Extension of the environmental Goods and Services Sector with Circular economy activities

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Explanation of symbols

:	Not applicable
.	Data not available
x	Publication prohibited (confidential figure)
-	Nil
0 (0.0)	Less than half of unit concerned
*	Provisional figure
**	Revised provisional figure (but not definite)

Abbreviations

CE	Circular Economy
CEPA	Classification of Environmental Protection Activities
COFOG	Classification of the Functions of Government
CPA	Classification of Products by Activity
CReMA	Classification of Resource Management Activities
EGSS	Environmental Goods and Services Sector
EP	Environmental Protection
FTE	Full-time equivalent
GDP	Gross Domestic Product
MLN	Million
NACE	Standard Industrial Classification
PRODCOM	Production Communautaire
RM	Resource Management
SUT	Supply and Use Table

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1. Introduction

Both internationally and nationally there is growing interest for the circular economy (CE) and its benefits for society. In 2018 the European Commission adopted a 'Circular Economy package' (European Commission, 2018). In order to support the monitoring framework, Eurostat developed CE related indicators and launched a website[1] devoted to the circular economy. Similar to the European ambition, the Dutch government launched a nationwide program called Netherlands Circular in 2050. The Dutch ambition is to reduce the use of primary abiotic resources by 50 percent in 2030, and to be 100 percent circular in 2050 (IenM & EZ, 2016).

In order to monitor the transition to a CE, Statistics Netherlands, in cooperation with other agencies, made a first attempt to monitor CE for the Netherlands (Potting et al., 2018). Although data is already available to measure some aspects of the circular economy, for instance recycling rates and waste statistics, more effort is required to measure other important aspects of a circular economy. One of them deals with socio-economic issues like the value added and employment of economic activities that are part of the circular economy. Socio-economic aspects provide insight in the effect of a transition to a CE on the economy.

Economic activities related to CE partly overlap with the activities of the Environmental Goods and Services Sector (EGSS)[2], which consists of economic production activities related to both environmental protection (EP) and resource management (RM). Especially the latter category is directly related to CE. However, CE is a very comprehensive concept and includes a wide variety of activities that not all fit within the conceptual framework of the EGSS.

The goal of the research project presented in this report is threefold. First, CE related activities are defined in the context of EGSS. This will identify which type of CE related activities should be or should not be included in EGSS. Second, CE related activities that are already included in EGSS are identified. Third, of the CE activities that are missing it is determined if these new activities should be included in the EGSS accounts or solely be used as part of a broad CE concept adopted by Dutch policymakers.

In chapter two of this report the conceptual frameworks of EGSS and CE will be discussed and compared in order to identify their similarities and differences. This will provide insight into economic activities that should be included in the EGSS-account, or solely be used for the purpose of measuring circular economy in a broader sense. Chapter 3 provides an overview of the methodology applied to identify and classify CE activities and to compile economic indicators for the circular economy. A mix of a top-down and bottom-up approaches is used. Chapter 4 presents the results obtained, including an overview of identified CE activities, distinguished between EGSS and CE in a broader concept. Finally, a time series (2001-2016) is presented, including employment, production and value added figures. The time series presented is a conservative estimation because not all CE activities are included yet.

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[1] https://ec.europa.eu/eurostat/web/circular-economy
[2] Reporting of data on the Environmental Goods and Services Sector is obligatory under Regulation (EU) No 691/2011.

2. CE related activities defined in the context of the EGSS framework

In this chapter definitions, concepts and related activities regarding the Circular Economy (CE) in a broad perspective and within the Environmental Goods and Services Sector (EGSS) are determined. Also the way in which EGSS and CE are classified is considered. This provides insight in the following:

- What is CE in a broad perspective?

- To what extent do CE activities fall within or outside the scope of the current EGSS?

- To what extent are EGSS and CE classifications related?

2.1 Circular economy in a broad perspective

2.1.1 Concept and definition

The circular economy is a trending topic, however there is not a commonly accepted definition of CE. This is shown clearly by Kirchherr et al. (2017) who gathered 114 definitions of the circular economy. Apparently CE means different things to different people. Various stakeholders using different definitions may blur the concept, which has been raised as criticism against CE. Therefore, as a starting point, the concept and its definition that are being used in this report is stated. We adopt the three principles, as described by McKinsey (2015), the CE rest upon:

1) *Preservation and enhancement of natural capital by controlling finite stocks and balancing renewable resource flows.*

2) *Optimization of resource yields by circulating products, components, and materials at the highest utility at all times in both technical and biological cycles.*

3) *Fostering system effectiveness by revealing and designing out negative externalities."*

Although the main focus regarding the circular economy is put on reducing the input of primary (non-renewable) resources, it also aims at reducing negative externalities such as the reduction of waste flows and environmental pollution.

2.1.2 Classification

CE is a relatively new concept which is still being developed further. There is not yet a widely accepted standardized international classification of CE activities. Because the circular economy is a comprehensive concept it comprises a wide variety of activities, ranging from rethinking business models and redesigning products at the top of the products life cycle to recycling materials or recovering energy from materials at the end of a products' life cycle. Aggregating these different type of activities in terms of economic output, employment and value added is not very meaningful. Therefore, it is important to use a classification system which allows to group certain type of CE activities. This classification system should be both theoretically sound and practically applicable.

Several classification systems have been applied in literature, for instance the so called '9R-framework' (Potting et al., 2018), the 7 Key elements (van Oort et al., 2017) and also McKinsey (2015) applies its own classification based on six business action. These three classification systems are presented in Annex A.

The 9R-framework as presented in table 2.1 is used is a starting point for the classification applied in this report. Initially, this framework was used because it allows for the most detailed breakdown of CE activities and it aligns best with current initiatives in the Netherlands. An additional category "substitution" is added to this framework. However, due to practical reasons we only used the three aggregates (use and create product more intelligently, lifetime extension of product and parts, and useful application of materials) and "substitution".

The most right column in table 2.1 describes the economic activities related to the corresponding R-group. It briefly describes what type of economic activities should be considered within each R-group. Furthermore, the first column shows a more aggregated classification on how the economic activity contributes to a more circular economy. The wide variety of circular activities contribute to a more circular economy in varying degrees. In general the following rule applies, the higher the activity is classified on the 9R-framework the higher is its contribution to the circular economy because the value of materials is kept as high as possible.

Table 2.1. Classification of CE activities, the 9R-framework technical-cycle

a) Use and create product more intelligently	R0 Refuse	Making a product redundant by abandoning its function, or supplying it with a radically different product.
	R1 Rethink	Intensify product use (for example by sharing products, or multifunctional products).
	R2 Reduce	Producing a product more efficient by using less (raw) materials in the product, or in its use.
b) Lifetime extension of product and parts	R3 Re -use	Re-use of discarded, still good product to the same function by another user.
	R4 Repair	Repair and maintenance of broken product for use in its old function.
	R5 Refurbish	Refurbish or modernize an old product.
	R6 Remanufacture	Use parts of discarded product in a new product with the same function.
	R7 Repurpose	Use discarded product or parts of it in a new product with a different function.
c) Useful application of materials	R8 Recycle	Process materials to the same (high-quality) or lower (low-quality) quality.
	R9 Recover	Incineration of materials for energy recovery purposes.
d) Substitution	Substitution	Substitution of non-renewable materials.

2.1.3 Difficulties regarding the delineation of CE activities

Although the concept and definition of the circular economy are rather clear and although the 9R-framework seems quite a logical classification of activities, in practice, it is not always straightforward whether a certain economic production activity should be considered part of the CE or not.

CE activities comprise a wide range of different types of economic activities and can be approached at different angles. Firstly, an economic activity can produce goods or services that in itself cause a reduction in need of primary resources or waste production (e.g. repair services). Secondly, an economic activity can produce goods and services that in itself do not benefit the environment but are produced by using environmental friendly inputs (.e.g bioplastics) or by an environmental friendly production process (e.g. eco-labeled products). Thirdly, it is also an option to consider a product as part of the CE solely because it is environmental friendly in its use phase (e.g. electric car). Finally, some business models are set up for the purpose of being environmental friendly, not the product itself but the way in which it is used is considered environmental friendly. For example by optimizing the use of products such that less products are needed and thus resources are being saved (e.g. car sharing with peers), or by improving the life time of products (e.g. delivering a product as a service). Whether or not to take these activities into account depends on the rational applied. There are no international standardized guidelines yet to facilitate the process of selecting CE activities.

2.2 CE activities within the Environmental Goods and Services Sector

2.2.1 Concept and definition

A handbook on how to compile EGSS is composed by Eurostat (Eurostat 2016a; Eurostat 2016b). Environmental activities relevant for EGSS encompass those economic activities (or the products produced as a result of that activity) whose primary purpose is to reduce or eliminate pressures on the environment or to make more efficient use of natural resources. Thus activities that directly serve an environmental purpose (so called characteristic activities) or that produce specifically designed products whose use serves an environmental purpose (so called non-characteristic activities).

Two types of environmental activities are distinguished:

1) Environmental protection (EP) activities include all activities and actions which have as their main purpose the prevention, reduction and elimination of pollution and of any other degradation of the environment, and

2) Resource management (RM) activities include the preservation, maintenance and enhancement of the stock of natural resources and therefore the safeguarding of those resources against depletion.

Although the primary purpose criterion helps to identify an activity or a product as environmental, sometimes it is not sufficient to characterize products and activities as environmental or not. For this reason an indicative compendium provides a practical list of activities and products that can be identified as part of EGSS (see annex 1-7 of the EGSS Handbook). Annexes also indicate the classes of environmental activities into which the items in the compendium can be classified; either EP or RM. These specific guidelines ensure that all EU countries take the same activities into account when compiling EGSS. Some activities are in theory part of the EGSS but for practical reasons (mostly due to the lack of data or the economic

insignificance of these activities) not included in the Dutch EGSS. More information on what is and what is not included in the Dutch EGSS can be found in Statistic Netherlands (2015, 2016) and at Statline[3] , CBS open data source.

2.2.2 EGSS activities related to CE

Although CE and EGSS overlap partly there are also clear differences. In general, the scope of EGSS is broader because it includes both environmental protection (EP) and resource management (RM) activities, whereas CE focuses mainly on RM activities. However, there are also EP activities that could be included in CE, such as waste- and wastewater management activities. But other EP activities, such as the protection of landscapes and biodiversity are not included in CE.

EGSS focuses on the production of environmental goods and services. In addition, CE also takes into account the production process itself (e.g. a cleaner and more resource efficient production process), the business model applied (e.g. re-thinking the business model such as sharing products or leasing instead of selling products) and the final effect of an economic activity (e.g. the primary purpose of secondhand shops might not be resource management and is therefore excluded from EGSS, but re-using products does reduce the input of primary resources into the economy and is thus included in CE).

Furthermore, contrary to EGSS, the CE concept takes into account the use of circular materials, i.e. the input of secondary materials in a production process. For instance, the production of jeans (a non-environmental good) may be included if it is produced using recycled textile, or the use of circular building materials in construction activities. However, measuring this in economic terms is very difficult and there is the issue of double counting. When including economic values of the same product twice, as a production output and as an input for subsequent economic activities (e.g. firstly the production value of recycled building materials and secondly the use of the same recycled materials in construction), results in an overestimation of the economic value of CE in the Dutch economy.

Chapter 2 provided the conceptual background of EGSS and CE to identify similarities and differences between both concepts. Chapter 4 will present an overview of CE-activities included, classified by the R-framework, and to what extent they fall within or outside the scope of the EGSS framework.

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[3] https://opendata.cbs.nl/statline/#/CBS/nl/dataset/83154NED/table?dl=16F34

3. Methodology

This section describes the general approach and methodology used to determine and classify CE activities and to compile relating economic figures such as output, value added and employment. EGSS was used as a starting point to identify CE activities. The selection of EGSS activities relating to CE was supplemented by applying two different approaches. For NACE categories that comprise activities fully related to CE a macro-approach (top-down approach) was used. In all other cases a micro-approach (bottom-up) was required.

3.1 EGSS as a starting point

The EGSS account is used as a starting point to identify CE activities. A first selection of CE activities can be derived from the CEPA and CReMA classifications and relating economic figures (output, value added and employment) can be obtained directly from EGSS data (2000-2016). EGSS data is also classified by NACE category, which is helpful to prevent double counting when adding up the outcomes of the different approaches. Furthermore, all CE activities were classified by type of activity according to the R-framework. In case of the EGSS-approach activities grouped by CEPA or CReMA class or NACE (Standard Industrial Classification) class could be allocated directly to a single category of the R-framework.

3.2 Adding CE activities by using a macro-approach

3.2.1 Identification of CE activities

The macro-approach, or top-down approach, is the most straightforward way to identify economic activities related to CE and to compile economic figures. The NACE-classification of economic activities and the CPA-classification[4] of products used in supply and use tables (SUTs) can both be used to identify economic activities, i.e. industries or products, related to CE. The NACE-classification is at 4-digit level, but a similar industrial classification in the Netherlands (SBI) is available at 5-digit level, which provides extra detail to identify specific circular economic activities.

3.2.2 Compilation of economic figures

After selecting NACE-classes that comprise activities fully related to CE, economic figures were derived directly from SUTs and labour accounts, which both use the NACE-classification system. The SUTs provide economic figures on output and value added, whereas labour accounts provide employment figures.

SUTs do not only provide data by industry (NACE) but also by type of product (CPA). The CPA-classification provides, for some economic activities, more detail than the NACE-classification and may therefore be a useful supplement. In addition to industries related to CE, products related to CE were identified and total output for each of these product types was derived from SUTs. In order to prevent double counting, those NACE-classes that were already completely marked as

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[4] Classification of Products by Activity

CE were filtered out when applying the CPA-approach. So an economic activity could only be taken into account by either NACE or CPA approach.

In case of the CPA approach only output figures can be derived from SUTs and no data on value added and employment is available. To estimate corresponding employment and value added figures, each product (CPA-code) was linked to its main producer (NACE-class) based on its first 2-digits[5]. For each NACE-class employment per output and value added per output ratios were calculated and used to convert output figures into employment and value added figures.

Some NACE-classes or CPA-classes comprise activities or products that only partly relate to CE. For instance, NACE code 33, repair and installation of machinery and equipment, includes both repair and maintenance activities which are part of CE and installation activities which are not. In these cases additional data sources, such as PRODCOM and labour statistics, were used to distinguish between CE and non-CE activities. The additional sources were used to determine a share of CE-activities within the total NACE- or CPA-class. However, this was not possible for all NACE- or CPA-classes. When no distinction between CE and non-CE activities could be made at macro-level the micro-approach was applied.

3.2.3 Classification of CE activities

Finally, all CE activities identified by the macro-approach were classified by type of activity according to the R-framework. In case of the macro-approach, whole groups of industries (NACE-classes) or products (CPA-classes) could be allocated directly to a single category of the R-framework. For instance, the complete industry NACE 95 'Repair of computers and personal and household goods', could be completely linked to R4-repair and is thus allocated to the more aggregated R-group 'lifetime extension of products and parts'.

3.3 Adding CE activities by using a micro-approach

3.3.1 Identification of CE activities

CE activities that are not included in the Dutch EGSS (paragraph 3.1) nor can be determined by selection of NACE- or CPA-classes in the macro-approach (paragraph 3.2) need to be identified by a so called micro-approach or bottom-up approach. In practice this means that CE activities have to be identified at business level rather than at national level by industry or product. This is a more extensive, subjective and time consuming approach. Therefore it was only applied when the macro-approach was insufficient. Basically, a list of businesses that perform CE activities was compiled and, separately for each business, an environmental share had to be determined that shows to which extent a business is circular[6].

There are multiple ways to compile a list of circular businesses. In this research two different approaches were applied. Firstly, network and business associations were contacted to help identify businesses that perform CE activities. They delivered lists of businesses claiming to be circular or businesses that were member of a certain CE network organization.

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[5] The first two digits of a CPA-code correspond to the first two digits of a NACE-class. For example, the first two digits of the good 'passenger cars' (PCA-code 29.10.2) correspond to the first two digits of the main producing industry 'manufacture of motor vehicles, trailers and semi-trailers' (NACE-code 29).

[6] In case all economic activities are circular then the whole business is included, but in case only part of the economic activities are circular then the business should only be partly included.

Secondly, web scraping, a technique used to extract text or data from websites, was applied to identify circular businesses. For most businesses the Dutch business register includes an URL-link to their website[7]. Web scraping was applied to scan through businesses' websites looking for particular keywords related to CE. Keywords were determined beforehand by experts, but also new keywords were added as a result of the learning process, because the web scraping results provided new insights and new input.

By combining these two methods an extensive list of possibly circular businesses was compiled. Each business had to be checked thoroughly to determine whether or not the business is circular and whether or not the business should be included in EGSS, this was done by taking into account the EGSS and CE definitions, classifications and demarcations. This report solely presents the results obtained relating to CE[8].

3.3.2 Compilation of economic figures

Compilation of economic figures is a bit more complicated in the micro-approach than in the macro-approach. Each circular business can be linked to the Dutch business register, in which all businesses are allocated to a NACE-class based on their principal economic activity. Once this link to the Dutch business register is established economic data can be retrieved. The Dutch business register can be linked to supplementing data sources such as production statistics to derive output and value added figures and labour statistics to derive employment figures. The obtained economic values are then multiplied by the environmental share of the corresponding business.

3.3.3 Classification of CE activities

Finally, also CE activities identified in the micro-approach were classified by type of activity according to the R-framework. Each business had to be assessed separately and allocated to the right category (or categories in case a business performs different circular activities) of the R-framework. Although this step seems rather straightforward it turned out to be very complicated in practice, because many businesses could be allocated to more than one R-group.

The CE activities identified by the macro-approach are often circular by main activity, i.e. recycling or repair industries can be completely included because their main activity is considered circular. However, CE activities identified by the micro-approach are often not circular by main activity but are circular because the main activity is executed in a circular way, e.g. by applying a circular business model. For instance, the production of modular phones (the main activity, production of phones, is not circular) is considered circular, because the product is designed in such a way that broken components can easily be replaced and thus extends the lifetime of the product. This business activity can be allocated to both R1-3 "create product more intelligently" and R4-6 "Life time extension". If a business case addresses multiple different CE activities, the CE activity that is highest on the R-framework, i.e. has the highest environmental impact, is selected. Still, for some economic activities it remains difficult to decide whether or not the activity is circular, and if so, were to allocate it on the R-framework.

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[7] Unfortunately URL-links are not available for all businesses because some businesses do not have a website. This is often the case for smaller businesses that are less significant economically and thus have a lower impact on the results.
[8] Also activities were identified that fall within the scope of EGSS, sometimes they overlapped with CE activities and sometimes they did not. Activities within the scope of EGSS but not related to CE are not published here. In 2019 there will be a rebase of the business population of the Dutch EGSS, in which the obtained results will be taken into account.

4. Results

This chapter is divided in two parts. In chapter 4.1 activities related to CE are identified for all three approaches described in the methodology section: EGSS data extended by macro- and micro-data. Furthermore, CE activities are allocated to the R-framework classification. In chapter 4.2 economic figures broken down by type of CE activity (R-framework) are shown. Economic figures comprise production value (i.e. output), gross value added and employment. EGSS data and macro-approach results are available for the period 2000-2016. The micro-approach has not been completed and therefore the results are not included in the total figures.

4.1 Overview of CE activities identified

4.1.1 CE activities derived from EGSS accounts

A first selection of CE activities is derived from EGSS accounts. EGSS data is broken down both by industrial classification (NACE) and by classifications of environmental activities, i.e. CEPA and CReMA classification. The NACE-classification is mainly useful to prevent double counting when applying the macro- and micro-approach to add more CE activities. Both CEPA and CReMA classification are used to make a first selection of CE activities because they make a clear distinction between environmental protection (EP) activities and resource management (RM) activities. The first, in general, is not part of CE while the latter is, as the circular economy is all about resource use and management.

Table 4.1.1. presents which CEPA and CReMA classes are considered part of CE in this study. So, all RM activities, apart from CReMA 12 'Management of wild flora and fauna', are considered part of CE. Furthermore, EP activities under CEPA 2 and 3 are also considered part of CE. In some cases it is not straightforward if an EGSS activity should be considered part of CE or not. Some of these activities will be discussed in the next paragraph. The right column of table 4.1.1, the R-framework, will be explained and discussed later.

Table 4.1.1 Allocation of CEPA and CReMA to CE and R-framework

Classification of EP and RM activities	CE	R-framework
CEPA, Classification of Environmental Protection Activities		
1: Protection of ambient air and climate	✖	
2: Wastewater management	✔	C
3: Waste management	✔	C
4: Protection and remediation of soil, groundwater and surface water	✖	
5: Noise and vibration abatement	✖	
6: Protection of biodiversity and landscape	✖	
7: Protection against radiation	✖	
8: Research and development	✖	
9: Other Environmental Protection activities	✖	
CReMA, Classification of Resource Management Activities		
10: Management of water resources	✔	A
11: Management of natural forest resources	✔	A

12: Management of wild flora and fauna	✖	
13: Management of energy resources:	✔	
13 A: Production of energy from renewable sources	✔	D
13 B: Heat/Energy saving and management	✔	A
13 C: Minimization of the intake of fossil resources as raw material	✔	Partly A and D
14: Management of minerals	✔	Partly A and C
15: Research and development activities for natural Resource Management	✔	A
16: Other natural Resource Management activities	✔	A

Treatment of specific CE activities in EGSS accounts

There is no general agreement yet in literature about which EGSS activities should or should not be considered CE. Different choices were made in earlier studies by Eurostat (2017) and van Oort et al. (2017). An overview of the choices made in these publications is presented in Annex B and is based on NACE-codes. In this paragraph we discuss the choices we made in this report regarding EGSS activities.

Not included are activities under CReMA 12 which involve maintenance and management of the stock of wild flora and fauna. Similar to CEPA 6 (protection of biodiversity and landscape), preservation of natural capital and its resulting eco-system services is not regarded part of the CE in this report. However, a sustainable use of natural capital is one of the requirements in the transition towards a circular economy. Regulating or provisioning eco-systems services can reduce the amount of depletable, non-renewable resources that are needed. Whenever these services become part of our economy, for example as a renewable substitute, they will be recorded as an CE related activity.

Material recovery activities are reported under CReMA, but all other waste management activities such as collection and treatment of waste are reported under CEPA 3. Because recovery of waste is not possible without collecting it, CEPA 3 activities are also regarded part of CE. Also other ways of waste treatment, like energy recovery from waste incineration, contributes to a more circular economy, although to a lesser extent. However, controlled landfilling, also part of CEPA 3, is in theory not considered part of CE. Although controlled landfilling has a lesser environmental impact than uncontrolled landfilling it is not be regarded as an activity with a purpose to save natural resources. Unfortunately, at this time it is not possible to separate landfilling activities from other waste treatment activities. Therefore, in practice, landfilling activities are included in the CE figures presented in this report.

In general, the primary purpose of activities of CEPA 1 and 4 is not to save natural resources but to protect air and climate, therefore they are not considered part of CE in this report. A possible exception to this could be the production of electric transport such as electric vehicles. Electric vehicles are included in CEPA 1 because they emit fewer air emissions than conventional cars. However, they are also more energy efficient in their use than conventional cars, which could be an argument to include them in the future. However, for now it was decided to exclude CEPA 1 completely. Organic farming, part of CEPA 4, is not considered part of the CE in this report. Although, some aspects of organic farming, like reduction of the use of artificial fertilizers, can be considered CE. However these aspects cannot be separated from aspects like animal welfare that are not considered part of CE.

The main purpose of wastewater management (CEPA 2) is to prevent environmental pollution (and health issues). However purifying wastewater also enables the re-use of water for economic purposes. Therefore, purifying wastewater before returning it to the environment could be considered CE as well. Eurostat (2017) only includes the collection of waste, while van Oort et al. (2017) also includes wastewater management. In order to be consistent with our Dutch planning agency we consider wastewater management part of CE in this report.

Some CE activities are in theory part of EGSS but for practical reasons (mostly due to the lack of data or the economic insignificance of these activities) not included in the Dutch EGSS. An example are products with an eco-label. Only products (with an eco-label) should be taken into account that contribute to resource reduction relative to standard products. To determine which eco-labels should be included and which not is hard to do and very time consuming, currently this is not included in the Dutch EGSS. Another example are upstream activities. These are production of goods or services that are used as an input in the production process of environmental goods. In practice only activities that can be identified are taken into account. Not taken into account in the Netherlands due to a lack of data are in-house production of environmental products. With regard to substitution, only production of bio fuels and renewable energy are taken into account. Environmentally friendly production of non-environmental products should in theory not be included in EGSS. Exceptions to this are renewable energy and organic agriculture, of which the first is and the latter is not included in the CE.

Allocation of EGSS activities to the R-framework

In this paragraph the allocation of CE activities, resulting from the Dutch EGSS, to the R-framework is presented and explained. Because it proved to be too difficult to allocate all EGSS activities to the detailed 9R-framework, we decided to allocate activities to a more aggregated classification level. This more aggregated classification is presented in the first column of table 2.1, the 9R-framework, and it also shows how it relates to the 9R-framework. So, for practical reasons CE activities are allocated to one of the following categories:
   A) Use and create products more intelligently;
   B) Lifetime extension of products and parts;
   C) Useful application of materials;
   D) Substitution.

The allocation of circular EGSS activities to the R-framework is presented in the third column in table 4.1.1. In some cases CEPA and CReMA is insufficiently detailed to allocate activities correctly to the R-framework[9]. In this case the whole (sub-) CEPA/CReMA category was allocated to a single, most relevant category of the R-framework.

The reason to consider waste and wastewater management as CE activity is that these activities enable the re-use of water and materials. Therefore they are related to material recovery and thus allocated to 'useful application of materials'. The production of renewable energy reduces the need of fossil fuels and is thus considered 'substitution' of fossil fuels. Heat and energy saving and management also reduces the need for fossil fuels, but should be placed higher on the R-ladder. Energy and heat saving correspond directly to 'use and create products more efficiently'. In Dutch EGSS material recovery is completely allocated to CReMA 14, and material recovery is allocated to 'useful application of materials'. In general, management of resources such as water,

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[9] It would be possible to get a better and more detailed allocation of EGSS activities to the R-framework. This could be achieved by taking into account the R-framework from the start when compiling EGSS figures instead of looking only at the aggregated results. However, for the sake of simplicity and to save time, Dutch EGSS results were allocated to the R-framework.

biomass, fossil fuels and minerals is allocated to the category 'use and create product more intelligently'. Also, CReMA 15 and 16 are allocated completely to this category, because the required level of detail to allocate the activities more precisely is missing. However, economic output of these categories are economically insignificant and do barely affect the results.

4.1.2 CE activities outside EGSS estimated by a macro-approach

The next step is to extend the list of CE activities derived from EGSS from a macro point of view. The macro-approach identifies economic activities that can be derived directly from the industrial (NACE) or product (CPA) classifications. Table 4.1.2 and 4.1.3 show the circular activities that were added in addition to EGSS activities, respectively based on industrial and product classification.

Unfortunately Dutch SUTs are not always sufficiently detailed to distinguish circular from non-circular activities. This is not a problem when an aggregated classification level consists solely of CE activities. For instance, economic activities within NACE 95 'repair of computers and personal and household goods' are all related to CE. On the other hand, some industries or products in the CPA or NACE classification include both CE and non-CE activities. For instance, in case of NACE 33 'Repair, maintenance and installation of machinery and equipment', repair and maintenance are grouped together with installation which is not a CE activity. In this case PRODCOM data was used to distinguish between repair and maintenance and installation activities (see also paragraph 3.2.2). However, a similar approach to distinguish between CE and non-CE activities is not always possible. In table 4.1.2 and 4.1.3 it is shown if and what additional data sources were used to estimate the CE part.

Table 4.1.2. Additional CE activities identified in Dutch SUTs[10], by industry classification.

Selection by industry			
Industries	Description	Additional sources	R-framework
33000	Repair, maintenance and installation of machinery and equipment	PRODCOM	B
46770	Wholesale of waste and scrap		C
4779	Retail sale of second-hand goods in stores	Production and labour statistics[11]	B
95000	Repair of computers and personal and household goods		B

Table 4.1.3. Additional CE activities identified in Dutch SUTs[12], by product classification.

Selection by product			
Products	Description	Additional sources	R-framework
3311900	Repair, maintenance and installation services of fabricated metal products	PRODCOM	B
3312900	Repair, maintenance and installation services of machinery	PRODCOM	B
3313900	Repair, maintenance and installation services of electronic and optical equipment	PRODCOM	B
3315000	Repair, maintenance and installation services of ships and boats	PRODCOM	B

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[10] The Dutch SUTs follow industry and product classifications similar, but not identical, to NACE and CPA. There are differences in the level of detail published.

[11] Sale of antiques is excluded but the sale of other second-hand goods is included.

[12] The Dutch SUTs follow industry and product classifications similar, but not identical, to NACE and CPA. There are differences in the level of detail published.

3316000	Repair, maintenance and installation services of aircraft and spacecraft	PRODCOM	B
3317000	Repair, maintenance and installation services of trains and other transport equipment	PRODCOM	B
4520000	Repair, maintenance and washing services of motor vehicles		B
5811300	E-books		A
5813200	On-line newspapers		A
5814200	On-line journals and periodicals		A
7711000	Rental and leasing services of motor vehicles		A
7712000	Rental and leasing services of trucks		A
9511000	Repair services of computers and peripheral equipment		B
9524000	Repair services of furniture and home furnishings		B
9590000	Repair services of other consumption goods		B

Treatment of specific CE activities of macro approach

It turned out to be difficult to come with a solid reasoning of why or why not renting and leasing (CPA 77) should be part of CE (Tukker, 2013). Renting or leasing should be part of CE when this activity results in 1) a reduction in the number of products needed or 2) an increased life span of the product. Unfortunately it is not always clear to what extent these results are obtained by renting or leasing activities. Here we give some examples. One can argue to include renting a drill from a hardware store because a single drill can be used by multiple households. The same argument can be applied to car rental. However if cars are rented by tourists we are doubtful if this benefits circularity of products. It can hardly be said that buying a car is an alternative to renting for most tourist. With regard to the latter case the same arguments might apply for tourist renting a room in a hotel.

With regard to leasing (renting over a long period of time) we think that this can only benefit CE in specific cases. For example, in case of a washing machine: it can be argued that households would buy a cheap machine that will not last very long but, in contrary, lease a machine that is built to last (for lease companies it would be more beneficial to rent out long lasting, easy to maintain washing machines). With regard to leasing cars this argument might not apply with the exception of specific cases like car companies that put effort in keeping their leased cars (or part of it) in use for as long as possible.

At this stage it is not possible to draw a clear line in the renting/leasing activities that should or should not be part of CE. We lack a clear concept of what to include but also data on the required level of detail. For now, in this report, all leasing and renting activities are included except for real estate. In the future we can investigate if, for these kind of activities, a micro-approach can provide a more clear cut distinction.

Not included in this report are cleaning services. One can argue that cleaning of products extents there lifespan (similar to the maintenance of products). However, to consider the cleaning of windows or offices as part of CE seems a bit farfetched.

Allocation of CE-activities to the R-framework: macro approach
For a detailed overview of the R-framework, see table 2.1. Wholesale of waste and scrap is considered to be a 'useful application of materials'. It is considered a CE activity because re-distribution of waste and scrap is necessary in order to recover the materials, which is why it is allocated to the same category as material recovery activities. Renting and leasing of products is about intensifying the use of products, and is therefore allocated to 'use and create product more

intelligently'. Repair and maintenance and the sale of second-hand goods is all about the 'lifetime extension of products and parts'. Finally, e-books and on-line newspapers, journals and periodicals are considered as 'use and create product more intelligently', because they make the use of paper redundant.

4.1.3   CE activities determined using the micro-approach

CE activities that are not included in the Dutch EGSS nor can be determined by selection of NACE- or CPA-classes through a macro-approach are identified by a so called micro (or bottom-up) approach. This means that CE activities are identified at business level rather than at national level, e.g. by industry or product.

Circular businesses were identified by using information of business associations and webscraping (see paragraph 3.3.1). Unfortunately, for a number of reasons, the results obtained by webscraping were somewhat disappointing. The Python script used to search through websites is working, but it needs to be developed further to optimize the results obtained. Further, due to data capacity limitations we were only able to scrape through homepages of websites and thereby missing important information of a business' activities. Finally, the results obtained greatly depend on the keywords used. To find the best combination of keywords is a learning-by-doing exercise which can further be improved in the future. So, eventually the search for businesses that used CE related keywords on their website did not result in a list of solely circular businesses, i.e. the list of businesses obtained included a lot of non-circular businesses as well. In the future we will improve the software in order for it to learn what type of business should or should not be included.

Thus, it turned out to be very difficult and time consuming to find a reliable population of businesses that comprise all CE activities missed by the previous approaches. Therefore we decided to identify CE activities by theme (like meat substitutes, education, biobased, share-platforms). Due to time constraints we were only able to analyze CE activities related to meat substitutes and share-platforms related to mobility. For the latter case we identified seven companies in which slightly more than 200 people were employed. With regard to meat substitutes we identified 12 Dutch companies. Some of the bigger companies produce both vegetable and meat based products. For these companies, due to lack of information, it turned out to be difficult to come up with a CE share. We estimated employment of around 335 people in the meat substitute industry.

4.1.4   Treatment of specific CE activities of micro-approach

A business that uses environmental friendly materials as input in its production process can be regarded part of CE in case the product is a direct substitute of a less-environmental friendly product. However, for practical reasons, the use of secondary materials, like scrap metal for iron production, is not taken into account in this report. It turned out to be too difficult to allocate value added and employment of a business to the amount of used secondary materials. However businesses that produce meat substitutes can be identified and are, therefore, taken into account. One could say that eating meat is a very inefficient way to obtain nutrients. Less resources, like energy and land, would be needed if nutrients are obtained direct from plant materials. Besides this, cows produce methane as a result of digestion process. By meat substitutes we mean products that replace a piece of meat like a vegie burger. Not taken into accounts are, for example, nuts, even though they can replace nutrients found in meat. Also not taken into account is the production of biotic products like algae that are used as input for the

production of meat products because algae in it itself are not a replacement of a less environmental friendly alternative.

A business that produces a service that provides opportunities to share a product or service in order for it be used more efficiently is only taken into accounts if its business model intents to stimulate the reduction of resources. This is the case when goods are being used more efficiently, by e.g. sharing, or are being reused, and therefore have a longer life span. The same arguments are used with regard to renting and leasing. Therefore included are services that facilitated sharing of products like car sharing platforms or companies that rent out products. Not included are people or companies that rent out themselves to provide a service like taxi services (also Uber) or hotels (also Airbnb). We did not include Uber because its business concept is to provide a taxi service without the intent to be more resource efficient. However, this does not mean that using Uber can actually be more resource efficient, e.g. if you use Uber instead of owning a car.

4.2 Employment and value added for CE related activities according to EGSS and Dutch CE policy

Because the business population of the micro-approach is not complete yet these results are not added to the results taken from the EGSS and macro-approach. This means that the final results are an underestimation of the CE economy.

4.2.1 Circular jobs in the Netherlands

The results presented are a conservative estimation of the number circular jobs in the Netherlands, because part of CE activities (those estimated by the micro-approach, see paragraph 3.1.3) are not yet included. Furthermore, there is no standardized internationally agreed definition or embarkation of CE activities. Therefore, the actual number of circular jobs could either be lower or higher, depending on the choices made of whether economic activities should be considered part of CE or not.

Figure 4.2.1. presents employment figures of the CE classified according to the R-framework for the period 2001 to 2016[13]. In total the number of circular jobs, measured in full-time equivalents (fte), has increased from 145 thousand in 2001 to 173 thousand in 2016, an increase of almost 20 percent. In 2016, CE accounts for over 2,4 percent of total employment (measured in fte).

Employment related to the 'useful application of materials' remained almost constant during this period. All other categories show an increase of employment over time, both in absolute terms and relatively to total employment in the Netherlands. The category 'substitution', which consist mainly of activities related to the production of renewable energy, grew strongest by 13 thousand fte. Also the category 'lifetime extension of product and parts' grew by 11 thousand fte. This growth can almost fully be attributed to the increase of repair and maintenance activities.

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[13] The underlying employment figures, and also gross value added and production value figures can be found in Annex C.

Figure 4.2.1. Circular jobs classified by R-framework, in thousand full-time equivalents
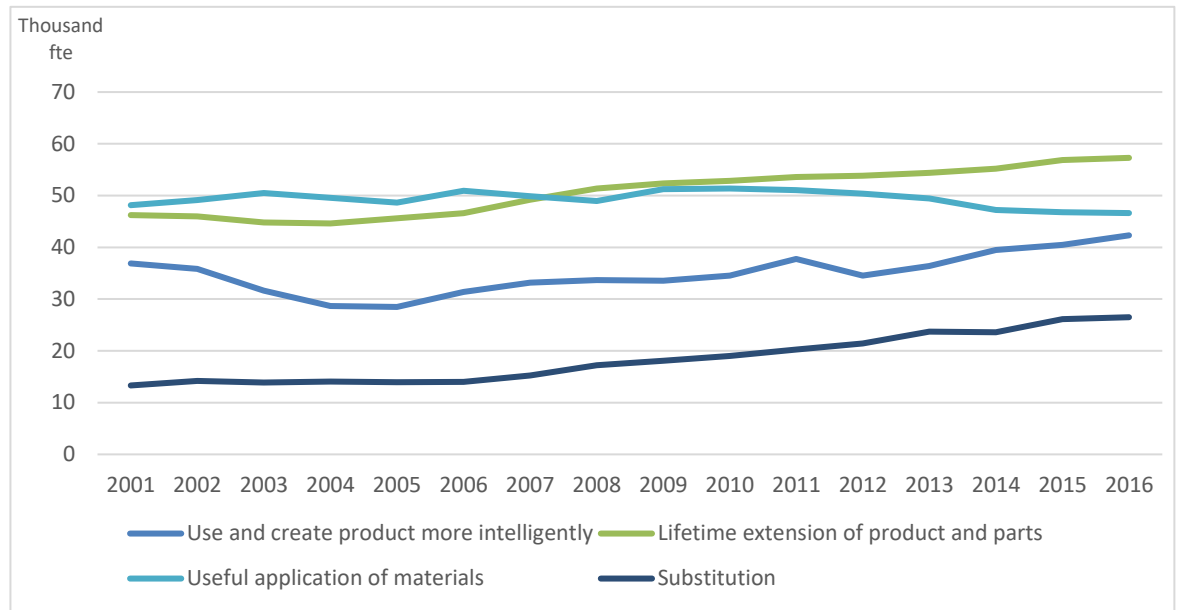
Comparison of the results

Circle Economy (2017), a Dutch organization aimed at promoting the CE in the Netherlands, estimates the total number of circular jobs in the Netherlands at 8,1 percent in 2015 (versus 2,4 percent in this report). They distinguish between enabling jobs (1,6%), core jobs (3,1%) and indirect circular jobs (3,5%). At first sight this seems to be a big difference, however, there are some explanations for this difference.

First, this report focuses only on direct jobs and does not determine indirect jobs. Second, Circle Economy distinguishes direct jobs into core jobs and enabling jobs. The core jobs comprise activities such as 'preserve and extend what's already made', 'use waste as a resource', 'regenerative resources' and 'rethink the business model'. These activities correspond to the activities measured in this report. Although 'rethink the business model' should be captured mainly by means of the micro-approach, which has not yet been completed. So, the conservative 2,4 percent measured in this report compares best to the 3,1 percent of core jobs measured by Circle Economy. Furthermore, Circle Economy talks about number of jobs whereas we talk about full-time equivalents. And finally the results depend greatly on the choices made regarding whether or not an economic activity is considered circular[14].

The enabling jobs comprise activities such as 'incorporate digital technology' and 'design for the future'. These type of activities are very hard to measure and could possibly be measured partly by means of the micro-approach or should be measured by a model-based approach as is applied by Circle Economy.

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[14] Circle Economy does not provide a detailed overview of economic activities that are considered part of CE. This makes it hard to compare the actual results.

4.2.2 Gross value added of the circular economy in the Netherlands

The contribution of the Dutch circular economy to the total economy can be measured in terms of gross value added. Figure 4.2.2. presents the share of gross value added of the CE to total GDP. Between 2001 and 2016 the share of the CE in total GDP has increased by over 7 percent, from 4,2 to 4,6 percent. This increase can be attributed to the category 'substitution', which increased from 0,2 to 0,6 percent of total GDP. The share of gross value added in total GDP generated by the other categories remained more or less constant. The share of 'lifetime extension of product and parts' remained constant, while 'useful application of materials' grew slightly and 'use and create product more intelligently' dropped slightly.

Figure 4.2.2. Gross value added of the CE as a share of total GDP, classified by R-framework
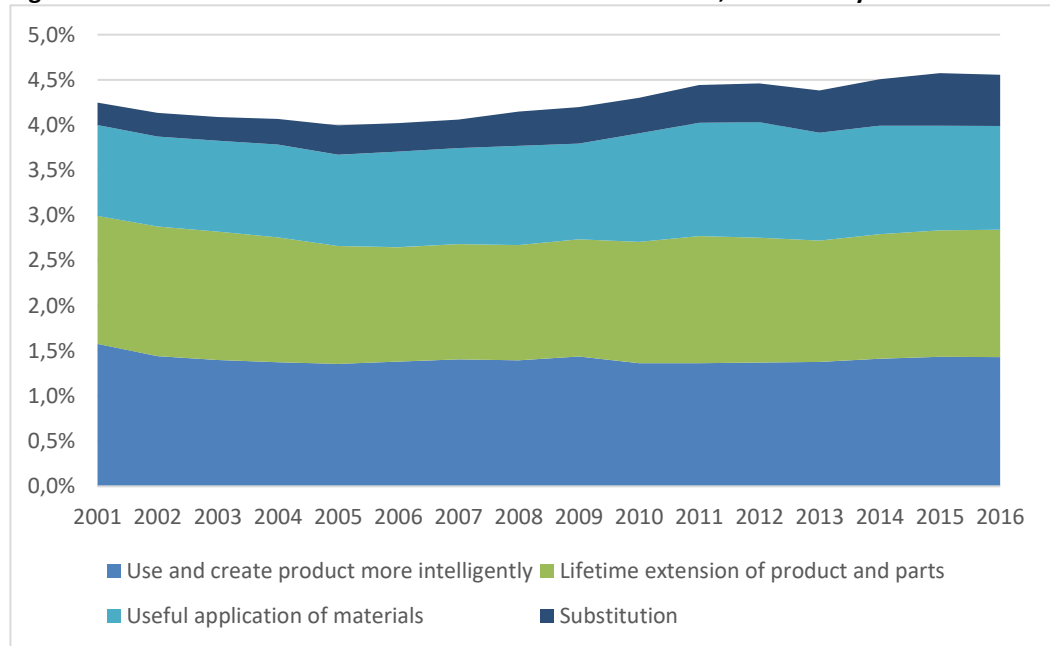
5. Discussion/conclusion/recommendation

This report provides a concept, definition and classification of the circular economy, clarifying which activities are considered circular and which are not. We adopt the three principles, as described by McKinsey (2015), the CE rest upon:1) Preservation and enhancement of natural capital by controlling finite stocks and balancing renewable resource flows, 2) Optimization of resource yields by circulating products, components, and materials at the highest utility at all times in both technical and biological cycles, 3) Fostering system effectiveness by revealing and designing out negative externalities.

Because the circular economy comprises of a wide variety of activities, ranging from rethinking and redesigning of products at the top of the products life cycle to recycling materials at the end of a products' life cycle, aggregating these different type of activities in terms of economic output, employment and value added is not meaningful.Therefore, we applied a classification system which allows to group CE activities related to 1) intelligent use and production, 2) lifetime extension and 3) useful application and 4) substitution. During this research it became very clear that the circular economy concept is very comprehensive and that it is very difficult to set a boundary as to delimit which activities should be regarded circular and which should not. In chapter 2 we argue what kind of activities should be included or excluded from CE and in chapter 4 we discuss some borderline cases.

In order to estimate employment and value added of the CE we take a three step approach. First, we determine what EGSS activities (classified by CEPA/CReMA) can be allocated to CE. Next, by using a macro approach, we determine what NACE (industries) and CPA (products) could be added to the activities already included in step 1. Finally , by using a micro approach, we try to identify businesses that were not included in the first 2 steps. Because results from the last step were not complete we only included figures from step 1 and 2 in our final results.

From the EGSS approach (step 1) we included all activities classified by CReMA apart from "management of wild flora and fauna". CEPA activities "water management" and "waste management" are also considered part of CE. EGSS focuses on the production of environmental goods and services. In addition, CE also takes into account the production process itself, the business model applied and the final effect of an economic activity. Furthermore, contrary to EGSS, the CE concept also takes into account the use of circular materials.

In order to include CE activities outside EGGS additional NACE and CPA codes are added (step 2). Most important activities were related to repair and maintenance, rental and leasing and trade of second hand goods. As pointed out before, adding activities by identifying CE businesses by following a micro approach (step 3) was not completed. Only figures for meat substitutes and share platforms related to mobility were compiled.

It is striking that the category 'lifetime extension of products and parts' is missing completely in EGSS. Apparently this is a main difference between EGSS and CE. Whereas the circular economy focuses on activities such as re-using, repairing, refurbishing, remanufacturing and repurposing products or parts to extend their lifetime and thereby saving natural resources, these activities are not considered environmental activities in EGSS.

In the future we will try to improve data collection for the micro approach in order to establish a representable population of CE business. In order to do this we will develop the web scraping methodology further by implementing software that allows for learning what type of businesses should be included or excluded from the CE.

The final results consider only step 1 and 2 because results from step 3 are not complete. The results are classified by the R-framework and show an increasing trend over time. Employment has increased from 145 thousand to 173 thousand full-time equivalents between 2001 and 2016, an increase of almost 20 percent. In 2016 the CE accounted for over 2,4 percent of total Dutch employment. Also the share of gross value added generated by CE activities in total GDP has increased by over 7 percent during this period, from 4,2 to 4,6 percent of GDP. This increase can be attributed to the R-group 'substitution', the share of gross value added in total GDP generated by the other R-groups remained more or less constant.

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Annex A

9R-framework (Potting et al., 2018)

Use and create product more intelligently	R0 Refuse	Making a product redundant by abandoning its function, or supplying it with a radically different product.
	R1 Rethink	Intensify product use (for example by sharing products, or multifunctional products).
	R2 Reduce	Producing a product more efficient by using less (raw) materials in the product, or in its use.
Lifetime extension of product and parts	R3 Re-use	Re-use of discarded, still good product to the same function by another user.
	R4 Repair	Repair and maintenance of broken product for use in its old function.
	R5 Refurbish	Refurbish or modernize an old product.
	R6 Remanufacture	Use parts of discarded product in a new product with the same function.
	R7 Repurpose	Use discarded product or parts of it in a new product with a different function.
Useful application of materials	R8 Recycle	Process materials to the same (high-quality) or lower (low-quality) quality.
	R9 Recover	Incineration of materials for energy recovery purposes.
Substitution	Substitution	Substitution of non-renewable.

7 Key elements (van Oort et al., 2017)

		7-key elements
Direct jobs	Core jobs	Prioritise regenerative resources
		Preserve and extend what's already made
		Use waste as a resource
		Rethink the bussiness model
	Enabeling jobs	Collaborate to create joint value
		Design for the future
		Incorporate digital technology
Indirect jobs		

Six business actions based on the three principles of the circular economy (McKinsey, 2017)

Regeneration	Shift to renewable energy and materials; reclaim, retain, and regenerate health of ecosystems; and return recovered biological resources to the biosphere.
Sharing	Keep product loop speed low and maximise utilisation of products by sharing them among users (peer-to-peer sharing of privately owned products or public sharing of a pool of products), reusing them throughout their technical lifetime (second-hand), and prolonging their life through maintenance, repair, and design for durability.
Optimizing	Increase performance/efficiency of a product; remove waste in production and the supply chain (from sourcing and logistics to production, use, and end-of-use collection); leverage big data, automation, remote sensing, and steering.
Looping	Keep components and materials in closed loops and prioritise inner loops. For finite materials, this means remanufacturing products or components and as a last resort recycling materials. For renewable materials, this means anaerobic digestion and extracting bio-chemicals from organic waste.
Virtualizing	Deliver utility virtually – books or music, online shopping, fleets of autonomous vehicles, and virtual offices.
Exchanging	Replace old materials with advanced non-renewable materials; apply new technologies (e.g. 3D printing and electric engines); choose new products and services (e.g. multi-modal transport).

Annex B

Selection of circular activities by NACE-classification, by Eurostat, van Oort (2017) and CBS[15]

NACE-class		NACE-description	Eurostat	van Oort	CBS
A		Agriculture, forestry and fishing			
B		Mining and quarrying			
C		Manufacturing			
	33	Repair and installation of machinery and equipment			Partly, installation is excluded
	33.11	Repair of fabricated metal products	100%	100%	100%
	33.12	Repair of machinery	100%	100%	100%
	33.13	Repair of electronic and optical equipment	100%	100%	100%
	33.14	Repair of electrical equipment	100%	100%	100%
	33.15	Repair and maintenance of ships and boats	100%	100%	100%
	33.16	Repair and maintenance of aircraft and spacecraft	100%	100%	100%
	33.17	Repair and maintenance of other transport equipment	100%	100%	100%
	33.19	Repair of other equipment	100%	100%	100%
D		Electricity, gas, steam and air conditioning supply			
E		Water supply; sewerage, waste management and remediation activities			
	36	Water collection, treatment and supply		100%	Partly, conform EGSS
	37	Sewerage		100%	100%
	38.11	Collection of non-hazardous waste	100%	100%	100%
	38.12	Collection of hazardous waste	100%		100%
	38.21	Treatment and disposal of non-hazardous waste		100%	100%
	38.22	Treatment and disposal of hazardous waste			100%
	38.31	Dismantling of wrecks	100%	100%	100%
	38.32	Recovery of sorted materials	100%	100%	100%
	39	Remediation activities and other waste management services		100%	
F		Construction			
G	45	Wholesale and retail trade; repair of motor vehicles and motorcycles			Partly, only repair and maintenance

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[15] This table aims to presents an overview of NACE classes that are considered more or less completely part of CE. Furthermore, CE activities may also take place in all other NACE-classes. These activities are not included by NACE selection but through EGSS or micro approach.

	45.11	Sale of cars and light motor vehicles		100%	
	45.19	Sale of other motor vehicles		100%	
	45.20	Maintenance and repair of motor vehicles	100%	100%	100%
	45.40	Sale, maintenance and repair of motorcycles and related parts and accessories	100%	100%	Partly
	46	Wholesale trade, except of motor vehicles and motorcycles			
	46.77	Wholesale of waste and scrap	100%	100%	100%
	47	Retail trade, except of motor vehicles and motorcycles			
	47.79	Retail sale of second-hand goods in stores		100%	100%, except antiques
H		Transportation and storage			
I		Accommodation and food service activities			
J		Information and communication			
K		Financial and insurance activities			
L		Real estate activities			
M		Professional, scientific and technical activities			
N		Administrative and support service activities			
	77	Rental and leasing activities			Excluded are real estate & intellectual property
	77.11	Renting and leasing of cars and light motor vehicles		100%	100%
	77.12	Renting and leasing of trucks		100%	100%
	77.21	Renting and leasing of recreational and sports goods		100%	100%
	77.22	Renting of video tapes and disks		100%	100%
	77.29	Renting and leasing of other personal and household goods		100%	100%
	77.31	Renting and leasing of agricultural machinery and equipment		100%	100%
	77.32	Renting and leasing of construction and civil engineering machinery and equipment		100%	100%
	77.33	Renting and leasing of office machinery and equipment (including computers)		100%	100%
	77.34	Renting and leasing of water transport equipment		100%	100%
	77.35	Renting and leasing of air transport equipment		100%	100%
	77.39	Renting and leasing of other machinery, equipment and tangible goods n.e.c.		100%	100%
	77.40	Leasing of intellectual property and similar products, except copyrighted works		100%	

O		Public administration and defence; compulsory social security			
P		Education			
Q		Human health and social work activities			
R		Arts, entertainment and recreation			
S		Other service activities			
	95	Repair of computers and personal and household goods	100%	100%	100%
S	96	Other personal service activities			
	9601	Washing and (dry-)cleaning of textile and fur products		Partly	
T		Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use			
U		Activities of extraterritorial organisations and bodies			

Annex C

Circular jobs classified by R-framework, in thousand full-time equivalents

R-framework	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Useful application of materials	48	49	50	50	49	51	50	49	51	51	51	50	49	47	47	47
Lifetime extension of product and parts	46	46	45	45	46	47	49	51	52	53	54	54	54	55	57	57
Use and create product more intelligently	37	36	32	29	28	31	33	34	34	35	38	35	36	39	40	42
Substitution	13	14	14	14	14	14	15	17	18	19	20	21	24	24	26	26
Total	**145**	**145**	**141**	**137**	**137**	**143**	**148**	**151**	**155**	**158**	**163**	**160**	**164**	**166**	**170**	**173**

Gross value added classified by R-framework, in billion euro and current prices

R-framework	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Useful application of materials	5,2	5,3	5,5	5,7	5,9	6,5	6,9	7,4	7,0	8,0	8,5	8,7	8,2	8,4	8,4	8,5
Lifetime extension of product and parts	6,8	7,2	7,3	7,3	7,2	7,4	7,9	8,3	8,1	8,6	9,2	9,0	8,9	9,2	9,7	10,0
Use and create product more intelligently	7,2	6,9	6,9	7,0	7,2	7,7	8,4	8,7	8,6	8,4	8,5	8,6	8,8	9,2	9,5	9,8
Substitution	1,2	1,3	1,3	1,5	1,8	1,8	2,0	2,5	2,5	2,5	2,7	2,8	3,1	3,5	4,0	4,0
Total	**20,5**	**20,7**	**21,0**	**21,5**	**22,0**	**23,5**	**25,1**	**26,8**	**26,2**	**27,5**	**28,9**	**29,1**	**28,9**	**30,3**	**31,6**	**32,3**

Production value classified by R-framework, in billion euro and current prices

R-framework	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Useful application of materials	10,2	10,7	11,0	11,3	11,7	12,6	13,3	14,1	13,6	15,2	16,3	16,5	16,1	16,4	16,3	17,2
Lifetime extension of product and parts	16,2	16,7	17,1	17,5	17,3	18,1	19,7	20,9	20,9	21,5	22,3	21,8	21,7	22,7	24,2	24,7
Use and create product more intelligently	12,5	12,1	12,0	12,1	12,4	13,5	14,6	15,6	15,3	15,2	15,8	15,8	16,1	16,6	16,9	17,9
Substitution	3,4	3,7	3,9	3,8	4,2	4,4	4,9	6,0	5,9	6,1	7,1	8,2	8,8	9,4	10,4	9,8
Total	**42,4**	**43,2**	**43,9**	**44,7**	**45,4**	**48,6**	**52,5**	**56,6**	**55,7**	**57,9**	**61,5**	**62,3**	**62,6**	**65,0**	**67,7**	**69,5**