources. Utilising domestic resources in terms of content, services and people, with emphasis on local characteristics, can deliver better results and more benefits for the stakeholders. It has been found that local communities are more supportive to actions from local actors and people with better local networking. The locality of the production - consumption - recycling cycle also reduces the environmental - energy footprint of transport.
- New jobs/ positions. The creation of new jobs and the promotion of professional opportunities created by the circular economy can be an incentive for the involvement of more and more professional categories and age groups, which will diffuse the circular economy concept and content.
- Designing policies and disseminating them to the general public while also referring to good practices. Policies should be designed by people who have a direct connection with those who apply them in order to properly predict and then update via the appropriate channels. It takes a holistic approach on the part of policy-makers to rely on what they want to achieve and on how this will become possible through existing processes.

Among highlighted conclusions of the session are:

- Interaction between stakeholders involved in order to design specific policies (public bodies and authorities, businesses, consumers).

- Adaptation of existing policy framework. The exchange of the participants' experiences in designing policies and the difficulties they faced thru the process as well as the obstacles created or overlooked or overturned during the implementation resulted in a better understanding of the concept and the content of the circular economy.
- Systematic education in schools at all levels and the widespread information of citizens via all media is emphatic.

### **Policy and Legal Context of Circular Economy**

The main legal instrument at EU level regulating waste management is Directive 2008/98/EC. Directive 2008/98/EC on waste is considered as a Framework Directive that sets the basic concepts and definitions (e.g. waste, recovery, recycling) for waste management. Amongst the basic concepts, the Directive explains when waste ceases to be waste, and under what circumstances it becomes a secondary raw material. The main aim of the Directive is to protect the environment and human health by way of preventing or reducing the harmful effects of waste generation and waste management. It establishes also the applicable waste hierarchy, with the following order of priority – prevention, preparing for reuse, recycling, other recovery, e.g. energy recovery, and disposal. The Directive also seeks to implement in practice the ‘polluter pays’ principle by establishing ‘extended producer responsibility’ for specific waste streams.

According to the Directive, the producer or holder of the waste maintains responsibility for carrying out the treatment of the waste, or the producer/holder needs to be sure that waste is handled by an authorised dealer, establishment or undertaking. Special attention is attributed to hazardous waste; thus Member States are required to ensure that hazardous waste is collected, transported, stored and treated in a way which provides protection for the environment and human health.

Waste treatment activities and facilities are subject to permits in a way that determines - inter alia - the quantity and the type of treated waste, the method used for the treatment as well as the monitoring and control operations, with the exception of certain activities which are only subject to registration. In addition, Member States shall establish one or more waste management and waste prevention plans, setting out the type, quantity and source of waste, as well as identifying existing collection systems and criteria for locating new ones.

Finally, the Directive requires Member States to ensure that waste management activities are subject to appropriate periodic inspections, while appropriate penalties against violators are also in place, including sanctions which should be effective, proportionate and dissuasive.

### *Activities and experience*

Recent trends suggest that turning waste into a resource is an essential part of increasing resource efficiency and closing the loop in a circular economy. The Union’s economy currently loses a significant amount of potential secondary raw materials found in waste streams. In 2013, total waste generation in the EU amounted to approximately 2.5 billion tons, of which 1.6 billion tons were not reused or recycled and therefore lost for

the European economy. By way of example, only a limited share (43%) of the municipal waste generated in the Union was recycled, with the rest being landfilled or incinerated (57%).

With respect to waste management, the Union also faces large differences amongst its Member States. In 2011, while six Member States landfilled less than 3% of their municipal waste, 18 landfilled over 50%, with some exceeding 90%. This uneven situation needed to be addressed.

Towards this direction, the European Commission presented in December 2015 the Circular Economy package, which included – inter alia – four legislative proposals for the amendment of six pieces of EU legislation, namely:

- Directive 2008/98/EC on waste
- Directive 94/62/EC on packaging and packaging waste
- Directive 1999/31/EC on the landfill of waste, and
- Directive 2000/53/EC on end-of-life vehicles, Directive 2006/66/EC on batteries and accumulators and Directive 2012/19/EU on waste electrical and electronic equipment.

Continuing in the spirit of the Circular Economy package, a European Strategy for Plastics was adopted in early 2018 (European Commission, 2018a), aiming to protect the environment from plastic pollution whilst fostering growth and innovation. The new rules adopted under the Circular economy package aim to prevent waste and, where this is not possible, to significantly accelerate recycling and packaging waste and gradually phase out landfilling (C.3.1.).

The new rules include ambitious targets which have to be achieved by the Member States, as shown in the Tables below.

**Table 1.** Recycling targets for municipal waste

<b>2025</b>	<b>2030</b>	<b>2035</b>
55%	60%	65%

**Table 2.** Recycling targets for packaging waste

	<b>2025</b>	<b>2030</b>
<b>Total Recycling (by weight)</b>	65%	70%
<b>Plastic</b>	50 %	55%
<b>Wood</b>	25 %	30%
<b>Ferrous metals</b>	70 %	80%
<b>Aluminium</b>	50 %	60%
<b>Glass</b>	70 %	75%
<b>Paper and cardboard</b>	75 %	85%

### *Knowledge gaps, next steps, actions, proposals*

As explicitly admitted by the European Parliament (European Commission, 2018b), “wide differences exist between Member States regarding the treatment of municipal waste, which represents around 10% of the total waste generated in Europe, measured by weight. The share of recycling and composting among waste treatment methods ranges from 64% in Germany to 12% in Malta and Slovakia (EU av.: 44%); 7 Member States landfill less than 10% of their municipal waste, while eight Member States landfill over 70% of their municipal waste (EU average: 28%); the amount of municipal waste per capita and per year varies from 254 kg in Romania to 758 kg in Denmark (EU average: 474 kg).

The above discrepancies led to the granting of derogations to specific Member States, by allowing for an additional 5-year period for the attainment of the quantitative targets.

Nevertheless, the new revised Waste Framework Directive also introduced a system of early warning reports to assess Member States’ progress towards these targets three years ahead of the respective deadlines.

In anticipation of this exercise, and in order to help Member States meet the 2020 target, the Commission has already conducted its first early warning study and issued in September 2018 a relevant Early Warning Report (European Commission, 2018c), which, inter alia, states that: “Based on an in-depth review of Member States’ recycling performance and waste policies, 14 Member States have been identified as at risk of missing the 2020 target of 50%. These are: Bulgaria, Croatia, Cyprus, Estonia, Finland, Greece, Hungary, Latvia, Malta, Poland, Portugal, Romania, Slovakia and Spain.

Scenario modelling performed for this exercise confirmed this and concluded that if no additional policy action is taken, some of the Member States concerned would probably not even meet the 50% target by 2025. In order to anticipate this problem, the Report includes country-specific actions that need to be undertaken at the earliest possible stage”.

### *Implementation implications: Case study Greece*

Greece produces approximately 441 kg/year/person of municipal waste, a figure which is below the Union average of 480 kg/year/person (2016). Regarding hazardous waste, Greece produces approx. 330,000 t per year, most of which originates from the industry, batteries, chemicals, hospital waste, liquid fuels and waste oils. As far as municipal waste management is concerned, the main option implemented is landfilling, since around 85% of waste generated is currently driven to landfills. Illegal dumping sites operating throughout the country during the last decades constituted a significant problem, for the operation of which Greece has been convicted twice by the European Court of Justice, having paid until today a lump sum of 64 million euros as a fine. Today (2018) the number of illegal sites has significantly decreased, though there are 14 uncontrolled dumping sites still operating in the country.

Environmental and waste management legislation in Greece is mainly EU driven. Greece has transposed – though in many cases with delays – all the relevant EU Directives on waste, including the EU Waste Framework Directive. A new National Waste Management was adopted in 2015 for the period up to 2020, while all the relevant Regional Waste Management Plans were issued during the years 2016-2017.

The main problems anticipated currently in Greece mainly relate to:

- Operation of illegal dumping sites.
- Absence of Integrated waste management facilities.
- Absence of facilities for the management of hazardous waste.
- Problems in implementing full separation at source (4 streams) and in achieving the targets specific quantitative targets for biowaste and glass.
- Potential risk of meeting the 2025 quantitative targets, as also stressed in the early warning report.

As main sources of the above problems, the following can be included:

- Delays in transposition of the relevant EU Directives in the national legal order.
- Delays in the adoption in the relevant implementing measures (Ministerial Decisions, Circulars, etc.).
- Quality of national legislation (series of amendments, provisions scattered between different legislative instruments, lack of legal clarity, etc.).
- Distribution of competencies (competencies distributed between Central Government, Decentralised Administrations, Regions and Municipalities, often with overlaps and lack of appropriate coordination).
- Lack of administrative infrastructure (due also to the prolonged financial crisis, the number of personnel in the relevant Environmental Departments has been significantly reduced).
- Lack of trust (the public is reluctant on whether any waste management facility will actually follow the terms and conditions of its permit).
- Significant delays in judicial procedures, especially regarding administrative courts.

Despite the problems, a number of significant initiatives have been undertaken during the recent years aiming to achieve gradual transition towards a circular economy, including:

- Adoption of a new Law on recycling in 2017, which transposes already the vast majority of the provisions of the new Waste Framework Directive.
- Enhancement of the legal framework regarding the implementation of extended producer responsibility (EPR) and legal requirement for the implementation of separate collection of at least four waste streams (metal, plastic, paper, glass).
- Enhancement of the administrative infrastructure of the Hellenic Recycling Agency, which is competent for the supervision and control of the operation of the Producer Responsibility Organisations for waste streams included under EPR.
- Establishment and operation of an Inter-ministerial National Circular Economy Committee, aiming to propose and coordinate actions aiming towards waste prevention and recycling.
- Drafting of legislation aiming to provide incentives through lower municipal fees for municipalities which achieve a high level of recycling.
- Finalisation of the national Forest Maps.

- Gradual implementation of the Regional Waste Management Plans and development of Integrated Waste Management Facilities.
- Full operation of the Electronic Waste Registry.

### *Knowledge gaps, next steps, actions, proposals*

Given that the new Circular Economy Directives were adopted in 2018, focus will be given towards their transposition and implementation in the Member States. At the same time, new funding tools are expected to be available during the coming period, aiming to promote incentives towards the industry, the public sector and the stakeholders involved for the transition towards a circular economy.

In addition, in the framework of the new EU Plastics Strategy, key initiatives shall include:

- Making all plastics packaging in the EU recyclable by 2030.
- Restricting/banning intentional addition of microplastics in products.
- Legislative proposal to curb single-use plastics consumption.

As far as Member States are concerned, their main efforts are expected to focus on two key pillars:

- Accelerating their pace in order to achieve the existing quantitative objectives for 2020 already in force.
- Preparing for the necessary public consultation necessary for the drafting and adoption of national legislation regarding the transposition of the new Circular Economy Directives in their national legal order, which has to be completed by July 2020 (transposition deadline).

Needless to say, that individual priorities, measures and initiatives shall differ significantly between the Member States, depending on the national achievements, opportunities and constraints.

### *Perspectives*

EU legislation provides for a building block for the transition towards a Recycling Society and a circular economy at Union level. New ambitious quantitative targets constitute a strong incentive towards the implementation of effective and sometimes even radical policies and measures, while at the same time ensuring the existence of measurable and clearly defined objectives.

Nevertheless, EU legislation on waste is mainly based on Directives, leaving in many cases significant discretionary power to the Member States, mainly regarding the policies and measures to be adopted at national, regional and local level, for the attainment of the EU targets. In a number of cases, this has facilitated the selection of the appropriate policy instruments at Member States level, depending on the specific national circumstances (for example, selecting between a State Fund or Privately-Owned Producer Responsibility Organisations for the implementation of Extended Producer Responsibility). In other cases, though, this discretion has led to totally different approaches by the Member States, directly affecting the effectiveness of the overarching EU policy objectives (for example, the adoption of totally different – and sometimes even contradicting – criteria regarding the determination of the end-of-waste status, according to Article 6 of the Waste Framework Directive).

Effectiveness of EU legislation highly depends on its proper implementation by the Member States. Effective implementation by the Member States varies significantly and is dependent on several parameters, including:

- Legal clarity: National legislation needs to be detailed and clear, avoiding generalities and vagueness, as also unnecessary cross-references to other pieces of legislation.
- Administrative capacity: Legislation should not only determine the arrangement of obligations, duties and competencies, but should also provide for the appropriate administrative capacities of the public bodies at central, regional and local level, which are necessary for the performance of the envisaged duties.
- Codification: The first pieces of EU legislation on waste were adopted as early as 1975 and since then they have been subsequently amended and/or repealed, while new legislation on waste streams and waste management treatment facilities is constantly adopted. This has resulted in many Member States to the existence of a fragmented and constantly amended national legislation, thus stressing the need for a codification of the relevant waste legislation.
- Allocation of competencies: National legislation should provide providing for a realistic distribution of competencies between the public and private actors involved. Especially the distribution between competencies at national, regional and local level needs to be carefully examined, in order to avoid overlaps or time-consuming procedures. In every case, a coordinating mechanism should be in place in order to ensure consistency of the policy at all levels.
- Monitoring and control: The development of an efficient and operational monitoring and control mechanism constitutes another crucial factor which needs to be determined by the national legislation. Use of electronic databases, preferably with interoperability features with other databases (for example electronic waste registry and tax/customs authority databases) shall ensure traceability of waste, as also effective monitoring mechanisms. On and off-site inspections need to be implemented on a regular basis for the assessment of compliance. Finally, penalties have to be threatened against infringements of the national legislation, which need to be effective, proportionate and dissuasive.

EU as also national legislation constitute the so-called “command and control” instruments and are indeed crucial for the effectiveness of waste legislation, but they are not the only ones. Legislative instruments have to be combined with the design and implementation of other instruments, such as:

- Economic (market-based) instruments: Economic instruments traditionally include taxes, levies, funding, incentives and disincentives, aiming to channel a national market towards a desired behaviour or approach. Striving towards a circular economy entails the use of various economic instruments, many of which have already been successfully applied in many Member States. These include for example:
  - Extended producer responsibility schemes for specific waste streams (packaging, ELVs, WEEEs, waste tires, oils, batteries and accumulators, etc.), where the producer of product becomes financially responsible for the management of the product after it becomes waste.
  - Funding Schemes: A number of funding schemes are already available, as for example for research and development of products with less packaging, or for minimisation of plastics.

- Taxes and levies: The vast majority of the Member States have already introduced charges for lightweight plastic carrier bags.
  - Incentives: In many countries, municipal fees are determined on the basis of the weight of the waste that the holder discards (Pay As You Throw schemes).
- Communicative instruments: One of the most important parameters in the transition towards a circular economy is clearly linked to behavioural change. Public awareness and participation constitute fundamental factors in the successful implementation of a new policy, aiming to the prevention and minimisation of waste. This is directly linked to the gradual and conscious change of existing behavioural and consumption patterns at all levels. Food waste prevention, management and separation of packaging waste, composting, choosing on the basis of the environmental performance of a product or service, avoidance of littering and of single-use plastics are only some out of many parameters in which the public is invited to play a vital role. Awareness raising campaigns, public information on a regular basis, use of social media and multimedia tools, active involvement of the public in consultations and initiatives, constitute necessary communicative instruments to supplement any effective policy towards circular economy.

### **Business innovation and regional development options related to blue economy**

Blue Economy is a necessity for the sustainable –in a socio-economic and environmental sense– development of coastal regions, especially those in the “closed” seas (in a geographical rather than political meaning), such as the Mediterranean and the Black Sea. The focus on the term *sustainable* is of decisive importance for the relevant discussion. This has to be restated as the pressure for new investments’ possibilities (given the continuing over-accumulation of financial capital globally) generates conceptual distortions of the term.

The report of the EU entitled “The 2018 Annual Economic Report on EU Blue Economy” is an example for this necessity. In the foreword of the volume Jean-Claude Juncker states that “*oceans can also contribute to our continent’s overall prosperity. They can produce investment, jobs and economic growth – and the healthier they are, the more productive they’ll be. Therefore, the Blue Economy must be a Sustainable Blue Economy.*” Obviously, according to this statement, sustainability is being instrumentalised for the sake of economic growth, which is quite different than recognising this as the main target. Consequently, the aforementioned report emphasises the produced GDP in the Blue Economy related sectors across Europe, including the marine extraction of oil and gas!

On the contrary, the European Economic and Social Committee underlines in the very first paragraph of the relevant opinion –REX/493 Blue Economy in the Western Mediterranean– that “*the socially and environmentally sustainable evolution of sea basins and coastal areas, counteracting the existing disparities and ensuring the conservation of cultural and bio-diversity, is of paramount importance*”. Moreover, the EESC calls for; (a) a safer and more secure maritime space, (b) a smart and resilient blue economy focusing on skills development, research and innovation, and (c) better governance of the sea, suggesting a further thematic broadening in biodiversity, conservation and intercultural communication.

Even more, *“small and very small enterprises, cottage industries and family businesses with traditional organisational structures, operational schemes and activities are the backbone of local economies on both shores of the Mediterranean basin. In that sense, networking and cooperative schemes for small and micro-producers may also improve resilience and cost-competitiveness by at the same time preserving the much-needed differentiation of the goods and services they provide. Therefore, the EESC considers that, in addition to innovative and technologically advanced entrepreneurship, it is at least equally important to promote specific, well-adjusted programmes for traditional economic activities as well, taking into consideration local particularities”*.

Giving the necessary emphasis on the issues of sustainability does not mean that the creation of new, prosperous jobs and the production of added value is irrelevant for the specific discussion. In the aforementioned opinion the rapporteur stresses out the importance of a concrete strategy for supporting small and very small (-scale) productive activities.

Blue Economy provides great business opportunities towards the socially and environmentally sustainable socioeconomic development, as it generates special prospects in sectors like fisheries, transport, energy, tourism, relevant R&D initiatives and coastal economic activities in general. Especially for port cities that concentrate added value in these sectors, the socioeconomic orientation towards a Blue Economy will have several multiplicative effects for local economic growth and development, while at the same time it can be directly linked to the possibilities of the cyclical economy and the application of relevant “smart” solutions in the public and private sphere.

Fisheries and sustainable utilisation of marine living resources, maritime transport of people and commodities and relevant port and logistics activities, shipbuilding and coastal tourism, as well as more innovative activities of high potential like “blue energy” (offshore wind and ocean energy), aquaculture, blue biotechnology and other relevant R&D activities generate several business opportunities, highly related to the notion of cyclical economy as well, especially for internationalised firms. Environmental awareness is becoming a prerequisite at a global level, thus bigger as well as small and medium sized enterprises must adjust to the new context including efficient waste management and the provision of new goods and services.

As an example, the environment-friendly policies which Hellenic Petroleum has implemented into the production process had specific positive impact on the firm’s function. Circular economy should be more than a compulsory context that companies have to deal with - not just a matter of legislation, but an attitude to life and a part of the corporate’s culture.

It provides tangible benefits, which help marketing and corporate social responsibility issues, as the next step towards circular economy is circular bio-economy. The decrease of carbon footprint for a firm and a wise waste management are two main criteria for international success. In order to achieve this goal, there must be a cooperation between industries so that the outflow of one system becomes the inflow of another system. Moreover, earth observation, being a dynamic tool for analysing the changes in cities’ climate, can be crucial in achieving urban sustainability by supporting the application of circular economy strategies at the firm level and also their evaluation by the public.

In that sense it is further important to strengthen the cooperation between academic institutions, research centres and internationalised small and medium sized firms. The circular economy pushes the frontiers of environmental sustainability by emphasising the idea of transforming products in such a way that there are workable relationships between ecological systems and economic growth. In the same context, start-ups can play a crucial role in an integrated ecosystem as regards to circular economy and blue economy entrepreneurship in general. Therefore, planning and implementation of a sufficiently far-reaching communication strategy that will publicise the resulting opportunities and prospects, in order (i) to record all the institutions and stakeholders that may be included and/or affected, especially at the regional and local level, and (ii) to circulate the relevant information among them is crucial.

Moreover, the quadruple helix approach should be adopted, at trans-national and especially regional / local level. Strengthened involvement of local authorities (municipalities and regions), as well as social partners and civil society organisations, within their respective areas of activity, is required. To that end, central agencies should invite local public and private-sector stakeholders to the consultation on the opened possibilities and on the specific areas of action – transport safety and security, fisheries, tourism and energy, relevant R&D, social cohesion and environmental sustainability.

Environment-conscious behaviour can be the main pillar of a new brand name for coastal countries and port cities. For instance, Greece and Thessaloniki could introduce a relevant strategy claiming in this way a strategic role in the Eastern Mediterranean basin. Recall that this could be of essential importance, as, mainly due to socio-political disturbances, EU Blue Economy promoting policy evolves mostly (if not exclusively) the western part of this closed sea. The EESC emphasises this by stating that this issue *“will not be handled efficiently in the long run, if we overlook the fact that the Mediterranean is a historical, economic and environmental unity. Therefore, even though the heightened geopolitical tensions and exacerbation of conflicts in the eastern part of the sea basin explain why the initiative is starting in the western Mediterranean, this should be understood as a pilot application that can provide useful experiences and best practices, to be extended into a holistic Mediterranean approach”*.

Relating the micro-entrepreneurial level with that of macro-policy initiatives, in perfect harmony to the existing international literature, cities, regions and countries of the (Eastern) Mediterranean could initiate a campaign for no-drilling zone in the whole of the basin, instead of being involved in antagonisms for controlling the blocks of exclusive economic zones for the sake of myopic, untenable mega-profits of globalised corporations. The well-known case of Dutch disease (The Economist, 26/11/1977, pp 82-83) speaks for that, as the establishment of drilling economy in the area will have severe effects on the economic and socio-political sustainability due to the following reasons: firstly, because this will cause conflicts with a serious impact on the security of the region and of course in human life itself; second, because this insecurity, as well as the environmental effects together with the over-concentration of investments in a mono-cultural economic sense counteracts the prospects of a wider range of forceful sectors and industries.

On the contrary, focusing on the principles of blue and circular economy will provoke a more dynamic and balanced development process, especially for small and medium sized, though internationalised, entrepreneurship in the related sectors, which can reach levels of added value far beyond than those that would be attainable through the extraction of oil and gas. The alternative forms of the marine and coastal

economy are increasingly receiving international attention: WWF, in a recent report (Randone et al., 2017), estimates that, given the 46.000 km coastline, the particularly important fishing stocks and the concentrated potential of maritime activity in the Mediterranean, the total exchange value that can be produced amounts to € 4.7 trillion! Also, recently, in 2017, the UN, in cooperation with the World Bank, has highlighted the opportunities and prospects for a blue economy and the sea-related sectors. The peoples of the area have to grasp the long-term sustainable path of the blue and circular economy as the real alternative to the dazzling challenge of the "lottery" of fuel stocks. Because in the end, the real wealth of the sea is not below it, but in its very essence.

### **Tourism sector and sustainable development**

The Circular Economy rules and the new EU recycling rates requirements set a new framework on waste management and recycling for the hotel industry in Greece. Greece unfortunately is still facing low recycling rates in many destinations due to seasonality, bad organized municipality waste management system and economic crisis. In terms of waste water management there are still areas/destinations where the sewage system is not completed, and hotels are using septic tanks.

The Greek hotel sector contributes to a production of 600.000 tons of waste annually. 60% is packaging and 40% is organic waste. This means that most of the waste could be well managed. In other words, with holistic management of waste the required recycling rates can be easily achieved.

The main problems tourist destinations are facing in terms of waste management are

- Recycling of waste and waste water infrastructure is not fully developed
- Various municipalities have different levels of infrastructure and management skills on waste management
- Biowaste is not organized yet
- The culture on waste management hasn't shift to the circular economy thinking yet.

Some proposals are

- a. Develop all required infrastructure in terms of waste and waste water management
- b. Introduce the Pay as you throw system
- c. Introduce tax incentives on environmental issues
- d. Ban plastic in tourist areas
- e. Allow the use of waste water for fire safety issues in the hotel sector
- f. Introduce zero waste strategies

Finally, it is worth saying two positive outcomes

- The Greek hotel sector is very mature on adopting the circular economy steps quickly if all the infrastructure / services / legislation is provided

- Many hotels in Greece can be considered as a global best practice approach on waste management, using own means and funds.

## ECOCITY profile

ECOCITY is a no profit organization with focus to urban environment. It was founded in Athens – Greece on 2004 and has departments in Thessaloniki and Patras. Is an active member of EEB, T&E, ECOS, PANEurope, ECONenergy and MIO/ECSDE. Since 2008, ECOCITY’s network with municipality authorities in Greece is focusing on consulting services concerning development of friendly environment strategies and projects. ECOCITY is governed by elected Board and Scientific Committee. Distinguished scientists and specialised professionals are listed among members of ECOCITY covering all areas of expertise concerning multilateral environmental development and circular economy implementation model.

ECOCITY’s services to cities also include coordination of public consultation, conducting environmental strategic plans, co-organisation of events and press events on special areas of interest (with environmental content).

ECOCITY’s annual programs and campaigns aim to advocate positive attitudes and behaviours on environmental issues, to motivate citizens on participating to debates and to support and educate local communities on benefits and opportunities to be accomplished by the integrated circular economy plans. The Organizing Committees of the above-mentioned programs and campaigns invite Municipal Authorities to co-act in order to expand results in local and national level.

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