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# Abbreviations

EU – European Union

EC – European Commission

LCA - Life Cycle Assessment

LCC – Life Cycle Cost

PPPY – Per Person per Year

TEA - Techno-Economic Assessment

ETV - EU Environmental Technology Verification

GDP – Gross Domestic Product

CPC - Cooperative Patent Classification

CE- Circular Economy

WH – Waste Hierarchy

SW – Solid Waste

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# Abstract

On the request of Clean Cluster - non-profit organization's environmental department, this research has been carried out in order to familiarize and evaluate the achievements of European countries in the circular economy. This paper is linked to the ongoing project, Circularity City, which aims to help small and medium-sized companies (SMEs) that work or want to work with the circular economy on a collaborative basis. Also, assist municipalities in finding new ways or examples based on the work of other countries.

The main objective of this work is to create an evaluation table that distinctly shows which countries are advanced in the circular economy, as well as to identify the strengths and vulnerability of the countries' activities.

The analysis was conducted on the basis of data from the European Statistics Department about waste management in the European countries. For the sake of clarity, the data is converted from the total amount in the country to the amount per citizen.

Additionally, data on Gross Domestic Product (GDP) collected to determine the impact of the change in GDP on the above-mentioned criterion - Municipal waste.

The project concludes that Western European countries are advanced in working with the circular economy than in Eastern and Central European countries. These conclusions are based on 2016 data.

This project shows which countries are currently leading according to these criteria and according to the data of the Department of European Country, but this is not a detailed analysis of the individual country.

# Introduction

The circular economy has a broad agenda and extensive opportunities for the development of the transition from a linear way of managing waste to the circular way. It is necessary to distinguish common grounds for the European approach for the circular strategy in order to exploit these opportunities without creating unnecessary troubles while maintaining the competitiveness and free market. (Jensen-Ellemann and Jarlov, 2018) Furthermore, from the Danish perspective, there was made a survey of 610 SMEs and 80% of the respondents are positive about the circular economy and they would like to work with it. While 51% of it does not have enough knowledge in order to start using the circular economy model. (Jensen-Ellemann and Jarlov, 2018) Therefore, CLEAN Cluster is as a bridge for SMEs to get a deeper understanding of the circular economy and find the right partners to develop their businesses.

This descriptive research has been developed in order to analyse the performance of the EU countries on the Circular economy. This research furthermore seeks to analyse in which aspects the countries are developing the most and in which they lack initiative. Since 2015, when the UN (United Nations) introduced society to the Sustainable Development Goals, the interest in sustainability and the circular economy has grown enormously across the citizen, corporate and governmental/municipal spheres. This followed as more companies and citizens began recognising the benefits of a circular strategy rather than a linear approach to improving and modernising their businesses.

This report has been produced to describe an overall assessment from the “Birdseye” perspective. Furthermore, the data used was collected in 2016, as the next European data update on the circular economy is expected in 2019.

# Methodology

The research is based on both qualitative and quantitative methods. Using the quantitative methods, the purpose was to understand the measurable impact of each European country on the circular economy. One of the main research sources used was the Eurostat database, where the circular economy data is defined by 4 main indicators. These four indicators are further split into sub-categories, with between 4 and 6 sub-categories found in each. Even though, the categories are mostly based on waste management systems. Moreover, the investments in the circular economy were taken to analyse which countries have higher gross investments in tangible goods, a number of persons employed and value added at factor cost in recycling and repair and reuse sectors.

For the qualitative analysis, research has been made on the Good Practices of showing the potential benefits of the circular economy as real-cases. This information has been gathered from the European Union database, where the most successful projects related to the circular economy are listed. Furthermore, the qualitative data has been used to get a deeper understanding of how the circular economy affects all three pillars of sustainability namely: the environment, economics and social.

# Objective and Sub-Questions

As part of the participation of the Circularity City, there was a need for more information of the performance of different countries in the European Union in CE. In the society, the circular economy is recognised as the more advanced waste management strategy. Moreover, others see it as a business opportunity which aims to a more sustainable and developed society. (Ghisellini, Cialani and Ulgiati, 2016) In order to find out which countries are seeking to become more sustainable the main objective and following research questions were made.

## **Objective:**

- Creation of systematic assessment of EU countries on the Circular economy.

The questions which have been raised for this research and corresponding sub-questions are:

- Which of EU countries are the leaders in the Circular economy?
  - In what categories is Denmark one of the leaders and in which does it need to take an example from others?

## ***Delimitation***

Geographically this research focuses on the countries that are in the European Union alongside Norway. Although outside the Union, Norway has been chosen due to its status in the EEA and in order to compare the Scandinavian countries within the EU against those outside the EU, in terms of circular economy indicators. It is also understood that this report may quickly become outdated as new data on circular economy indicators will be released in 2019.

Finally, in order to evaluate the performance on CE, the waste management and investments into the circular economy were chosen which were described on the Eurostat's database. This decision was based on the time and workforce given to accomplish this project.

# Waste Hierarchy Today

In most of the EU countries the most common way of dealing with the municipal solid waste is the: Landfilling, incineration, recycling and composting. Whereas, developed countries are seeking ways to minimise the waste ending their lifespan in the landfills or incineration. While looking into increasing the recycling and recovery rates of the materials. (Halkos and Petrou, 2008) On the other hand, the waste management sectors base their activities on the commonly accepted hierarchy shown in the figure below (Hoornweg and Bhada-Tata, 2012).



Figure 1 Waste Hierarchy (Hoornweg and Bhada-Tata, 2012)

Waste hierarchy (WH) describes the options of waste management. The most endorsed option is to **reduce** initiatives, meaning taking actions in the prevention of the MSW such as **prevention, minimization and reuse**. Reduce initiatives objective is to lower the quantity of the waste generation through modernising and redesigning the products together with transforming the patterns of consumption and production. (Hoornweg and Bhada-Tata, 2012) A good example is made by the France government. In order to reduce the waste, they have made a new legislative hierarchy regarding food waste, which consists of 36 steps to achieve it (Mourad, 2015). The food recovery hierarchy is added to the existing incineration and landfill diversion targets which all business and institutions who have to produce large volumes of food and organic waste. By the year of 2025 institutions and organisations who will exceed the allowed verged of produced waste will have to manage their resources in the way to achieve the highest possible use of it. For example, recovery of the food for human consumption, industrial use, anaerobic digestion and composting, animal feed (Mourad, 2015). Furthermore, for the supermarkets, it became forbidden to throw away food which is close to „Best until date“ to the dumpsters. Supermarkets have to donate the food to institutions, business or organizations. In this way, they not only reduce the food waste but also tackling another problem such as – “dumpster diving”. (Mourad, 2015)

The second steps in the waste hierarchy are **recycling and recovery**. The purpose of the recycling and recovery is to minimise the quantities of the disposal waste by seeking for ways to return the materials to the economy. Furthermore, there are two additional ways of recycling



or recovering materials – Upcycling and down-cycling. The upcycling of the waste materials is involves the process where form waste materials or the unwanted items the new usable product is being created (Vats, 2016). Whereas, the down-cycling is less favourite method which includes the breaking the item down into different components being reuse if possible but in most of the case as a lower quality product (Vats, 2016).

The final steps in the WH are the disposal of waste. It consists of waste disposal in the landfills or incineration plants. The disposal of solid waste in the landfills is the last step in the WH as it is the most harmful method for the environment and human health. As the solid waste (SW) being disposed of incorrectly might provide ideal breeding conditions for insect-vectors, pest, vermin and etc. following with an increase of the transmission of various diseases (Fronti and Poor, 1994).

# Clean Cluster – Innovating Green Solutions

CLEAN is Denmark's leading green cluster organization with more than 600 members from the entire cleantech sector. It is politically and technologically neutral platform connecting Danish and foreign companies, organizations, knowledge institutions and authorities. CLEAN assist in knowledge exchange and creation of the new partnerships and has a part in new innovative projects. (Cluster, 2018)

CLEAN working with the aim of increasing growth and job creation through innovative partnerships with SMEs and large companies. CLEAN is a result on two cluster development projects under the FP7 frameworks (Lean Energy Cluster and Copenhagen Cleantech Cluster). Furthermore, Clean is working in a different section which consists of smart energy, smart city environment, and internationalization. (Clean, 2018)

At the moment CLEAN is one of the strongest clusters in Europe and has the Gold Cluster Certificate under the Cluster Excellence Europe programme. This certificate ensures that is a lean and well-functioning cluster with close ties to its members. (CLEAN Cluster, 2018)

## 1.1 Being a Part of Clean Cluster

As an intern in CLEAN, I was a part of environment department where I had a chance to improve my skills, get a deeper understanding on how non-profit NGO works and be a part of the project they are developing at the moment. The project is called Circularity City which will be explained more in the next chapter. Clean cluster let me improve my skills and knowledge about the CE, but it helped me with expanding my network by sending me to the conferences around Denmark, furthermore, participate in workshops and was a part of the process of creation few of the workshops and conferences, which have been made by CLEAN. I had a chance to participate in:

- Workshop with SMEs in Aarhus
- Robot cluster conference in Odense.
- TechBBQ conference in Copenhagen
- Kick-off conference about the circular economy in education institutions in Aarhus
- Circularity City Conference in Brande

During these conferences, my main objective was not only to find innovative projects for today's problems but also broaden my network. Furthermore, I have been as one of the CLEAN representatives on the projects as Circularity City and INNODRONES campaign.

Whereas, I was able to meet a people who were a part of Circularity City project and find out more about their products, moreover, finding out new alternatives for the building' material.

My internship position was as a project assistant where I assist them in evaluating some of the applications for the Circularity City before they being approved. Furthermore, one of my main tasks was to create a ranking system of European countries on their performance on the circular economy.

The internship gave an opportunity to get in touch with the project management methodologies and software.

## ***1.2 Circularity City***

The circularity city project is an initiative which is a part of the implementation of Central Denmark Region's growth plan from 2016 to 2020. It connects the acts in the field of circular economic and smart urban development. A municipal pool project can include all types of circular method within the construction industry - from optimization of existing building pulp, recycling of resources for upcycling or new building materials, value chain cooperation, lighthouse projects (demonstration), the use of circular principles in procurement material, and the provision of new urban areas or different forms of public-private partnerships. The pool allows for application for consultancy/facilitation at the consortium as well as funds for obtaining expert assistance. (Circularity City, 2018)

After submission, the applicant receives a response to your application after approx. one week. If there are ambiguities, the steering committee will contact the applicant with follow-up questions. The CC project steering committee makes the final decision as to which projects are awarded.

The circularity city project was split into two similar projects in order to distribute the money in a more efficient way. The second project is named „Circular Building Solutions“. The project 'Circular Building Solutions', which enables companies to apply for money for circular projects in the field of construction. The project is part of Region Midtjylland's initiative in Circular Economic. It is crucial that projects leave a lasting impression, so candidates are encouraged to think about the future course of the project before the application is made. (Circularity City CBL, 2018)

The goal is to increase the number of innovative SMEs operating with circular construction solutions, in collaboration with relevant companies and knowledge institutions. Knowledge sharing and experience exchange will be through targeted innovation.

### **The main objectives of the Circularity City:**

- Promote green growth in the business and development of Central Denmark Region
- Value chain collaborators across the region's SMEs and knowledge institutions
- Increased exports of innovative construction solutions including new business models with earnings opportunities for companies
- Ensure the development of new circular technologies and building solutions
- More flexible applications of construction
- Promote green growth in the business and development of Central Denmark Region

**Created by** (Circularity City, 2018b)

### **The main objective for the Circular Building Solutions:**

- Promote green growth in the business and development of Central Denmark Region
- Value chain collaborators across the region's SMEs and knowledge institutions
- Increased exports of innovative construction solutions including new business models with earnings opportunities for companies
- Ensure the development of new circular technologies and building solutions
- More flexible applications of construction
- Increased recycling and high quality in the recycling of building materials in the region.

**Created by** (Circularity City CBL, 2018)

### 1.3 Circularity City Criteria for SMEs Applications

There is the possibility to apply for project funds in the following themes, which are described below:

1. Recycling of building materials (private market): when materials from construction are recycled for new purposes, e.g. brick, concrete, wires, metals. This theme is aimed at waste from construction and there-with the private market. This is a very direct recycling of residues from construction and demolition. The goal is to create a market for more recyclable materials than concrete and bricks that are established recycling markets. (Circularity City, 2018a)
2. Certifications and relevant training: continuing training/certification of craftsmen, contractors, construction engineers and the like. If you want to implement circular principles, it is essential that there are also hand workers/descendants, architects and other relevant professional groups who can solve the task. (Circularity City, 2018a)
3. Offering: The municipality in demand of the Circular economy. Here, both, urban development projects that are desired to be established with circular principles, the municipality itself as a developer or an interaction with entrepreneurs who build buildings in the municipality. Focus on how to make demands and how to ensure that the requested solutions are also implemented in reality. (Circularity City, 2018a)
4. Recycling of waste (municipal market): when waste is recycled into new materials. Here is the focus on municipal waste management, and a search for the possibilities for recycling a greater part of the waste. E.g. Plastic, metal, wood or other. Can cooperation be created that can provide the required volume and security of supply. Or it may be cooperation with industrial designers or subcontractors for the construction industry. (Circularity City, 2018a)
5. The commitment of business: cooperation between the municipality and the local business community. Can the municipality help companies identify the circular possibilities, link a company's residual products with one of the company's productions, create new value chains and collaborate, thereby creating local growth and workplaces. (Circularity City, 2018a)
6. Other initiatives: Other circular actions related to construction, demolition, recycling processes. (Circularity City, 2018a)

#### Successful application criteria for Circularity City project:

Number	Criteria		Weight
1	Project Content	Does the application contain a clear: <ul style="list-style-type: none"> <li>• Project description;</li> <li>• Activity description and milestones;</li> <li>• Addresses the project CC's themes.</li> </ul>	10%
2	Innovation Value	<ul style="list-style-type: none"> <li>• Originality;</li> <li>• New Knowledge Demonstration;</li> <li>• Activity;</li> <li>• News Creation.</li> </ul>	20%
3	Development Potential	<ul style="list-style-type: none"> <li>• Opportunities for further development as well as possible sources for further funding described.</li> </ul>	25%

4	Potential for savings and efficiency improvements	<ul style="list-style-type: none"> <li>• Resource savings;</li> <li>• Environmental impacts;</li> <li>• Growth potential for business.</li> </ul>	20%
5	Communication	<ul style="list-style-type: none"> <li>• Communication of performance of the project</li> </ul>	15%
6	Organization and economy	<ul style="list-style-type: none"> <li>• Quality of project Own Financing</li> </ul>	10%

**Table 1 Circularity City Successful Application Criteria** (Circularity City, 2018a)

### Successful application criteria for CBS project:

The application places particular emphasis on the projects' innovation value, development potential, market potential and environmental impacts. In addition, project content and dissemination are also weighted. Below is the weighting of the individual criteria in the application form:

Number	Criteria		Weight
1	Project Content	Does the application contain a clear: <ul style="list-style-type: none"> <li>• Project description;</li> <li>• Activity description and milestones;</li> <li>• Addresses the project CC's themes.</li> </ul>	10%
2	Innovation Value	<ul style="list-style-type: none"> <li>• Originality / New Knowledge ;</li> <li>• Useful knowledge of research and knowledge institutions;</li> <li>• Demonstration activity;</li> <li>• News-creating value.</li> </ul>	30%
3	Development Potential	<ul style="list-style-type: none"> <li>• Opportunities for further development as well as possible sources for further funding described.</li> </ul>	25%
4	Market potential and environmental impacts	<ul style="list-style-type: none"> <li>• Target group size;</li> <li>• Growth potential for business Export potential;</li> <li>• Environmental impacts.</li> </ul>	25%
5	Communication	<ul style="list-style-type: none"> <li>• Broad Membership</li> <li>• Dissemination of project results</li> </ul>	10%

**Table 2 Circular Building Solutions Successful Application Criteria** (Circularity City CBL, 2018)

### Formal minimum requirements:

- There must be at least 3 SMEs in the project and a knowledge institution. If there is not a knowledge institution attached to the application initially, the project consortium will help find the right knowledge institution to join the project.
- If external resources are sought for advice, there must be a clear description of what the external resources are to be used for and argued why it is precisely this amount requested.
- The product/ service/solution must be circular and aimed at the construction sector.

# Circular Economy Regulations in EU

The European Commission has adopted a Circular Economy Package which includes measures that should help stimulate Europe's transitions from a linear economy towards a circular economy. The goal of this policy is to expand global competitiveness, foster sustainable economic growth and generate new jobs. (European Commission, 2018)

The Circular Economy package is an EU action plan which will establish detailed and ambitious programmes which will accelerate the transition from a linear way of waste management to more circular, whilst additionally creating new legislation on waste. (European Commission, 2018)

The revised legislative proposals on waste set clear targets for the reduction of waste and for the credible long-term path for waste management and recycling. The main takeaways by the most recent data on waste include:

Proposed Waste Management Targets	Year	
	2025	2030
The share of municipal waste prepared for reuse and recycling.	60%	65%
The share of municipal waste landfilled.	N/A	10%
The share of all packaging waste prepared for reuse and recycling.	65%	75%
The share of plastic packaging waste prepared for reuse and recycling.	55%	N/A
The share of wood packaging waste prepared for reuse and recycling.	60%	75%
The share of ferrous metal packaging waste prepared for reuse and recycling.	75%	85%
The share of aluminium packaging waste prepared for reuse and recycling.	75%	85%
The share of glass packaging waste prepared for reuse and recycling.	75%	85%
The share of paper and cardboard packaging waste prepared for reuse and recycling.	75%	85%

**Table 3 Proposed waste management targets (Created by (European Commission, 2016)**

The target for the year 2020 is to reach 50% in the recycling of household waste. This is expected to be achieved by increases in the recycling rate of materials such as glass, paper/cardboard, metals and textile. In contrast, increases in bio-waste recycling are expected to be much more modest. (European Commission, 2016)

The table above indicates the performance in each criterion in the circular economy described in Eurostat. Each country has been evaluated based on points from 1 to 5 in every criterion, with 1 indicating low performance and 5 indicating high performance. Assessment has been made based on data from 2016. In some cases, data is not presented. There is no information on specific criteria or they were not published.

The country overall grade is calculated by the average of their performance in each criterion. Each criterion has been explained in separate chapters alongside an explanation of how the evaluation is made. Tables can be found in the Appendix.

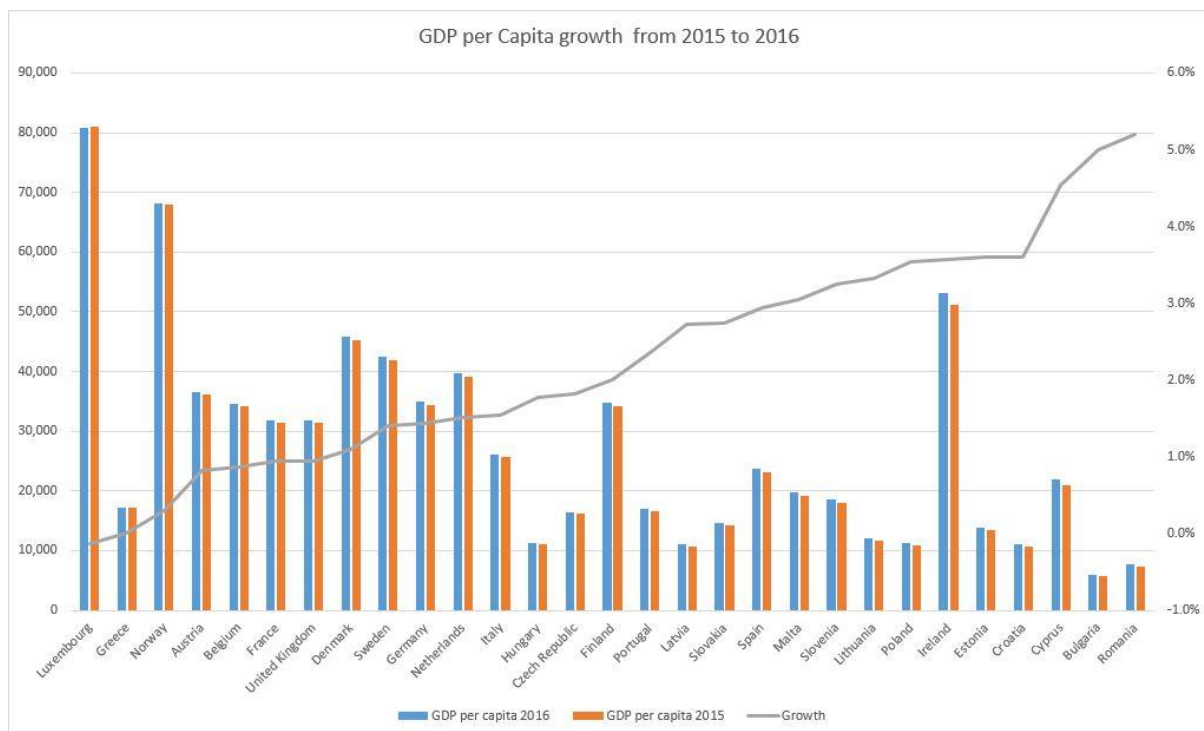
# Empirical Findings

## 1.4 GDP per capita

The first part of the analysis explores the change in GDP per person per year from 2015 to 2016, as the Gross Domestic Product has an impact on the following research. In most cases, GDP has an impact on a population's willingness to spend more money which further an impact on the amount of waste has produced. The period has been chosen in order to have the most recent data and the most realistic outcome.

According to the United Nations knowledge platform, the developed countries have a twice as high footprint per capita compared to the developing countries. This gap is regarding all types of materials. Furthermore, talking about fossil fuel the gap is 4 times larger in developed countries than in developing countries. (United Nations, 2017)

Below, you can see the graph with a comparison of GDP from 2015 to 2016 and the equivalent growth in percentage on the right side of Y-axis. The left side of Y-axis shows the GDP per capita in every country and X-axis shows the EU countries and Norway. Numbers can be found in the Appendix.



**Graph 1 GDP per Capita Growth from 2015 to 2016**

The highest growth has been noticed in Romania with 5.2%, Bulgaria with 5% growth and Cyprus with 4.5% growth. There is only one country that has a negative growth in GDP – Luxembourg with 0.1% drop. The average growth of EU countries is 2.3% and the median of 2%

The Scandinavian countries had growth in Norway with 0.3%, Denmark with 1.1% and Sweden with 1.4% growth. Therefore, we can state that the Scandinavian countries growth was below the EU average. On the other hand, they are still remaining as one of the richest countries in Europe.

## 1.5 Municipal Waste

Country	Municipal waste PPPY in kg	Weighting (1- Need to improve, 5 - good)
Romania	261	5
Poland	307	4
Czech Republic	339	3
Slovakia	348	3
Estonia	376	3
Hungary	379	3
Croatia	403	3
Bulgaria	404	3
Latvia	410	3
Belgium	420	3
Spain	443	3
Sweden	443	3
Lithuania	444	3
Portugal	461	3
Slovenia	466	3
United Kingdom	483	2
Italy	497	2
Greece	498	2
Finland	504	2
France	511	2
Netherlands	520	2
Ireland	563	2
Austria	564	2
Luxembourg	614	2
Malta	621	1
Germany	627	1
Cyprus	640	1
Norway	754	1
Denmark	777	1

This table shows the measure of the waste collected by or on behalf of municipal authorities and disposed of through the waste management system. It consists of a large extent of waste generated by households, though similar wastes from sources such as commerce, offices and public institutions may be included.

The most waste is produced in Denmark and Norway, whereas the least is in Poland and Romania. However, this does not describe the potential appliance of the circular economy since there are different factors that might influence these numbers. The potential factors that could influence the number are that of urbanization and how many people are living in rural areas, buying power, social aspects and political decisions.

The evaluation has been made by points which represent their performance. For this criterion, there is no precise target for what should be achieved by each country, therefore a baseline has been chosen in the country with the most municipal waste produced in EU. In this case, it is Denmark with 777 kilograms PPPY. Therefore, it received the lowest evaluation of 1. Afterwards, each country has been assessed by the percentage of how much they deviate from the start point. Each point represents 20% (e.g. Slovenia is deviated from Denmark by 40% therefore, Slovenia is evaluated by the point of 3).

The top 5 countries in relation to the Municipal waste collected per person, per year are:

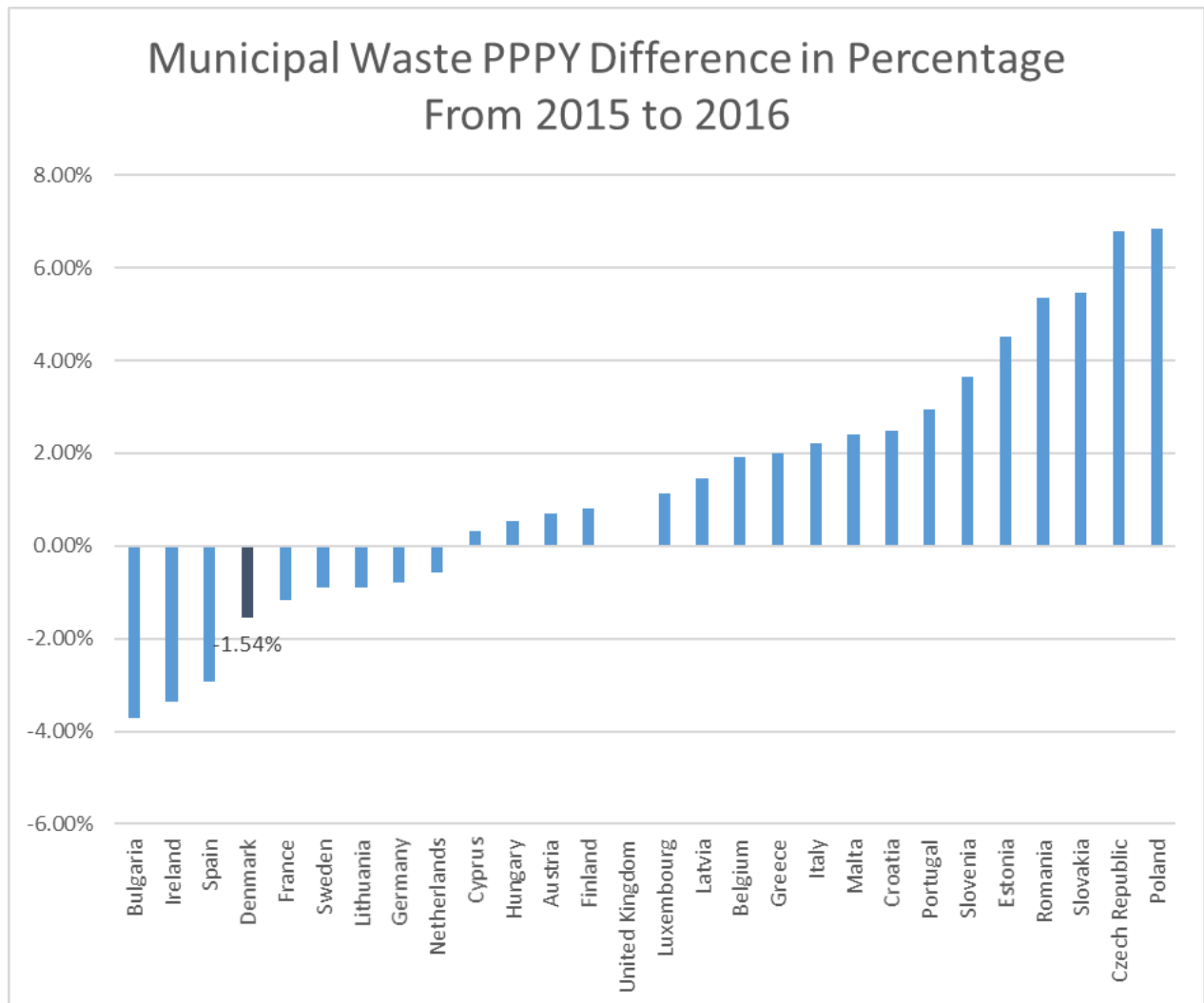
1. Romania ( 261 kg)
2. Poland ( 307 kg)
3. Czech Republic ( 339 kg)
4. Slovakia ( 348 kg)
5. Estonia ( 376 kg)

**Table 4 Municipal Waste in 2016** (Eurostat, 2018)



On the other hand, as the table above shows all the waste that has been collected in 2016, the graph below shows the difference in the percentage of growth of Municipal Waste being collected in the period of 2015-2016. This graph shows the other side of the statistics as it describes the change, which is happening in order to reduce the Municipal Waste.

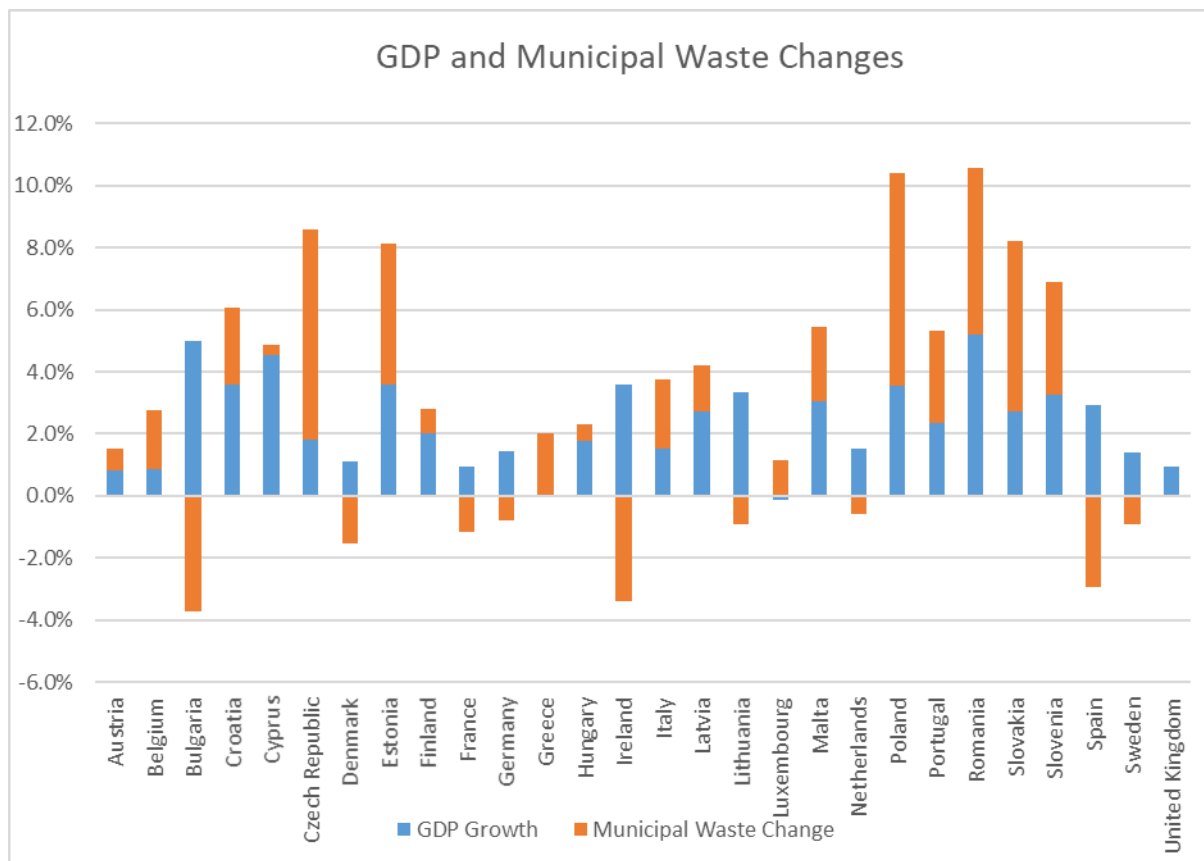
From the data gathered it is possible to see that less than half of the EU countries have been reducing their municipal waste. Geographically, it is noticeable that more countries in the Western part of Europe have shown improvement, while Eastern and Central parts have an increase in MW.



**Graph 2 Municipal Waste PPPY Difference In Percentage From 2015 to 2016** (Eurostat, 2018)

In order to see the performance, there was made an additional comparison of the countries on the changes through the years from 2015 to 2016. The performance is shown by the percentage in the graph, where the „-“, shows the reduce amount of the waste per year and the positive numbers shows the increase.

Furthermore, the best performance has been shown by Bulgaria (-3.71%), Ireland (-3.37%) and Spain (-2.93%). Whereas, Denmark have reduced their municipal waste by 1.54%, France by (1.17%), and Sweden and Lithuania by 0.9%. Moreover, the expected leading countries such as Germany and Netherlands have only reduced their municipal waste by 0.8% and 0.58%.

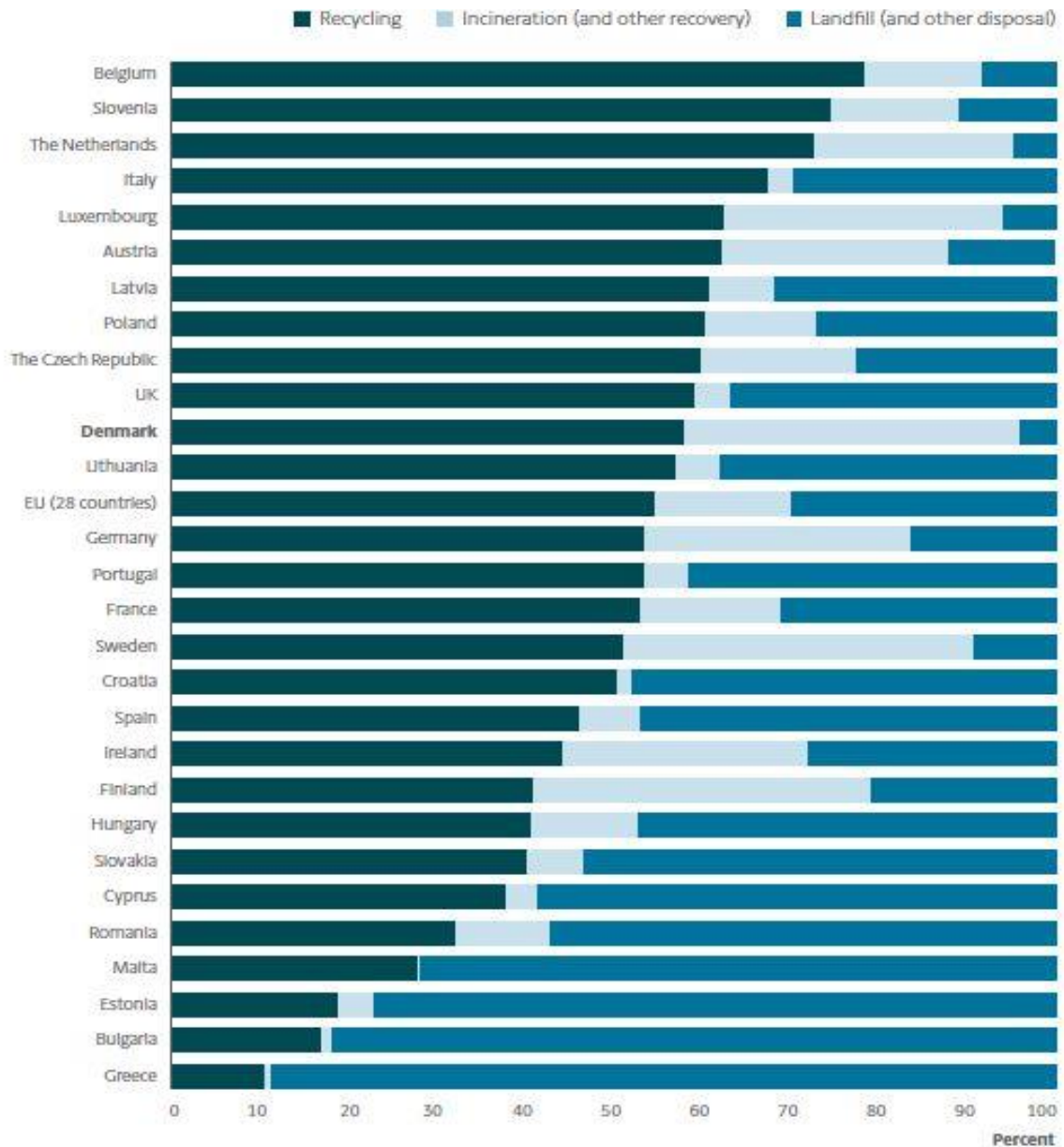


**Graph 3 Correlation between GDP and Municipal Waste growth** (Eurostat, 2018)

The graph above shows the correlation between the GDP and Municipal waste collection. From the graph, we can see that there are three main countries that have decrease their municipal waste growth and at the same time have increased their GDP. These countries are Bulgaria, Denmark, France, Germany, Ireland, Lithuania, Luxembourg, Netherlands, Spain and Sweden. On the other hand, there are some countries that have GDP increases whilst their municipal waste has increased too. The highest increases are in the Czech Republic, Estonia, Poland, Romania, Slovakia and Slovenia. The rest of the EU countries have not had that large of an impact, as their GDP growth is similar or even to the municipal waste growth.

If we look geographically, we can see that the Western part of Europe is implementing better solutions in order to reduce the municipal waste. Whereas, the Southern part of Europe countries having their GDP increased, have spent more on buying goods and producing more waste.

On the other hand, it is necessary to acknowledge that this is a linear way of assessing the municipal waste. To make the transaction from linear to the circular way of thinking municipalities have to do more detailed inspections on waste treatment. Graph 4 below shows the percentage of how much percentage of collected municipal waste end up in **Recycling, Incineration (and another recovery) and Landfills (and other disposals)**.



**Graph 4 Waste treatment in the European Union** (Jensen-Ellemann and Jarlov, 2018)

This waste treatment graph illustrates the data from 2014 about the performance on the waste treatment of each EU country. The dark blue colour shows the percentage of the total waste recycled, light blue – shows the percentages of waste being incinerated or used by other recovery methods and the blue colour shows the percentage of the waste which ends up in landfills or other disposals.

## 1.6 Municipal Recycling rate

Country	Municipal recycling rate	Weighting (1- Need to improve, 5 – good)
Germany	66%	5
Austria	58%	5
Slovenia	58%	5
Belgium	54%	5
Netherlands	53%	5
Sweden	49%	4
Denmark	48%	4
Lithuania	48%	4
Luxembourg	48%	4
Italy	45%	4
Poland	44%	4
United Kingdom	44%	4
Finland	42%	4
France	42%	4
Ireland	41%	4
Hungary	35%	3
Czech Republic	34%	3
Bulgaria	32%	3
Portugal	31%	3
Spain	30%	3
Estonia	28%	2
Latvia	25%	2
Slovakia	23%	2
Croatia	21%	2
Cyprus	17%	1
Greece	17%	1
Romania	13%	1
Malta	7%	1

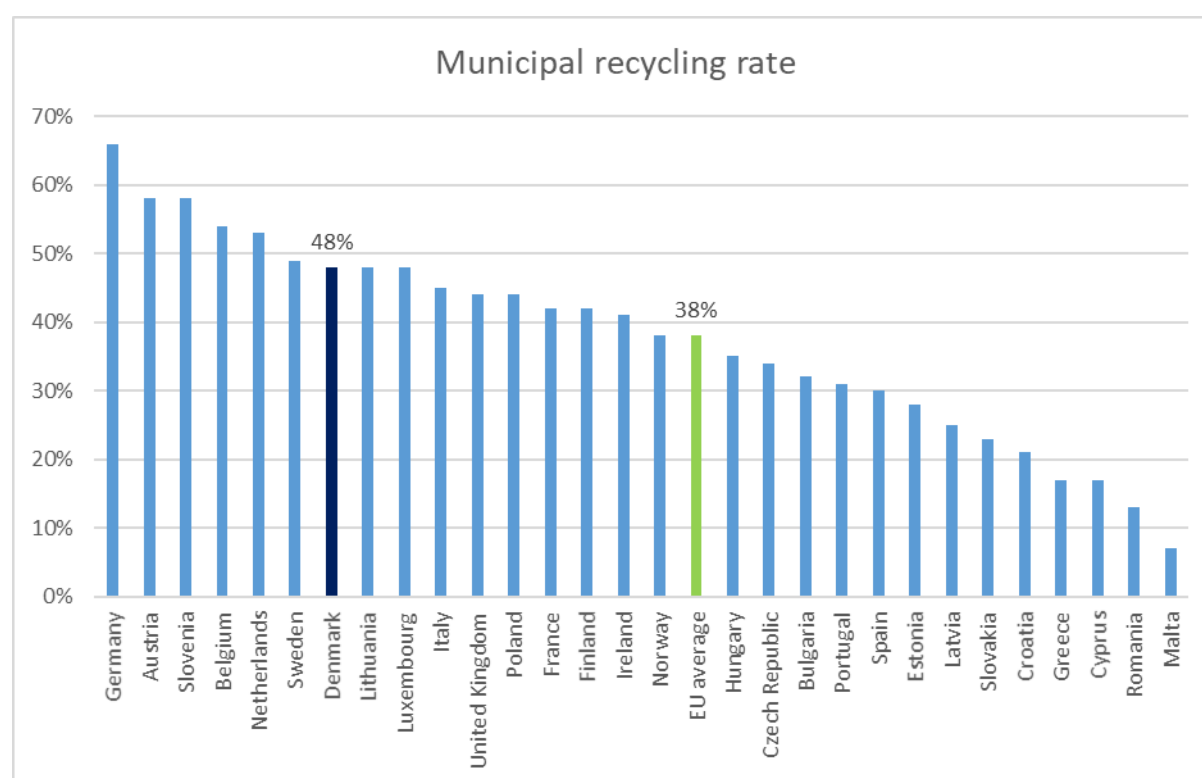
**Table 5 Evaluation of Municipal Recycling Rate**

**Table 4** indicates the evaluation of the EU countries by the municipal recycling rate. The data represents the year 2016 and it has been an assessment by the performance towards EU target to have the municipal recycling rate minimum 50% by the year 2020. (European Commission, 2016)

The methods used for this evaluation is based on how far away they are from the main target. The starting point has been chosen based on the regulated target of 50% of Municipal recycling rate. Calculations were made as 50% represents the target, so the countries who have from 50% and above are evaluated as 5, countries from 49% to 40% are evaluated as 4, from 39% to 30% evaluated as 3, from 29% to 20% as 2 and from 19% to 0% are evaluated as 1.

The top 5 countries in relation to the municipal recycling rate are the ones who have already exceeded the required target for 2020. These countries are:

1. Germany (66%)
2. Austria (58%)
3. Slovenia (58%)
4. Belgium (54%)
5. Netherlands (53%)



**Graph 5 Municipal Recycling Rate in 2016** (Eurostat, 2018)

The indicator on the graph below measures the share of recycled municipal waste in the total municipal waste generation. Recycling includes material recycling, composting and anaerobic digestion. The ratio is expressed in per cent (%) as both terms are measured in the same unit, namely tonnes. (Eurostat, 2018)

Furthermore, recycling meaning of the operations where waste materials reprocessed from waste materials to the products, materials or substances for original or different purposes. This action does not include energy recovery, is used as fuel or backfilling operations. (Ferrer, Krachman and D'Alonzo, 2013)

## 1.7 Material Reuse Rate

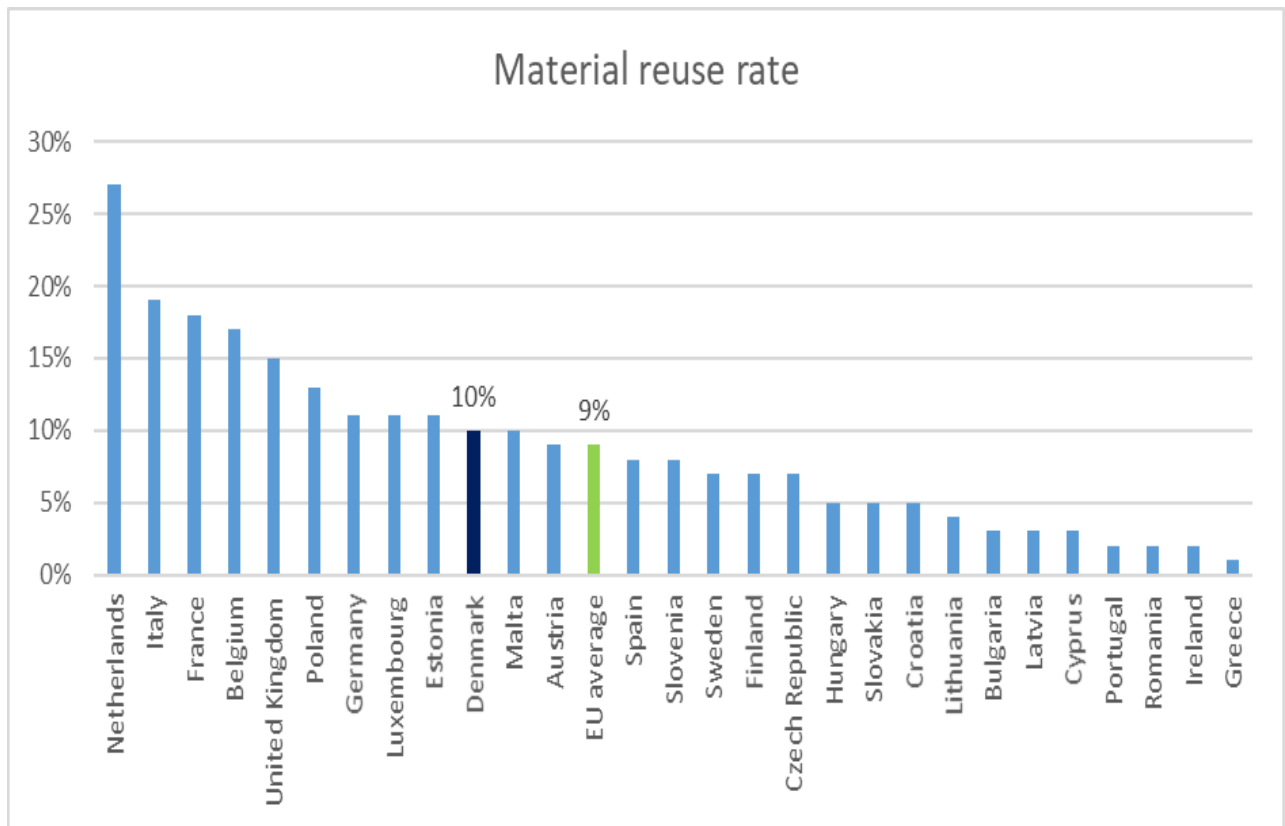
Country	Material reuse rate	Weighting (1- Need to improve, 5 – good)
Netherlands	27%	5
Italy	19%	3
France	18%	3
Belgium	17%	3
United Kingdom	15%	2
Poland	13%	2
Estonia	11%	2
Germany	11%	2
Luxembourg	11%	2
Denmark	10%	2
Malta	10%	2
Austria	9%	2
Slovenia	8%	2
Spain	8%	2
Czech Republic	7%	2
Finland	7%	2
Sweden	7%	2
Croatia	5%	1
Hungary	5%	1
Slovakia	5%	1
Lithuania	4%	1
Bulgaria	3%	1
Cyprus	3%	1
Latvia	3%	1
Ireland	2%	1
Portugal	2%	1
Romania	2%	1
Greece	1%	1

**Table 5 Evaluation on Material Reuse Rate**

The material reuse rate evaluation has been calculated in the way that 27% indicates the target as at the moment there is no precise target for 2020. Therefore, the country with the highest material reuse rate has been chosen as the main target.

Methods used to evaluate the Material reuse rate followed the same as the previous criteria where the evaluation points were given by the deviated from the Netherlands. The Points systems were made as 27% represent the max. Therefore, from 100% to 81% is evaluated by 5 points, from 80% to 61% by 4 points, from 60% to 41% by 3 points, from 40% to 21% 2 points and from 20% to 0% is 1 point. The calculations are shown in Appendix.

The meaning of the **reuse** the operation which the components or products which are not considered as waste are being used again for the same purpose that they were created. (European Commission, 2016)



**Graph 6 Material Reuse Rate in 2016** (Eurostat, 2018)

The graph above shows the percentage on material reuse rate. The highest percentage is shown in Netherlands – 27%, while the EU average is 9%. Denmark has 10%, Sweden 7% and there is no data given on the performance of Norway. The smallest material reuse rate is determined by Greece – 1%, then Ireland, Romania and Portugal, all with 2%.

The top 5 leaders in on the material reuse rate:

1. Netherlands (27%)
2. Italy (19%)
3. France (18%)
4. Belgium (17%)
5. United Kingdom (15%)

## 1.8 Food waste

Country	Food waste (per year per person) In kg	Weighting (1- Need to improve, 5 - good
Slovenia	72	5
Malta	76	5
Romania	76	5
Greece	80	5
Czech Republic	81	5
Croatia	91	5
Bulgaria	105	5
Latvia	110	4
Slovakia	111	4
Lithuania	119	4
Portugal	132	4
Spain	135	4
France	136	4
Denmark	146	4
Germany	149	4
Hungary	175	4
Luxembourg	175	4
Italy	179	4
Finland	189	4
Austria	209	4
Sweden	212	4
Ireland	216	3
United Kingdom	236	3
Poland	247	3
Estonia	265	3
Cyprus	327	3
Belgium	345	3
Netherlands	541	1

**Table 6 Evaluation of Food Waste**

The evaluation on Food waste PYPP is based on the leading country Slovenia, as it has the lowest amount of food waste in the whole EU. This decision was based on the lack of agreement on the target by the EU commission. In 2016 the European Court of Auditors released research on food waste, and in their report, it has been said that in 2015 the circular economy package target for the year 2030 is to reduce food waste by half.



*“EU and MS committed to meeting the 2030 target of halving per capita food waste at the retail and consumer level, and reducing food losses along the production and supply chains.”*

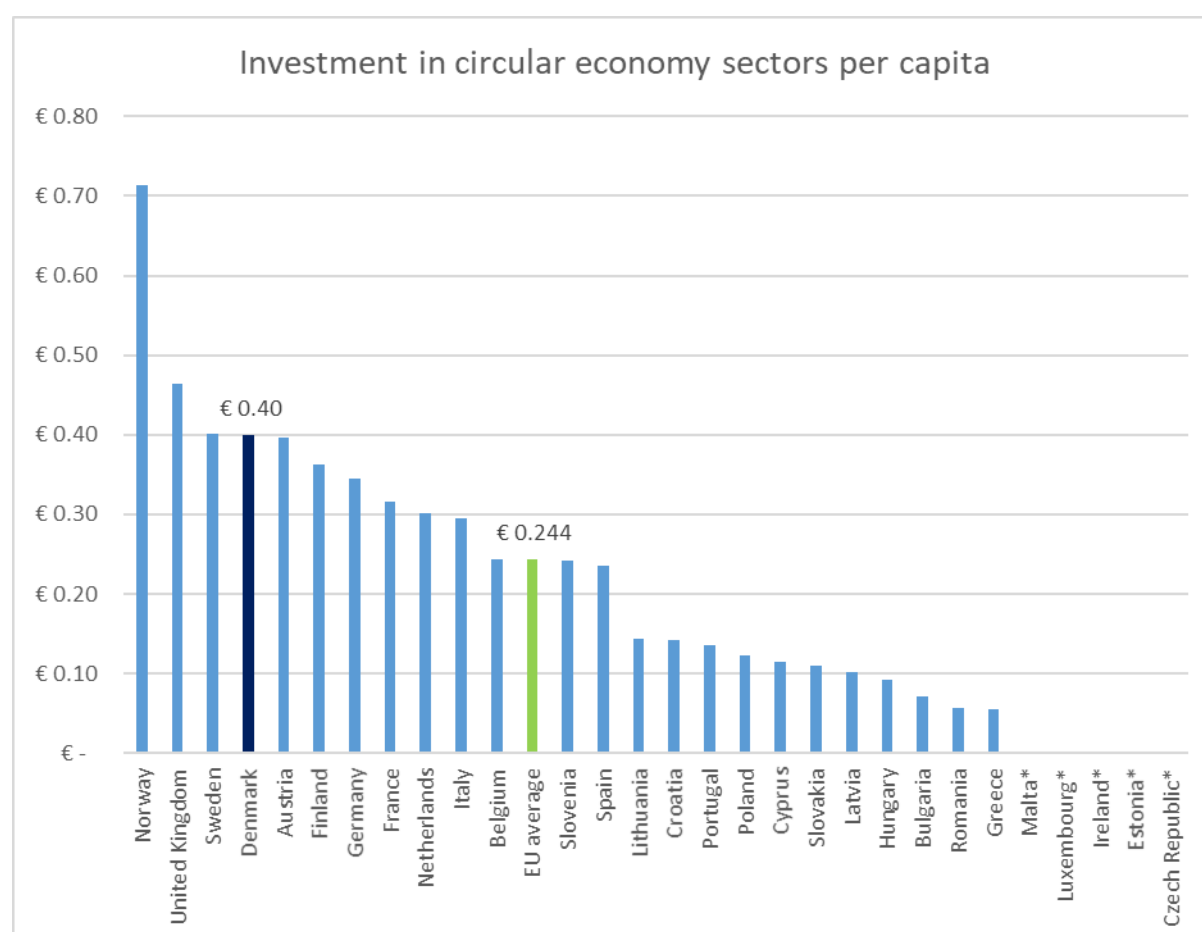
*(ECA, 2016)*

This statement does not provide a precise target to be based on. Therefore, the evaluation was calculated from the Netherlands as it has the highest amount on food waste. The 541 kg PYPP represents 100%. The countries who have 100% to 80% were evaluated by 1 point. From 79% to 60% by 2 points, from 59% to 40% by 3 points, from 39% to 20% by 4 points and from 19% to 1% by 5 points.

The top 5 leaders who have the least amount in food waste per year, per person are:

1. Slovenia (72 kg)
2. Malta (76 kg)
3. Romania (76 kg)
4. Greece ( 80 kg)
5. Czech Republic ( 81kg)

## 1.9 Investments



**Graph 7 Investments into Circular Economy per Capita per Year in 2016** (Eurostat, 2018)

The indicator shows that Scandinavian countries and the United Kingdom has been spending the most on the circular economy per capita, following with Austria, Finland, Germany, France, and the Netherlands. The graph shows – the wealthier a country is the more it is in-

vesting in the circular economy. Below the EU average are the countries such as Lithuania, Croatia, Portugal, Poland, Cyprus, Slovakia Latvia, Hungary, Bulgaria, Romania and Greece.

On the other hand, there is missing data from five EU countries: Malta, Luxembourg, Ireland, Estonia and the Czech Republic. These countries are marked with indicator - „\*“.

Country	Investment in circular economy sectors per capita	Evaluation
United Kingdom	€ 0.46	5
Sweden	€ 0.40	5
Denmark	€ 0.40	5
Austria	€ 0.40	5
Finland	€ 0.36	4
Germany	€ 0.35	4
France	€ 0.32	4
Netherlands	€ 0.30	4
Italy	€ 0.29	4
Belgium	€ 0.24	3
Slovenia	€ 0.24	3
Spain	€ 0.24	3
Lithuania	€ 0.14	2
Croatia	€ 0.14	2
Portugal	€ 0.14	2
Poland	€ 0.12	2
Cyprus	€ 0.11	2
Slovakia	€ 0.11	2
Latvia	€ 0.10	2
Hungary	€ 0.09	2
Bulgaria	€ 0.07	1
Romania	€ 0.06	1
Greece	€ 0.06	1
Czech Republic*	N/D	N/D
Estonia*	N/D	N/D
Ireland*	N/D	N/D
Luxembourg*	N/D	N/D
Malta*	N/D	N/D

**Table 6 Evaluation on Investment in Circular Economy Sectors per Capita**

The evaluation of investments in circular economy sectors per capita was made by taking the target of 0.46 Euro cents per capita. This target has been chosen because there is no current target stated by the EU Commission.

This evaluation is based on the percentages and is divided into 5 points. Each point represents 20%. Therefore, the performance of the United Kingdom target is evaluated as 100%. The countries from percentage 100% to 80% are evaluated by 5 points, from 79% to 60% evaluated 4 points, from 59% 40% evaluated by 3 points, from 39% to 20% by 2 points and from 19% to 0% evaluated by 1 point.

# The Overall Assessment of EU countries

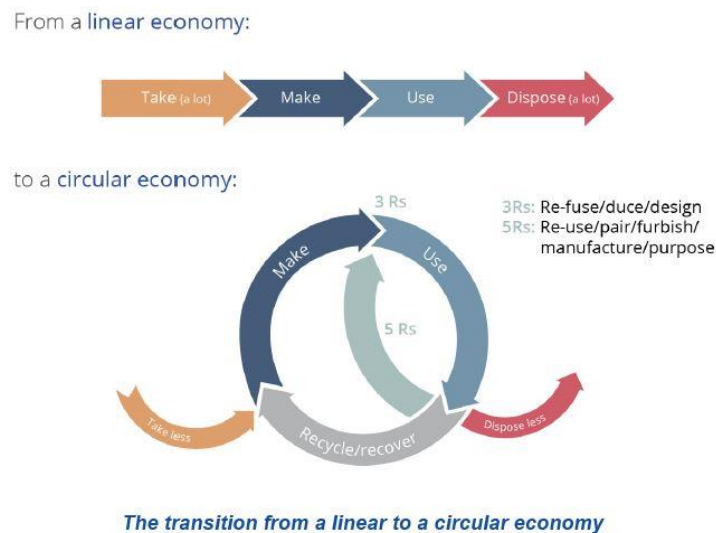
The following table below shows the overall grade of each European country. Grades are taken from criteria analysed in “Empirical finding” section. Results of food waste, material reuse rate, municipal waste, municipal recycling rate and investment in circular economy sectors are placed together. The overall grade represents the average of the sum of evaluation from separate criteria.

Country	Food waste	Material reuse rate	Municipal waste	Municipal recycling rate	Investment in CE	Overall grade
Austria	2	2	2	5	5	3.2
Belgium	2	3	3	5	3	3.2
Bulgaria	4	1	3	3	1	2.4
Croatia	4	1	3	2	2	2.4
Cyprus	2	1	1	1	2	1.4
Czech Republic*	4	2	3	3	N/D	3.0
Denmark	3	2	1	4	5	3.0
Estonia*	2	2	3	2	N/D	2.3
Finland	3	2	2	4	4	3.0
France	3	3	2	4	4	3.2
Germany	3	2	1	5	4	3.0
Greece	5	1	2	1	1	2.0
Hungary	3	1	3	3	2	2.4
Ireland*	2	1	2	4	N/D	2.3
Italy	3	3	2	4	4	3.2
Latvia	4	1	3	2	2	2.4
Lithuania	4	1	3	4	2	2.8
Luxembourg*	3	2	2	4	N/D	2.8
Malta*	5	2	1	1	N/D	2.3
Netherlands	1	5	2	5	4	3.4
Poland	2	2	4	4	2	2.8
Portugal	4	1	3	3	2	2.6
Romania	5	1	5	1	1	2.6
Slovakia	4	1	3	2	2	2.4
Slovenia	5	2	3	5	3	3.6
Spain	3	2	3	3	3	2.8
Sweden	2	2	3	4	5	3.2
United Kingdom	2	2	2	4	5	3.0

# Discussion

In the process of making this assessment of the European country performance on the circular economy not always we can trust the numbers because numbers not always reflect the real situation. Furthermore, the evaluation targets are moving targets, stated to be realistic and achievable for some of the countries whereas, for other countries, it is extremely optimistic. As it is with the data collected from the Eurostat. This data does show how much municipal waste collected but is it not the linear way of trying measuring the performance of the circular economy?

The circular economy model does not aim only for the waste adjustments to make a lower negative impact of the linear economy model. It aims to the opportunities to make and generate long-term products which increase the opportunities for business and economic growth by finding the innovative ways of prolonging materials continuance in the life cycle. (Ellen MacArthur Foundation, 2017)



**Illustration 1 Transition from a linear economy to the circular economy** (European Investment Bank, 2018)

Therefore, the adaptation of the circular economy should demand new measurability methods. Methods which would focus not only on the negative impacts and to the end of the life cycle but also would focus on the whole life cycle of the material (if it is possible). It is understandable that it demands magnificent changes but the world is becoming progressively digitalized. (EU, 2016)

The amount of municipal waste should explain more detailed as what is considered waste in one municipality does not mean it is waste in another. This could happen as it is in one of the best examples of circular economy in Denmark – Kalundborg Symbiosis. Kalundborg symbiosis is a project where nine public and private companies in Kalundborg municipality work together in the way to reduce the waste and reduce their carbon footprint. (*Kalundborg Symbiosis*, 2018)

There are more examples of implementation of the circular economy, yet the question is: when it will become like a new standard for society?

## Conclusions

This research concludes the insights on the EU country positioning in the circular economy perspective. The evaluation table (ref. **Table 2**) shows the performance and aims at which countries are the leaders? On most of the criteria, the target has been chosen as a country with the highest number for the criteria, which is set at 5.

From the data that has been gathered, the top countries who have shown the best performance in the circular economy are listed in the table below.

Country	Overall assessment
Slovenia	3.6
Netherlands	3.4
Austria	3.2
Belgium	3.2
France	3.2
Italy	3.2
Sweden	3.2

**Table 7 Top Countries with the Highest Overall Score**

Slovenia has the highest position with a score of 3.6, with collected highest points of 2 and 5 for Food waste and Municipal recycling rate. When compared to the other EU nations, Slovenia has performed averagely on the Municipal waste targets and Investment in the circular economy sector.

In the second place is the Netherlands, with an overall score of 3.4. The Netherlands received the highest points on the Material reuse rate and Municipal recycling rate. Furthermore, it received a high evaluation for the Investment in the circular economy, but also the lowest point of 1 for Food waste and 2 for Municipal Waste.

The third place is shared between five countries who have performed differently on each criterion but with the same average. The distribution of points is shown in the table below.

Country	Food waste (per year per person)	Material reuse rate	Municipal waste (per year per person)	Municipal recycling rate	Investment in circular economy sectors per capita	Overall grade (1- Need to improve, 5 - good)
Austria	2	2	2	5	5	3.2
Belgium	2	3	3	5	3	3.2
France	3	3	2	4	4	3.2
Italy	3	3	2	4	4	3.2

**Table 8 Third Place Distribution of Points**

The countries that have shown the best performance by the criteria are:

Municipal Waste Per year, per person	Municipal recycling rate	Food Waste per year, per person in kg	Material Reuse Rate	Investments in the Circular Economy sector
Romania	Germany	Slovenia	Netherlands	United Kingdom
Poland	Austria	Malta	Italy	Sweden
Czech Republic	Slovenia	Romania	France	Denmark
Slovakia	Belgium	Greece	Belgium	Austria
Estonia	Netherlands	Czech Republic	United Kingdom	Finland

**Table 9 Top countries by different criteria**

As for Denmark, the most crucial objective is to reduce the amount of Municipal Waste. It would not make sense to follow the example of a country with a much lower GDP such as Slovenia. Therefore, Denmark should take an example of how to deal with this issue in its surrounding, for example, Sweden has similar GDP, but the Municipal waste PPPY is much lower. Therefore, the suggestion would be to consult Sweden on how to effectively deal with this problem.

For the Material reuse rate, there is no doubt that Denmark has to look at examples from the Netherlands, as they have the highest reuse rate in the whole of Europe. However, when discussing the Municipal recycling rate, Denmark is climbing to the top. Even though, there is still some space to improve. As Denmark is surrounded by wealthy countries such as it is itself, it should also identify practices its neighbours are using, such as in this case, Germany, who is one of the leading countries in Municipal recycling rate.

To sum up, there are countries that are doing a great job in relation to the circular economy. It is necessary for other countries to follow their example and adapt their regulations, technology and mindsets to strive towards a more sustainable world.

This report took good practices of European countries as an example of what the circular economy can be and what kind of benefits it brings. Furthermore, this reports the main purpose was to investigate the performance of the circular economy of EU countries including Norway to compare the Scandinavian countries against this EU external benchmark. These findings are subject to change as new data is released by Eurostat every 3 years.

For the data collected, we can conclude that there is no precise one top leader in every part of the circular economy throughout the EU countries. It is, however, clear to say that, we can see the development of the circular economy in many different aspects in different geographies at this time. Geographically, the leaders are in the Western part of Europe and Scandinavian countries, as they are investing more than many other nations in the implementation of the circular economy.

There is a need for the follow-up assessment of this report. As it was mentioned before the most recent data is only from 2016. Furthermore, from 2015 there is a magnificent interest in SDG's (Sustainable Development Goals), therefore, the number might have changed during the past 3 years. Therefore, it would be necessary to assess the data from 2016 to 2019 when the new data will be released for the public.

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# Appendix

Country	Municipal waste (per year per person)	Municipal recycling rate	The share of goods traded that are recyclable raw materials	Material reuse rate	Patents related to the circular economy (since 2000)	Investment in circular economy sectors (in Millions)
United Kingdom	483 kg	44%	0.35%	15%	292	€ 31.00
Germany	627 kg	66%	0.25%	11%	1260	€ 28.70
France	511 kg	42%	0.24%	18%	542	€ 21.30
Italy	497 kg	45%	0.19%	19%	294	€ 17.80
Spain	443 kg	30%	0.20%	8%	210	€ 11.00
Netherlands	520 kg	53%	0.17%	27%	169	€ 5.20
Poland	307 kg	44%	0.18%	13%	298	€ 4.70
Sweden	443 kg	49%	0.19%	7%	49	€ 4.10
Austria	564 kg	58%	0.32%	9%	122	€ 3.50
Belgium	420 kg	54%	0.22%	17%	105	€ 2.80
Denmark	777 kg	48%	0.31%	10%	53	€ 2.30
Finland	504 kg	42%	0.06%	7%	111	€ 2.00
Portugal	461 kg	31%	0.26%	2%	22	€ 1.40
Romania	261 kg	13%	0.13%	2%	34	€ 1.10
Hungary	379 kg	35%	0.23%	5%	36	€ 0.90
Slovakia	348 kg	23%	0.15%	5%	10	€ 0.60
Greece	498 kg	17%	0.14%	1%	5	€ 0.60
Croatia	403 kg	21%	0.23%	5%	4	€ 0.60
Slovenia	466 kg	58%	0.41%	8%	8	€ 0.50
Bulgaria	404 kg	32%	0.11%	3%	10	€ 0.50
Lithuania	444 kg	48%	0.15%	4%	19	€ 0.40
Latvia	410 kg	25%	0.18%	3%	11	€ 0.20
Cyprus	640 kg	17%	0.13%	3%	4	€ 0.10
Malta	621 kg	7%	0.12%	10%	1	N/A*
Luxembourg	614 kg	48%	0.97%	11%	24	N/A*
Ireland	563 kg	41%	0.18%	2%	38	N/A*
Estonia	376 kg	28%	0.26%	11%	3	N/A*
Czech Republic	339 kg	34%	0.25%	7%	72	N/A*

**Table 6 Raw numbers without weighing**

EU Countries	GDP per capita 2016	GDP per capita 2015	Growth
Austria	36,500	36,200	0.8%
Belgium	34,500	34,200	0.9%
Bulgaria	6,000	5,700	5.0%
Croatia	11,100	10,700	3.6%
Cyprus	22,000	21,000	4.5%
Czech Republic	16,500	16,200	1.8%
Denmark	45,800	45,300	1.1%
Estonia	13,900	13,400	3.6%
Finland	34,800	34,100	2.0%
France	31,800	31,500	0.9%
Germany	34,900	34,400	1.4%
Greece	17,100	17,100	0.0%
Hungary	11,300	11,100	1.8%
Ireland	53,100	51,200	3.6%
Italy	26,000	25,600	1.5%
Latvia	11,000	10,700	2.7%
Lithuania	12,000	11,600	3.3%
Luxembourg	80,900	81,000	-0.1%
Malta	19,700	19,100	3.0%
Netherlands	39,800	39,200	1.5%
Norway	68,200	68,000	0.3%
Poland	11,300	10,900	3.5%
Portugal	17,000	16,600	2.4%
Romania	7,700	7,300	5.2%
Slovakia	14,600	14,200	2.7%
Slovenia	18,500	17,900	3.2%
Spain	23,800	23,100	2.9%
Sweden	42,500	41,900	1.4%
United Kingdom	31,800	31,500	0.9%

**Table 7 GDP Changes from 2015 to 2016 in percentage**

EU Countries	GDP per capita 2016	GDP per capita 2015	GDP Growth
Austria	36,500	36,200	0.8%
Belgium	34,500	34,200	0.9%
Bulgaria	6,000	5,700	5.0%
Croatia	11,100	10,700	3.6%
Cyprus	22,000	21,000	4.5%
Czech Republic	16,500	16,200	1.8%
Denmark	45,800	45,300	1.1%
Estonia	13,900	13,400	3.6%
Finland	34,800	34,100	2.0%
France	31,800	31,500	0.9%
Germany	34,900	34,400	1.4%
Greece	17,100	17,100	0.0%
Hungary	11,300	11,100	1.8%
Ireland	53,100	51,200	3.6%
Italy	26,000	25,600	1.5%
Latvia	11,000	10,700	2.7%
Lithuania	12,000	11,600	3.3%
Luxembourg	80,900	81,000	-0.1%
Malta	19,700	19,100	3.0%
Netherlands	39,800	39,200	1.5%
Poland	11,300	10,900	3.5%
Portugal	17,000	16,600	2.4%
Romania	7,700	7,300	5.2%
Slovakia	14,600	14,200	2.7%
Slovenia	18,500	17,900	3.2%
Spain	23,800	23,100	2.9%
Sweden	42,500	41,900	1.4%
United Kingdom	31,800	31,500	0.9%

**Table 8 GDP growth from 2015 to 2016 change in percentage**

Country	Municipal waste (per year per person) in kg 2016	Municipal waste (per year per person) in kg 2015	Municipal Waste Difference
Austria	564	560	0.71%
Belgium	420	412	1.90%
Bulgaria	404	419	-3.71%
Croatia	403	393	2.48%
Cyprus	640	638	0.31%
Czech Republic	339	316	6.78%
Denmark	777	789	-1.54%
Estonia	376	359	4.52%
Finland	504	500	0.79%
France	511	517	-1.17%
Germany	627	632	-0.80%
Greece	498	488	2.01%
Hungary	379	377	0.53%
Ireland	563	582	-3.37%
Italy	497	486	2.21%
Latvia	410	404	1.46%
Lithuania	444	448	-0.90%
Luxembourg	614	607	1.14%
Malta	621	606	2.42%
Netherlands	520	523	-0.58%
Poland	307	286	6.84%
Portugal	474	460	2.95%
Romania	261	247	5.36%
Slovakia	348	329	5.46%
Slovenia	466	449	3.65%
Spain	443	456	-2.93%
Sweden	443	447	-0.90%
United Kingdom	483	483	0.00%

**Table 9 Municipal Waste Difference from 2015 to 2016 in Percentage**

Country	Population	Investment in circular economy sectors	Investment in circular economy sectors per capita
Malta*	475,700	€ 0.0	€ -
Luxembourg*	602,000	€ 0.0	€ -
Ireland*	4,857,000	€ 0.0	€ -
Estonia*	1,315,000	€ 0.0	€ -
Czech Republic*	10,650,537	€ 0.0	€ -
Greece	10,816,286	€ 600,000.0	€ 0.06
Romania	19,622,000	€ 1,100,000.0	€ 0.06
Bulgaria	7,050,034	€ 500,000.0	€ 0.07
Hungary	9,771,000	€ 900,000.0	€ 0.09
Latvia	1,953,000	€ 200,000.0	€ 0.10
Slovakia	5,426,000	€ 600,000.0	€ 0.11
Cyprus	876,000	€ 100,000.0	€ 0.11
Poland	38,433,600	€ 4,700,000.0	€ 0.12
Portugal	10,291,196	€ 1,400,000.0	€ 0.14
Croatia	4,230,000	€ 600,000.0	€ 0.14
Lithuania	2,799,840	€ 400,000.0	€ 0.14
EU average	6,798,451	260,227	€ 0.249
Spain	46,788,820	€ 11,000,000.0	€ 0.24
Slovenia	2,066,880	€ 500,000.0	€ 0.24
Belgium	11,469,204	€ 2,843.5	€ 0.24
Italy	60,494,118	€ 17,800,000.0	€ 0.29
Netherlands	17,255,408	€ 5,200,000.0	€ 0.30
France	67,320,000	€ 21,300,000.0	€ 0.32
Germany	83,290,300	€ 28,700,000.0	€ 0.35
Finland	5,517,887	€ 2,000,000.0	€ 0.36
Austria	8,823,054	€ 3,500,000.0	€ 0.40
Denmark	5,745,547	€ 2,300,000.0	€ 0.40
Sweden	10,201,988	€ 4,100,000.0	€ 0.40
United Kingdom	66,789,911	€ 31,000,000.0	€ 0.46

**Table 10 Investments of each EU country per capita to CE**