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ANALYZING WASTE MANAGEMENT WITH RESPECT TO CIRCULAR ECONOMY

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Abstract

The term 'Circular Economy" (CE) currently is very popular with economists and on the political agenda. Policy makers, academics and world business leaders emphasize that moving towards a circular economy has a crucial importance in solving global environmental and economic problems. In this present paper, we intend to highlight the most important notions of (CE) with respect to waste management. Before we analyze the key concepts of circular economy, it is important to review the development and major events of the past in connection with global environmental challenges. The paper presents the possibilities of circular economy by reviewing specialist literature and analyzing data. The data of the Eurostat were used for evaluation. Conclusions are drawn on the basis of facts and analyses that could help understand the necessity and development of circular economy.

Keywords

circular economy, sustainable development, waste management, EU waste targets

1. Introduction

Each year humanity uses resources and ecosystem services that would require 1.5 Planet Earths to be able to keep up with and support our societies [1]. Humanity is facing big challenges: climate crises, financial crises, global poverty, ozone depletion, extinction of species, epidemics, deforestation, armed conflicts, fresh water shortage, social anxiety, natural disasters and so on. We are daily faced by alarming reports about the state of nature and humanity. Research finding, such as the Millennium Ecosystem Assessment [2], Planetary Boundaries [3, 4], Ecological footprint [1] and IPCCs [5], have drawn the same conclusion that the natural cycles, ecosystems and natural resources are being degraded and altered by human impact and the environmental problems are serious.

Human activities have, since the start of industrialism –including fossil fuel dependence and industrialized agriculture – destabilized the Earth systems and natural cycles and forced the environment into a destabilized state [3].

Four major causes of environmental problems are population growth, wasteful and unsustainable resource use, poverty and a failure to include the harmful environmental costs of goods and services in market prices [6].

Due to the forthcoming crisis endangering our planet, the commission of the UN proposed the one-time Norwegian prime minister in 1983 to work out a thorough program to outline the necessary changes. The Brundtland Committee submitted their report in 1987 entitled 'Our Common Future' that caters for the principles and requirements which would save the Earth for future generations should they be met [7].

The most important message of the Report is that forced growth could lead to the breakdown of the biosphere. That is why economic growth should no longer be carried out in its present form. Sustainable development does not call for limiting our demands, rather, it urges us to meet the requirements by minimizing materials and energy as well as the negative consequences of our production. The governments of the developed civil democracies have worked out several environmental programs but none of them have considered the fact that the standard of satisfying needs must also be lowered in some uneconomical societies and it is not enough to rationalize only consumption.

The concept of sustainable development has gained ground in environmental sciences within a short time. However, there is still some confusion in terms of sustainability and sustainable development [8] distinguishes environmental sustainability, economic sustainability, social sustainability and sustainable development. Economic sustainability equals environmental sustainability as both of them refer to the sustainability of stock. The definition above takes Hicks' terms of income into account [9] according to which income is the maximum income that can be spent without reducing real consumption in the future. Social sustainability means the sustainability of social capital. Sustainable development refers to all the three terms in this interpretation.

According to the report Our Common Future [7] it is such a development that ensures meeting the demands of the present without compromising the satisfaction of the needs of future generations. According to another interpretation it means improving the quality of human life within the sustaining capacity of supporting ecosystems [10].

Meadows et al. [11] defines sustainable society as the one that can be sustained for generations and it is careful enough not to ruin its vital system.

According to Daly [12] three criteria must be met to achieve material and energy sustainability. They are as follows:

- the rate of renewable resources must not exceed regeneration rate;
- the rate of non-renewable resources must not exceed the regeneration rate of sustainable renewable ones and
- the emission rate of pollutants must not exceed the assimilative capacity of the environment.

Opschoor [13] introduces the time concept as it states

- the time concept of human interaction must be in balance with the time concept of natural processes if we take either the degradation of waste or the regeneration rate of renewable resources and ecosystems into account.

The most important message of sustainable development is treating the right of satisfying the needs of future generations on a level-playing field with the right of the present generation. On the basis of the prerequisites for sustainability Tietenberg [14] states that the previous generations can make use of the resources until the level of well-being of the future generations reaches at least the level of any previous generation. If the well-being of people is lower than at present as a consequence of taking resources away, it does harm the criterion of sustainability.

Of the several kinds of interpretations of sustainable development [15] distinguishes three basic types.

1. Sustainability can be interpreted as constant consumption. This corresponds with the weak sustainability criterion where natural and man-made stock can substitute each other. Total output of production and the standard of consumption per capita can be maintained as long as the profit gained from using natural resources is not consumed, rather invested in funds.
2. The term can be interpreted as the constant stock of natural resources in time. This corresponds with sustainability in its strict sense, i.e. natural and man-made capital can complement but cannot substitute each other.
3. Sustainability can also be interpreted as equality between generations. There is no further rule concerning the substitution of natural capital with man-made one.

The United Nations Conference on Environment and Development, which took place in 1992 in Rio de Janeiro, has been a cornerstone of modern sustainable development policies and has strongly influenced the direction they have taken. It has enabled a consensus between the otherwise conflicting objectives of economic growth, social equity and environmental protection by embracing the multi-dimensional concept of sustainable development. The Rio Declaration on Environment and Development also known as the Rio Declaration, and Agenda 21 were the major outcome documents of the Rio conference.

Twenty years after the first Rio conference, the United Nations Conference on Sustainable Development (UNCSD) was held in June 2012, again in Rio de Janeiro – therefore also called 'Rio+20' The conference has been conceived as a landmark event in the global movement for sustainable development. As the main outcome, world leaders decided to launch a process for the development of a set of Sustainable Development Goals (SDGs), which will constitute the goals of the 2030 agenda for sustainable development, thus replacing the MDGs after 2015.

Following the Rio+20 Conference, the UN launched a post-2015 process, which culminated in the definition of the 2030 agenda for sustainable development. The 2030 agenda, approved in September 2015 by the UN General Assembly (27) defines sustainable development goals and targets, refers to the development of a global indicator framework and calls for revitalized global partnership to ensure its implementation. Many actors at the political, technical and scientific level are involved in the definition of the different elements of the 2030

agenda. Several international organizations, as well as stakeholders from the civil society and the private sector have been involved at different stages of the post-2015 process.

The Europe 2020 strategy (Table 1.) adopted by the European Council in 2010 is the EU ten-year strategy for growth and jobs. It puts forward three priorities to make Europe a more sustainable and more inclusive place to live:

–It envisages the transition to smart growth through the development of an economy based on knowledge, research and innovation.
–The sustainable growth objective relates to the promotion of more resource efficient, greener and competitive markets.
–The inclusive growth priority encompasses policies aimed at fostering job creation and poverty reduction.

Table 1. The Europe 2020 strategy's key priorities, headline targets and flagship initiatives [16]

	Targets	Flagship initiatives
Smart Growth	— 3 % of GDP to be invested in the research and development (R&D) sector. — Reduce the rates of early school leaving to below 10 %, and at least 40 % of 30 to 34 year olds to have completed tertiary or equivalent education.	— Innovation Union — Youth on the move — A digital agenda for Europe
Sustainable Growth	— Reduce greenhouse gas emissions by 20 % compared to 1990 levels. — Increase the share of renewables in final energy consumption to 20 %. — 20 % increase in energy efficiency.	— Resource efficient Europe — An industrial policy for the globalisation era
Inclusive Growth	— 75 % of 20 to 64 year old men and women to be employed. — Reduce poverty by lifting at least 20 million people out of the risk of poverty and social exclusion.	— An agenda for new skills and jobs — European platform against poverty and social exclusion

The linear economy is a definition for the present economic growth model. In this model "linear" refers to cradle to grave flow of natural resources (take-make-waste). This linear flow is the consequence of cheap and amply resource of supplies leading producers to focus on supplying customers increasing amount of goods. In this model, environmental impact is unaccounted for. The incentives to minimize waste during use and product end-of life are weak. No attention is paid to ensure discarded goods are put into new use or back into a production process as raw material [17]. A linear economy flows like a river, turning natural resources into base materials and products for sale through a series of value-adding steps [18]. At the point of sale, ownership and liability for risks and waste pass to the buyer (who is now owner and user). The owner decides whether old tires will be reused or recycled – as sandals, ropes or bumpers – or dumped. The linear economy is driven by 'bigger-better-faster-safer' syndrome – in other words, fashion, emotion and progress. It is efficient at overcoming scarcity, but profligate at using resources in often-saturated markets. Companies make money by selling high volumes of cheap and sexy goods.

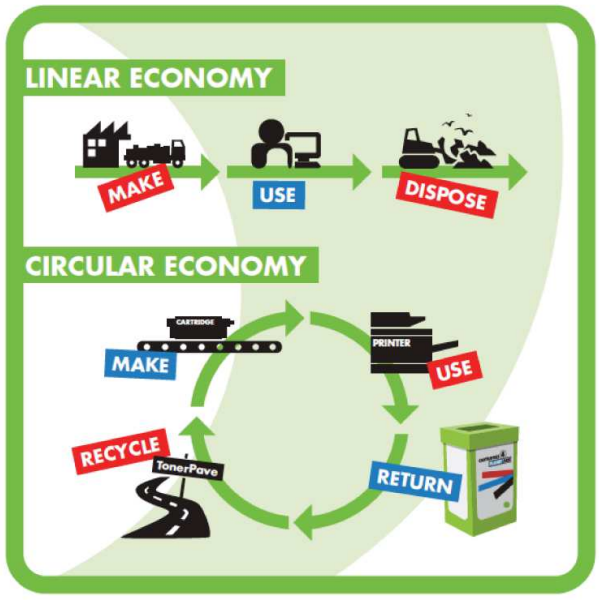

Figure 1. Linear vs circular economy [19]

2. Circular Economy

The starting point for the ideas on CE has been to change the linear economic system of take-make-

waste in order to lower resource use and waste of natural capital. It builds on the notion of cycles in nature fueled by solar energy, where nothing is wasted but just goes around in loops. Figure 1 illustrates the difference between a linear and circular economy.

In nature, materials cycle endlessly and nothing is wasted, but humans have developed a linear approach of producing, consuming and disposing of items. The idea of a circular economy, a closed loop process in which we reuse, recover and recycle these valuable materials and keep them in the productive economy for as long as possible, is gaining traction in many business processes (Figure 2). A circular economy is like a lake. The reprocessing of goods and materials generates jobs and saves energy while reducing resource consumption and waste. Cleaning a glass bottle and using it again is faster and cheaper than recycling the glass or making a new bottle from minerals. Vehicle owners can decide whether to have their used tires repaired or whether to buy new or retreaded replacements – if such services exist. Rather than being dumped, used tires are collected by waste managers and sold to the highest bidder.

Circular-economy business models fall in two groups: those that foster reuse and extend service life through repair, remanufacture, upgrades and retrofits; and those that turn old goods into as-new resources by recycling the materials.

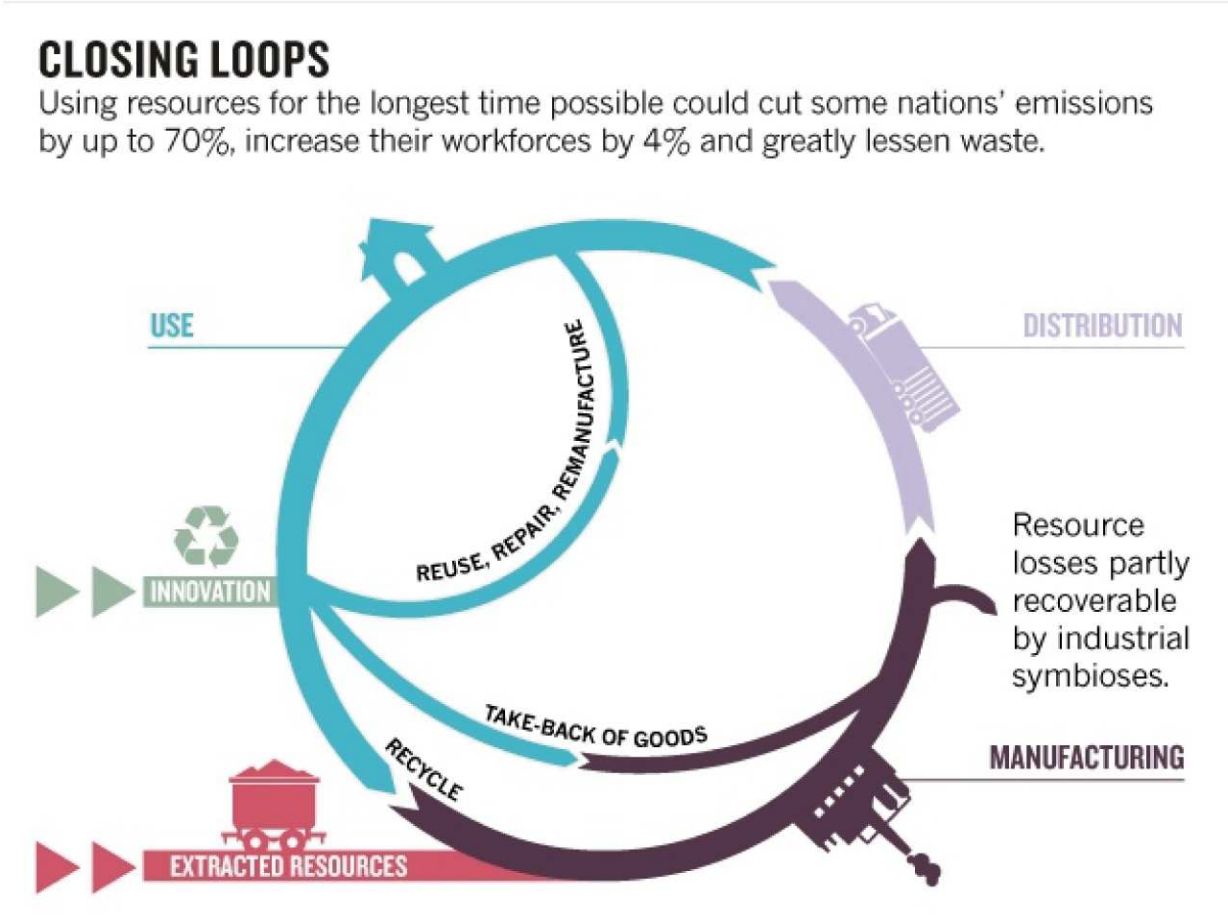

Figure 2: Closing the loop [20]

The concept of this model heavily focuses on the urgent need of decoupling: a transition to an inclusive and circular economy. Decoupling refers to the ability of an economy to grow without corresponding increases in energy and resource use (source limits) and in environmental pressure (sink limits). A decoupled economy should ideally not negatively affect soil fertility and biodiversity, not diminish resource stocks and not lead to increased toxicity of land, water and air. Relative decoupling will buy time, i.e. give the economy some extra time before it runs into resource constraints and/or excess pollution. Once the economy comes close to a boundary, absolute decoupling will be a requirement so as to enable the economy to continue to develop sustainably. While relative decoupling of economic

growth from resource use has been happening over the past decades (Figure 3.), the gains made so far have been rapidly eaten up by a combination of economic growth and the so-called rebound effect, i.e. that the resources freed up by increased efficiency are used up very soon through increased consumption. Here is where the circular economy as a powerful concept can be applied [21].

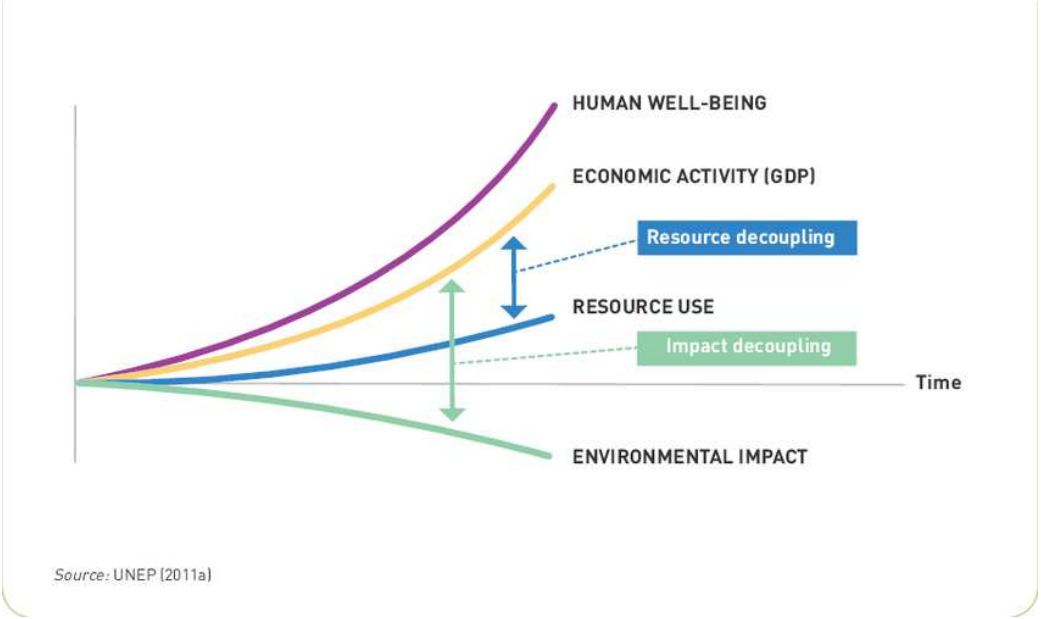

Figure 3. Aspects of decoupling [22]

CE proponents claims CE to be a new paradigm for industry since it aims at generating ecological, social and economic value resulting in effectiveness improving the state of the environment and even go beyond sustainability [23].

The European Commission adopted a so called Circular Economy Package in 2015. The Package includes revised legislative proposals on waste to stimulate Europe's transition towards a more circular economy which will boost global competitiveness. It consists of an action plan establishing a concrete 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. In the following the most important aspects of the action plan is reviewed.

A circular economy starts at the beginning of a product's life. The design phase and production processes influence sourcing, resource use and waste generation throughout a product's life. Better design can make products more durable or easier to repair. Unfortunately, current market signals appear insufficient to make this happen. The main reason for this can be found in the different interests of producers, users and recyclers. It is essential to provide incentives for improved product design, while preserving the single market and competition, and enabling innovation. Electrical and electronic products are particularly significant in this context. Their reparability can be important to consumers, and they can contain valuable materials that should be made easier to recycle. In order to promote a better design of these products, in the future, issues such as reparability, durability, upgradability, recyclability, or the identification of certain materials or substances will be systematically examined.

The Ecodesign working plan for 2015-2017 will focus on the implementation of reparability, upgradability, durability, and recyclability of products by developing product requirements relevant to the circular economy in the future.

EU consumers often find it difficult to differentiate between products and to trust the information available. Green claims may not always meet legal requirements for reliability, accuracy and clarity [24]. That is why it is inevitable to make green claims more trustworthy, and ensure better enforcement of the rules in place.

Planned obsolescence practices can also limit the useful lifetime of products. Through an independent

testing program, extensive work should be carried out to detect such practices. In addition, the revised legislative proposals on waste include new provisions to boost preparation for reuse activities.

Waste management plays a central role in the circular economy: it determines how the EU waste hierarchy is put into practice (Figure 4). The waste hierarchy establishes a priority order from prevention, preparation for reuse, recycling and energy recovery through to disposal, such as landfilling. To achieve high levels of material recovery, it is essential to send long-term signals to public authorities, businesses and investors, and to establish the right enabling conditions at EU level, including consistent enforcement of existing obligations.

Figure 4. EU's waste hierarchy [25]

Today, only around 40% of the waste produced by EU households is recycled. This average masks wide variation between Member States and regions, with rates as high as 80% in some areas, and lower than 5% in others. New legislative proposals are being put forward on waste to provide a long-term vision for increasing recycling and reducing the landfilling of municipal waste, while taking account of differences between Member States. These proposals also encourage greater use of economic instruments to ensure coherence with the EU waste hierarchy.

The revised waste proposals will also address key issues relating to the calculation of recycling rates. This is essential to ensure comparable, high-quality statistics across the EU, and to simplify the current system and encourage higher rates of effective recycling for separately collected waste.

Another barrier to higher recycling rates is the illegal transport of waste, both within the EU and to non-EU countries, which often results in economically sub-optimal and environmentally unsound treatment.

When waste cannot be prevented or recycled, recovering its energy content is in most cases preferable to landfilling it, in both environmental and economic terms. 'Waste to energy' can therefore play a role and create synergies with EU energy and climate policy, but guided by the principles of the EU waste hierarchy.

The need for integrating natural resources into the development and decision-making processes of various sectors on a political level is becoming apparent in the European Union [26]

The revised legislative proposals on waste set clear targets for reduction of waste. The most important elements of the revised waste proposal are as follows:

–A target for recycling 65% of municipal waste by 2030;
–A 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 harmonized 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).

In the following the latest available statistical findings (Figure 5.) are presented in relation with the waste proposal.

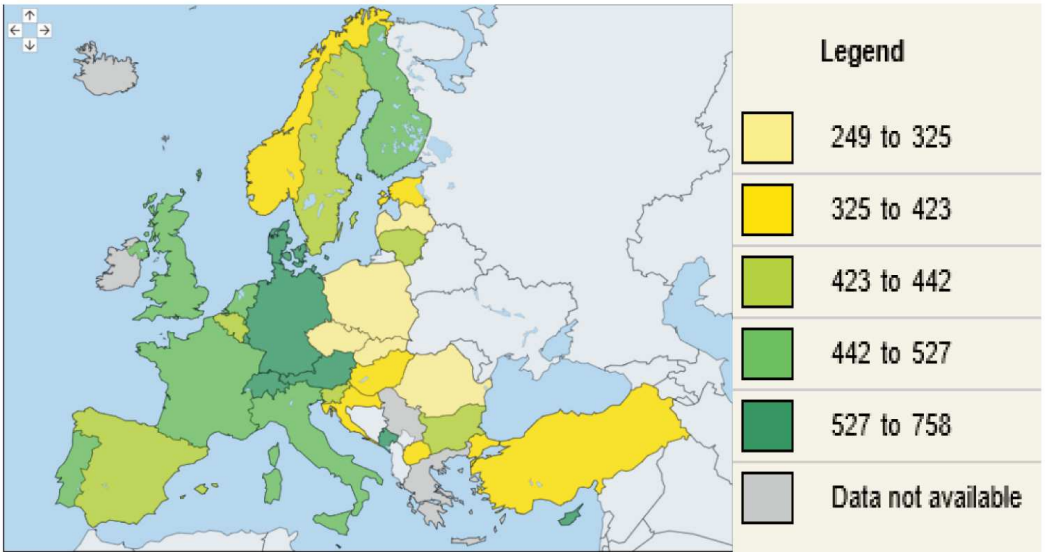

Figure 5. Total waste generated in tons in EU 28, 2014 [27]

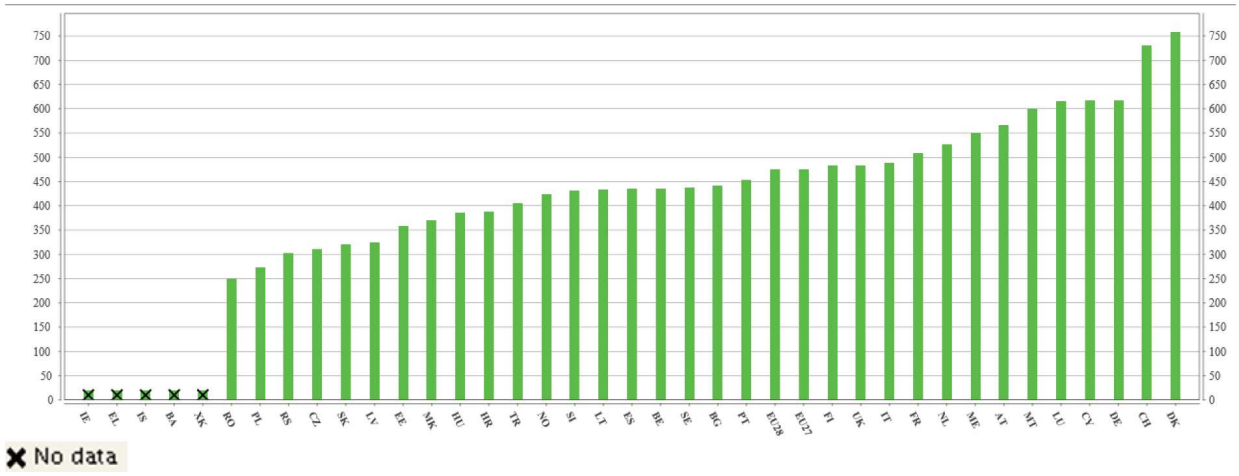

Figure 6. Total waste treatment in tons in EU 28, 2014 [27]

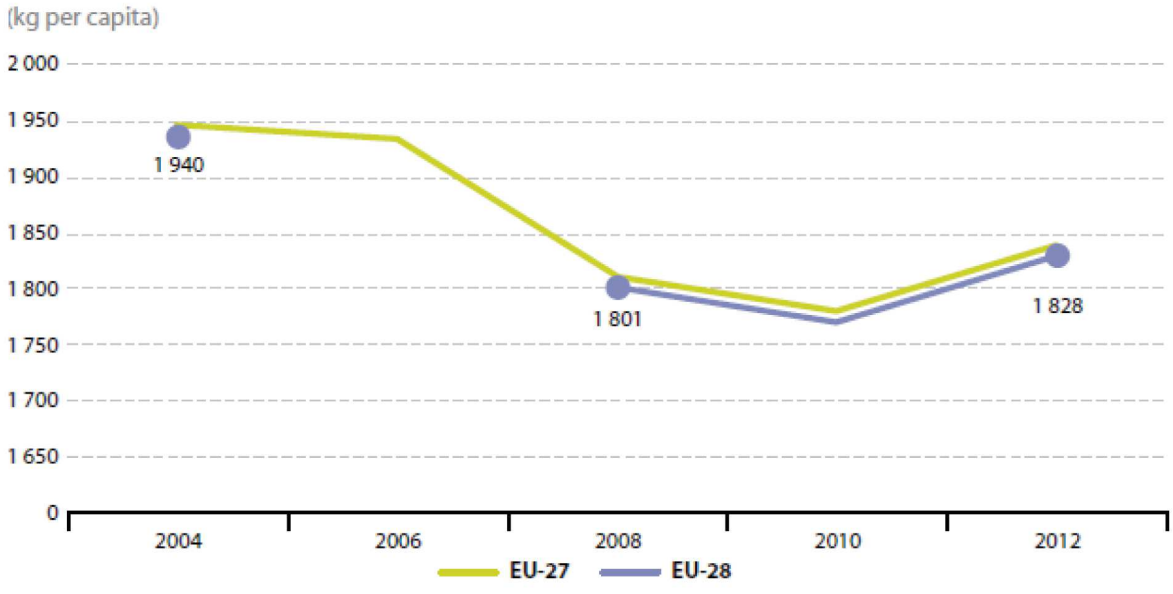

Figure 7. Generation of waste excluding major mineral wastes, 2004–2012 [27]

Figure 6 shows that the greatest waste producer is Germany but at the same time total waste treatment is the highest in this country.

Figure 7 shows that the amount of waste excluding major mineral wastes generated in the EU-28 reduced by 5.8 % over the long term between 2004 and 2012. This trend was reversed in the short term, with waste excluding major mineral wastes rising by 1.5 % between 2008 and 2012.

In the long term, the amount of waste excluding major mineral wastes generated per inhabitant in the EU-28 declined at an annual average rate of 0.7 %, from 1.9 tons in 2004 to 1.8 tons in 2012. This reflects reductions in almost two-thirds of the Member States, with particularly strong declines in Cyprus and Croatia. In the short term, the indicator has started growing at a rate of 0.4 % per year, from 1.8 tons per capita in 2008. The EU experienced a substantial drop in the amount of waste excluding major mineral wastes between 2006 and 2008 (6.5 %). This was most likely affected by the slowdown in economic activity during the economic crises. However, the falling trend in the period between 2006 and 2010 was reversed in 2012, with an increase of 3.3 %.

At Member State level, in 2012 the generation of waste excluding major mineral wastes varied by a factor of 13, from 0.6 tons per capita in Croatia to 8.6 tons per capita in Estonia. The exceptionally high rate in Estonia is mainly due to large amounts of waste coming from the energy and refinery sector as a result of enrichment and incineration of oil shale. This also explains the high amount of hazardous waste generated in Estonia (see the 'hazardous waste' indicator on p. 89). In addition, considerable amounts of wood waste contribute to the high figures in Finland, Austria and Sweden. Generation of waste excluding major mineral wastes decreased in 17 Member States between 2004 and 2012, with the strongest decreases occurring in Cyprus (63 %), Croatia (45 %) and Austria and Hungary (39 % each).

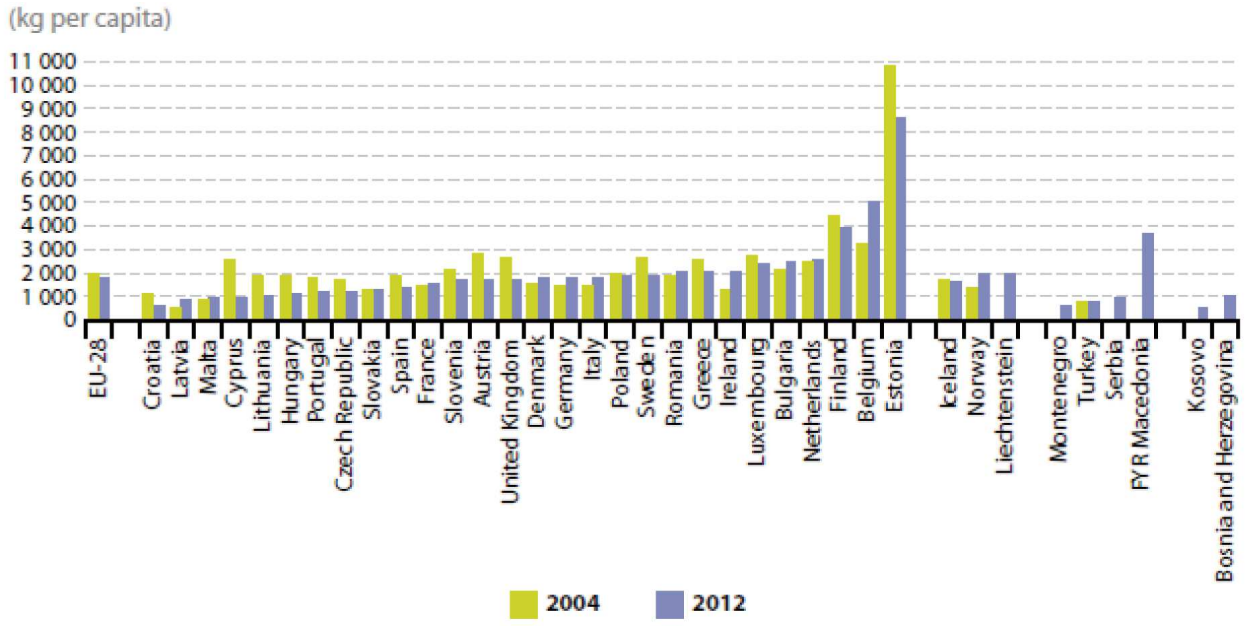

Figure 8. Generation of waste excluding major mineral wastes, by country, 2004 and 2012 [27]

Waste excluding major mineral wastes (Figure 8.) is an important indicator for environmental policies because it covers most of the waste for which reduction is an important environmental objective. Although the indicator focuses on waste excluding major mineral wastes, it is considered to reflect the general trend in waste generation more accurately and in a more comparable way than the total including mineral waste. This is because of the strong fluctuations in waste generation in the mining and construction sectors, and their limited data quality and comparability. Moreover, for a considerable share of mineral wastes, prevention is not the main environmental objective. This indicator presents the amount of waste excluding major mineral wastes generated, expressed in kilograms per capita and per year. The indicator covers hazardous and non-hazardous waste from all economic sectors, administrations and households, including waste from waste treatment (secondary waste) but excluding major mineral waste, contaminated soils and dredging spoil.

The EU recovered and reprocessed 52 % more waste through recycling and composting in the long term, between 2000 and 2013. In the short term, the share of recycling and composting increased from 36.3 % in 2008 to 41.8 % in 2013. The shift away from disposal was driven by EU and national strategies for sustainable waste management.

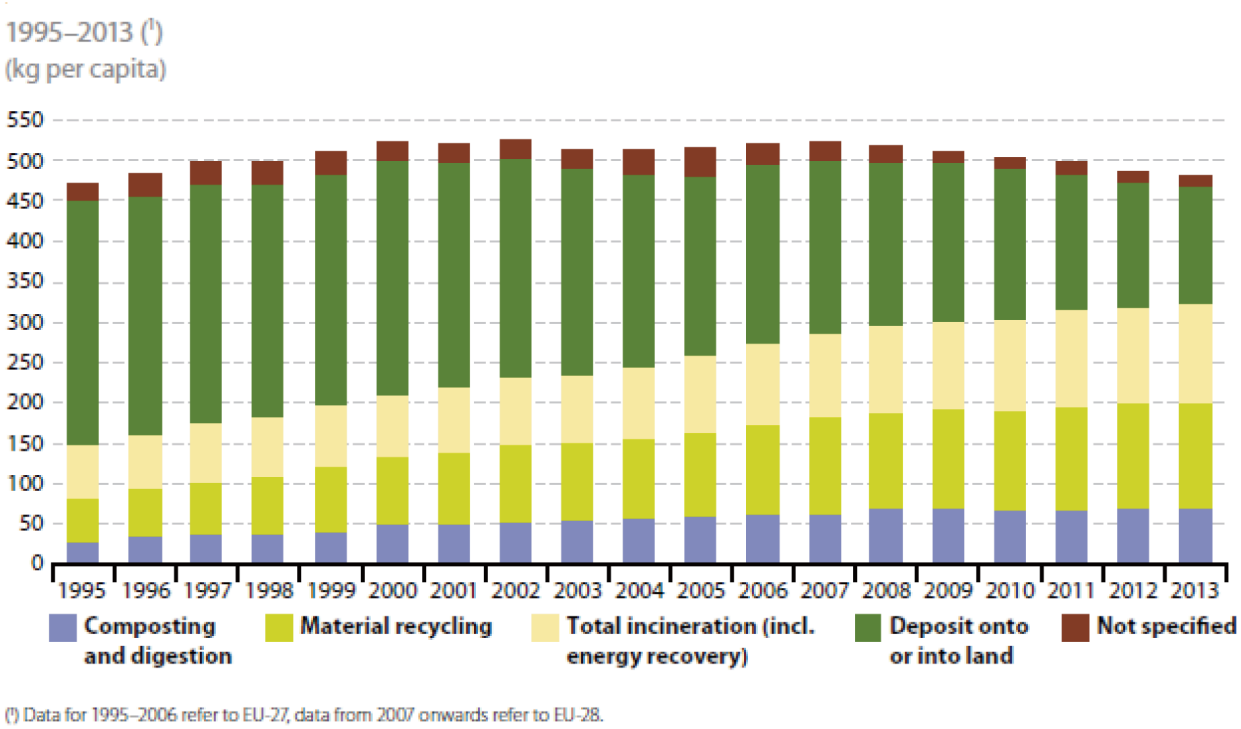

Figure 9. Municipal waste generation and treatment, by type of treatment method, EU-28, 1995–2013 [27]

In the long term, the average amount of municipal waste (Figure 9.) generated per EU inhabitant fell from 1.43 kg per day in 2000 to 1.32 kg per day in 2013. Between 1995 and 2000 the amount of total municipal waste generated annually in the EU was gradually increasing, from 455 to 499 kg per inhabitant. In the following period, between 2000 and 2007, total EU municipal waste was more or less stable, fluctuating within the range of 514 and 523 kg per inhabitant. It was only in the short term, between 2008 and 2013, coinciding with the onset and aftermath of the economic and financial crises, that the total amount of generated municipal waste started to fall steadily, reaching 481 kg per person in 2013.

In 1995, 64 % of municipal waste generated in the EU-28 – originating from everyday household waste and other sources such as commerce, offices and public institutions — was disposed at landfill sites. In 2000, more than half of municipal waste was still being landfilled (55.1 %). But by 2013 there had been a clear shift towards recycling and composting (41.8 %) and incineration with energy recovery (25.4 %). Waste prevention – the top aim of European policy's 'waste hierarchy' — also seems to have been taken up across Member States, with 18 out of 31 countries having adopted waste prevention programs by the end of 2013 as required by the EU Waste Framework Directive. The observed improvements in waste management have been to a large extent driven by EU and national strategies prioritizing efficient waste management through various instruments. These include setting targets for recycling and recovery, imposition of taxes and other restrictions on landfill waste. The trend towards sustainable municipal waste management has also been reinforced by some external factors such as the increase in urbanization and population densities and the rise in prices of raw material, recycled materials and fuels.

The amount of total municipal waste treatment in the EU varied from 747 kg per inhabitant in Denmark to 220 kg per inhabitant in Romania in 2013. Despite the large body of EU waste legislation, which has been in place for about 20 years, the dynamics of waste treatment vary greatly among Member States. Whereas Romania landfills more than 96.8 % of its municipal waste and Malta, Croatia, Latvia and

Greece more than 80 %, Germany, Sweden and Belgium dispose of less than 1 % in this way. In large part, the vast differences in countries' performance can be explained by their different starting positions, the existence of derogation periods for some, and the fact that some had started increasing municipal waste recycling long before they were required to by EU policies. However, formal transposition of EU law into national legislation is often not sufficient for achieving EU's minimum target levels on waste management. In general, better performing countries in terms of landfilling and recycling tend to have a wider range of instruments and measures in place. These include active recycling policies in combination with 'landfill bans on biodegradable waste or non-pre-treated municipal waste; mandatory separate collection of municipal waste types, especially bio wastes; and economic instruments such as landfill and incineration taxes and waste collection fees that strongly encourage recycling'. Member States with dedicated and diverse policy instruments and strict regulations on waste management, such as Sweden and the Netherlands, deliver relatively high recycling (including composting) and incineration rates, both above 45 %. The large discrepancies across Member States reflect some gaps in the implementation of EU waste objectives into national legislation. These gaps are due to a series of technical, market or administrative barriers.

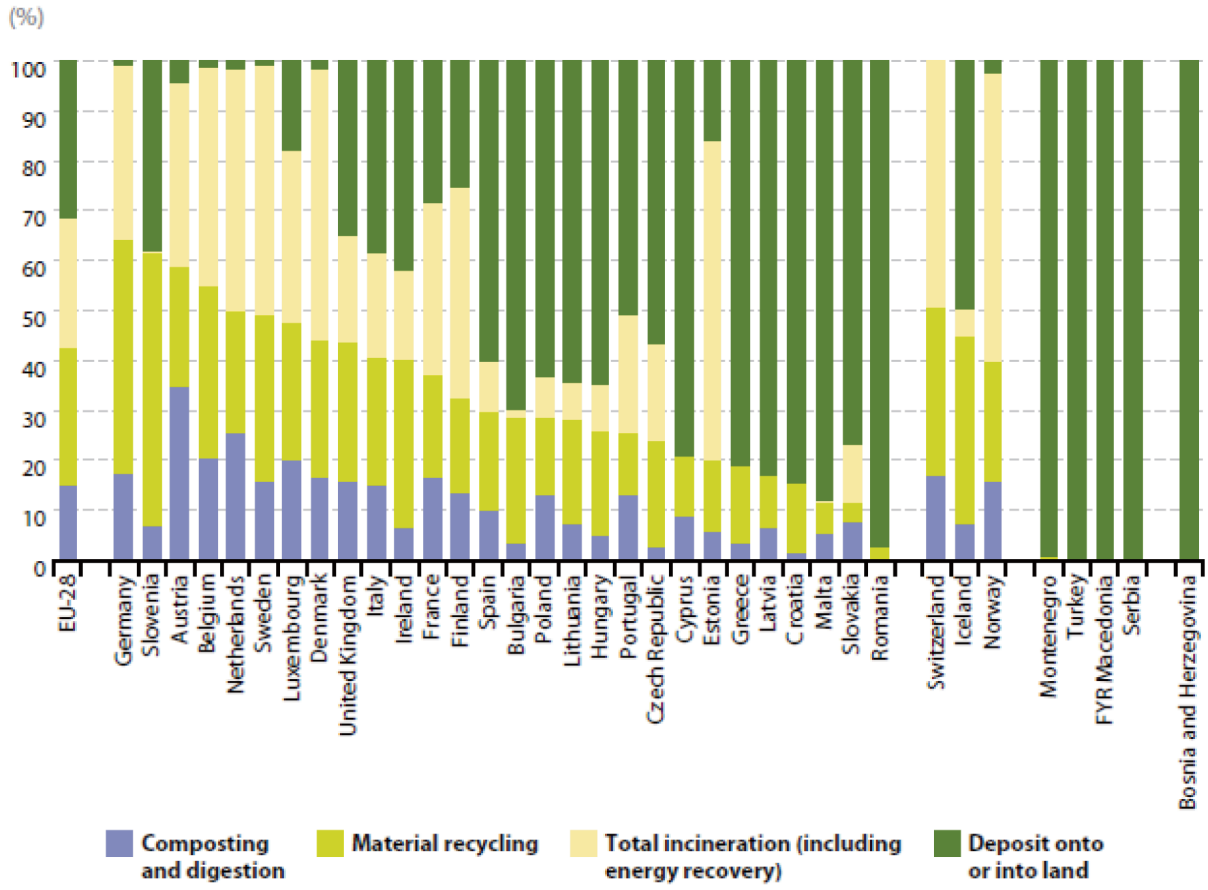

Figure 10. Municipal waste treatment, by type of treatment method, by country, 2013 [27]

At the international level, Europe is outperforming countries such as the United States and Japan with regard to shifting waste management practices away from landfilling and incineration towards more environmentally friendly ones such as recycling. More than 40 % of Europe's waste is recycled or composted (Figure 10.). The only country to surpass Europe is the Republic of Korea with almost 60 % of its municipal waste being treated through recycling or composting (Figure 11.).

Waste has become increasingly recognized as an important material resource and potential energy source. In this respect, it can generate economic value and help to decouple resource use from economic growth. Environmentally friendly ways of waste management such as recycling and composting reduce negative environmental impacts on the environment and human health. Increasing the proportion of waste recycled and composted reduces the amount to be disposed of. It also reduces primary

resource extraction. The municipal waste treatment indicator presents the amount of municipal waste recovered through recycling and composting as well as the amount disposed of through landfilling and through incineration.

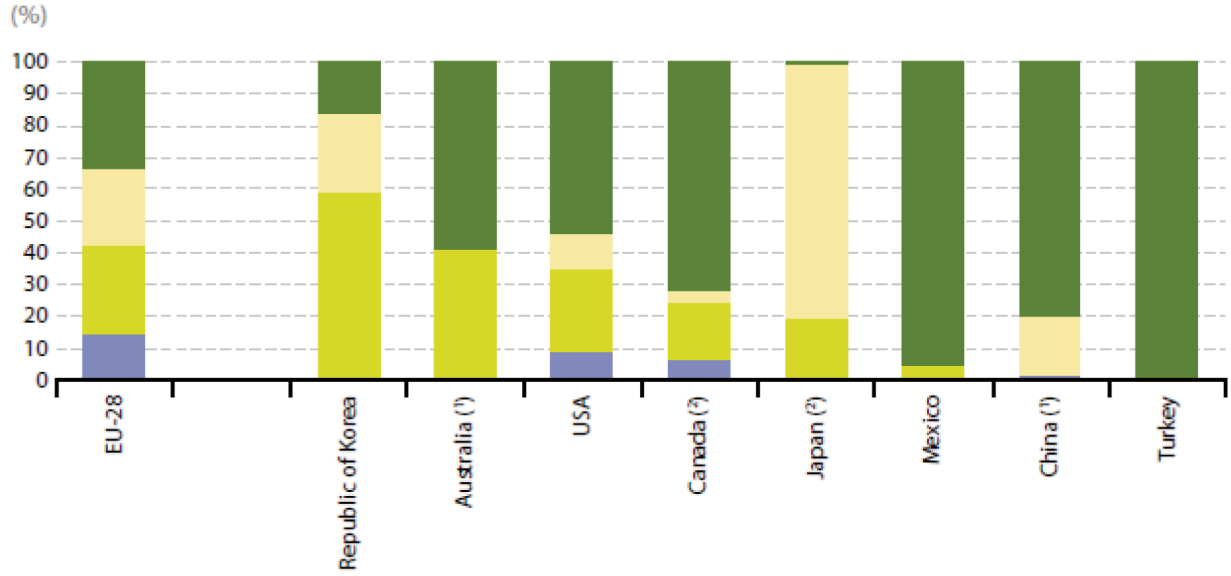

Figure 11. Municipal waste treatment, by type of treatment method, by country, 2012 [27]

3. Conclusion

From the statistical data it can be seen that waste management in the EU improved significantly between 1995 and 2013. Not only did the amount of waste disposed of at landfill sites fall, but the amount of waste recovered and reprocessed through recycling and composting or transformed into energy through incineration also rose. Other actions can be taken to reduce the amount of household waste. This is often more effective at national and local level, where it can be better targeted: awareness campaigns and economic incentives have proven particularly effective. For example, international and local zero waste movements can play a decisive role.

In circular economy landfilling is not supported. this means that funding for new landfill will be granted only in exceptional cases (e.g. mainly for non-recoverable hazardous waste) and that funding for new facilities for the treatment of residual waste, such as incineration or mechanical biological treatment, will be granted only in limited and well justified cases, where there is no risk of overcapacity and the objectives of the waste hierarchy are fully respected

The circular economy could boost the EU's competitiveness by protecting businesses against scarcity of resources and volatile prices, helping to create new business opportunities and innovative, more efficient ways of producing and consuming. It could create local jobs at all skills levels and opportunities for social integration and cohesion. At the same time, it will save energy and help avoid the irreversible damages caused by using up resources at a rate that exceeds the Earth's capacity to renew them in terms of climate and biodiversity, air, soil and water pollution. Wider benefits of the circular economy can be in lowering current carbon dioxide emissions levels. Action on the circular economy therefore ties in closely with key EU priorities, including jobs and growth, the investment agenda, climate and energy, the social agenda and industrial innovation, and with global efforts on sustainable development.

Economic actors, such as business and consumers, are key in driving this process. Local, regional and national authorities are enabling the transition, but the EU also has a fundamental role to play in supporting it. The aim is to ensure that the right regulatory framework is in place for the development of the circular economy in the single market, and to give clear signals to economic operators and society at large on the way forward with long term waste targets as well as a concrete, broad and ambitious set of actions, to be carried out before 2020.

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