# Policies for Resource Efficient and Effective Solutions

## A review of concepts, current policy landscape and future policy considerations for the transition to a Circular Economy

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# List of abbreviations

BTA............... Border Tax Adjustment
CE................. Circular Economy
CSR............... Corporate Social Responsibility
DMC............. Domestic Material Consumption
EC................. European Commission
EEA............... European Environment Agency
EEB............... European Environment Bureau
EMS.............. Environmental Management System
EPR............... Extended Producer Responsibility
EU ................ European Union
GDP.............. Gross Domestic Product
GPP .............. Green Public Procurement
IPR................ Individual Producer Responsibility
LCA............... Life Cycle Assessment
LCC............... Life Cycle Cost
MLP.............. Multi-Level Perspective
OEM............. Original Equipment Manufacturer
PEF ............... Product Environmental Footprint
PPI................ Public Procurement for Innovation
RE................. Resource Efficiency
REES............. Resource Efficient and Effective Solutions
SCP............... Sustainable Consumption and Production
SME.............. Small and Medium (size) Enterprise
UNEP............ United Nations Environment Programme
VAT .............. Value Added Tax
WFD............. Waste Framework Directive

# 1 Introduction

Since the Club of Rome's report Limits to Growth in 1972 (Meadows et al., 1972), concerns over the exploitation of the earth's natural resources and the potential future shortage of vital to humankind resources have grown considerably worldwide. In parallel, concerns over increasing environmental pressures, such as global warming and pollution, which also have adverse health effects, have increased and at times overshadowed resource issues. At the same time studies of planetary boundaries (Rockström et al., 2009) demonstrate that the ability of nature to endure stress and regenerate itself is limited.

Therefore, in a resource-constrained world the urgency of accelerating the transition from a linear economic system, which overexploits resources and fails to account for their sustainable management, to a Circular Economy (CE), which takes into account the limited supply of the earth's capacity, is more pressing than ever.

The continued reliance on the shrinking pool of earth's natural resources increases the risk in the economy, and therefore to society as a whole, due to price volatility of critical resources and potential disruptions in resource supply. If linear ways of production and consumption are complemented, and ideally, substituted with circular material flows, substantial resource efficiency improvements can be achieved. Products and services, therefore, need to be designed purposefully for resource efficiency, assuming a lifecycle perspective. New methods for reuse, repair, remanufacturing and recycling of products and their components are required in this 'new' Circular Economy, which would allow products to re-enter into material circulation and given 'new life' by introducing a product life cycle. However, there are significant gaps in knowledge and practice with regard to developing resource efficient, effective and circular solutions. One level of intervention, on which the challenges of increased resource efficiency and the transition to a Circular Economy can be addressed, is that of products and services. Innovative solutions on a product level (or offering), may lead to significantly reduced use of resources and impact on the environment during manufacturing, use and end-of-life phases.

In this respect, the Swedish Foundation for Strategic Environmental Research (Mistra) invested in an ambitious research programme aiming to advance Swedish manufacturing industry's transition towards a Circular Economy and to enhance its capability to develop sustainable world-leading, resource efficient and effective solutions based on Circular Economy thinking, through the close collaboration and mutual learning between industry and academia.

The programme entitled 'Resource Efficient and Effective Solutions (REES) based on circular economy thinking' will investigate potential solutions that would promote resource efficiency in the Swedish manufacturing industry. Mistra REES is aiming to develop principles, methods and guidelines that make resource-efficient products, services and business models possible. Another aim is to propose policy instruments and policy packages that favour the transition to a more Circular Economy. Ultimately, the reduced supply risks, costs and environmental impacts resulting from the programme outcomes are expected to increase industrial competitiveness and job creation in Sweden.

## 1.1 Purpose and scope

This report aims to provide a general overview of related to the REES programme concepts and especially those of relevance to resource efficiency and Circular Economy. Moreover, the report identifies and describes the current policy context by focusing on policies for resource efficiency and Circular Economy at national and EU level. It further presents a list of barriers and drivers identified in literature, both for implementing resource efficiency strategies based on Circular Economy principles and for inducing fundamental changes in business operations (new business models).

The REES programme sets out to research resource efficient solutions in the manufacturing sector in Sweden. Therefore the report focuses on manufacturing industries, while relevant aspects of consumption of products and/or services will also be highlighted, as production and consumption systems are largely interlinked. The production of products and/or services is represented by the throughput of materials in order to provide the desired/designed offering and forms the primary focus of the REES programme. Product use and product end-of-life constitute integral parts of a product life cycle within a Circular Economy perspective and will also be addressed in this review and in the REES programme. Therefore, policies that affect an entire life-cycle of a product and its components after the end-of-life phase will be taken into consideration.

Furthermore, the REES programme focuses on material resource efficiency, which means that the primary focus of research is on materials, material throughput efficiency in manufacturing and material resource conservation. Energy savings might be relevant for improving manufacturing processes and product specifications in a low carbon economy, but energy efficiency is outside the scope of this paper.[1]

## 1.2 Methodology

The research methodology used for producing this report included extensive literature review of academic sources in related to resource efficiency thematic areas and relevant policies at EU and National level on the Circular Economy. The thematic areas reflect the broad scope and complexity of the REES programme and in particular the part of the programme concerning policies for REES. They are categorised (in random order) as follows:

- Circular Economy
- Sharing economy, collaborative economy, the commons and digitalisation
- Environmental/resource economics
- Governance and institutional work
- Innovation/transition management
- Material resource efficiency
- Policy studies/evaluation
- Product-Service Systems (PSS)
- Public procurement, Green Public Procurement (GPP) and Innovation Procurement
- Eco-design
- Remanufacturing
- Sustainable Consumption
- Waste management – waste prevention

The literature review started by searching for publications with the aforementioned keywords in such databases as Web of Science, Scopus, Science Direct and Google Scholar. Then snowballing technique was used (in terms of keywords, authors' names and journal titles) to expand the preliminary reference list for all the thematic areas.

The report is mostly based on peer-reviewed scientific articles, but also informed by official EU and National policy documents, as well as EU and National documentation for supporting policy decisions (such as preparatory studies, impact assessments and other related reports). Finally, trusted sources for environmental and natural resources information, such as the European Environment Agency (EEA) and the Swedish Environmental Protection Agency (Naturvårdsverket), were used as well. The latter type of sources are considered essential, especially in the case of thematic areas that are relatively new in academic literature, such as the concept of the Circular Economy which still lacks proper definition and framing. The academic discourse on the Circular Economy is booming and therefore all relevant information sources

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[1] However, energy from fossil (non-renewable) resources could be relevant to discuss in the debate about resources and resource pricing.

should be considered, albeit with caution. EU and National policy documents are considered necessary as information sources for this report in order to present the current policy landscape concerning resource efficiency and Circular Economy.

# 2 Resource Efficiency and the Circular Economy

In this chapter, material resource efficiency and the recently revived concept of the Circular Economy are scrutinised, while at the same time a comparison of the concepts (in section 2.4) reveals the extent to which and how these concepts overlap or not.

## 2.1 Defining resources

Both concepts of material resource efficiency and the Circular Economy refer to 'Resources' and in what way the use of resources can become more efficient while their properties and utility is kept constant as long as possible in the economy. So 'What is a resource?' and 'How resource use can be optimised?' This section answers to the first question, while the second question is addressed in sections 2.2 and 2.3.

To define 'Resources' is undoubtedly a very difficult task and there is as yet no common definition. Even the number and type of resources that could be included in the definition is widely debatable. For policy purposes, there in an attempt by the United Nations Environment Programme (UNEP) to formulate a definition that is easily understood and can be used to inform policy decision making processes concerning resources and their sustainable management thereof. According to UNEP (2010: p.42), resources are: *'The naturally occurring assets that provide use benefits through the provision of raw materials and energy used in economic activity (or that may provide such benefits one day) and that are subject primarily to quantitative depletion through human use. They are subdivided into four categories: mineral and energy resources, soil resources, water resources and biological resources.'* Resources can be material or immaterial, the latter requiring some intermediate step (use of material resources) in order to be harnessed, such as air and solar power. Although the definition above refers to 'Resources' in general, and therefore acts as an all-purpose definition for resources, its focus is clearly on what is understood as 'natural resources' referring to the material and immaterial assets that the earth provides for use by humans in the economy.

Making the definition even more precise and targeting specifically material resources, another definition is presented in a subsequent UNEP report (2011: p.2): '*Material resources are natural assets deliberately extracted and modified by human activity for their utility to create economic value. They can be measured both in physical units (such as tons, joules or area), and in monetary terms expressing their economic value.'* This definition particularly stresses the fact that material resources can be measured in physical and monetary terms.[2]

A recent report by the European Environment Bureau (EEB, 2015) on material resource efficiency concluded that many of the documents used in discussing resource policy are either vague or uninformed when it comes to defining the term 'resources'. This is rather problematic since a vast array of materials, products and resources fit under this umbrella term and there is a risk that policy interventions will not be devised, implemented or effective. The same report attempts to set a comprehensive framework for (natural) resources in order to inform potential policy processes on product development and associated resource efficiency issues. Adapting the proposed framework, Figure 1 presents the sum of natural resources existing in the environment and can be used in economic activities. This is considered to be a 'traditional' representation of resources as understood by the majority of relevant stakeholders in the debate over resources, and more precisely 'natural resources'.

[2] This will be discussed later in sections 2.2.1 and 2.2.2 about physical and economic resource efficiency

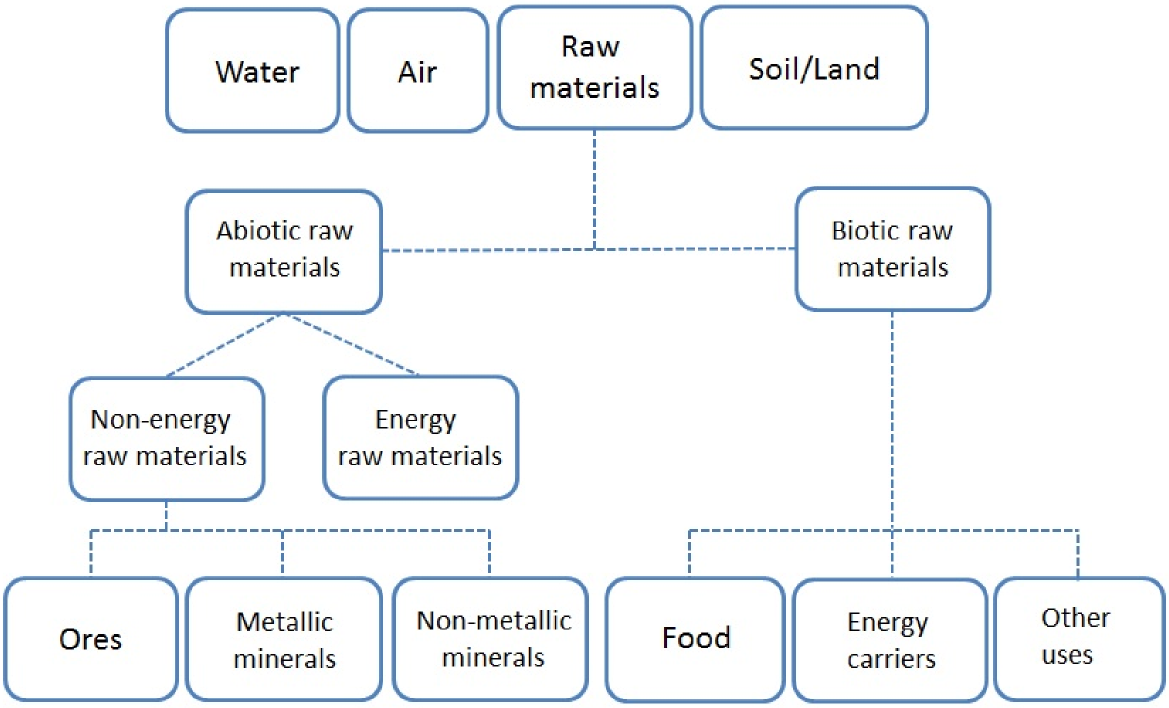


***Figure 1: Resource Categories (adapted from EEB, 2015)***

Resources comprise 'water', 'air', 'materials' and 'soil'. The term 'raw material' is used to signify the state of the resource before any manipulation or technical alteration by human activities. 'Soil' is considered to be a 'raw material' in a sense that 'raw materials' serve as inputs to technical activities in the economy, such as manufacturing or construction activities, while soil serves as a substrate for the exploration and exploitation of 'material' resources (inputs, such as ores, food and fibre). 'Water' and 'Air' are considered as input resources for several production activities, either biological or technical processes, including energy production.

For the purposes of the REES programme, the resources of relevance are mostly concentrated in the branch of 'Abiotic raw materials' in Figure 1. These are primarily Industrial ores and minerals'- materials used as inputs by participating in the REES program companies. In the same branch, there are also 'Energy raw materials', widely known as fossil fuels, which are outside the scope of the study. This is related to the fossil energy use in production processes as well as energy embedded in products and will only be attributed indirectly through the environmental impact function (e.g. GHG emissions) of products and services. In addition, water, soil and air also fall outside the scope of this study, unless there are indications of massive negative side effects on these resources as a result of resource efficiency policy interventions targeting another resource group. However, this is considered highly unlikely within the scope of this study and the range of industries under research.

Despite the efforts to define resources and its constituent components, the definitions above leave out one main element of the 'human-made' economy - the humans themselves and their capacity to act as resources (through labour) for making the economy function. Schumacher (1973) for example even distinguishes physical labour inputs of humans from the mental capabilities in humans, stating that the key factor of economic development and success of humankind derives not (only) from the utilisation of natural resources but primarily from the ingenuity of the human mind and the ability of humans to make use of these resource. He also concludes that progress comes through education: *'in a very real sense, therefore, we can say that education is the most vital of all resources'* (Schumacher, 1973: p.64). In this sense, it is possible to define another category of resources consisting of 'knowledge' and 'information' that are crucial in today's advancement of industrialised societies.

Going a step further and taking into account the argumentation presented above concerning human and knowledge resources as vital components of modern economies, Figure 2 gives an illustration of an alternative categorisation of resources. This 'new' view on the distribution of resources might be of certain significance for policy formulation on resource efficiency and the Circular Economy. Figure 2 is follows suggestions from authors, such as Walter Stahel and Robert Ayres, e.g. (Ayres and Voudouris (2014); Stahel (2013); von Weiszäcker and Ayres (2013), claiming that the vital property of resources to be considered for policy purposes is whether they are renewable or not. Taking into consideration this suggestion, the 'new' representation of resources in Figure 2 might give a new perspective in the debate over resources and resource definitions. Additionally, it also shows the relations (arrows) between the resources within the confines of the limited earthly space. It is obvious that renewable resources are largely dependent on the non-renewable resources and therefore their significance in relation to resource conservation efforts for supporting the economy is deemed higher than renewable resources which can be regenerated (ideally in short periods of time, although this is not always the case). What Figure 2 exemplifies is that resources such as knowledge and information in an industrialised modern society are deemed higher in the 'value chain' of resources and at the same time seems to be the most vulnerable, being dependent on a long array of resource inputs. Similarly, human resources are highly dependent on other renewable and non-renewable resources.

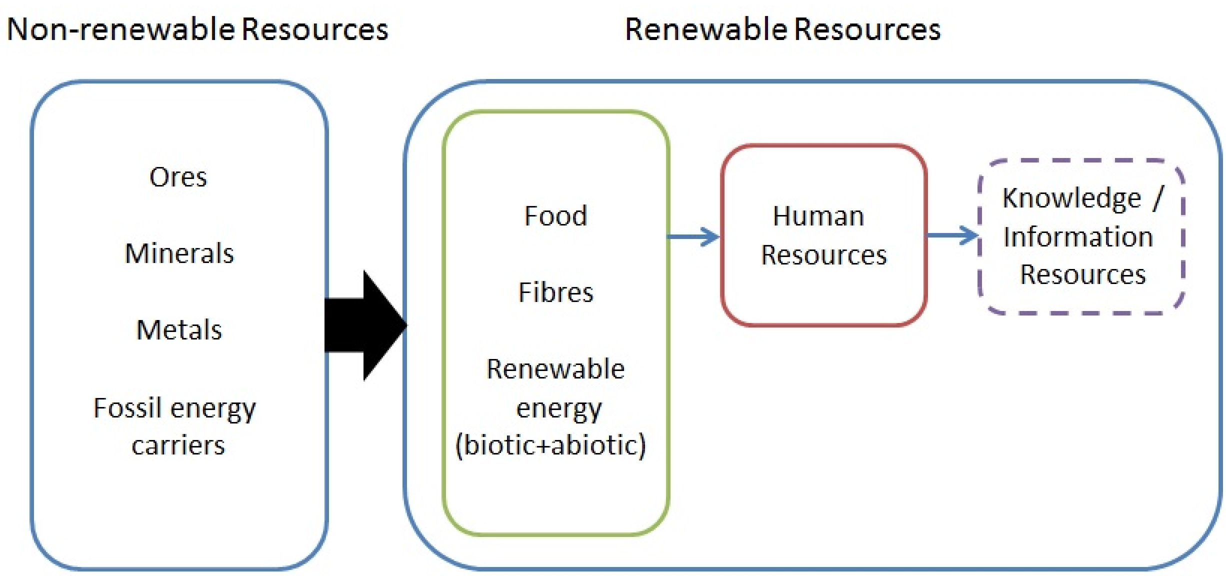


*Figure 2: Revised version of resource categories*

This representation of resources is also highly relevant for the REES programme which aims to devise resource efficient and effective solutions for the manufacturing sector in Sweden. In manufacturing, innovation and knowledge creation could be considered as driving forces for product development and economic growth and therefore could be viewed as the most precious of resources. Thus it is vital to sustain the chain of resources that support the creation and development of knowledge and human resources. This fact is also reflected in a recent European Commission report investigating the framework conditions for resource efficiency in business in EU-28. Among the top requirements for businesses to improve their resource efficiency, the access and utilisation of specialised knowledge and information was identified as being of critical importance (EC, 2015a).

Within the REES programme, solutions aiming at minimising the use of non-renewable resources would ideally be sought, while solutions that maximise the use of human and knowledge resources (R&D and services provision) should ideally be prioritised.

Lastly, it is worth mentioning that from an environmental protection perspective, there is a clear distinction between resource conservation, which implies a reduction in the absolute use of natural resources, and resource efficiency, which is the reduction of resources used per product or functional unit. In the following sections, the concepts of Resource Efficiency and Circular Economy will be presented along with a wide range of relevant strategies on the efficient use of resources.

## 2.2 Material Resource Efficiency

As identified in the previous section, material resources constitute the necessary building blocks of modern societies. The importance of resources in driving industrial economies and fulfilling the material demand of a rapidly growing population for its needs (and wants) is vividly illustrated by the ever-increasing consumption of resources. Nearly 68 billion metric tonnes of material resources (biomass, fossil energy carriers, ores and industrial minerals and construction minerals) were extracted in 2009, a figure which in comparison is almost ten times the amount of resources used in 1900 (Krausmann et al., 2009). Global per capita resource use is projected to increase from 8 tonnes in 2000 to 16 tonnes in 2050 (UNEP, 2011), while a sustainable per capita consumption of resources is estimated to be 8 tons (Mont et al., 2013). Essentially, product life spans have steadily declined in recent decades, thus increasing material flows through society (Bakker et al., 2014).

Despite the alarming rate of increasing material resource use, for most materials required in order to provide products, buildings, infrastructure, and all other types of equipment, the global stocks of material resources are still sufficient to meet anticipated demand for the foreseeable future (Allwood et al., 2011). However, increasing resource use might result in scarcities and push the limits for finite, non-renewable resources (Hirschnitz-Garbers et al., 2015). For instance, available high-grade reserves of economically relevant metals and minerals are expected to be at high supply risk around 2040 for phosphorus (Sverdrup et al., 2011), around 2050 for copper (Sverdrup et al., 2014), and as early as 2030 for zinc, tin, indium and silver (Sverdrup et al., 2013). The extraction of these resources, therefore, will remain economically viable for only a few decades.

Since the report ‘Limits to Growth’ in 1972 (Meadows et al., 1972), it seems that no considerable effort was made until the turn of the 20th century in the direction of conserving resources. The report presented possible scenarios for the future, aided by computer modelling simulation, and predicted in the ‘standard run’ scenario (something like a ‘Business-as-Usual scenario, with background assumption from the 1970’s) a global collapse before the middle of this century. Turner (2008) used historical data for 1970-2000 and concluded that the trends in resource use match very closely the simulated results of the ‘standard run’ scenario. This is an alarming discovery in terms of the trend in resource use at the global level. The last 15 years, however, has seen massive global awareness and policy efforts (e.g. EU, Japan, China) concerning the efficient use of resources, but still the results of these efforts are yet to be seen. Europe has reduced its Domestic Material Consumption (DMC) per capita, as seen in Figure 3, however the reasons behind this decrease need to be carefully analysed. The global economic crisis of 2008 might have an influential role to play in such a decrease, since the construction sector –being one of the most resource intensive– was particularly affected by the economic crisis.

Apart from impending resource scarcities, the environmental impacts of materials production and processing are rapidly becoming critical. Resource extraction and use is closely linked to emissions and waste generation, which contribute to the accumulation of adverse environmental impacts (Hashimoto et al., 2012). The global ecological footprint of human activities has increased from less than one planet Earth in 1961 to more than 1.4 planet Earths in 2005 (Galli et al., 2012) and is expected to grow further to two planet Earths around 2030 (Moore et al., 2012).

These environmental impacts can be mitigated to some extent by the ongoing activities for efficiency within existing processes, but since demand is anticipated to grow it will lead to the significant increase of overall impacts, unless the total requirement for material production and processing is reduced.

Consequently, Allwood et al. (2011) argue that this is the goal of material efficiency and drawing from that they propose a definition for material efficiency:

‘Material efficiency means providing material services with less material production and processing.’

In other words, what Allwood et al. (2011) propose is the reduction in materials (in physical units) and processing (by using less energy) of products while keeping the functionality (or the utility) of the product unchanged. This, however, constitutes a narrow definition of material resource efficiency, while UNEP (2010) suggests a broader and more inclusive definition of resource efficiency:

‘Resource efficiency is about ensuring that natural resources are produced, processed, and consumed in a more sustainable way, reducing the environmental impact from the consumption and production of products over their full life cycles. By producing more wellbeing with less material consumption, resource efficiency enhances the means to meet human needs while respecting the ecological carrying capacity of the earth.’

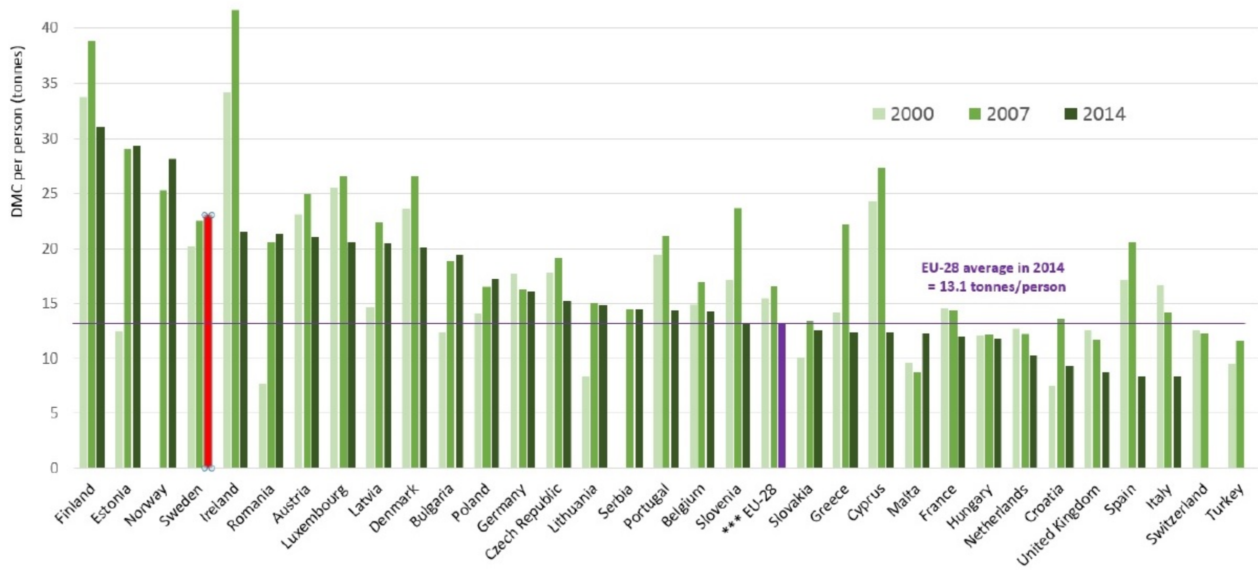


***Figure 3: Domestic Material Consumption per capita in EU-28 Member States in 2000, 2007 and 2014 (EEA, 2016)***

In the definition above, resource efficiency is identified in the full life cycle of a product addressing equally the materiality of a product, the environmental impacts of processes for resource extraction and production, as well as the final consumption. Lastly, it stresses the social and ecological aspects of using less material resources. Clearly, the consumption aspect of resource efficiency is missing from the Allwood et al. definition.

Furthermore, to reduce the adverse environmental impacts of excessive resource use, economic development should be ‘decoupled’ from the amount of resources consumed which, in turn, should be decoupled from the impacts that resource use exerts on the environment. The notion of ‘decoupling’ is an alternative, or rather complementary concept, to resource efficiency and is defined by UNEP (2011) as *‘using less resources per unit of economic output and reducing the environmental impact of any resources that are used or economic activities that are undertaken’*. Figure 4 presents graphically the two key aspects of decoupling, namely resource decoupling and impact decoupling.

Resource decoupling means reducing the rate of resource use per unit of economic activity. This is achieved through using less materials, energy, water and land resources for the same economic output. Resource decoupling leads to an increase in the efficiency with which resources are used. Such a decoupling can be expressed through increased resource productivity (usually expressed as the ratio

DMC/GDP), while it is also possible to demonstrate resource decoupling via comparing the gradient of economic output over time with the gradient of resource input.

Impact decoupling, by contrast, requires increasing economic output while reducing negative environmental impacts. Such impacts arise from the extraction of required resources, production processes, the use of commodities, and in the post-consumption phase (e.g. waste).

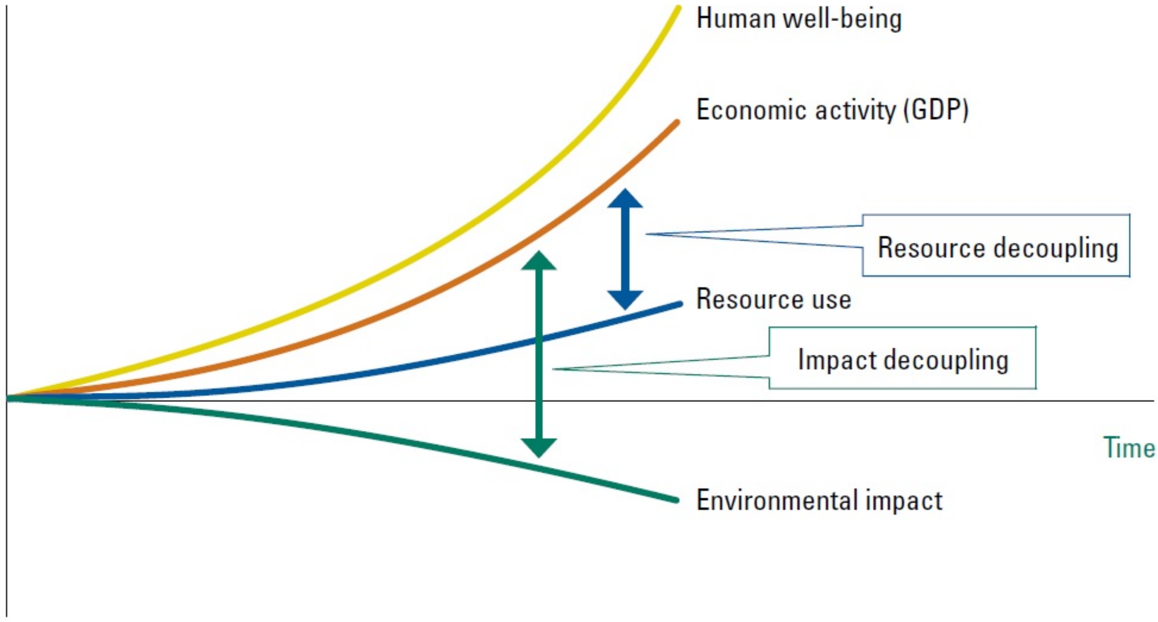


***Figure 4: Graphic representation of the concept of 'Decoupling' (UNEP, 2011)***

Additionally, a distinction can be made between 'relative' and 'absolute' decoupling. Relative decoupling of resources or impacts means that the growth rate of the environmentally relevant parameter (resources used or some measure of environmental impact) is lower than the growth rate of a relevant economic indicator (e.g. GDP). Such relative decoupling seems to be fairly common. With absolute decoupling, in contrast, resource use declines, irrespective of the growth rate of the economic driver (UNEP, 2011).

In Sweden, DMC is very strongly correlated to GDP (R2 = 0.63-0.85) confirming overall economy dependency on material resources. The material flows normalized by population were constant in Sweden, therefore the observed relative decoupling was achieved mostly due to GDP growth and especially in the service sector, which is less resource-intensive than the industrial sector (Kalmykova et al., 2015). DMC per capita is constantly increasing since 2000 as shown in Figure 3.

In order to elaborate on different approaches for material resource efficiency and strategies for achieving material resource efficiency, it is important to bear in mind that material resources can be measured in physical and monetary terms (see section 2.1). Therefore, this report aims to approach the aspects of material resource efficiency from a physical and economic perspective respectively.

### 2.2.1 Physical Resource Efficiency

Material efficiency refers to the anticipated low material input and the avoided associated environmental impacts that result from reducing the amount of engineered and processed materials used to produce one unit of economic output or to fulfil human needs in a broader sense. Allwood et al. (2011) suggested that the urgent need for increased material efficiency derives from the limited (economic) availability of natural resources and the environmental benefits of lower material use. They identified five major strategies for reducing material demand through material efficiency were identified (Allwood et al. 2011, 2013):

- Longer life, more intense use, repair and resale
- Product upgrade, modularity and remanufacturing
- Component reuse
- Using less material to provide the same service
- Yield improvements, reducing yield losses

By using an equation for expressing the total emissions associated with the production and processing of some material,[3] they derived a set of specific options for resource efficiency:

- Increasing the recycling rate of materials.
- Reducing new demand for products – this might be challenging if taken to mean impeding growth in developing countries, but could imply supporting a less materially intensive path to prosperity.
- Designing 'lightweight' products with less material input.
- Increasing the average lifespan of products – either by using products more intensely and for longer period of time, or by providing means to repair, upgrade or remanufacture products when discarded by their owners.
- Increasing the fraction of material supplied through reuse, in the case that emissions related to reuse are low, which is most often the case.

However, in the last two options, care should be taken concerning the environmental impacts of increasing the lifetime of certain products through repair, refurbishment, remanufacturing and reuse, as some cases have shown opposite effects (Gutowski et al. 2011). For example, in a case study in the UK, refurbishing a C-rated washing machine and using it for additional 9 years could save 220 000 tonnes of $CO_2e$ per year, compared to replacing it immediately by a new A-rated washing machine (WRAP, 2010).

The two middle options, 'reducing demand' and 'lightweighting' are obviously the most effective in reducing material use, but at the same time they are the most unlikely to be adopted as priority resource efficiency options.

The most common resource efficiency option, which is the one that is heavily promoted by related legislation, and in the case of EU with rather stringent legislation, is the option of 'recycling'. However, there are several operational challenges embedded in strategies for recycling. Allwood at al. (2011) indicate that high uncertainty over the availability of recycled material (in several waste streams) requires that large stocks of recycled materials exist in order to match the supply with demand in an open market for recyclables. The logistics and infrastructure for material collection and sorting is complex and highly specialised by waste stream. The time delay between production and disposal creates inefficiencies as demand for goods is growing faster and represents the sum of replacement and new demand, while the supply of recycled material cannot match this increasing demand. The issue of existing large stocks of readily available materials for recycling is also raised by Ayres (1999) who argues for the possibility of total recycling but only with two pre-conditions, that (1) there must be a large stockpile of inactive materials as well as (2) an exogenous source of energy (e.g. solar) for a stable steady-state recycling system to be able to function in an industrial society.

### 2.2.2 Economic Resource Efficiency

The physical dimension of material resources is undeniably linked to human economic activities and as such, material resources adopt an additional dimension – the economic value of resources. There is a strong correlation between economic growth and the consumption of energy and materials, as well as the gradual depletion of easy-access resources such as topsoil, land, freshwater, fossil fuels and other minerals

[3] by analogy with the Kaya identity, see, (Allwood et al., 2011) for details

(von Weiszäcker and Ayres, 2013). On the other hand, taking into account that planet Earth is a closed finite system with a certain amount of non-renewable resources, it is apparent that material resources should be managed in such a way that the future yield does not get compromised and that the future generations will not be worse off. In this manner, material resources can be viewed as a 'bank account' where the capital (deposited amount) remains constant in time in order to generate a steady supply of interest for humans to live on (Andersen, 2007). Therefore, the aspect of economic resource efficiency in modern industrialised societies becomes increasingly relevant (if not more relevant than the physical aspect of resource efficiency).

Allwood et al. (2013) noted that the word 'efficiency' always refers to a ratio, but taking into account the fact that there have been several definitions of such a ratio, it is likely to create confusion especially when examining the economic implications of strategies aiming at material resource efficiency. In economics, the most commonly used denominator for measures of efficiency is a monetary value (money at certain currency relevant to the area of study), reflecting the amount of material that is required to deliver each monetary unit of revenue or gross domestic product (GDP). Therefore, material use and the availability of material resources in manufacturing processes becomes a function of an economic parameter such as GDP (Allwood et al., 2013).

The intuitive notion of 'resource scarcity' can be quite misleading, as the critical factor which renders a resource as 'scarce' or 'rare' is whether the price of the resource is increasing over time, or not (von Weiszäcker and Ayres, 2013). Historically, increasing prices are perceived to indicate scarcity of a resource, while on the other hand declining prices imply that resources are in abundance. In contrast to the physical approach to resource efficiency Söderholm and Tilton (2012) argue that concerns over potential future resource scarcities do not represent a strong motive for introducing policies aiming to foster greater material efficiency, but that environmental externalities and information failures in the relevant material markets do. The role of the markets is fundamental in signalling such scarcities, while the role of public policy is to make sure that existing prices reflect all costs to society and that the market mechanisms provide appropriate incentives for resource efficiency and for preventing the aforementioned scarcities. Furthermore, increased material efficiency does not represent a desirable end in itself while policy measures that promote material efficiency are not necessarily expected to be economically efficient (Söderholm and Tilton, 2012).

Baptist and Hepburn (2013) state that engineers and scientists tend to define 'materials' in different ways than economists do. Physical inputs such as iron ore and steel, often measured in units of mass, are considered as material resources by engineers. In contrast, economists do not usually differentiate between 'material' in itself and other intermediate inputs to production processes, partly because it is difficult to distinguish 'raw' materials from other processed physical components. Notably, the approach of many engineers and scientists is that they often consider depletion to be related to a deterioration of a fixed stock of resources. However, according to the economic perspective, the focus is put on economic rather than physical depletion. There is a realisation that resource depletion is a threat in the long run but not the short run, and that depletion can affect renewable as well as non-renewable resources (Söderholm and Tilton, 2012).

At this point, it would be highly relevant to address the issue of 'opportunity cost' as it becomes rather useful in understanding the economic aspect of resource efficiency. The perception of resource depletion focuses on what society would be required to give up – usually measured in terms of real prices – to acquire one more unit of a given resource (Söderholm and Tilton, 2012). For instance, presumably the real price of copper increases over the long run. Then society would have to give up more of other economic activities in order to obtain another unit of copper and as such copper is becoming scarcer or less available. Under the opportunity cost paradigm, resource depletion can push production costs and prices up as society is forced to exploit poorer quality and thus more costly sources of supply. If prices rise to uneconomic levels then the demand in the various end-uses of a given resource will start diminishing and ultimately fall to zero, or put in other words the total demand for the given resource will practically cease. As resources become uneconomic (i.e., at prohibitive high costs), they may remain unexploited but not depleted. Consequently, the economic depletion of material resources occurs before, probably long before, physical depletion becomes imminent.

Coming back to the relation of resource efficiency to economic utilisation of resources, UNEP (2011) notes that the vision set out most commonly by policy makers is that of reducing the resource intensity of GDP so that the GDP can grow indefinitely in a finite material world. However, there is an inherent conflict in this proposition since resource efficiency tends to reduce prices and thus primarily impact negatively economic values and the GDP. In practice, efficiency gains are often offset by secondary effects, also known as rebound effects (Sorrel, 2009).

As van den Bergh (2011) noted, when the price of resources is high, the rebound effect is observed to be rather weak. Consequently, it seems that resource prices are one of the most important factors of steering the direction of the economy, and that an artificial signal of rising resource prices could greatly influence the stabilisation or even induce reductions in the consumption of natural resources and perhaps tackling the rebound effect without seriously affecting economic growth (Malmaeus, 2016). However, there is abundant empirical evidence that high resource prices tend to lead to an economic slowdown. Malmaeus (2016) provides the example of Japan and the phenomenon of 'stagflation' during the time of high energy prices (1974–1983). Japan, being highly dependent on energy imports had much higher domestic energy prices during that time and therefore suffered no stagflation while it succeeded to perform extremely well under such pressure, as domestic industry developed innovative energy efficient technologies. From the Japanese and some other experiences, it can be suggested that a strategy of purposefully increasing resource prices could be considered as a strategy for material resource efficiency and it should not be excluded from the arsenal of environmental policy interventions.

Technical innovations or efficiency gains which result in increasing product utility (extended use and service proposition) without significantly affecting the costs of production do not add to GDP volume, unless they stimulate investments in physical capital. Therefore, the neo-classical notion of productivity is found to be relevant only as a micro-economic concept. In practice, GDP growth is mostly explained by capital throughput and accumulation and a key question is whether capital accumulation can be decoupled from the use of materials and energy or not. Although immaterial capital may also contributes (in the form of immaterial services provision), physical capital has historically been the most important form of value creation, and a strong relationship between capital and energy use remains likely to continue in the future (Malmaeus, 2016).

## 2.3 Circular Economy

The concept of Circular Economy has only recently come widely into prominence within the public debate in Europe, as a policy concept that should be targeted holistically by the European Union, and the Member States respectively, at different levels of sectoral and geographical configurations. Instrumental in popularising the concept during the last few years in Europe has been the Ellen MacArthur Foundation, a non-for-profit think tank that was formed in 2010, which holds as founding principle that the Circular Economy provides a coherent framework for systems level redesign and as such offers an opportunity to harness innovation and creativity to enable a positive, restorative economy (Ellen McArthur Foundation, 2012).

Therefore, as Murray et al. (2015) suggest, the Circular Economy represents the most recent attempt to conceptualise the integration of economic activity and environmental and resource concerns in a sustainable way. Despite the fact that the Circular Economy has been growing (though slowly) as a political and particularly a business vision in recent years, there is yet little formal academic debate about its conceptual development within the policy, business and sustainability literature. According to Murray et al. (2015) the Circular Economy as a concept has largely emerged from legislation, e.g. the Japanese Sound Materials Cycle Strategy and China's Circular Economy Strategy, rather than from a group of academics who have started a new research field, such as for example Ecological Economics that sprouted from the Environmental Economics, as described by Røpke (2004; 2005). This may explain why the Circular Economy has not yet been scrutinised adequately in relevant academic journals. So far there are no appropriate channels of academic debate around this emerging concept (Murray et al., 2015).

The most widely used definition of a Circular Economy is the one that was formulated by the Ellen MacArthur Foundation. Academics offer no concerted effort to define the concept of Circular Economy, with few exceptions (e.g. Murray et al., 2015).

The basic concept of a Circular Economy reflects a model of production and consumption systems that rely primarily on the continuous reuse, recycling and recovery of natural resources. According to the widely used Ellen McArthur Foundation definition a Circular Economy is *'an industrial system that is restorative or regenerative by intention and design. It replaces the end-of-life concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models'* (Ellen McArthur Foundation 2012). In short, what becomes apparent from this definition is that the business case of the model is based on keeping natural resources in the economy for as long as possible while retaining their economic value and technical properties.

Another definition, with higher policy significance, can be found in the first few lines of the recent Circular Economy Action Plan of the European Commission entitled 'Closing the loop - An EU action plan for the Circular Economy' (COM(2015) 614/2). Although there is no clearly stated 'official' definition of the concept, the understanding of the European Commission regarding the concept of the Circular Economy can be deciphered by these words *'[…] circular economy, where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimised.'*

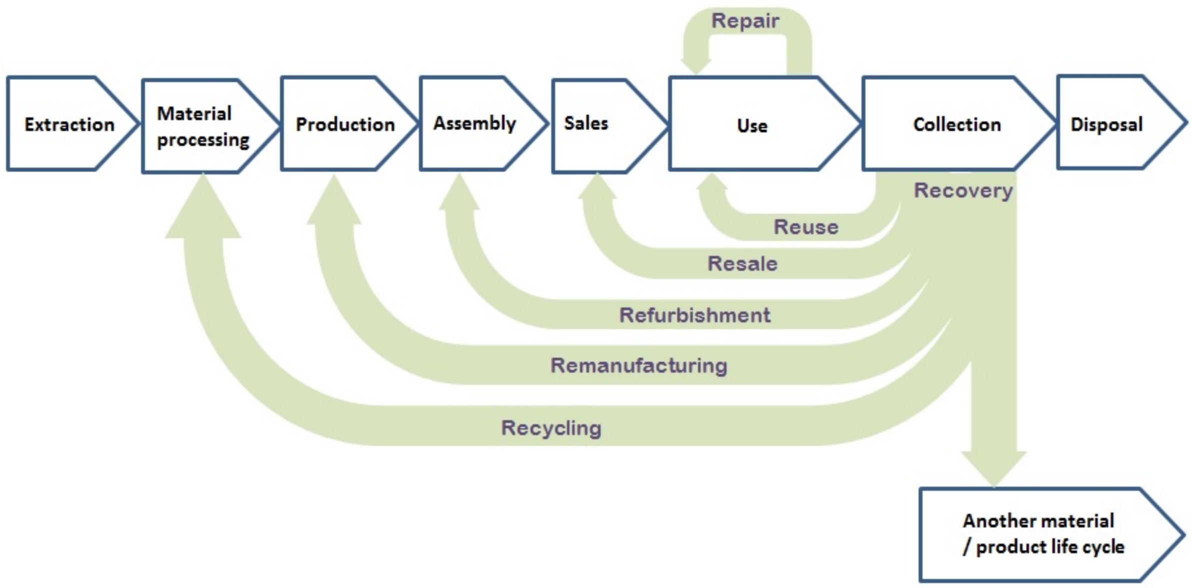


***Figure 5: Graphic representation of Circular Economy key elements throughout a product life cycle***

From the environmental economics perspective, Andersen (2007) points out that a Circular Economy is based on a material balance principle, which implies that all material flows in the economy would need to be accounted for. However it will be the economic value of the materials and not their physical flows that will guide the principles of their efficient management in the economy.

Taking into account all the above, there is a need for a deep transformation of production chains and consumption patterns in order to fulfil the principles of a Circular Economy. Although there are some elements of circularity, e.g. recycling and composting, in the current 'linear' economic system, progress in which needs to be maintained and scaled up, a Circular Economy goes beyond the mere pursuit of waste prevention and waste minimisation strategies into various technological, organisational and social innovations of circular material flows that span within and across value chains.

A Circular Economy would require producers (e.g. manufacturers and their component suppliers, retailers etc.) to adopt 'take-back' schemes for used goods and incorporate reconditioning and remanufacturing within their business operations. Furthermore, producers would need to create linkages with other firms specialising in such activities, but also to redesign goods as stocks and consumption as an activity grounded in leasing and temporary use, rather than ownership and permanent possession of goods (Gregson et al., 2015). As Stahel emphasises, a Circular Economy is about stock optimisation and not the continuous production of goods and the use of new material resources (Stahel 2016). It is rather a continuous effort to turn goods that are at the end of their service life into resources for other purposes, closing loops in industrial ecosystems and minimising waste. The concept of Circular Economy therefore would change the economic logic as it replaces production with material sufficiency where the aim is '*to reuse what you can, recycle what cannot be reused, repair what is broken, remanufacture what cannot be repaired'* Stahel (2016). The Circular Economy promotes the production of goods through closed loop material flows. This should create economic incentives to ensure that post-consumption products get reintegrated into the manufacturing process (Sauvé et al., 2016). However, in the current global economic system businesses face significant challenges to adopt Circular Economy principles (see section 4.1 for barriers to Resource Efficiency), as they are structurally 'locked in' to a system where profits are directly linked to the volume of sales of material goods (Røpke, 1999).

The most crucial problem in the current business environment at the market economy is its persistent failure to internalise the environmental and social costs associated with the production of products. Therefore there is a need for a new model of economic development that can ensure continued prosperity and at the same time stabilisation or reduction of environmental and social impacts (Sanne, 2002).

The transformative process towards a Circular Economy and the required changes in production and consumption systems need to be accompanied by the development of new and competitive business models (Planing, 2015). This process, however, will result in unavoidable transition costs. There would be high costs for restructuring in business with a considerable risk of producing several stranded assets which have been instrumental in the production and consumption systems of a 'linear' take-make-dispose economy. Thus, the transition to Circular Economy will inevitably create winners and losers (EEA, 2016a).

Transforming production and consumption is a task that requires mutual learning and cross-fertilisation between sectors and relevant actors in the society. Because of its overarching and holistic nature, the Circular Economy has to be implemented at multiple levels. Therefore, increased cooperation and constant communication between government, civil society and private economic actors is considered necessary (Stahel, 2013). However, there is a general lack of knowledge about Circular Economy among the actors in society. To overcome this general lack of knowledge, Stahel (2013) exemplifies a set of principles that would apply in a Circular Economy:

- The smaller the loop (activity-wise and geographically) the more profitable and resource efficient it is.
- Loops have no beginning and no end, therefore materials constantly circulate in the economy and feed into new production processes, virtually eliminating waste
- Maintaining the value, quality and performance of goods through stock management replaces the concept of value added in the linear economy.
- The speed of the circular flows is crucial, as the efficiency of managing stock in the Circular Economy increases with a decreasing flow speed.
- Expanding ownership is cost-efficient: reuse, repair and remanufacture without a change of ownership saves on double, triple etc. transaction costs.
- A Circular Economy needs functioning markets.

Similar principles have also been popularised by the Ellen MacArthur Foundation. They help shape strategic thinking of the relevant actors in designing their circular operations (Ellen MacArthur Foundation, 2012):

- Minimisation of material use in the production of a product from virgin material resources at the design and production phase and the use of products for as long as possible.
- Maximising the number of secondary use cycles of primary products, enabling extensive product reuse, repair and remanufacturing for as many times as possible.
- Using products in cascades, so in case the product loses its original purpose it can be used in other lower demanding (or low quality) uses.
- Keeping material cycles pure, avoiding the use of toxic chemicals and other composite/integrated materials in order to facilitate easier reuse and recycling of separate and clean materials of high quality.

The conceptual message of Circular Economy, as outlined by the above principles, is a very powerful message based on reducing wasteful processes and saving resources through effective design and circular thinking involving recovery, reuse, recycling and remanufacturing of products. The Circular Economy thus becomes not only an option, but it is regarded as inevitable for continuing economic prosperity and ecological balance to maintain human life and economic growth (Jawahir and Bradley, 2016). However, Jawahir and Bradley (2016) argue that this emerging concept, although gaining attention, lacks a technological perspective for effective implementation. According to Murray et al. (2015) the concept is also currently missing a social dimension, concentrating primarily on the redesign of manufacturing and service systems in relation to preserving resources and mitigating adverse effects in the biosphere. It is not explicitly mentioned at the moment that the concept of Circular Economy aims to promote greater social equality, apart from its job creation potential. Murray et al. (2015) proposes a definition, including an additional dimension related to the social axis of sustainability: *'The Circular Economy is an economic model wherein planning, resourcing, procurement, production and reprocessing are designed and managed, as both process and output, to maximize ecosystem functioning and human well-being.'*

Finally, despite the growing interest in the link between resource efficiency and competitiveness, the term Circular Economy has been applied inconsistently by governments and companies, while awareness of the concept is still relatively low (Preston, 2012). Developing a common understanding of the concept of Circular Economy and its constituent components would enable a wider uptake, encourage cooperation and avoid confusion in future application of the concept by businesses and governments alike. The only documented approach to providing a comprehensive framework for the Circular Economy has been identified in the contribution of Lieder and Rashid (2016), who present a pyramid relationship for CE (Figure 6) based on three interrelated perspectives:

- ***Economic benefits in CE*****:** Each individual company aims at maximising economic benefits in order to secure profitability and a competitive edge. This requires an integrative approach, including business models, product design, supply chains and choice of materials.
- ***Resource scarcity in CE*****:** Social prosperity depends on planet earth's finite resource supplies. Within this context circularity of resources, material criticality and volatility are considered crucial, especially under the light of increased global manufacturing activities.
- ***Environmental impact in CE*****:** Reduced environmental impacts are a desirable condition for societies around the world. CE aims at reducing waste and emissions through activities such as reuse, remanufacturing and/or recycling.

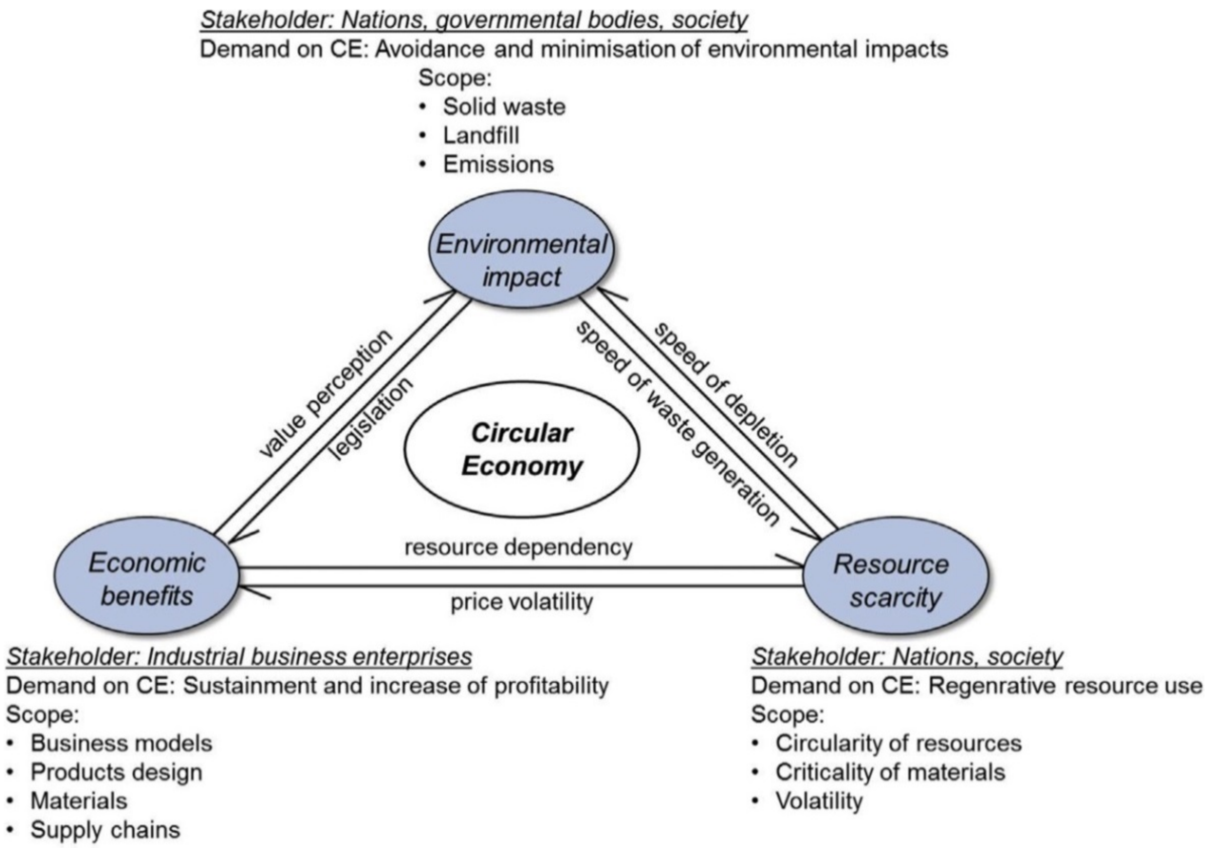


*Figure 6: A comprehensive Circular Economy Framework (Lieder and Rashid, 2016)*

### 2.3.1 Origins of Circular Economy thinking and its related concepts

The origin of the term Circular Economy itself is largely debated (Murray et al., 2015) and can be traced back more than half a century to a conception which resembles the contemporary general idea of a Circular Economy. The idea of a circular system (similar to what is considered today a Circular Economy) in manufacturing processes certainly existed long before, along the lines of efficient manufacturing in the early days of industrialism, and an example of this can be demonstrated as early as 1848, when Hofman, the first President of the British Royal Society of Chemistry, stated *'…in an ideal chemical factory there is, strictly speaking, no waste but only products. The better a real factory makes use of its waste, the closer it gets to its ideal, the bigger is the profit'* (Lancaster, 2002).

However, an increasing number of recent literature on the subject of Circular Economy (Andrews, 2015; George et al., 2015; Ghisellini et al., 2016; Gregson et al., 2015; Lieder and Rashid, 2016; Murray et al., 2015; Sauvé et al., 2016) mentions two critical points in academic publishing that shaped the term Circular Economy and framed its conception. These two main contributions mentioned above refer to Boulding's *'The economy of the coming spaceship earth'* (1966) and Pearce and Turner's *'Economics of Natural Resources and the Environment'* (1990).

Elements critical in the concept of Circular Economy were portrayed extensively in Boulding's 'spaceship economy' in which he described Earth as a spaceship *'without unlimited reservoirs of anything, either for extraction or for pollution'* (Boulding, 1966). He argued for a new economic model – one modelled after a circular, closed-cycle system – and the requirement of a new 'circular relationship' with the world, if human was to survive on Earth (Boulding, 1966). Boulding expressed a number of principles that play a vital role in the development of such a 'spaceship economy':

- production and consumption (throughput) should be minimised

- success is measured by the state and utility of total capital stock, not throughput
- stock maintenance should be prioritised over other economic activities
- technologies resulting in less throughput in the economy should be encouraged
- human health and well-being forms an integral part of the economy

However, despite the inspirational conception of an alternative economic system that takes into account the finite resources of the Earth, the term Circular Economy was not formulated by Boulding but much later, in 1990, by Pearce and Turner (1990) trying to model an economy applying a materials balance perspective which follows the first and second law of thermodynamics. In their book *'Economics of Natural Resources and the Environment'* they presented environment-economy interactions and discussed the implications of ignoring the environment in economics, suggesting that a linear system is the result of ignoring the environment. Their concept of a Circular Economy (referred as a materials balance model) is one in which *'the economy and environment are not characterized by linear interlinkages, but by a circular relationship. Everything is an input into everything else. Simply saying that the end purpose of the economy is to create utility, and to organize the economy accordingly, is to ignore the fact that, ultimately anyway, a closed system sets limits, or boundaries, to what can be done by way of achieving that utility'* (Pearce and Turner, 1990).

Pearce and Turner (1990), claim that the term Circular Economy was first used in western literature in the 1980's to describe a closed system of economy-environment interactions. However, it was Walter Stahel and Genevieve Reday-Mulvey who first referred to a closed-loop economy in a report to the European Commission for job creation, later published as a book (Stahel and Reday-Mulvey, 1981). Furthermore, they proposed that materials should ideally be processed in a 'closed loop' and that 'waste' would return back in the process as a resource. Stahel defined this as a 'Cradle-to-Cradle'. Then, identified the need to extend product life through repair and remanufacture (Stahel and Reday-Mulvey, 1981), which is also now seen as integral to the Circular Economy. Stahel's idea of increased product durability was actually drawn directly from Boulding (1966, p. 12) who wrote: *'I suspect that we have underestimated, even in our spendthrift society, the gains of increased durability'*.

Cradle-to-Cradle has been adopted also as a design method by William McDonough and Michael Braungart who state that it facilitates *'design for abundance'* (McDonough and Braungart, 2002) and as a consequence of which they developed the C2C benchmark to endorse and promote products that meet this standard (Andrews, 2015).

Moreover, Circular Economy encompasses and builds upon a number of complementary approaches, including eco-design (Dalhammar, 2015), lean manufacturing (Nakajima, 2000), waste-to-resources (Kama, 2015), industrial ecology (Erkman, 1997), industrial symbiosis (Ehrenfeld and Gertler, 1997), cradle-to-cradle (Stahel and Reday-Mulvey, 1981), dematerialisation (Andrews, 2015), sustainable consumption (Mont and Heiskanen, 2015), functional economy (Stahel, 1997), and product-service systems (Tukker, 2015).

The term Circular Economy has therefore been linked with a range of meanings and associations by different authors, but what they generally have in common is the concept of cyclical closed-loop system. The decoupling of environmental resources from economic growth is a key reoccurring concept (Sauvé et al., 2016).

Although the concept of Circular Economy is not new, what is new is the momentum that the concept is gaining among business practitioners (Ellen MacArthur Foundation, 2015), policy advocates (Preston, 2012), and educators (Webster, 2013). Further, the concept is being adopted by governments in both Europe (Bonciu, 2014) and East Asian countries, such as China, Korea and Japan (Aoki-Suzuki, 2015; EC, 2014; Geng and Doberstein, 2008).

### 2.3.2 Implementation of Circular Economy strategies

The concept of Circular Economy proved to be hard to define in absolute terms and one generally accepted and agreed upon definition still lacks in academic and policy circles, as discussed above. Furthermore, there is a wide variety of relevant concepts that touch upon the principles of Circular Economy, but it is not entirely clear whether they are fully integrated components of such an economic system or could play a complementary/auxiliary role in promoting higher resource efficiency in the economy, without being necessarily 'circular' solutions. These approaches on the essence of Circular Economy will be discussed in this and the following sections.

First attempts to incorporate some elements of Circular Economy into policy considerations can be traced to the 1980s and 1990s in German and Japanese policy, largely influenced by the intriguing and then 'new' concept of the closed-loop economy, as presented in the Spaceship Earth analogy of Boulding (1966), and later developed by Stahel and Reday-Mulvey (1981) (Triebswetter and Hitchens 2005; Moriguchi, 2007). These policies, in turn, inspired China to devise the Circular Economy as its major framework for industrial development, delivering increased economic growth with decreased environmental impacts (Murray et al., 2015). The European Union has been processing a variety of strategies and roadmaps concerning greater resource efficiency over the last 10 years, but a strategy dedicated to Circular Economy made its appearance only in 2014, in the form of a EC Communication entitled 'Towards a circular economy: A zero waste programme for Europe' (COM(2014) 398 final). The programme was criticised as unambitious and another plan for a Circular Economy in EU was presented in December 2015, entitled 'Closing the loop – An EU action plan for the Circular Economy' (COM(2015) 614). In the Americas, there is apparently an absence of policy interventions aiming for a Circular Economy, while in general the implementation of Circular Economy worldwide seems to be at the early stages, mainly focusing on recycling rather than reuse, repair and remanufacturing (Ghisellini et al., 2016).

The application of the concept in China, Japan and Europe seems to have taken a slightly different approach, but still has been firmly rooted in the basic principles of Industrial Ecology and the idea of considering the benefits of CE mainly in physical terms rather than monetary flows (Andersen, 2007; Mathews and Tan, 2011).

For example, the main focus in the EU has been heavily put on policies promoting efficient and effective waste management, aiming at increasing recycling rates in Europe and potentially harnessing the benefits of higher resource circulation in the economy. However the latter part was not directly foreseen by the policies in place but rather expected to come indirectly as a result from the policy implementation. Notably, the first EU strategy on Circular Economy, which was hastily withdrawn, had a particular focus on improving the waste regulation framework while other very important aspects of the Circular Economy (such as design, financing and consumption) received disproportionately little attention, compared to waste management. However, the recent action plan for Circular Economy in EU 'Closing the loop – An EU action plan for the Circular Economy' (COM(2015) 614) refers extensively to the fact that policy interventions are needed throughout the entire life cycle of products/services. The action plan treats specific areas of production, consumption, waste management, enabling market conditions and innovation in equal terms recognising the significance of each step in the value chain.

On the other hand, policies in China were layered in different levels of industrial/societal systems and resemble more closely Industrial Symbiosis and Industrial Ecology systems. Such approaches were used on the micro-level (company or single consumer level), the meso-level (e.g. eco-industrial parks) and the macro-level (cities, provinces and regions) (Feng and Yan, 2007). The literature points out that all other countries, except China, present cases of application of CE at a single level only, most often the meso-level (Ghisellini et al., 2016).

The adoption of Circular Economy aspects in policies so far have succeeded in preventing the loss of valuable materials and at the same time enabled the reduction of waste management costs for municipalities (e.g. see Geng et al., 2010) and of externalities in the society (lower pollution), while creating new jobs opportunities and increasing welfare for low income households (Castellani et al., 2015). This is because reuse, repair and remanufacturing activities are labour intensive instead of resource intensive as in the present linear model of production and consumption (Stahel, 2013). In turn, a decreasing dependence on natural resources, in particular non-renewables, translates to a lower exposure of the economy to the negative effects of resource prices shocks (Preston, 2012).

However, Lieder and Rashid (2016) suggest that the Circular Economy has evolved primarily towards systemic intervention on waste prevention/minimisation, resource use and environmental impact, neglecting business and economic perspectives. This neglect, they argue, poses the risk of inhibiting CE implementation since advantages for industry are inexplicit. Despite existing success stories of circular system implementation in industry, a large scale implementation of CE would require a radical change in the way businesses operate and commitment from higher management in industry (Lieder and Rashid, 2016).

Finally, Stahel (2013) argues that CE has not yet reached any wide implementation stage, because policymakers and economic actors know neither the basic principles of CE, nor their impact on the economy. Therefore Stahel urges all relevant stakeholders to engage in deeper cooperation structures in order to promote CE.

### 2.3.3 Conflicts and misconceptions about the Circular Economy

In the previous sections, the overview on Circular Economy as a theoretical concept as well as its practical implementation raises a number of questions about what could be considered an integral component of CE and how it can be expressed in reality – in business and policy considerations.

Recently published extensive literature reviews on the concept, see among others e.g. see (Ghisellini et al., 2016; Lieder and Rashid, 2016), have revealed interesting insights concerning the extent to which Circular Economy is applied in practice and what is considered to be a part of the Circular Economy and what not. Although, maintaining the value of products as long as possible in the economy (the inner circles of 'reuse, repair and remanufacturing') and expanding the ownership (and consequently the subsequent use) of a product through increased utilisation (the so-called functional economy or product-service systems), are considered highly desirable strategies of the Circular Economy (see section 2.3), Ghisellini et al. (2016) fail to account for the potential of these strategies in their review article, as a part of CE in the cases they studied. Lieder and Rashid (2016) only very briefly mention the terms 'functional economy', 'Product-Service System' (PSS) and there is no mentioning at all of the newest concept entering the field of resource efficient use of assets, the 'collaborative economy' (or 'sharing economy'). Taking this into account, the CE concept needs to be expanded to capitalise on resource efficient strategies the aforementioned approaches may offer.

Moreover, there is an apparent etymological inconsistency when talking about the ***Circular Economy*** and concepts such as PSS and 'sharing economy'. The word *circular* implies the cyclical movement of resources in the economy from one function to another, without (significant) degradation, feeding the following processes in the chain and rematerialising from one product to another. At least, this is the literal conception of the term. Therefore, the 'sharing economy' and the PSS concept seem to be void of the cyclical interpretation of the term Circular Economy, although a significant distinction between the two can be identified. This distinction is primarily related to the ownership and the management of the product or service. In PSS, the ownership is typically attributed to some producer or service provider (Mont, O. K., 2002), which takes the responsibility for designing a system that optimises the resource use, and consequently is responsible for the maintenance and end-of-life management of the product as well. On the other hand, in the 'sharing economy' the distinction between user and provider is much more unclear. Furthermore, producers often find themselves outside the use cycles of the 'sharing economy' and therefore it becomes difficult to say that the use of the product or service would be optimally designed and that the physical components in the system (products) would be responsibly managed at the end-of-life. This will be discussed also later, after the brief presentation of the aforementioned concepts and their relation to the Circular Economy.

Product-service systems (PSS) are defined as 'a mix of tangible products and intangible services designed and combined so that they are jointly capable of fulfilling final customer needs' (Tukker and Tischner, 2006). It is further argued by the authors that an increase in service orientation, rather than product orientation, will facilitate the design of systems with significantly lower environmental impacts while maintaining economic prosperity. In this way, PSS may substitute the traditional materially intensive ways of production and product utilisation by the possibility to fulfil consumers' needs through the provision of increasingly dematerialised services, which is often associated with changes in the ownership structure (Mont, O. K., 2002). Product-service systems are in effect an approach to designing integrated products and services with a focus on both customer and product life cycle activities (Tan et al., 2010). Several types of PSS have been identified in literature (Tukker, 2015):

- product-oriented services, which are centred on product sales, including additional services such as maintenance and take-back agreements
- user-oriented services, which are based on product leases, rentals, sharing and pooling
- result-oriented services, which provide specific desired outcomes of a service

Ultimately, PSSs aim at minimising environmental impact of consumption by (Mont, O. K., 2002):

- closing material cycles
- reducing consumption through alternative product use
- increasing overall resource productivity and dematerialisation
- providing system solutions by optimising system elements and improving the resource and functional efficiency of each element of PSS

Thus, it becomes apparent that the two concepts (PSS and CE) share some common elements but do not identify entirely with each other. Aspects of material cycles, resource efficiency, system optimisation and dematerialisation form common grounds between the concepts, but reducing levels of consumption is not something that is explicitly professed by any CE principle. Moreover, the Circular Economy in the policy sphere is considered as an 'alternative growth discourse' to the linear economy and not as an 'alternative to growth discourse' similar to the economic orientation of degrowth (Demaria et al., 2013; Kallis, 2011) and steady state economics (Daly, 2007). As such CE is not targeting the decrease of consumption levels, which may negatively affect economic growth.

Nevertheless, Pangburn and Stavrulaki (2014) showed that compared to selling of products, leasing provides a far greater incentive to raise durability, and thus increasing the intensity of product use in time and space. However, users of PSS need to be located within a certain community or location (e.g. big cities) or should be part of a larger network for easy access to such systems (Preston, 2012).

From what is presented above, there is definitely a valid ground for incorporating PSS into the Circular Economy paradigm and re-introducing PSS as one of vital Circular Economy strategies (or business models) that can contribute to efficient and effective use of resources, reducing the demand for natural resource extraction and the associated environmental and social impacts.

Another concept missing from literature about the Circular Economy is the 'sharing economy' or otherwise known as 'collaborative consumption' (extensive literature is emerging in the field). This area is more related to sharing of resources between users and not so much to establishing relations between businesses and users. The 'sharing economy' is an emerging and dynamic economic activity and there are almost no legal rules governing the 'sharing economy'.

In academic circles the 'sharing economy' is discussed as having some potential for efficient use of resources. Being in an infancy state of scientific research, a homogenous basic understanding of the approach towards the 'sharing economy' is still missing. Richter et al. (2015) present a set of definitions to the concept and try to identify common elements and derive relevant categorisations. The 'sharing economy' is defined as '*An economic model based on sharing underutilised assets from spaces to skills to stuff for monetary or non-monetary benefits'* (Botsman, 2013: n.p.) or *'Sharing economy, also known as* *collaborative consumption, is a trending business concept that highlights the ability (and perhaps the preference) for individuals to rent or borrow goods rather than buy and own them.'* (Rouse, 2013: n.p.). Through the sparse (and mainly non-academic) literature on the concept, three dimensions of the 'sharing economy' are identified (Richter et al., 2015):

- sharing of digital content
- sharing of physical goods
- participation in commercial, cultural and social projects

The first point is related to dematerialisation while the second point is directly related to PSS, albeit in a different setting ambiguously defined and involving the use of digital or other communication platforms. The last point above is entirely out of scope of a Circular Economy.

The confusion around these concepts and their relation to the Circular Economy is becoming even more apparent when one of the main brains behind the development of CE from the start, Walter Stahel, is coming to contest these concepts and introduce another dimension. According to Stahel (2016), these forms of product offering into the economy go a step further than what the Circular Economy is about, in what Stahel names the 'performance economy'. Stahel (2016) distinguishes three kinds of industrial economy: linear, circular and performance. So the question remains: Do sharing and collaborative consumption and product-service systems (PSS) form part of the Circular Economy paradigm or constitute other elements, aiming at resource efficiency through use intensity and not by recirculating resources? However, the difference lies in the fact that while in PSS, the business providing the offering is responsible for maintaining functionality by durable design, maintenance, repair and remanufacturing, a 'sharing economy' platform this is not usually the case. In times of rising resource prices, corporations retaining ownership of their goods and embedded resources over the full life of their products would gain a high future resource security and resource price guarantee and a competitive cost advantage against throughput-based competitors (Stahel, 2013). On the other hand, in the 'sharing economy', products and services are shared between users but the end-of-life of these products is not prescribed by the offering, and as such consumption of resources for optimising the shared use of the product or service might increase rather than decrease. Several such cases have been observed in the 'sharing economy' with examples like Uber and AirBnB where new product and new capacity is created instead of utilising idle capacity, as in the definition of the 'sharing economy'. Moreover, aesthetic investments (investing in improving the appearance and attractiveness of the offering), that will attract 'users' of the service and therefore revenue to the supplier, increase the resource use embedded in the product or service. Thus, the 'sharing economy' might not always drive resource efficiency and use optimisation, and results in the opposite direction. As a result, the concept of 'sharing economy' should be used carefully in relation to CE as it does not entirely fulfil the principles of CE, at least in practice as identified in the above cases.

Another critical issue to be raised at this point is the question whether dematerialisation is indeed a strategy for Circular Economy or not. Strictly speaking, dematerialisation means the substitution of materials and the physical state of a product by an alternative non-material offering that serves the same utility to the user. In theory, dematerialisation is not explicitly included in the principles of CE (see section 2.3). However literature on resource efficiency (Allwood et al., 2011) and CE (Andrews, 2015) consider dematerialisation (reducing material input while maintaining performance) an integral part of the Circular Economy, despite the fact that no circulation of material resources takes place.

Enthusiasm for dematerialisation has often focused on the use of digital technologies to provide information services without other media – 'the paper-less office', online newspapers, directories etc. (Allwood et al., 2011). However, much digitalisation entails several underlying issues that are not directly associated with resource use, such as increased materiality in the infrastructure required to support the dematerialised system (e.g. data centres, physical networks etc.) and more importantly the energy use for the support and maintenance of that infrastructure. Massive data stored in diffused data centres worldwide are expected to be always 'on' (available) to respond to users demand at any time anywhere in the world, creating never-ending standby requirements and constant energy use for running and back-up of data. The energy demand of data centres is growing exponentially, coupled to the ever-increasing (also exponentially) storage of data (Koomey, 2008; 2011). From 2000 to 2005, just in five years, the energy demand of data centres doubled and was equal to 1% of the global electricity consumption (Koomey, 2008). This increase can be translated as an annual average increase of 16.7%, which is in itself remarkable. From 2005 to 2010 although the increase in electricity consumption was limited to a slower rate, still the increase observed was around 56% reaching 1.5% of the global electricity consumption (Koomey, 2011). Furthermore, the environmental implications (let alone the social – such as massive loss of jobs) have not been thoroughly investigated. What is apparently missing is the comparison of the environmental impacts of dematerialisation in broad production systems and/or product level, despite some specific case investigations, e.g. on-line magazine (Achachlouei and Moberg, 2015) and digital music listening and sharing/buying platforms (Hogg and Jackson, 2009), which quite audibly – but not definitely – have concluded that the benefits of dematerialisation are not as positive as initially perceived and that in the most scenario cases the impacts are negative, based on LCA and LCC methodologies.

In order to have a significant impact, dematerialisation would be required in major materials using sectors, such as the construction sector or heavy machinery and transport equipment. However, it is unclear whether dematerialisation of construction is even possible, although many buildings remain empty for more than half of the time during each day, so there is potential for design for multiple uses. Moreover, a shift from private to public transport would lead to relative dematerialisation, as well as the redesign of products to avoid over-specification of electronic appliances could lead to significant savings (Allwood et al., 2011).

Lastly, sustaining the virtuous loops of production and consumption in the economy by keeping material use circulation in the system for as long as possible might pose a particular problem, as inevitably material circulation reaches its limits. At some point, the extra cost of improving and refining further a circular material flow will exceed the corresponding benefits to society. Specifically, a Circular Economy should promote loops when socially desirable and efficient (Andersen, 2007), for as long as the benefit is greater than or equal to the cost. So, apart from concern over the physical limits to material recycling, which is argued that it is not possible to be maintained at 100% recycling rate due to entropy constrains, there is a growing doubt whether there are economic and social limits to the Circular Economy. Is the cost of extended use and circulation of materials outweighing the benefit of using resources for other social purposes? For example, would it be beneficial to invest in new infrastructure in order to recycle a specific material for reducing waste and preserving this natural resource, or by keeping exploiting the raw material at cheaper cost, and then using the short term benefits to educate future generations would make more sense in a social context?

Concluding, there is a need to address three underlying trends which pose significant doubts in the effort of achieving a truly Circular Economy:

1 Global population is increasing at fast pace and therefore there is no chance to fully close material circles without reducing material intensity in production AND consumption patterns through efficiency and sufficiency strategies (Alcott, 2008),.
2 100% recyclability is not possible (governed by physics laws) and endless reuse and recycling is not possible because a range of materials lose their properties over time (with the exception of metals and some minerals) and therefore are downcycled at some point in their subsequent circulations in the economy, and ultimately are discarded.
3 Current material flows within the economy are not enough to fulfil the material demand resulting from points (1) and (2), and therefore there is a need to capitalise on 'historically' lost resources that might lie hidden in old landfills or stored out-of-use somewhere (e.g. old mobiles). In this respect urban mining could play a role in enhancing CE.

## 2.4 Resource Efficiency and Circular Economy: How the concepts relate to each other?

The previous sections offered an extensive presentation of the concepts of Resource Efficiency and Circular Economy, highlighted the key elements of both concepts and to what extent they can be considered as converging or merely complementing each other. Many key related concepts to Resource Efficiency seem to be incompatible with the framework of the Circular Economy and its 'material loops', although in principle they could apply.

However, the frameworks for Resource Efficiency and Circular Economy are intimately interrelated. Circular Economy offers a conceptual model of resource flows in a socio-economic system that can underpin the vision of a Resource-efficient Europe, as it is presented in the European Commission's Roadmap to a Resource-Efficient Europe (COM(2011) 571). The model of Circular Economy entails significant (even radical in some cases) changes in the production systems and underlying business models to revolutionise the flow of resources through the economic system. Provided the model is effective in shifting economic activities to sustainable use, recovery and regeneration of secondary resources, it will contribute to decoupling economic growth and resource consumption.

The vision of Resource Efficiency relates to a broader debate on green economy and sustainable development. Discussions about a Circular Economy also need to be considered in this larger context. A Resource-efficient Circular Economy model needs to be systemic and consider both changes in the production system and in consumption practices and lifestyles (EC, 2014b).

Circular Economy is based on 'closing loops' through reuse, repair, remanufacturing, recycling and recovery of resources by transforming material into useful goods and services through resource efficiency (Webster, 2013). On the other hand, Resource Efficiency within CE is achieved by keeping the added value of materials through the prudent use of raw materials and energy consumption throughout all stages of the value chain of material products and by using the products for as long as possible, thereby eliminating waste (Bilitewski, 2012). In a sense, improved material efficiency is a key to improving the Circular Economy and capturing value in industry (Shahbazi et al., 2016).

Concluding, Resource Efficiency strategies such as dematerialisation, material substitution, extended (intensive) use of products, process yield improvements and 'light-weighting', are not explicitly considered as Circular Economy strategies since the 'circular' component is missing. However, the inner and most valuable circle of CE – reuse – implies shared use of material resources in the sense that once a product has fulfilled its first use phase, then it is recirculated back in the economy for a second use phase etc. Thus the use of the product is understood to take place consecutively and not in parallel (within its first life-cycle), as in the case of PSS and collaborative economy. However, as discussed above, PSS can be considered as a CE strategy because the ownership of products is retained by a company (and not the user), who will maintain and recirculate its produce (or its utility) for as long as possible in the economy.

# 3 Barriers and drivers to Resource Efficiency

In this chapter, the barriers and drivers to resource efficiency, as identified in literature, will be presented (sections 3.1 and 3.2). Furthermore, the enabling conditions for establishing a functional Circular Economy will be showcased in section 3.3. In the context of this report, drivers and enabling conditions are distinguished in a sense that 'drivers' refer to actual conditions that would potentially incentivise greater resource efficiency, while 'enabling conditions' refer to a hypothetical set of drivers, which if put in place could promote the transition to CE. This is not the most common distinction of the terms, but it is used here to denote 'real' on the ground drivers and wishful thinking about ideal conditions that might apply – or not – in the future.

## 3.1 Barriers to Resource Efficiency

There is a multitude of barriers that affect the ability of businesses to widely adopt resource efficiency strategies in their operations. Developing alternative production processes for increased material efficiency as well as new business models to capitalize on their improved efficiency is a challenging task for the majority of companies (Andrews, 2015). This is partly due to lack of knowledge and understanding of the concept and because it represents a significant change of industrial practice, requiring prior acquired knowledge and high investment and training costs. Concerns and barriers may be practical (e.g. low supply of recycled materials) while other barriers may be perceptual (common belief that remanufactured parts or recycled materials are inferior to virgin materials) (ibid). It is rather likely that manufacturing companies possess certain awareness about the environmental impacts of their industrial activities. However, due to competitive pressure such impacts tend to remain unaccounted for as the primary focus is put on economic benefits and company growth (Lieder and Rashid, 2016). The competition becomes even more aggravating factor in the increasing globalisation environment of industrial production. Local initiatives (e.g. upgrade and leasing) risk losing against competition with global supply chains (in the short term) as the initial cost of founding such a model could become a hard to overcome barriers, especially in the case of SMEs.

An important market failure of major relevance for material efficiency, which is particularly stressed by Söderholm and Tilton (2012), is the situation where one firm manufactures a product in a way that increases the cost of recycling or reuse for the downstream processor. The potential waste recovery facility downstream in the value chain possesses no means to provide the manufacturer with the incentives to change the product design for easier and cost-effective recycling or reuse (Calcott and Walls, 2000). Companies do not use the potential of eco-design for resource efficiency to its full extent. In order to reap the benefits of eco-design, it is required that appropriate infrastructure was in place that would enable easy collection and disassembly, retaining economic value by returning (recirculating) secondary raw materials (or components) back to the manufacturing process. Companies would need to invest heavily in new design practices and R&D for resource-efficient products. However, these costs would be born only by the company itself, while the benefits of easy disassembly and recyclability at the end-of-life will be reaped by another actor downstream the value chain, leaving the initiator of the change (manufacturer) without any benefits. This situation, ultimately, disincentives companies from proceeding with improvements in the design of products, unless a well-established infrastructure is in place, coupled with effective traceability of products and good functioning markets for take-back and recycling, and vice-versa (Milios, 2016).

Another problem is that the time needed for technological innovation usually mismatches concurrent availability of capital and thus creates a lock-in to currently available technologies in industrial production that limits the potential for resource efficiency innovations. In contrast, a high pace of technological innovation may also drive unsustainable material use. Tukker (2015) illustrates that the high speed of innovation strongly limits the potential for take-back and re-use of products. The demand for staying up-to-date with new technologies reduces customer willingness to use second hand products.

Barriers to elevating Resource Efficiency and hindering the adoption of relevant strategies in business and largely in the economy are presented in a comprehensive way in Table 1 below. The frame of Table 1 is taken from Shahbazi et al. (2016), but it is populated by findings from literature (Allwood et al., 2011, 2013; Andrews, 2015; Ekvall et al., 2016; Ghisellini et al., 2016; Gregson et al., 2015; Hirschnitz-Garbers et al., 2015; Kama, 2015; Lieder and Rashid, 2016; Machiba, 2010; Pajunen et al., 2012; Shahbazi et al., 2016; Stahel, 2013; Söderholm and Tilton, 2012) and (EEA, 2016a; 2016b).

***Table 1: Barriers to Resource Efficiency***

| | | |
|---|---|---|
| Technological barriers | Design/ Engineering | Design barriers: the vast majority of companies and designers do not design their products for easy disassembly, repair, refurbishment and remanufacturing |
| | | Engineering barriers, e.g. advanced knowledge of materials and chemical engineering science |
| | | Lack of technical and detailed knowledge, e.g., waste material awareness, chemical content in different components, composite materials separation |
| | | Product type and difficulties in finding lower-impact materials |
| | | Widespread planned obsolescence in products |
| | Technology and infrastructure | Lack of advanced technology and equipment with lower-environmental impacts in manufacturing processes |
| | | Resistance to innovation and technological change in established industries |
| | | Lack of networks and/or supply chains for disassembled products and components and recycled materials (reverse logistics) |
| | | Difficulties in management of technological risks |
| Economic barriers | Financial | Limited financial capability for investments in resource efficiency technologies, companies avoid high short-term costs and low short-term economic benefits |
| | | Strategies for maximising short-term profit and retaining competitive advantage |
| | | High labour costs related to product disassembly and source separation of waste |
| | Material and product cost | Difficulty to adapt and maintain competitive prices of products |
| | | Costs associated with the environmental impacts of production, the so-called externalities, are not reflected in the price of materials |
| | | High purchasing cost of environmentally sound materials and packaging |
| | | High cost of collection and segregation |
| | | Mismatch between used components and scrap material and actual demand for products |
| Organisational barriers | Management | Limited environmental awareness and top management commitment and support for sustainability initiatives |
| | | Higher priority of other issues over resource efficiency in business, e.g. production expansion, market share etc. |
| | | Management resistance to change – limited application of new business models |
| | Markets | Lack of well-functioning markets for secondary material (of high quality) |
| | | Re-use and recycling would compete for the same stream of materials |
| | | Poor partnership formation and management – uncooperative suppliers |
| | | Non-alignment between actors within and across value chains (e.g. between producers and recyclers) to improve cross-cycle and cross-sector performance |
| | | Lack of demand from suppliers |
| | | Limited sustainable public procurement incentives in most public agencies |

| | | |
|---|---|---|
| | Vision and culture | Company culture – Locked-in to traditional production practices<br>Lack of focus on corporate image and social responsibility<br>Unclear/weak strategic and business goals, lack of environmental goals in company vision and corporate values, and misalignment of short- and long-term strategic goals |
| | Human resources | Negative employee attitudes, limited environmental motivation and awareness among employees<br>Lack of human resources and time<br>Resistance to organizational change and operational inertia<br>Insufficient technical and environmental training, education and reward systems<br>Lack of support and guidance, limited in-plant expertise/capability |
| Legal barriers | Legislation and regulation | Difficulties associated with the process of applying/complying with legislation and/or environmental management system<br>Gaining 'secondary material' status is a burdensome, costly and lengthy process under the existing environmental permit system<br>Lack of or low effectiveness of environmental law enforcement<br>Weaknesses in policy coherence at different levels<br>No defined targets for resource efficiency in policy<br>Lack of governmental incentives (e.g. financial) for resource efficiency |
| | Methodology and measurement | Lack of clarity, know-how, methodologies and processes, e.g. appropriate LCA modelling for reuse and recycling<br>Lack of effective approaches and measures to evaluate resource efficiency, difficulties in quantifying resource efficiency |
| Informational / Knowledge barriers | Communication | Poor communication to/between relevant actors for increasing resource efficiency, e.g. academia, companies and policy jurisdictions and administrations<br>Limited intra-organisational cooperation and interaction<br>Poor communication across the value chain of products (upstream/downstream) |
| | Uncertainty and risk | Uncertainty about potential results, market benefits, performance impacts and environmental benefits<br>Uncertainty regarding future legislation |
| | Information | Lack of information, e.g. regarding environmental legislation or collection and disposal options<br>Lack of internal/external auditing of resource efficiency practices in business<br>Confidentiality and trust issues hamper exchange of information among relevant actors in the economy |
| Social barriers | Preferences and demand | Lack of market preference and customer demand for circular products<br>Low public pressure, lack of demand from shareholders, investors and community<br>Limited acceptance of potentially more efficient service oriented business models, e.g. leasing rather than owning, performance-based payment models<br>Lack of extended product warranties and reuse and repair options |
| | Understanding and perception | Common perception that remanufactured, reengineered parts and recycled materials are inferior to virgin materials<br>Lack of awareness, understanding, knowledge and experience with resource efficiency issues among relevant actors<br>Resistance from powerful stakeholders with large interests in status quo<br>Rebound effects of resource efficiency and sufficiency strategies |

Further barriers to the adoption of materially efficient strategies identified by Allwood et al. (2011), Ekvall et al. (2016) and Stahel (2016) include:

- The quantity of used components and scrap material in the long run cannot be greater than the quantity of products that are taken out of use. For certain materials, such as polymers and textiles, recycled material is a less adequate substitute for virgin materials.
- Reuse and recycling would compete for the same material stream. If a certain amount of one type of material is diverted to reuse, it may lead to supply shortage in recycling which drives price increase for material recycling, and thus a reduced incentive for reuse as the material will acquire value in the recycling market and most likely be redirected there.
- All current economic systems are predicated on growth and as a result, business models in production companies are oriented towards growing sales volumes. Material efficiency which may reduce material production might be opposed as a threat to a company unless it can reclaim value through other activities or alternative business models.
- GDP measures financial flows over time, while resource efficiency aims at preserving physical stocks. A new metric is urgently needed that measures wealth in the economy and well-being in society, not by measuring throughput of financial flows and material resources but utilisation and sustainable management of existing stocks.

## 3.2 Drivers for Resource Efficiency

In this section, the driving forces towards increasing Resource Efficiency, which can be identified already in the current policy and economic landscape, will be briefly presented. This approach, of identifying such existing drivers aims at solidifying the potential of policy interventions aiming exactly at this type of driving forces which already have demonstrated a steering effect in inducing resource efficiency practices in business. The evaluation of their effectiveness, however, remains outside the scope of this section. Drivers identified in relevant literature (Allwood et al., 2011, 2013; Ekvall et al., 2016; Pajunen et al., 2012; Stahel, 2013; Tan et al., 2010) and (EEA, 2016a; 2016b) include:

- Reduced waste management costs by reusing and recycling waste
- Cost recovery by selling valuable recyclable materials
- Perceived environmental and social benefits (CSR)
- Rising and/or volatile costs of virgin raw materials
- Material supply security
- Compliance with legislation and especially waste prevention, recycling and recovery targets
- Taxes on natural resources promote resource efficiency and/or substitution of resources
- Profitable new (innovative) business models based on higher financial returns from dematerialisation, sharing of assets and extended use of products, compared to traditional business approaches
- Extended producer responsibility participation
- Best Available Techniques (BAT) in industrial processes and dissemination of BAT Reference documents (BREFs)
- Legal pressure to decrease certain material resources (e.g. chemicals)
- Market forces that favour one material over another might trigger material innovation and substitution of material inputs to industry

## 3.3 Enabling conditions for establishing a Circular Economy

The enabling conditions that would be required in order to drive the transition to a Circular Economy relate to the reduction of barriers identified in section 3.1. Clearly, appropriate solutions should be devised in order to overcome the barriers and realise the vision of a Circular Economy.

Table 2 summarises potential conditions that would catalyse a transition to a Circular Economy. Although these parameters are considered important in a Circular Economy the level of their application in the economy has not been evaluated yet and the effectiveness of each measure is not taken for granted, and thus these constitute merely ‘enabling conditions’. The successful application of these conditions might be influenced by other parameters as well. It is important to recognise at this point that there is no single ‘golden formula’ for a Circular Economy and that the resulting system would be internally diverse, depending on the local conditions, the sector in the economy and on the properties and availability of natural resources used to deliver a function or a service.

***Table 2: Enabling conditions for a Circular Economy***

| | |
|---|---|
| Technological solutions | Design for durability, reuse, disassembly, upgrade, remanufacturing and recyclability |
| | Design for minimum material input and free of toxic chemicals – innovative production processes |
| | High quality recycling, avoiding (if possible eliminating) downcycling |
| | Scientific breakthrough in material engineering – new ways to utilise materials longer and higher recovery ability of existing material streams |
| Economic incentives | Widely applied taxation of natural resources (especially non-renewable resources) |
| | Removal of environmentally harmful subsidies |
| | Taxation shift away from labour towards material and energy resources |
| | Finance mechanisms supporting Circular Economy approaches |
| | Internalisation of external costs of industrial processes (resource depletion, emissions, environmental pollution etc.) |
| Organisational solutions | Well-functioning and extensive market networks for secondary raw materials; global recycling markets |
| | Wide development of reverse logistics and take-back systems |
| | Development of new business models, employing a variety of resource efficient business offerings (e.g. PSS etc.) |
| | Value-chain cooperation and coordination, better communication from manufacturer to recycler and waste management, and vice-versa in order to optimise material use and recovery |
| | Phasing out of landfilling and incineration, elimination of resources must be limited to the absolutely necessary minimum (e.g. toxic waste, non-recyclables) |
| Legal interventions | Better definitions, scope and focus in resource related (and waste ) and consumption related policies |
| | Systemic approach in policy making, integrating resource concerns in all levels and themes of policy interventions |
| | Reconsideration of manufacture, retail, consumption and property rights, and respective amendments in ownership and warranties regime |
| | Mandatory ‘green’ purchasing in the public sector will greatly incentivise resource efficient approaches in manufacturing |
| | Measures supporting innovation towards the Circular Economy |
| | Regulatory bans and other restrictions of resource unsound practices, e.g. landfilling/incineration of recyclables, excessive use of packaging and other wasteful practices such as disposable products (from plastic cups to photo cameras etc.) |
| Informational / Knowledge development | ICT is instrumental in disseminating knowledge and action towards resource efficient practices throughout all societal actors in the economy – increasing cooperation |
| | Development of labelling schemes for CE and the sustainable use of material resources |
| | Development of new and appropriate indicators for measuring resource efficiency, economic prosperity and social well-being |
| | Academic research and commercial R&D developing the knowledge base for a Circular Economy – increasing the potential of CE |

| | |
|---|---|
| Social conditions | Collaborative consumption, embedding consumption in society as a sharing activity and not as accumulation of material goods for acquiring social status |
| | Awareness raising about sustainable lifestyles and priorities in consumption patterns |
| | Widespread education in schools and other institutions in order to create a favourable environment for an upcoming paradigm shift in socio-economic relations through the Circular Economy |

A vision of a Circular Economy and a narrative of what CE entails is provided by famed academic Walter Stahel in his latest popular article in Nature. According to Stahel (2016) the knowledge base of CE is already well developed but it is concentrated mainly in big industries which are hesitant to adopt the model unless there is a clear window of opportunity. CE knowledge is also developing in academic circles and has already been introduced in education curricula. He argues that a broad 'bottom up' movement will emerge if SMEs would be able to hire such graduates who have the economic and technical know-how to change business models. However, he points out that more research is needed in order to convince businesses and governments that CE is feasible. Moreover, broad and far-reaching communication and information strategies are needed to raise the awareness of manufacturers and the public about their responsibility for products throughout their service lives. He cleverly suggests that it should be the fashion magazines and trend-setting media that advocate the sharing of products, e.g. jewellery sharing, leasing of jeans and renting of designer handbags – and not some academic journal entirely invisible in the eyes of the general public.

Going back to his routes of academic thinking, Stahel (2016) suggests that policies should focus on performance; internalisation of external costs; and the stewardship of products over ownership. Value-added tax (VAT) should be levied on value-added activities, such as mining, construction and manufacturing, but not on value-preserving stock management activities, such as reuse, repair and remanufacture. Finally, Stahel (2016) raises the issue of measuring societal wealth and well-being in capital accumulation instead of capital flow. Growth then would ideally correspond to a rise in the quality and quantity of all capital stocks.

However, GDP as a monetary indicator is measuring the throughput of products and services within an economy by its economic value. In theory, growth can also be achieved by increasing the share and importance of services within the economy, which can equally generate revenue and increase value in the economy without necessarily depending on the utilisation of products and materials. The level of this contribution though has not been assessed and it is not possible to predict how much it could lead to growth. There could be a possibility that the value of services is too low compared to production value so ultimately the GDP will fall and economic growth will not be achieved.

Success stories in CE business models point out the need for an economic return on investment, in order to provide suitable motivation to companies and investors. Currently, there is a need for increased focus on upstream measures to close material loops (e.g. eco-design, business models, consumer behaviour) to complement the well-established downstream measures for waste management and prevention laid down in CE policy approaches (Ghisellini et al., 2016).

# 4 Current policy context in EU-28 and in Sweden

In this chapter, the current policy landscape in EU-28 and in Sweden will be presented, outlining all relevant regulations, strategies, action plans and initiatives.

## 4.1 Policy context in the EU

Over the last 10 years the strategic direction of the EU has been consistently towards the sustainable use of natural resources, increasing resource efficiency, scaling up the recycling of waste coupled with an intense interest in waste prevention, while at the same time aiming at sustainable levels of economic growth. By 2005, EU was already setting the stage for its future policy direction concerning resources conservation and the sustainable management of resources, introducing two 'Thematic Strategies', one on the sustainable use of natural resources (COM(2005) 670 final) and the other on the prevention and recycling of waste (COM(2005) 666 final). Following the global developments on the stage of Sustainable Consumption and Production (SCP) and the efforts spearheaded by UNEP at the time, EU introduced an integrated Action Plan for Sustainable Consumption and Production and Sustainable Industrial Policy (COM(2008) 397 final). The Action Plan proposed the implementation of a series of measures to improve the energy and environmental performance of products throughout their life cycle, and to stimulate demand and consumption of better quality products, thus creating a 'virtuous circle'. In this Communications already some first notions of Circular Economy seem to emerge, although the basis of the Action Plan was mostly related to Resource Efficiency practices, while the consumption side of resources and product demand was not particularly scrutinised.

A pivotal point in EU resources policy comes with the EUROPE 2020 Strategy for smart, sustainable and inclusive growth (COM(2010) 2020 final). Several guiding aspects for future economic and social development in the EU are outlined in the Strategy, of which several initiatives sprung up that will shape the Resource policy of EU until today. Direct derivatives of the Europe 2020 strategy are the 'Eco-innovation Action Plan' (Eco-AP) (COM(2011) 899 final), the 'Flagship initiative for a Resource-efficient Europe' (COM(2011) 21 final) and the resulting 'Roadmap to a Resource Efficient Europe' (COM(2011) 571 final).

Today, the guidance in the EU Environmental Policy is drawn from the General Union Environment Action Programme to 2020, called 'Living well, within the limits of our planet' (Decision No 1386/2013/EU), which is also known as the 7$^{th}$ Environment Action Programme (7EAP). The 7EAP will guide European Environmental policy until 2020. The Plan identifies nine priority objectives and sets out a long-term vision of where it wants the EU to be by 2050. Guided by the long-term vision of *'In 2050, we live well, within the planet's ecological limits'*, the 7EAP identifies 3 priority action areas for the EU, of which one specifically aims towards a Resource-efficient economy. In order to transform the EU into a resource-efficient, low-carbon economy, the 7EAP calls for:

- full delivery of the climate and energy policy package to achieve the 20-20-20 targets and agreement on the next steps for climate policy beyond 2020
- significant improvements to the environmental performance of products over their life cycle
- reductions in the environmental impact of consumption, including issues such as cutting food waste and using biomass sustainably

The focus of the above policies mainly centres on the concept of Resource Efficiency, defined as a development that 'allows the economy to create more with less, delivering greater value with less input, using resources in a sustainable way and minimising their impacts on the environment' (COM(2011) 571 final).

However, in the last few years, and largely due to the revitalisation of the CE concept in Europe, the European Commission moved accordingly by reframing the general framework of Resource Efficiency which formed the basis of its policy on resources, into that of the Circular Economy. The EU Circular Economy Package, which consists of the EU Action Plan for the Circular Economy (COM (2015) 614 final) and proposed amendments of several EU Directives (on waste, packaging and packaging waste, landfilling, end-of-life vehicles, batteries and accumulators and waste batteries and accumulators, and waste from electrical and electronic equipment) was initially launched in July 2014 by Environment Commissioner Potocnik under the Barroso II Commission, but it was withdrawn in late December 2014 in the context of the new 2015 work programme of the incoming Juncker Commission in order to be reformulated to a more ambitious version later in 2015, and was finally published by the Commission on 2 December 2015.

A comprehensive list of the strategic policy initiatives in the EU aiming to create an appropriate framework for improving resource efficiency and enabling innovation and economic growth is presented below (Table 3).

***Table 3: EU strategic policy framework for Resource Efficiency and economic growth***

Strategic policy initiatives, action plans, roadmaps and programmes aiming for improved resource efficiency in the EU:

- General Union Environmental Action Programme to 2020 ‘Living well, within the limits of our planet’ (7EAP), Decision No 1386/2013/EU
- Closing the loop — An EU action plan for the Circular Economy, COM(2015) 614 final.
- Roadmap to a Resource Efficient Europe, COM(2011) 571 final
- Flagship initiative for a resource-efficient Europe, COM(2011) 21 final
- Eco-innovation Action Plan (Eco-AP), COM(2011) 899 final
- The raw materials initiative: meeting our critical needs for growth and jobs in Europe, COM(2008) 699 final
- Sustainable Consumption and Production and Sustainable Industrial Policy Action Plan, COM(2008) 397 final
- Thematic Strategy on the sustainable use of natural resources, COM(2005) 670 final.
- Thematic Strategy on the prevention and recycling of waste, COM(2005) 666 final.

Strategic policy initiatives that aim at market harmonisation, market development, innovation and industrial and economic development in the EU:

- For a European Industrial Renaissance, COM(2014) 14 final
- Single Market Act II, Together for new growth, COM(2012) 573 final
- Europe 2020 A strategy for smart, sustainable and inclusive growth, COM(2010) 2020 final.
- A lead market initiative for Europe, COM(2007) 860 final.

Strategic policy initiative for the improvement of the law making process, implementation and harmonisation of legislation in the EU:

- Interinstitutional Agreement between the European Parliament, the Council of the European Union and the European Commission on Better Law-Making of 13 April 2016

The Circular Economy Package aims to improve competitiveness by protecting EU businesses against scarcity of resources and volatile prices, help to create new business opportunities and innovative, more efficient ways of producing and consuming. The conception of Circular Economy is envisaged to create local jobs in the EU at all levels of skills in the workforce and opportunities for social integration and cohesion for the weaker fractions of society. It is particularly stressed in the Circular Economy Action Plan (COM (2015)

614 final) that the economic actors, such as business and consumers, are the key drivers in the process to moving towards a Circular Economy. Local, regional and national authorities are expected to act as catalysts in this transition, but the EU also has a fundamental role to play in supporting it, by ensuring that the right regulatory framework is in place for the development of the Circular Economy in the single market. The EU CE Action Plan presents the potential policy interventions that would enable the development of CE in EU-28. It outlines the specific actions that will be taken by the Commission in the near future at different stages of the economy and the product value chain, as well as some horizontal measures applicable throughout the value chain. More specifically, the Action Plan (COM (2015) 614 final) includes the following:

1. Production
   - Product design (special focus on the reparability, upgradability, durability, and recyclability of products, developing product requirements relevant to the Circular Economy in its future work under the Ecodesign Directive)
   - Product processes (BATs, BREFs)

2. Consumption
   - Green Public Procurement (GPP) – emphasising Circular Economy aspects in new or revised criteria, supporting higher uptake of GPP
   - Promote reuse, extended guarantees and durability of products, information to consumers (Eco-labelling)

3. Waste management
   - Revised targets
   - Better implementation of waste law (EU directives)
   - EU funding in waste management (through cohesion funds)

4. From waste to resources: boosting the market for secondary raw materials
   - Standards for secondary materials

5. Innovation
   - Horizon 2020
   - Identify regulatory hot spots for innovators

Moreover, it identifies five priority material/waste streams that require particular attention, due to low efficiency performance or criticality of the resource for the EU economy, and urgent measures will be taken to improve their resource efficient management. There are:

- Plastic waste
- Food waste
- Critical raw materials
- Construction and demolition waste
- Biomass and bio-based products

The number and complexity of interactions among the related actors in a Circular Economy create a complicated policy landscape, which inevitably extents across the different parts or production and consumption systems and affect directly or indirectly several other parts in the value chain. Based on the narrative of the CE Action Plan (COM (2015) 614 final), the policy landscape of the Circular Economy today in Europe looks something like the representation in Figure 7.

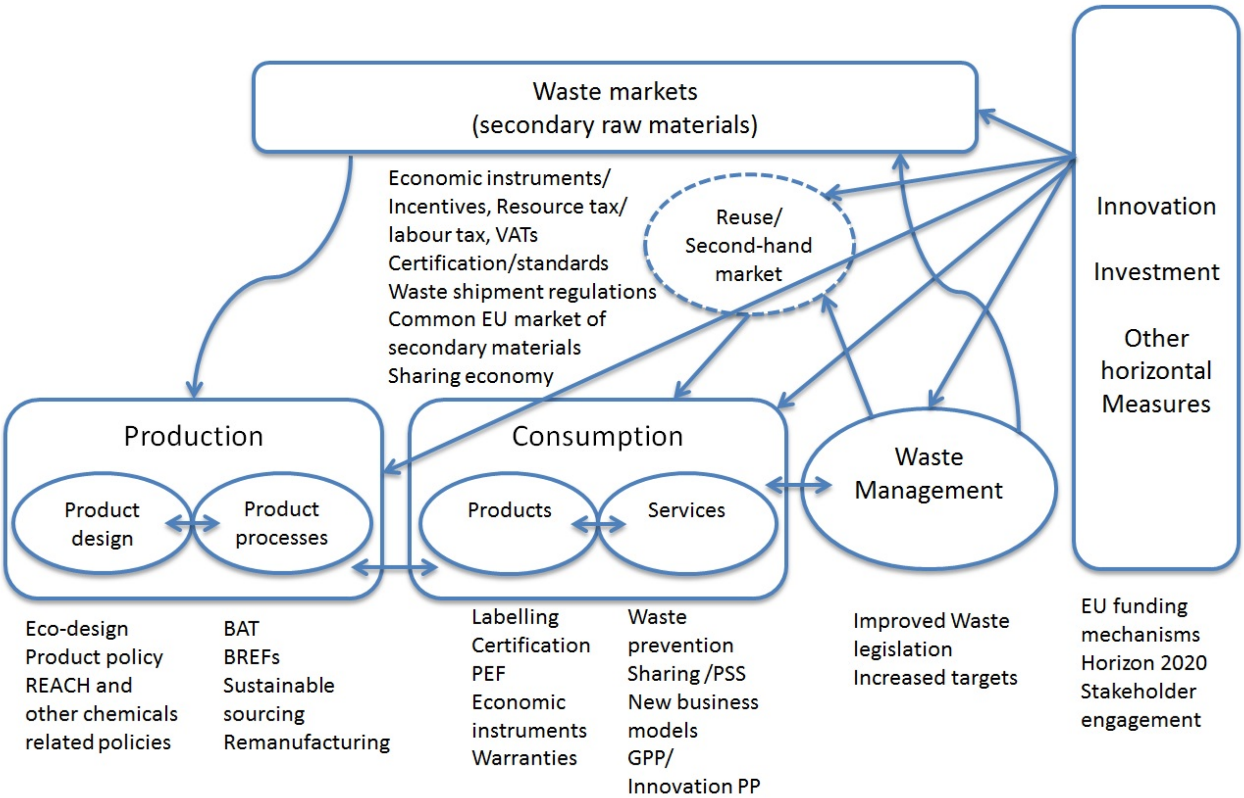


*Figure 7: Policy landscape according to the EU Circular Economy Action Plan*

Using the same level of categorisation into four separate functions in the economy and one that cuts through the functions horizontally (e.g. innovation policies), as presented in the CE Action Plan (see above for details), the following tables list all relevant policies in the EU attributing each policy's relevance to a specific stage of intervention in the Circular Economy. These lists of policies are distinguished by the fact that Table 4 presents legally binding legislation (in the form of regulations or directives), while Table 5 presents Communications of the European Commission which represent policy orientation and proposals for policy in the EU.

*Table 4: Legally binding EU legislation and its relation to the Circular Economy value chain*

| | Production | Consumption | Waste mngm | Markets secondary m. | Horizontal measures |
|---|---|---|---|---|---|
| Regulation (EU) No 660/2014<br>on shipments of waste, amending Regulation No 1013/ 2006 | | | (✓) | ✓ | |
| Regulation (EU) No 691/2011<br>on European environmental economic accounts | | | | | ✓ |
| Regulation (EU) No 305/2011<br>on the marketing of construction products | ✓ | | | (✓) | |
| Regulation (EU) No 849/2010 on waste statistics | | | ✓ | | |
| Regulation (EC) No 66/2010 on the EU Ecolabel | (✓) | ✓ | | | |
| Regulation (EC) No 1221/2009 | ✓ | (✓) | | | |

| | Production | Consumption | Waste mngm | Markets secondary m. | Horizontal measures |
|---|---|---|---|---|---|
| on the voluntary participation by organisations in a Community eco-management and audit scheme (EMAS) | | | | | |
| Regulation (EC) No 1907/2006<br>on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) and setting up a European Chemicals Agency | ✓ | ✓ | (✓) | (✓) | (✓) |
| Directive 2015/720<br>as regards reducing the consumption of lightweight plastic carrier bags, amending Directive 94/62/EC | (✓) | ✓ | (✓) | | |
| Directive 2014/24/EU<br>on public procurement, repealing Directive 2004/18/EC | (✓) | ✓ | | (✓) | |
| Directive 2013/56/EU<br>amending Directive 2006/66/EC on batteries and accumulators and waste batteries and accumulators | ✓ | | ✓ | | |
| Directive 2012/19/EU<br>on waste electrical and electronic equipment (WEEE) | (✓) | | ✓ | | |
| Directive 2011/65/EU<br>on the restriction of the use of certain hazardous substances (RoHS) in electrical and electronic equipment | ✓ | | | (✓) | |
| Directive 2010/30/EU<br>on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products | ✓ | (✓) | | | |
| Directive 2009/125/EC<br>establishing a framework for the setting of ecodesign requirements for energy-related products | ✓ | (✓) | | | |
| Directive 2009/1/EC, amending Directive 2005/64/EC<br>on the type-approval of motor vehicles with regard to their reusability, recyclability and recoverability | ✓ | | (✓) | (✓) | |
| Directive 2008/98/EC<br>on waste and repealing certain Directives | | | ✓ | | |
| Directive 2006/21/EC<br>on the management of waste from extractive industries | | | ✓ | | |
| Directive 2000/53/EC<br>on end-of life vehicles | | | ✓ | | |
| Directive 1999/44/EC<br>on the sale of consumer goods and associated guarantees | (✓) | ✓ | | (✓) | |
| Directive 1999/31/EC<br>on the landfill of waste | | | ✓ | | |
| Directive 94/62/EC<br>on packaging and packaging waste | (✓) | | ✓ | | |

✓ = Direct relation (✓) = Indirect relation

The majority of waste legislation in the EU is implemented in the form of Directives, recognising the differences between the Member States in organisational set-up and performance level of the waste sector and allowing for diversity in measures to achieve the prescribed legislation, while legislation affecting all Member States equally, without special conditions, are passed directly as EC Regulations (e.g. shipments of waste, REACH etc.). The difference between a ‘Regulation’ and a ‘Directive’ is that a regulation is a binding legislative act and must be applied in its entirety across the EU, while a directive is a legislative act that sets out a goal that all EU Member States must achieve, but it is up to the individual Member State to devise its own laws on how to reach these goals.

***Table 5: EC Communications and their relation to the Circular Economy value chain***

| | Production | Consumption | Waste mngm | Markets secondary m. | Horizontal measures |
|---|---|---|---|---|---|
| Standardisation package – European standards for the 21st century, COM(2016) 358 final | ✓ | | | (✓) | |
| A European agenda for the collaborative economy COM(2016) 356 final | | ✓ | | (✓) | |
| Upgrading the Single Market: more opportunities for people and business, COM(2015) 550 final | (✓) | (✓) | | ✓ | |
| Better regulation for better results - An EU agenda COM(2015) 215 final | (✓) | (✓) | (✓) | (✓) | ✓ |
| Resource Efficiency opportunities in the building sector COM(2014) 445 final | ✓ | | ✓ | (✓) | |
| Green Action Plan for SMEs COM(2014) 440 final | ✓ | | | | ✓ |
| Review of the list of critical raw materials for the EU and the implementation of the Raw Materials Initiative COM(2014) 297 final | ✓ | | | (✓) | |
| A vision for the internal market for industrial products COM (2014) 25 final | (✓) | | | ✓ | |
| Building the Single Market for Green Products COM(2013) 196 final | ✓ | (✓) | | | |
| European Innovation Partnership on Raw Materials COM(2012) 82 final | | | | | ✓ |
| Horizon 2020 - The Framework Programme for Research and Innovation, COM(2011) 808 final | (✓) | | (✓) | | ✓ |
| A Roadmap for moving to a competitive low carbon economy in 2050, COM(2011) 112 final | ✓ | (✓) | | | ✓ |
| Tackling the challenges in commodity markets and on raw materials, COM(2011) 25 final | | | | ✓ | |
| An Integrated Industrial Policy for the Globalisation Era, Putting Competitiveness and Sustainability at Centre Stage COM(2010) 614 final | ✓ | | | | ✓ |
| Public procurement for a better environment COM(2008) 400 final | (✓) | ✓ | | (✓) | |
| Integration of Environmental Aspects into European Standardisation COM(2004) 130 final | ✓ | | | (✓) | (✓) |
| In progress: | | | | | |
| Proposal for amending Directive 94/62/EC on packaging and packaging waste, COM(2015) 596 | | | ✓ | | |
| Proposal for a Directive of the European Parliament and of the Council amending Directive 2008/98/EC on waste' COM(2015), 595 final | | | ✓ | | |

| | Production | Consumption | Waste mngm | Markets secondary m. | Horizontal measures |
|---|---|---|---|---|---|
| Proposal for amending Directive 1999/31/EC on the landfill of waste, COM(2015) 594 | | | ✓ | | |
| Proposal for amending Directives 2000/53/EC on end-of-life vehicles, 2006/66/EC on batteries and accumulators and waste batteries and accumulators, and 2012/19/EU on waste electrical and electronic equipment, COM(2015) 593 | | | ✓ | | |
| Product environmental footprinting (PEF) | ✓ | (✓) | | | (✓) |

✓ = Direct relation (✓) = Indirect relation

From Table 3 and Table 4, it is observed that although the conception of a specific legislation by the European Commission may target one specific policy area, it is possible that it may affect indirectly other areas as well in the economy. Therefore, a new approach in policy making needs to be considered and largely this is what the initiative for better regulation in the EU is all about.

However, there is concern about the role of the Commission in the Circular Economy, as the current Commission is promoting an exceptionally neo-liberal economic policy. In the CE Action Plan, the EC proclaims that the transition to a Circular Economy will primarily be guided by economic actors, such as businesses and consumers, while the EU will have only a supportive role in ensuring that the right regulatory framework is in place and in setting clear signals for the development of a Circular Economy in the single market. In contrast, neo-liberalism calls for a wide deregulation in all sectors in the economy and promotes market forces. By limiting regulatory powers, there is a risk that the EU will not be able to play its role as a supportive actor in the transition to CE and therefore market forces might follow a counter direction. Ultimately, the need for some kind of regulation on the market, and especially on markets for secondary raw materials and used products would be a prerequisite for the transition to a Circular Economy, as it is also recognised in the CE Action Plan.

At Member State level, apart from the multitude of EU legislation, the countries have the freedom to devise their own policies for Resource Efficiency as long as they do not counteract EU regulations. However, only three countries (Austria, Finland and Germany) have taken steps further than the EU to establish dedicated strategies for material resource efficiency, while two other countries have dedicated strategies at a regional level, namely in Flanders (Belgium) and Scotland (United Kingdom). Most countries incorporate material use and resource efficiency in a wide variety of other strategies and policies, including those on waste and energy, industrial development and reform programmes, or in national environmental or sustainable development strategies. Waste management and recycling initiatives as well as waste prevention plans and initiatives on the use of secondary raw materials play a prominent role in Member States' resource efficiency related policies (EEA, 2016b).

Despite the lack of resource efficiency strategies in Member States, material resource efficiency and waste management are very closely related issues, and therefore there is an opportunity to address both themes simultaneously, through CE strategies. However, CE strategies in the Member States are still developing and no comprehensive approach for CE has been identified. The majority of Member States see compliance with existing EU legislation as the main driver of any action taken at the national level (EEA, 2016b).

Recently, a very ambitious policy example came into prominence when France passed the 'Act on Consumption and preventing planned product obsolescence'. This is one (rare) example of policy in Europe which goes beyond the traditional recycling and resource conservation strategies which has dominated EU policy developments in the last 10 years, and one that clearly emphasises some of the principles of CE – 'longer lifespan of products'. The Act on Consumption, adopted by France in March 2014, addresses product durability and aims at preventing planned obsolescence. Despite the fact that its primary objective is to increase consumer protection, the law includes several articles related to the lifespan of consumer goods. The measures of the Act targeting product lifespan include: (1) the duration of legal product guarantees is extended from six months to two years, and (2) the retailer is obliged to inform the consumer about the timespan that spare parts are going to remain available for the product in question.

## 4.2 Policy context in Sweden

The policy landscape in Sweden concerning Resource Efficiency is characterised by a general lack of a national specific strategy or action plan for resource efficiency. However, the main areas of policy interventions for increasing resource efficiency, as identified in EU strategic policy directions, such as the Roadmap to a Resource Efficient Europe (COM(2011) 571 final), are to a large extent covered by the Swedish Generational Goal and the Environmental Quality Objectives which form the core environmental policy framework in Sweden. Given that there is no nationally defined strategy for resource efficiency, there is no national definition of the concept either. Figure 8 presents a comprehensive outline of the resource efficiency related policy landscape in Sweden.

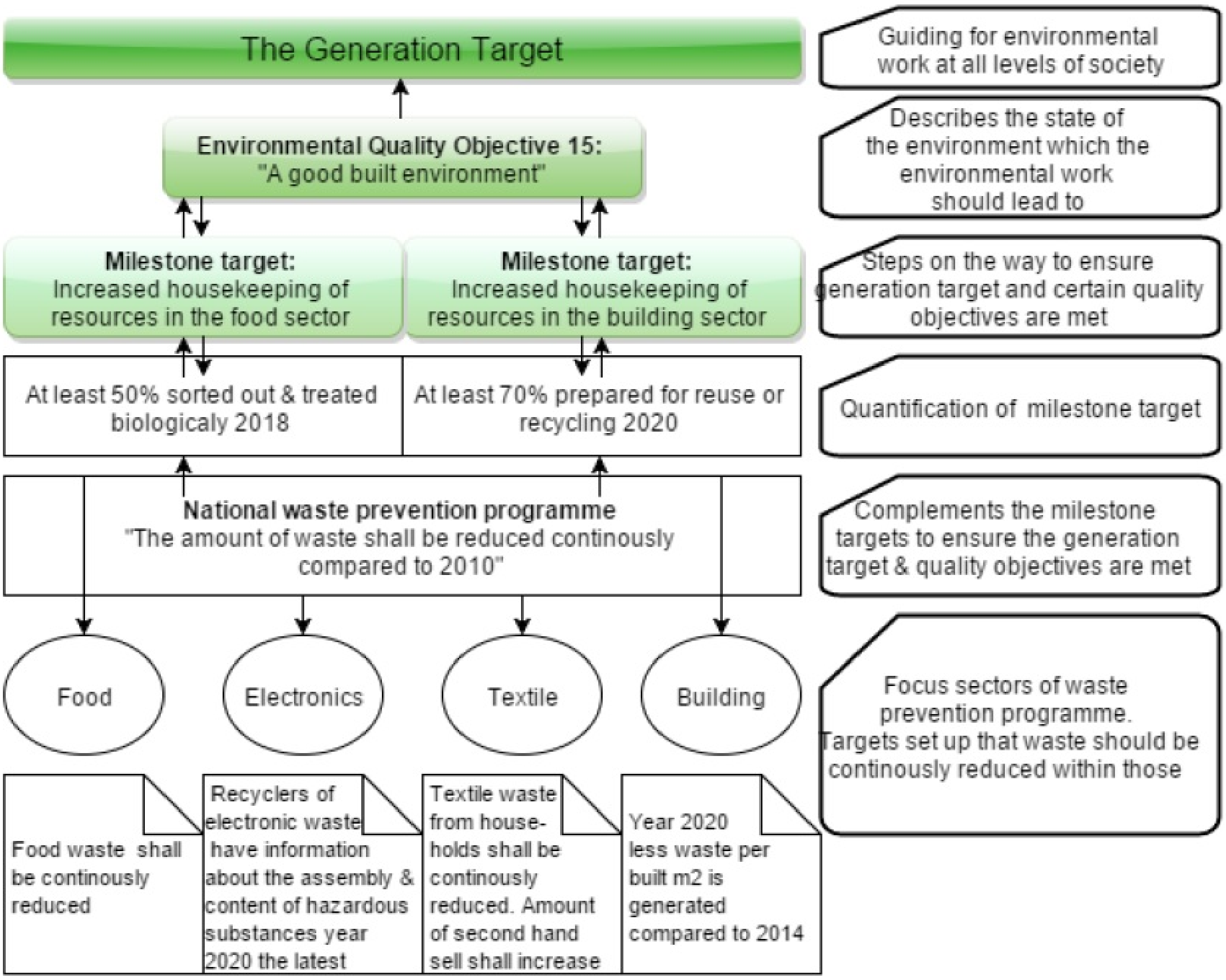


***Figure 8: Framework of Resource Efficiency related policies in Sweden (Westblom, 2015)***

The primary legislation governing the environment is Sweden is the 'Swedish Environmental Code' (Miljöbalken 1998:808). The Swedish Environmental Code refers in general to the sustainable management of resources in Sweden, by stating that it should be applied in a way to ensure that the use of land, water and the physical environment in general shall be such that secures long term good management in ecological, social, cultural and economic terms; and reuse and recycling, as well as other management of materials, raw materials and energy are encouraged with a view to establishing and maintaining natural cycles.' Material resource efficiency is included in the 'Generational Goal', which aims at handing over to the next generation a society in which the major environmental problems have been solved without increasing environmental and health problems outside Sweden's borders. Moreover, Sweden has 16 Environmental Quality Objectives, of which some are related to resource efficiency, though not always with quantitative targets. In addition to the Environmental Quality Objectives there are Milestone Targets. The Milestone Targets are intended to identify a desired social change and specify steps towards achieving the Generational Goal and one or more of the Environmental Quality Objectives (EEA, 2016c).

Other major strategic policy documents related to resource efficiency in Sweden include the national waste management plan 'From Waste Management to Resource Management – Waste plan of Sweden 2012–2017' (*'Från avfallshantering till resurshushållning – Sveriges avfallsplan 2012–2017'*), the national waste prevention programme (*'Tillsammans vinner vi på ett giftfritt och resurseffektivt samhälle – Avfallsförebyggande programmet'*) and the national 'Minerals Strategy' which aims at the sustainable use of mineral resources which create economic growth in Sweden.

Sweden has historically enjoyed abundance of natural resources and has very good access to a variety of economically important material resources, including iron and other metals among others. These resources have historically contributed to the creation of national wealth over the last centuries. However, concerns over the security of supply of these materials, as well as access to international resources, have not been a main driver of resource efficiency in Sweden (EEA, 2016c).

Based on the key policy documents presented above, it appears that the major parameters for material resource efficiency in Sweden are linked to concerns over the preservation of the natural environment and issues of competitiveness. Effective waste management and waste prevention considerations have been driving resource policy making.

As a result, the implemented so far policies by the Swedish governments have not been instrumental in reducing the resource intensity of the Swedish economy. Domestic Material Consumption (DMC) of resources is strongly correlated with GDP, confirming that the overall economy is largely dependent on intense material use. Moreover, the implemented measures have entirely failed to influence consumption patterns, preventing waste and reducing resource consumption. Remarkably, consumption levels rapidly returned to high levels and continue to grow after the recent recession in the economy, while no political instruments are currently being implemented or planned to reduce the materials consumption, apart from that targeting fossil fuels (Kalmykova et al., 2015).

More than half of all waste in Sweden is incinerated and the use of incineration is increasing faster than recycling (Kalmykova et al., 2015). Wilts and von Gries (2014) identified significant incineration overcapacities in EU and especially in Sweden the incineration capacity in relation to Municipal Solid Waste (MSW) generation is at 113%. Such development could seriously hamper material recycling in the future. The competition for commercial waste seems to lead to low price levels for energy recovery and may block in particular efforts of the medium-sized recycling industry. Recycling levels of MSW, although consistently high over the last years, fail to cross the threshold of 50% recycling rate, which is also the Waste Framework Directive (2008/98/EC) target for recycling of MSW (see Figure 9). The impact of incineration seems to influence strongly this development and is as an obvious risk in reaching the target by 2020, unless specific measures are taken to contain incineration of waste (Milios, 2013). Despite that, municipal waste management planning in Sweden shows an expanding MSW incineration sector (Avfall Sverige, 2014). Moreover, waste generation in Sweden is constantly increasing as a result of consumption growing faster than recycling. So far, no policies focusing on reducing demand and final consumption of goods have been implemented (Kalmykova et al., 2015).

Apart from the waste management targets found in EU legislation, and which Sweden is required to fulfil as all EU Member States, there are nearly no other solid quantifiable targets in place for measuring resource efficiency in Sweden. The only additional target (beyond the ones found in EU Directives) is the one concerning food waste in the national waste management plan. Specifically, the plan stipulates that appropriate measures should be taken so that, by 2018, resource management in the food chain is improved through separation and biological treatment of at least 50% of food waste from households, catering services, shops and restaurants, with the aim of recovering nutrients, with at least 40% treated in such a way that energy is also recovered (EEA, 2016c).

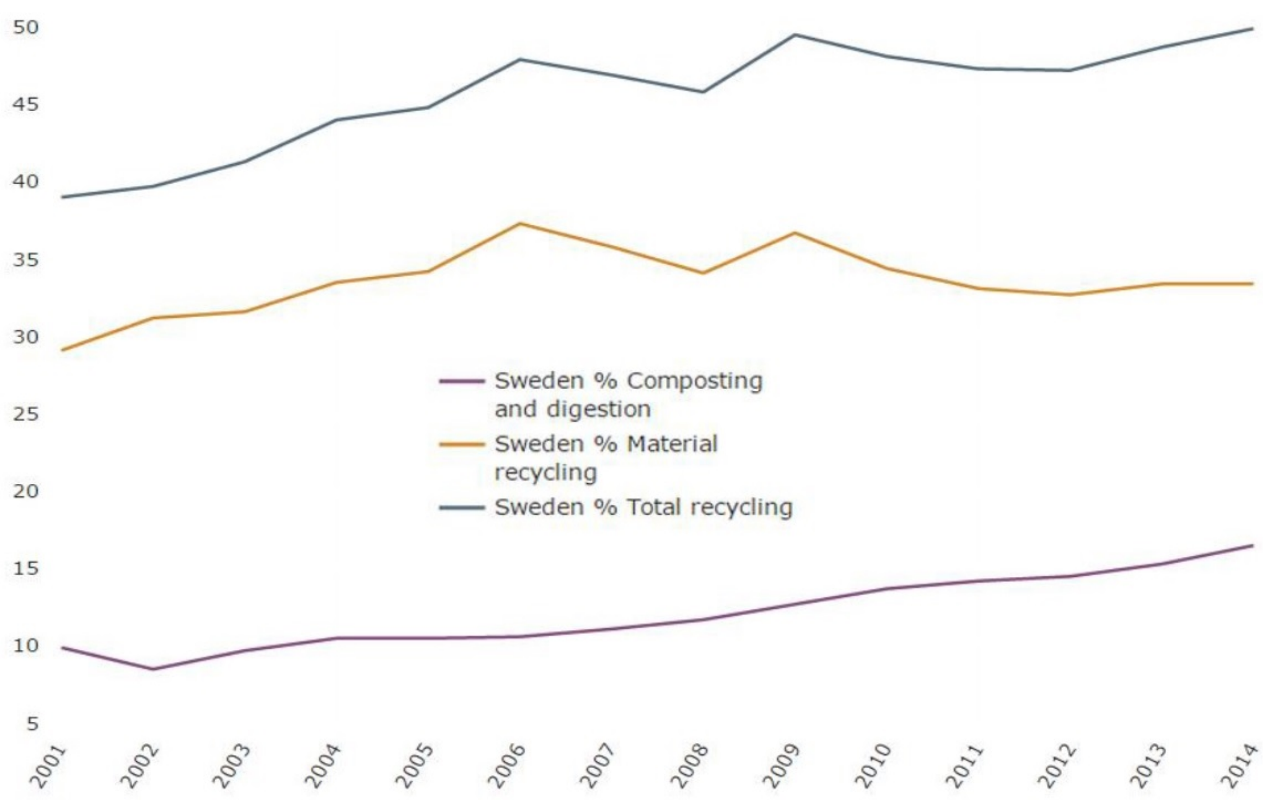


***Figure 9: Recycling rates of MSW in Sweden, 2001-2014 (EEA, 2016c)***

Sweden compiles data on economy-wide material flow accounts (EW-MFA), according to the EU regulation on environmental accounts (Regulation (EU) No 691/2011), but no indicators or targets are set based on EW-MFA data.

Combining the information above, the findings seem to align quite well with the research of Aoki-Suzuki et al. (2012) in the context of Asia. According to their findings, prerequisite drivers for countries to draw dedicated resource strategies and use MFA-based indicators include: (1) the volume of exports of manufactured goods is larger than imports; (2) resource imports are larger than exports; (3) typically show a high percentage of manufacturing sector in the total GDP; (4) high urbanisation levels and (5) large population. Sweden seems to lack some of above drivers (i.e. low resource imports, low urbanisation rate and low population) and therefore the need for drawing up a resource strategy is not yet apparent in the Swedish political context.

Despite this ‘unfavourable’ low-incentive environment for resource efficiency policy interventions, there is an active engagement of the Swedish government in promoting several initiatives that focus on resource efficiency strategies, especially in the manufacturing sector - an important sector of the Swedish economy. Recently, a large scale study investigating policy needs for resource efficiency in Sweden presented some of the most ambitious government policy initiatives and identified several significant gaps where further attention is required by the Swedish state.

The initiatives include (IVA, 2016):

- The new industrialisation strategy, launched by the government on the 21 January 2016 in order to strengthen corporate adaptability and competitiveness. In the strategy four focus areas are identified: Industry 4.0, Sustainable Production, ScientificBoost Industry and Testbed Sweden. The following points in the strategy are mostly related to Resource Efficiency:
    - Sustainable production:
        - Encourages business models that create value based on the Circular Economy.
        - Ensures that regulatory and other instruments facilitate resource-efficient and environmentally friendly sustainable supply chains.
    - Testbed Sweden:
        - Directs research and innovation efforts towards areas that have particular potential to contribute to New Industrialisation and long-term competitiveness.
        - Opens up the public sector industry to solve societal challenges in close collaboration with stakeholders at local and regional level. Increase the use of innovation procurement.
        - Makes it more attractive for companies to invest in and conduct R&D activities.
- Reduced VAT for repairs was announced by the government in January 2016, by halving VAT for repair of shoes and bicycles. The changes are proposed to apply from 1 August 2016.
- Investigation for the potential of the ‘sharing economy’. The goal of this investigation is to find ways to achieve a more resource efficient and Circular Economy through policy instruments that will stimulate producers, consumers and businesses to trade used products.

Apart from the initiatives above, the Centre for Resource Efficiency in Sweden (CERISE) is considered to be an invaluable resource for promoting resource efficiency in the economy. The Centre involves companies, authorities and research institutes, and its objective is to contribute to industries’ efforts to increase resource efficiency; improved energy efficiency; greater efficiency in the use of ecosystem services; increased competitiveness; and reduced environmental impact.

The gaps in RE policy considerations include (IVA, 2016):

- Use of material flows and cost analyses as indicators for efficient use of products and waste prevention in various economic sectors.
- Increased cross-sector collaboration, interdisciplinary thinking and systems approach that would promote diversification and alternative solutions away from the current approach in education and research, industry and policies.
- Traceability of related operations aiming at preparation for repair, refurbishment, reuse and recycling. Incentives for the design and development of products that simplify refurbishment, reuse and recycling.
- Increase the utilisation of products through ‘sharing economy’ and services.
- Well-functioning markets for secondary raw materials; most preferably in global markets.
- Increase the use of recycled and renewable material. New perspectives on resource use and resource social value need to be established.

# 5 Policies for REES

Taking into consideration (1) the theoretical background of Resource Efficiency and the concept of Circular Economy which has recently gained particular prominence (Ch. 2); (2) the identified barriers and drivers for resource efficiency and the enabling conditions for a transition to CE (Ch. 3); and lastly (3) the current policy landscape in the EU and particularly in Sweden (Ch. 4); the aim of this chapter (Ch. 5) is to open new horizons and pave the way for future policy considerations that address the issues discussed so far, and produce Resource Efficient and Effective Solutions (REES), based on a CE thinking, for the manufacturing sector in Sweden and beyond.

Policies for Resource Efficiency typically represent a rather complex and large-scale challenge (Ekvall et al., 2016). One material type is often used in many widely diverse applications and across different sectors in the economy. Moreover, the economic interdependencies of material streams in international trade complicate even further the situation by involving a multitude of independent actors in extended value chains across national boundaries.

Taking into account the specific conditions of each material application and each actor is practically impossible. Failing to respond to all these diverse messages from different actors would pose a risk that the policy interventions may shift the use of resources to other applications or regions in the world, rather than increase resource efficiency in the targeted applications or sectors in the national economy. Furthermore, efficiency gains obtained from improving resource efficiency would likely trigger increased consumption of the same good/service or of other goods and services, failing to fulfil its intended purpose and cause the so-called ‘rebound effect’ (Berkhout et al., 2000; Binswanger, 2001; Figge et al., 2014).

Therefore, policies aiming at enabling and facilitating the Circular Economy would need to be based on a systemic vision. This implies an explicit reflection on the desired roles and interdependencies of the major actors and activities in the future economic model. The vision needs to be comprehensive and recognise that a Circular Economy would be innovative and versatile, making use of the available resources. As such, the approach to CE policy interventions would differ depending on the functional area of economy and on the properties and availability of natural resources used to deliver the function or service. This means that an internally coherent policy would possibly require choices about priorities and preferences that may come at the cost of some other activities.

Policies supporting the transition to a Circular Economy and aiming to promote resource efficient practices within the economy and society at large would require embracing a systems innovation approach. Changes at the level of individual companies are necessary but not sufficient to overcome systemic challenges and lock-ins. The systems innovation approach has been advocated since the 1990s by innovation researchers exploring technological regimes, technological innovation systems and system innovations (e.g. Geels 2005, Kemp and Loorbach, 2006).

Policy making, as a start, should be as neutral as possible to allow for a broad range of alternative technologies to compete in the technological and innovation field and on the market, thus avoiding the potentially undesirable situation of regulators attempting to pick out winning solutions for a Circular Economy, that might be neither optimal not effective in catalysing the shift (Söderholm and Tilton, 2012). As a result, appropriate mechanisms for monitoring the progress of implementing policies against the original goals and anticipated results of the policy need to be established. So, it becomes apparent that another important aspect in policy making is the setting of relevant targets and the appropriate monitoring framework for measuring success. Targets would create a strong push effect in policies targeting resource efficiency and induce change towards this direction. Penal measures would also be considered as a last resort in cases of severe non-compliance, but for resource efficiency this would be rarely the case as exploitation of resources is an economic activity and not a criminal activity (except in cases of illegal logging, see for example the EU illegal timber regulation Regulation (EU) No 995/2010)

Finally, when talking about EU policies for CE, it is important to bear in mind that one of the most significant aspects of EU policy, leveraging the principles of the Circular Economy worldwide, would be the so-called 'Brussels effect'. The 'Brussels effect' refers to the indirect influence of EU policies on the production systems of other economic areas around the world (Bradford, 2012). By imposing certain regulations for compliance in the EU single market, the EU makes explicit the rules of the 'game' to all economic partners who wish to enter the single market and do business with European jurisdictions and as a result leading to a notable "Europeanisation" of important aspects of global production and commerce. Therefore, regulations on products, chemicals, waste trade, recycling and material resource specifications would indirectly – but firmly – be promoted in other economic areas of the world and influence their production processes towards increased resource efficiency.

## 5.1 Policy interventions identified in literature and policy documents

The following policy interventions have been identified in literature as promising approaches and prerequisite conditions for a transition to CE. The six policy interventions (sub-sections 5.1.1 – 5.1.6) target all relevant aspects of a product's life cycle at various steps in the value chain of Circular Economy, from extraction to production until final use and return back to the economy.

### 5.1.1 Promoting durability, reparability and remanufacturing

In a Circular Economy, the aim is to retain the inherent value of products in the economy by utilising a product as long as possible within the shorter loops of material cycling, i.e. reuse, repair and remanufacturing. Therefore, it only makes sense to start investigating the most appropriate way – in terms of policies, technologies and business activities – to establish increased material circulation in production processes (e.g. reuse) and to achieve ultimately high resource efficiency in the economy. In this sub-section the focus is on policies that would enable the inner loops of Circular Economy and address issues of product durability, repair, reconditioning and remanufacturing. The special characteristics of each of the aforementioned resource efficient solutions are discussed briefly in the following paragraphs coupled with the necessary interventions that would potentially lift the specific barriers identified.

Durable products, i.e. products that are designed to last longer or be easily repairable, hold the greatest potential to save resources by maintaining their operational utility longer while at the same time benefiting their users by saving money on replacement purchases. Currently, there is no formal or legally binding definition of durability in any EU country and worldwide, although there have been several attempts to define the term. One such definition is presented in a European Commission study (EC, 2015b; p.4): *'Durability is the ability of a product to perform its function at the anticipated performance level over a given period (number of cycles/uses/hours in use), under the expected conditions of use and under foreseeable actions. Performing the recommended regular servicing, maintenance, and replacement activities as specified by the manufacturer will help to ensure that a product achieves its intended lifetime.'*

According to this definition, durability and reparability of a product comprise integral design features that make it possible to maintain, upgrade and reuse or sell discarded products on second-hand markets for further use. Therefore, durability and reparability can be considered as the two faces of the same coin and should be addressed together (Maitre-Ekern and Dalhammar, 2016). In addition to design considerations, two more issues are of high importance for the durability and/or reparability potential of a product: (1) access to spare parts at reasonable cost, and (2) access to appropriate repair information. However, it has been observed that manufacturers often try to prevent other actors on the market from having access to spare parts, or from refurbishing and re-selling old products. In addition, manufacturers often hesitate to release product information that could facilitate repair activities, either by the product users or third party repairers (i.e. not affiliated with the manufacturers, the so-called "gap-exploiters"[4]).

[4] Gap-exploiters are actors who utilise "lifetime value gaps", overcapacity or leftover value in product systems due to the mixed product life of components, e.g. working modules in broken computers, leftover ink in printer cartridges, etc. Their

Moreover, there are several other ways to limit the reparability of products, such as creating incompatibilities between spare parts in old products with similar parts of more recent models, and preventing disassembly by using specific tools and screws or by using chemical adhesives to fit the parts together (Maitre-Ekern and Dalhammar, 2016).

There are several ways that policies can be utilised to foster durability in products, either directly or indirectly. One approach is to regulate durability in a direct manner, such as setting clear mandatory requirements on product lifetime (e.g. through the Ecodesign Directive 2009/125/EC). Other potential approaches that could directly influence durability include integrating durability information in energy labelling, or entering into voluntary agreements with industry over durability issues. On the other hand, there are several policy approaches that could affect durability indirectly, such as the adoption of legal measures that make products easier to repair or upgrade, for instance by requiring that spare parts are made available for a number of years after product purchase (e.g. the recent amendment of the consumer law in France – Law no. 2014-344); and by mandating manufacturers to provide information to repairers and remanufacturers that can facilitate repair and remanufacturing practices. A different legal approach is to mandate longer warranties for consumers, or require manufacturers to inform consumers about the expected lifetime of the product (Maitre-Ekern and Dalhammar, 2016).

Despite the potential of the abovementioned policy interventions, in reality it is quite challenging to include durability provisions both in binding ecodesign standards and in energy labelling for many product groups. The development of harmonised methodologies to measure durability and reparability across different product groups is considered to be a prerequisite for the application of such standards. In addition, the existence of threshold indicators and calculation methodologies for defining and validating the estimated life-time for specific product groups is critical. However, in the absence of such standards, it is rather challenging to establish a theoretical lifespan of a product for legal purposes and therefore any application of durability standards at the moment seems unlikely (with a very few exceptions, e.g. vacuum cleaners). Furthermore, in the case of spare parts, an important aspect that has been overlooked in the law-making process is the cost of the spare parts. More often than not, the major reason for consumers to purchase a new product rather than repairing their old is related to the associated costs. The cost of one spare part is often just below the price of the new product, and it is rather easy for retailers to convince consumers not to proceed with repairing their old product but buy a new one instead. This situation might as well further be aggravated if the consumer has to repair a product more than once. The added cost of all spare parts may quickly exceed the price of the product itself (Maitre-Ekern and Dalhammar, 2016). Therefore, a careful consideration of the pricing and availability of spared parts, in contrast to new production, should be prioritised and appropriate solutions should be devised in cooperation with manufacturers and retailers.

Apart from extending the life-time of products through durability, maintenance and repair, another very promising area of Circular Economy is remanufacturing, which enables the refurbishment and reconditioning of products to a level of quality, functionality and warranty that equals and competes with brand new products, while retaining the maximum of the value and resources in the old products. Remanufacturing is considered as one of the critical elements for realising resource-efficient manufacturing (Matsumoto et al., 2016). A remanufactured product should be practically indistinguishable from a new product from the purchasers' point of view (Walsh, 2010). The remanufacturing process consists of disassembling, cleaning, inspecting, repairing, replacing, and reassembling the components of a product to restore it to "as new" condition. Moreover, remanufacturing can also imply product upgrade by adding new and/or better functionality to used products (Matsumoto et al., 2016).

Despite the many potential benefits of resource-efficient remanufacturing, it remains still an under-exploited method of reducing environmental burdens deriving from manufacturing and material use in products (Walsh, 2010). The major manufacturing sectors that have established remanufacturing activities

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main revenue stream comes from selling excess of existing products, parts and services or from selling repaired products and parts worldwide include automobile parts, heavy duty equipment, aerospace equipment, machinery, medical devices, photocopiers, ink and toner cartridges, ICT equipment, vehicle tires, office furniture, and photo cameras. The automobile parts are the largest remanufacturing sector worldwide. There are also other sectors in which remanufacturing is slowly developing; however the remanufacturing of consumer products is still at a very early stage. Product categories that have only recently appeared on the markets, such as renewable energy generation systems and battery systems, are challenging areas for remanufacturing at the moment, but have a good potential for future remanufacturing (Matsumoto et al., 2016). Not all types of products are suitable for remanufacturing. Ideally, products that have the highest potential for remanufacturing show the following characteristics (Matsumoto et al., 2016): (1) stable product technology; (2) stable process technology; and (3) a physical lifetime of critical subparts that is substantially longer than the actual life-time of the product itself. However, attention should be paid to whether the remanufacturing process may contribute to overall resource efficiency, especially when taking into account the energy use of products throughout their life cycle. For products, for which use phase energy consumption dominates over energy used for materials production and manufacturing combined, incremental changes in use phase energy efficiency can significantly outweigh the claimed savings from materials production and manufacturing. For products with no – or constant – use phase energy requirement, remanufacturing can save energy and is considered the preferable option (Gutowski et al., 2011).

Typically, three categories of remanufacturing activities are distinguished in literature (Karvonen et al., 2015; Matsumoto and Umeda, 2011; Walsh, 2010), and these include: (1) the Original Equipment Manufacturer (OEM) which performs the remanufacturing itself; (2) remanufacturing performed by 'official' contractors/agents contracted by OEMs; and (3) independent or third-party operators, who perform remanufacturing activities without OEM approval or guidance. In the first two cases, OEMs retain at least some control over both the rewards and the quality of the remanufactured products, while in the third case OEMs remain completely uninvolved and unaccountable for the final remanufactured product.

According to Gutowski et al. (2011), the primary requirement for remanufacturing is that the disposed product has significant residual value left at the end of life stage. A second requirement is that the remanufacturing firm can effectively capture the end-of-life product. The third is that the product can be restored to a "like new" condition with only a modest investment. However, empirical data show that establishing remanufacturing systems for OEMs require large initial investments (e.g. it took over 10 years for Fuji Xerox and Fuji Film to recoup their initial investments), while for third party (independent) remanufacturers it might not be necessary to make large initial investments (in contrast to OEMs). OEMs, in general, pursue higher quality control levels and thus the cost for establishing remanufacturing systems increases significantly compared to third party remanufacturers (Matsumoto and Umeda, 2011).

In remanufacturing, the quality, quantity and timing of end-of-life products cannot be controlled as effectively as the supply of materials in manufacturing. This means that planning remanufacturing processes is a difficult task. Guide and van Wassenhove (2002) state that the effective handling of the quality, quantity and timing of returned products is a key component in creating a profitable remanufacturing system. However, it is noted that the most advanced OEMs do not regard remanufacturing – in principle – to be any different to business-as-usual manufacturing, and usually run both operations in parallel (Walsh, 2010).

Apart from remanufacturing as a "manufacturing" alternative, OEMs might choose to employ different business models to promote such an activity, including a product-service system (PSS) for remanufacturing. If OEMs are paid for the services they offer rather than the products they provide, the products and consumables become cost factors for the companies. In this case, the companies have a greater incentive to engage in remanufacturing operations rather than risking a conflict between new and remanufactured product sales (Matsumoto et al., 2016).

There are arguably a number of drivers behind a PSS for remanufacturing, including economic reasons, customer needs, and the competitive advantage that services can provide. Opresnik and Taisch (2015) show in a recent contribution, that the higher the level of PSS activities in a company, the stronger is the positive impact for remanufacturing. In addition, they show that PSS with remanufacturing can substantially increase the competitive advantage of both the provider and the consumer, despite the fact that some risks might be present when shifting the business model to PSS. Matsumoto et al. (2016) stress that there needs to be a drastic shift in the mind-set of employees, as a PSS requires different skills than product sales. There are also issues surrounding the costs of PSSs. Due to the high labour intensity, a PSS can be more expensive than selling a product. Furthermore, services provision increases the OEM's responsibility for uncertainty and risks, as e.g. in the case of leasing, where a PSS provider has to finance the capital costs and is paid back over a long period of time, which in turn increases the company's burden of financial risks (Matsumoto et al., 2016). Companies interested in remanufacturing and establishing remanufacturing PSS need to understand that they do not need to undertake all the additional activities. Instead, they can benefit from collaboration and there are several possibilities for organising the remanufacturing activities (Karvonen et al., 2015).

OEMs regularly face a multitude of challenges and obstacles in their effort to adopt and scale up remanufacturing systems. Barriers identified in literature are summarised below (Matsumoto et al., 2016; Karvonen et al., 2015; ERN, 2015; Gutowski et al., 2011; Matsumoto and Umeda, 2011):

- Effective collection of used products.
- Development of efficient remanufacturing processes (including efficient disassembly process and reverse logistics).
- Customer acceptance of remanufactured products.
- OEMs do not always have an incentive to remanufacture.
- Lack of technical information on third party products.
- Legal ambiguity, as there is no clear guidance on the use of remanufactured components in new products or whether remanufactured products need to be declared as 'second-hand'.
- Ambiguity of waste definition, as it is unclear whether remanufacturing activities are considered as 'waste processing'.
- Competition from lower cost products (often of lower quality and shorter life-time).
- Lack of technically skilled engineers for remanufacturing operations.
- Poor design for remanufacturing, particularly when remanufacturing is not embedded within the OEM culture, remanufacturing can sometimes be inhibited by poor design.
- Technology shifts, as advances in materials and electronics occur remanufacturers also need to make advances in their processing technologies to ensure that the end product matches the performance of new products. This includes energy efficiency, new materials and the incorporation of electric/electronic systems into traditionally mechanical-based products.
- Cost and availability of storage space, as storing large volumes of reused components is a large expense for remanufacturers.
- A lack of remediation techniques: in some sectors, technological advances in remediation are needed to ensure that remanufactured products match the performance of new products.
- Trans-boundary shipments of waste and the interpretation of Extended Producer Responsibility rules.
- International trade barriers/import bans for recycled parts/restrictions in cross-border repatriation of used parts are all barriers.
- High taxes can make remanufacturing prohibitively expensive in some cases.
- The End of Life Vehicle (ELV) Directive motivates dismantlers to focus on direct resale of components. Often products that could be remanufactured end up in scrap. A significant barrier is also that dismantlers work on ELVs up to 25 years of age, and thus parts are not very valuable.

In addition, another major barrier is related to the low awareness of remanufacturing among industrial actors, as identified by Karvonen et al. (2015) through a survey in the Finnish manufacturing sector. Remanufacturing was not known to responses, although one-third of the companies conducted remanufacturing or worked with a company that did. Although the survey was limited to the geographic location of Finland, it is an indication that similar low awareness might be observed elsewhere too.

Concluding, it is apparent in literature that remanufacturing is attracting a growing attention worldwide, however there is still a wide range of issues that require attention and further research. The promotion of remanufacturing in society requires cooperation and coordination of stakeholders, including OEMs, third party remanufacturers, governments, customers, and researchers of various disciplines. The research challenges for remanufacturing include (Matsumoto et al., 2016):

- Product and process design to facilitate remanufacturing
- Remanufacturing process engineering
- Remanufacturing process optimisation
- Business models to facilitate remanufacturing

Finally, there is a significant gap in research concerning a general framework of rules for products that return to the market after repair and remanufacturing operations. The question that remains largely unanswered concerns the legal responsibility for the remanufactured product once it is returned back to use. It will not always be clear who puts the product on the market, and when repair or remanufacturing may impede the rights of the original producer. Also, the unresolved legal issues include compliance to several EU rules, especially those concerning EPR. Another question is whether remanufacturing by third party operators actually breach intellectual property of OEMs over their products, and how such situations can be resolved in the future? The former issue is most likely to be considered of high importance by remanufacturers, as they do not want to become 'producers' in the meaning of some EU Directives, and thus being economically responsible for e.g. collection and recycling of waste products, among other responsibilities. Also remanufactured products may not comply with criteria put on 'new' products, such as energy efficiency requirements (Maitre-Ekern and Dalhammar, 2016).

### 5.1.2 Green Public Procurement and Procurement for Innovation

Governments and public authorities, apart from their role in policy, regulation, administration and monitoring, also exercise a significant leverage on the market as a large consumer of goods and services. The purchasing power of the public sector is reflected in the procurement of materials and/or services that facilitate the operations of public authorities, at local, regional and national level. When goods and/or services are purchased by a public organisation with public funds it is called public procurement (Edquist and Zabala-Iturriagagoitia 2012). The significance of procurement has increased in the public sector over the last decades and the EU is emphasising its role as a policy instrument for demand-side innovation (Edler and Georghiou, 2007). The inclusion of environmental requirements in the procurement process is defined as Green Public Procurement (GPP). Specifically, GPP is *'the approach by which public authorities integrate environmental criteria into all stages of their procurement process, thus encouraging the spread of environmental technologies and the development of environmentally sound products, by seeking and choosing outcomes and solutions that have the least possible impact on the environment throughout their whole life cycle'* (Michelsen and de Boer, 2009).

In its Communication on public procurement for a better environment COM(2008) 400 final the European Commission identifies public procurement as an effective instrument in promoting environmentally-friendly products and services and in encouraging eco-innovation, thus contributing to sustainable development. The objective of this Communication is to provide guidance on how to reduce the environmental impact caused by public sector consumption and how to use Green Public Procurement (GPP) to stimulate innovation in environmental technologies, products and services. EC stresses the need to define common green public procurement criteria, which ideally could be based on criteria used in the granting of the European Eco-label, or national ecolabels. GPP criteria are divided into two categories: (1) the 'core' criteria, designed to allow easy application of green public procurement and (2) the 'comprehensive' criteria which take into account more aspects and are based on higher levels of environmental performance, for use by authorities that want to go further in supporting environmental goals.

The application of these criteria is up to the governments and the public authorities to decide, according to their aspirations for resource efficiency. However, the way the demands are made in the contracts affects the outcome of sustainability and innovation. There are two ways to make demands in public procurement, the ‘functional demands’ and ‘specific demands’. An important aspect which should be considered when looking at the possible outcomes of the demands made in GPP contracts is the indirect effects. The direct effects are most important for large markets and purchasers, while the indirect effects are crucial when the direct effects are small (Marron, 2003). Three examples of indirect effects are identified by Marron (2003): (1) there is induced innovation when GPP creates a niche market and leads to the development of new products, technologies or services. This is usually most effective in the early stages of the innovation process and when the procuring governmental entity is large and with a long term strategy; (2) when the purchaser is a large consumer, the consistent demand created by GPP can lead to cost reductions for the production of new technologies and products; and (3) the government can act by setting an example.

In Sweden, public authorities consume 16-22% of GDP (Edquist, 2014) and hence have the potential to influence the market, not the least if the indirect effects are included (Marron, 2003). Research shows that GPP has a positive influence on the Swedish market, as the stipulated environmental requirements in public purchasing have increased and work with environmental requirements is improving (von Oelreich and Philp, 2013). However the progress is patchy and there are significant differences between local authorities and within the authorities when it comes to aspects of sustainability (Preuss, 2007). A lot of research addresses this problem and is looking to identify barriers to GPP (Günther and Scheibe, 2006; Grandia et al., 2013; Bratt et al., 2013; von Oelreich and Philp, 2013; Guenther et al., 2013; Preuss, 2007; Marron, 2003) where commonly identified barriers include: size of the governmental entity, the actors involved in the procurement process, lack of knowledge within and between involved actors, lack of strategic approach and costs.

One reason for the differences in the success of GPP in municipalities and regions can be related to size. A case study of Norwegian municipalities and regions shows a correlation between the size of the municipality and GPP, where GPP is significantly more established in larger municipalities, while smaller municipalities might have to collaborate. Larger municipalities also to a higher extent have a purchasing department and a purchasing strategy, which is seen to be important in order to develop effective GPP (Michelsen and de Boer, 2009). Also Marron's (2003) findings show that GPP is more effective when the government sector is a large co-ordinated purchaser of products.

A commonly identified reason to why GPP is not used to full potential in municipalities are the obstacles set by different key actors within the public procurement process (Günther and Scheibe, 2006; Grandia et al., 2013; Bratt et al., 2013; Brammer and Walker, 2011). Market, state, citizen, procurement department, finance department, environmental department and users are actors often involved in the process and can all be sources for ‘disturbing factors’ such as: no goals, no regulations, no information, no knowledge or no incentive system (Günther and Scheibe, 2006).

Another weakness seen in the procurement department is the lack of guidance from clear definition of resource efficiency in the selection of criteria, where the competence in working groups is not broad enough to cover strategic sustainable thinking (Bratt et al., 2013), more collaboration is therefore needed between purchasers and people knowledgeable in resource efficiency strategies.

Since the knowledge about GPP is limited in many municipalities, a need for the national authorities to provide guidance and templates for GPP is brought up as important by von Oelreich and Philp (2013). However, if policies are conflicting and setting unclear or unrealistic goals, it creates uncertainty for the procurers instead of help (Sporrong and Kadefors, 2014).

The possibility to use GPP as a pro-active tool for resource efficiency is not fully utilised. Short term decisions are often made to comply with procurement law and the criteria is often adopted for existing products and services on the market, while innovative product-service system solutions are not stimulated. It is therefore important to set objectives for both short and long term, which are defined, agreed upon and understood within the whole group (Bratt et al. 2013).

To overcome this barrier and allow innovative products or services to enter the market, governments have also a big role to play by promoting a different approach to procurement, the so-called Public Procurement for Innovation (PPI). The Government Offices of Sweden define PPI as *'the procurement that promotes the development and the introduction of new solutions and innovations. Innovation procurement includes both procurement that takes place in such a [way] that it does not exclude new solutions, so-called innovation-friendly procurement, partly procurement of innovation, i.e. procurement the development of new solutions that have not yet arrive on the market.'* (Regeringskansliet, 2012: p.55)

Main barriers for innovation reported by the suppliers' side point to the lack of interaction with the procuring organisations and over-specified demands in tenders as opposed to outcome based specifications. Low competence of procurers and poor managerial decisions of the procuring entities could also pose risks during the procurement process. Such barriers are perceived most strongly by R&D intensive organisations. Particularly, smaller firms and not-for profit organisations encounter greater difficulties with innovation arising from the procurement process (Uyarra et al., 2014).

Finally, Witjes and Lozano (2016) studied the possibility of introducing a new form of procurement combining the aspects of PSS with the function demands from public organisations. In this case, the main objective of the tendering negotiation between supplier and procurer switches from product oriented procurement to PSS (see Mont, 2002, for PSS definition), thus switching from a price per product unit to price per delivered service, as the functional unit of the tender negotiations. As a result, increased collaboration between procurers and suppliers can lead to reductions in raw material utilisation and waste generation, while at the same time promoting the development of innovative and more sustainable business models (Witjes and Lozano, 2016).

### 5.1.3 Strengthening secondary resource markets and optimising EPR

Waste has traditionally been considered as the endpoint of economic life of a product and can be described as an 'archetypal externality' (Moore, 2012). So far, conventional waste management was driven by efforts to minimise the costs of collection and disposal and identify the most cost-efficient option among landfilling, incineration and recycling (Stahel, 2016). However, in the face of increasing environmental pressures from waste management and the sheer quantity of waste generation, it is considered that an effective strategy for decreasing the environmental impacts of waste management is in most cases recycling (Finnveden et al., 2013).

In a Circular Economy, the objective is to maximise value at each stage of a product's life cycle. Therefore, new systems for capturing this value are needed at each step of the chain (Stahel, 2016). Despite the fact that it is relatively commonplace to extract additional value from end-of-life goods through recycling or recovery operations, this is generally not reflected in the mechanisms of product design, pricing and market regulation. Quite the contrary, the exchange of waste, and in particular of hazardous waste, has largely been an activity flirting with informal, sometimes even illegal, transactions (Kama, 2015). Also, Gregson et al. (2015) points out that such practices, which also expand to the global market, create an antithesis in EU aspirations for a Circular Economy which call for high-quality recycling. Publications around the EU 'Roadmap to a resource efficient Europe' recognise a 'dirty trade' challenging the EU vision of a recycling society, while EC documentation refers to the shipments of wastes outside the EU as an 'illegal trade' resulting in 'significant loss of resources for the EU' and links this to key areas of resource insecurity (Gregson et al., 2015).

Therefore, if the EU aims to turn waste into resources, this would certainly require the holistic transformation of the waste management sector into a secondary resource recovery sector, coupled with its integration with the manufacturing sector, which at the moment continues to rely heavily on virgin resources, and extended (intra EU or even global) markets of recyclables.

Policy interventions that aim to increase recycling of a certain material should take into consideration whether there is a well-established and functional international recycling market in place or not. For materials where such a market exists, policy instruments should primarily focus on increasing the collection for recycling. The collected recyclables can then be assumed to substitute the demand of virgin materials in the international market where the two commodities (virgin/recycled) compete. In that case, Finnveden et al. (2013) argue that a policy instrument that focuses on increasing the use of recycled materials only in Sweden may be relatively ineffective in a situation where the established recycling markets are international. As an isolated support for use of recycled materials in Sweden may result in lower recycling rates in other countries, and therefore not contribute to increased resource-efficient use of the material. Preferably, such policies should be combined with instruments supporting the supply of recyclable materials in order to increase global recycling (Söderholm, 2011).

As the markets for recyclables are expanding nationally, but most importantly internationally, several issues arise concerning the functioning and properties of such markets and their actual contribution to the Circular Economy vision. Nicolli et al. (2012) point out that there is a significant risk of high search and transaction costs associated with recyclable materials in secondary markets, related to incomplete information. Users and suppliers of recycled materials may find it hard to locate and communicate effectively with each other. There could be a lack of information concerning the quality and properties of potentially recyclable or reusable materials and products, which usually poses a barrier to the successful completion of a transaction between the parties. Moreover, the provided information quite often is asymmetric, in the sense that the supplier holds a negotiating advantage by knowing more about the quality or properties of the material or product than the potential buyer does. In such cases, a broad range of policy instruments can be used in order to support the markets (Finnveden et al. (2013). The establishment of harmonised quality standards for recycled materials and/or certification schemes could be useful in overcoming such barriers. Also requirements to provide information on the content of materials in products, before these turn up as waste for recycling, may be useful for determining the output quality of the recycling process. Other examples of policies for reducing information asymmetries in secondary materials markets include support to industrial symbiosis networks by removing institutional barriers for increased recycling of industrial by-products and wastes, support for establishing information hubs or hiring waste brokers. Many of these initiatives exist already today, but there is a need to investigate and develop these instruments further (Finnveden et al., 2013).

A critical issue discussed already above is the quality of recycled materials. Apart from the need to communicate the quality of the recycled materials on the market, as presented in the previous paragraph, there is a need to achieve this quality in practice at recycling facilities. Although the technology aspect of recycling operations is important, another aspect that might be considered even more important or critical is the operations preceding the recycling plant. The design and use of certain materials in a product, the collection systems (level of separate and clean collection of materials) and efficiency of the sorting operations (sorting out single materials from mixed waste fractions), are considered fundamental in increasing recycling in quantity, quality and efficiency (Gregson et al., 2015). This issue becomes more relevant in the current technological status of manufacturing, where products are increasingly made of technical materials in composite forms and with increasing use of chemical adhesives. The treatment and recycling processes established today are able to recover only a limited amount of these technical materials. What is left becomes waste or contaminants in secondary materials, and as a result a share of the resources embedded in these materials is lost (EEB, 2015). Therefore, policy interventions clearly should target cleaner material flows and separate collection systems that will be able to safeguard a minimum quality of inputs for high quality recycling.

Furthermore, it becomes increasingly apparent that pre-existing technologies of waste treatment do not fit to the CE goal of recovering secondary resources from waste materials. For example, the United Kingdom is struggling in managing high volumes of low quality recycling outputs, while systems in Sweden are struggling with how to shift from energy recovery to recovering materials, given its infrastructural commitments to expanding incineration capacity and the need to change incentives for different actors in the value chain (Gregson et al., 2015). Policy incentives should help shift away from incineration and low quality recycling output to developing cleaner material cycles and high quality recycling. However, the policy interventions in the recycling sector should be carefully considered to not only provide direct support for recycling that reduces the downstream impacts of technological externalities (i.e. cost-effective recycling), but also influence the upstream incentives to internalise such externalities (Söderholm and Tilton, 2012). For instance, if resources are allocated towards the development of sorting technologies that enable the recycling of composite waste fractions, product designers and manufactures will be discouraged from redesigning their products, as the advanced sorting technologies will take care of their composite products. This situation is quite common in environmental policy, also called the 'chicken-and-egg' dilemma (Dalhammar, 2016). Policymakers are usually hesitant to set new regulations unless there are systems to prove compliance to the related regulatory requirements, while on the other hand industry has little incentives to develop costly compliance systems without imminent regulation.

A related policy that would incentivise such attitude from industry is that of 'Extended Producer Responsibility' (EPR), developed by Thomas Lindhqvist in the 1990s and defined as *'an environmental protection strategy to reach an environmental objective of a decreased total environmental impact from a product, by making the manufacturer of the product responsible for the entire life-cycle of the product and especially for the take-back, recycling and final disposal of the product'* (Lindhqvist, 2000). Furthermore, Lindhqvist (2000) specified that the concept '*Extended Producer Responsibility is implemented through administrative, economic and informative instruments. The composition of these instruments determines the precise form of the Extended Producer Responsibility'*.

The numerous requirements on the producers could sufficiently motivate to develop products that are more resource-efficient, easier to recycle and that do not contain hazardous substances. In general, EPR has three goals: (1) to stimulate recycling and as a result reduce the use of virgin resources; (2) to reduce the consumption of waste-generating products; and (3) to increase recyclability of products. In the current practice of EPR systems in Sweden and EU, the concept has succeeded in promoting the realisation of the first two goals, but the fulfilment of the third objective has not received high attention (Hage, 2007).

Producers seem to believe that EPR rules can no longer provide design incentives for recyclability, as also discussed above, but the national authorities and municipalities that set up and run such systems still believe so and support such systems (Dalhammar, 2016). The way the current EPR systems are set up, involve several actors in the take-back and recycling systems, and therefore the valuable waste materials will end up with third parties and not with the producers themselves. In addition, actors outside the EPR schemes are increasing their efforts to receive more valuable waste materials (Kunz et al., 2014). For these reasons, producers cannot reap the benefits of improved eco-design themselves, as they will not get the materials back. With increasing resource prices though, manufacturers might be interested in getting their products back in order to recover the material values (Kunz et al., 2014). Therefore, if the EPR system is set up by a company/producer as an individual system (IPR) then the producing companies might find it beneficial to reduce the costs of recycling by better product design. As it is today, in the case of collective EPR, the incentive of better design and reduced costs of recycling does not exist, and the technological externality then remains in the product. A legal requirement for design for recycling may in this case be more effective, rather the EPR scheme. Such a requirement could possibly be introduced in the Eco-design directive (Finnveden et al., 2013).

Another interesting finding from literature is that industry actors hold the belief that resource prices would always be more important than any legal requirements in promoting recycling and/or eco-design of products (Dalhammar, 2016). A further implication of the EPR system, concerning the issue of inducing design changes, is the fact that it cannot account for products that are produced in other jurisdictions, outside the confines of the system. Importing companies may participate in take-back and recycling schemes fulfilling their EPR requirements, but apart from managing the cost-effective recycling of the products, they have absolutely no power to influence the design in the originating county, probably far away from the point source of waste.

Currently, in Sweden there are eight EPR schemes for eight corresponding product groups (batteries, cars, tires, electrical and electronic products, packaging, paper, pharmaceutical and radioactive products). In addition, there are voluntary commitments, similar to producer responsibility, for office paper and agricultural plastic. Perhaps it would be worthwhile to investigate if there are more material groups that from an environmental or resource efficiency point of view would be interesting to include in EPR schemes (IVA, 2016).

### 5.1.4 Resource–labour tax shift (green tax reform)

The idea of a general shift of taxation from labour, as it is the common practice today, to natural resources is not a new one. One of the most prominent proponents of this idea over the last decades is Swiss architect and academic Walter R. Stahel, who exemplified his ideas in a recent publication, see (Stahel, 2013), following this line of thought for improving resource efficiency in the economy. In principle, as taxes play a very important role in steering the economy (both intentionally and unintentionally) it is common sense to look for solutions there first. The type and level of taxation should be adjusted in order to better reflect the effects of value creation and value extraction in the economy, taking into account possible externalities. From a purely economic perspective, a tax that incorporates the externality approach ensures that the marginal costs of the external effects will be reflected in market prices, and therefore market actors will take these into account in their mutual transactions. In this way, the consideration for the environment in economic activities will become visible and its costs identifiable. Some external effects will most likely persist, but as a price is allocated to natural resources (the 'environment') the benefits of a given economic activity will need to exceed the social costs imposed. As a result, producers may choose to employ more labour and less 'environment' by promoting resource efficiency strategies, such as reuse, remanufacturing or recycling (Andersen, 2007).

According to Stahel (2013), the transition to a Circular Economy can be accelerated by only one simple shift in public policy, that is, adapting the tax system to the principles of sustainability by not taxing renewable resources, including labour. In principle, Stahel (2013) continues that sustainable taxation should reward desired developments in society and the economy at large and discourage unwanted effects of economic activities. In a sustainable economy, taxes on renewable resources including human labour are viewed as counterproductive and should be abandoned. The resulting loss of state revenue could be fairly compensated by taxing the consumption of non-renewable resources in the form of materials and energies, and of undesired effects, such as waste and emissions. Such a shift in taxation would promote a Circular Economy which aims at reduced material throughput.

Environmental taxes in general are considered to be 'growth-friendly', as they are less distortive compared to taxes on labour and income, while the administration and transaction costs of such taxes are lower than that of other taxes (notably income taxes). Furthermore, the efficiency losses from environmental taxes are far smaller than for labour taxes (Andersen et al., 2014).

By the tax shift, the cost on labour will eventually decrease while the cost (prices) of products will increase. This in turn will result in diminished purchasing power of consumers in terms of products acquisition (higher prices), but services (not affected by resource taxes) will become more affordable for consumers to buy. Finally, this could lead to reduced material resource use and promote resource efficiency in the economy as a whole. Moreover, when taxes on labour go down, human resources (manpower, craftsmanship and knowledge development) become more affordable. This creates the opportunity for businesses to employ a variety of alternative solutions, favouring labour-intensive business models such as repair and maintenance services, remanufacturing of products and R&D. A lower tax burden on labour also favours sectors such as healthcare, education and scientific research.

Stahel (2013) also notes that high labour taxes, despite bringing revenue to governments, indirectly affect the levels of employment in society and therefore impose additional costs for governments which might outweigh the importance of the tax revenue. Unemployment is considered as a cost in society that governments have to pay (at present), as well as a major cost for the education system (at least in some countries, e.g. Sweden) which prepares people for finding a job tomorrow. Therefore, the cost is double and usually not accounted for in general tax effectiveness assessments.

Moreover, the architecture of modern European tax systems originated from a point in time when globalisation and movement of labour was not yet as prominent as today and the tax system took the presence of labour in the economy as fixed.

Baptist and Hepburn (2013) support Stahel's idea but recognise that it remains largely hypothetical, and that it has not received yet wide attention in political thinking or actual implementation. In fact, they note, that implementation could be extremely difficult in the real economy. Taking into account the fact that the current share of labour tax compared to energy/material taxes is much higher, a potential tax on material resources would have to be set at an extremely high level in order to maintain net government income, and this would give a significant first-mover disadvantage to industries in any country beginning the switch. Especially in Sweden, the share of labour tax in relation to the total taxation is very high, the highest among all other EU Member States (Figure 10), at 58.6% in 2012 (Eurostat, 2014). At the same time the share of environmental taxes is rather low, at 5.6% in 2012, which corresponds to the fourth lowest in EU28 after Belgium, Spain and France (Eurostat, 2014).

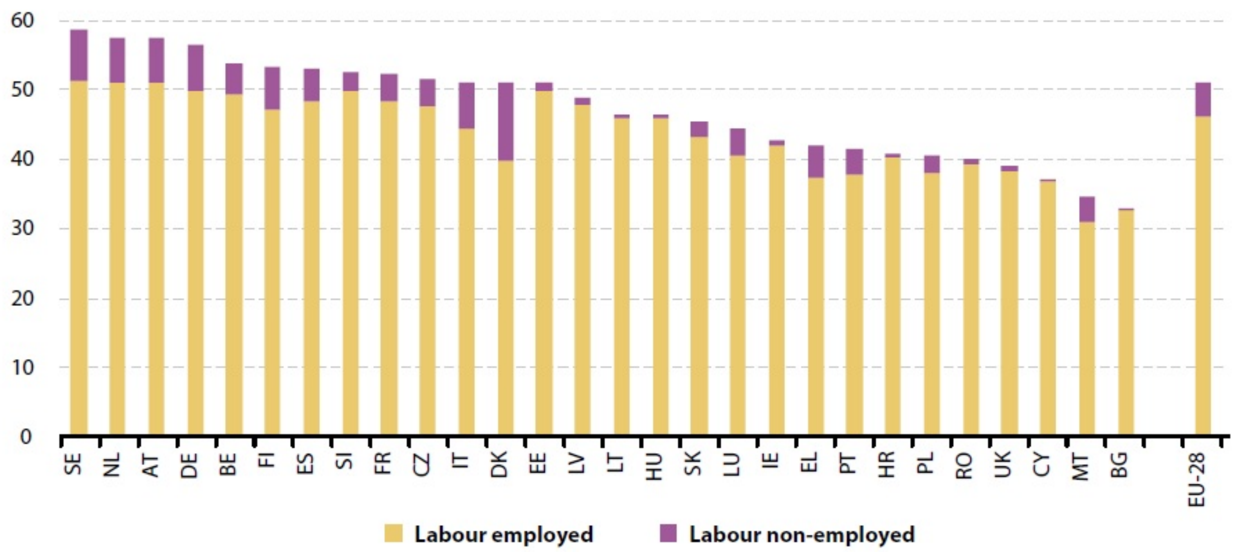


***Figure 10: Taxes on labour as a percentage of total taxation in 2012, EU28 (Eurostat, 2014)***

It becomes apparent, that there is room for a tax shift in Sweden; however the high dependency on labour taxes might incur some deficiencies in the implementation of the shift, unless the resource tax level is adjusted to appropriately high levels. The appropriate level of a potential tax will be discussed also further below.

The effects of a tax on material resources differ according to the phase of the value chain to which it is applied, mainly due to diverse material-demand strategies and the available innovation options that industrial actors can employ. In particular, demand elasticity to price (and then to the tax), as well as market dynamics and innovation possibilities can vary at different phases of the value chain of a material. For a single non-renewable material resource, there are three stages in the value chain in which a tax could be applied (ETC/SCP, 2015):

- Extraction of the raw material
- Input of the material at the first industrial use
- Final consumption of products with embedded material content

In order to achieve a positive reaction from industrial users or consumers resulting in resource- efficient practices, the material tax level needs to be sufficiently high regardless of where in the value chain it is applied. As this high tax rate might cause considerable economic change, high adaptation costs and most importantly opposition from stakeholders, the resulting environmental and resource net benefits should be carefully assessed (Ekvall et al., 2016). The material tax in itself could be expected to have moderate effect because own-price elasticity of demand is often low for materials. Therefore, the development of material taxes requires some additional considerations before they can be implemented. Notably, issues related to imports and exports may be problematic and need some further attention (Finnveden et al., 2013).

A material extraction tax imposed in a country/region would directly affect international trade of the targeted commodity. The tax would put domestic producers at a cost disadvantage compared to foreign producers, leading inevitably to the reduction of domestic extraction, a corresponding increase in imports, and potentially, depending on demand elasticity to price, a total demand reduction for the material in question. The increase in imports would imply increase in production activities in third countries, and while there might be no apparent effect of resource extraction and use, in terms of the extracted material the net environmental effect could possibly be negative if the technologies abroad are worse than domestic ones (ETC/SCP, 2015).

Therefore, counterbalance measures would be required to neutralize the negative environmental effects of such shift in production location that a resource tax would possibly lead to. ETC/SCP (2015) proposed the introduction of a border tax adjustment (BTA) on imported minerals. In addition to neutralising the effects of a tax on domestic producers, BTA would also act as a shield for the competitiveness of domestic industries. The effect on the competitiveness of the Swedish industry, however, would be much smaller if the tax is not calculated on the basis of the quantity of materials extracted in or imported to Sweden, but on the estimated quantity of non-renewable raw materials that are extracted to produce products that are used in Sweden (Finnveden et al., 2013). Other measures that could potentially prevent competitiveness losses for the Swedish industry could be to levy the tax on materials and products used domestically in Sweden, including on imported products as well as on domestically produced products, but exempt materials produced in Sweden for export.

In the case of a material input tax, which means tax levied at the resource input of manufacturing (the first time a material in used) differs from a resource tax at the production of the material (extraction based), as a supplementary BTA is not needed because this type of tax does not distinguishes between domestic and imported materials. However, it would be fair to be complemented by a BTA on the material content of imported intermediate and final products. In order for such a tax to be easily implementable, the main requirement would be that there are limited product groups subject to this taxation. In other case, the implementation would be quite challenging (ETC/SCP, 2015).

A material input tax, like the one described above, could instead of encouraging substitution of the taxed material, stimulate technological innovations aimed at reducing the use of that material by for example, 'light-weighting', which would be very favourable in terms of resource efficiency. However, if material-saving innovations were not available at the time of imposing the tax (or at an early stage of development), then the full deployment of such innovations could only be achieved if the level of taxation is high enough so as to outweigh the cost of fully developing the technological innovation. Furthermore, given the complexity of material-intensive manufacturing products, such as cars or consumer electronics, it is likely that material saving innovations would require overall product redesign, which can have unpredictable effects on the material mix (ETC/SCP, 2015).

The last possible phase for introducing a recourse tax is at the final use of products. Tax on the consumption of products that include large amounts of a specific resource is possible, however, its application might prove rather challenging and its effectiveness uncertain. There could be significant problems in identifying the share of a specific material within a final product, making the taxation base uncertain (ETC/SCP, 2015). Taxation at this stage might be better thought of as a tax based on the intensity of multiple materials, possibly taking a life-cycle analysis (LCA) perspective. Andersen (2007) argues that once reasonable estimates are available for the external costs of a product, it would be possible to internalise these in market transactions by introducing relevant environmental taxes and charges. This allows for a first theoretical approach on the application of PEF-based (Product Environmental Footprint based) taxation structure. The latter would be interesting to investigate further, however, the sheer amount and diversity of products and product groups would be a formidable challenge, to say the least.

Increasing recycling is a basic principle of resource efficiency. Taxation schemes based on input or consumption taxes would ideally target only virgin materials, and not their recycled equivalents. This could pose challenges in designing taxes for metals as the recycling rates of many, including steel and copper, are already quite high (ETC/SCP, 2015). Furthermore, with the expansive global recycling markets, recycled metals such as iron could be easily integrated into intermediate products and parts and their detection in final products would be really difficult. Ekvall et al. (2016) on the other hand, suggests that the tax should be applied also on recycled materials since it aims specifically to increase material efficiency and therefore the reduction of material inputs regardless if the material is virgin or recycled. He continues that a materials tax should be levied on all types of materials in order to avoid burden shifting between materials. It could be levied even on renewable materials, as renewable resources need also to be used efficiently, because their production rate is limited.

The possibility of substitution constitutes a critical factor for the effectiveness of resource input and consumption taxes, and forms a major drawback if designed to address a single material resource. Possible side-effects include (ETC/SCP, 2015):

- Taxing a single material might result in substitution rather than overall resource efficiency
- Substitutes of the taxed material may have other unpredictable environmental disadvantages, such as higher energy intensity or lower recyclability

Taxing material groups could be a better approach, but that might shift the problem to comparing the material groups themselves, for instance plastics versus metals, instead of single material groups, such as copper versus aluminium (i.e. metals).

Concerning the reuse of products, Stahel (2013) identified that a tax on resources would increase the comparative advantage of used goods in two ways: (1) through lower labour costs in service-life maintenance activities; and (2) through higher raw material costs in competing manufactured goods.

Concluding, the research performed by the European Topic Centre on Sustainable Consumption and Production for the possibility of resource taxation in Europe shows that even under trade-neutral taxation schemes based on a material resource tax and supplemented by BTA, it is not likely that a European-level or country-level tax on a single material resource would effectively materialise, since such a tax raises significantly the risk of cross-material substitution effects with uncertain resource and environmental implications. However, a global multilateral extraction tax on all non-renewable and non-energy resources, could be considered. Its expected effect would lead to a global price increase of resources, resulting in global demand reductions. The actual design and implementation of such a resource tax, however, would be far from simple in the current global political environment (ETC/SCP, 2015).

Lastly, it is worth mentioning the proposition by von Weiszäcker and Ayres (2013), who suggest a 'ping-pong' adjustment between resource productivity and resource prices. If resources become scarce but there are abundant human resources available, then the overall economic benefit from a shift to resource productivity while slowing down the increase of labour productivity should be positive (and vice-versa).

### 5.1.5 Other economic instruments

The importance of economic instruments for a transition to a Resource Efficient Circular Economy is analysed in the previous section in terms of resource taxation and the shift of taxation away from labour. However, there is a variety of other economic instruments that could incentivise such a transition and in this section a few of them are presented. The economic instruments below have been identified in literature (e.g. IVA, 2016) as promising measures for inducing resource efficiency in the economy.

**Subsidies –** Direct subsidies are considered as useful tools in the effort to promote the use of recycled materials in manufactured products increasing their overall resource efficiency. However, the introduction of subsidies should be generally considered with caution. There are many reasons for this, as subsidies negatively affect government finances and the tax basis as a whole, could affect national exports and imports and could be incompatible with EU state aid rules. Furthermore, subsidies sometimes cause market failures, if introduced without sufficient regard to other potentially affected sectors or to other policies.

Subsidies are more easily accepted and implementable for promoting research and development of new technologies with increased environmental or resource efficiency performance. In that case subsidies should not be permanent, and not be technology specific but induce general innovation in different fields and in different directions.

Finally, but most importantly, there is an urgent need for removing environmentally harmful subsidies. This would result in a benefit for the environment and at the same time remove distortions from the market, which makes the economy more efficient. This economic instrument could also be important for making the shift in taxation (as described in section 5.1.4) easier to communicate and comprehend in the public sphere (Ekvall et al., 2016).

**Differentiated VAT –** One way to lower the price of resource efficient business models and products is by introducing a VAT reduction. Many countries have differentiated VAT rates. Sweden has traditionally been restrictive with multiple VAT rates, as it creates inefficiencies and increased transaction costs, and because they have some of the negative effects mentioned for subsidies.

All commodities have both environmental benefits and disadvantages, and it is difficult to identify the products that are as per definition 'environmentally friendly'. A bicycle might be seen as one of the few products that only have positive qualities from an environmental perspective, but also such a claim would be challenged depending on the technology and context. For many products it is more complex to identify their environmental impacts, while for some others (products or services) it is clear that they are harmful to the environment.

One aspect of the proposed VAT reduction is that it only provides incentives to repair one type of product (while excludes others), which in other words gives no incentive to reduce environmental impact per se. In addition, changing conditions over time makes it more difficult for the authorities to design an accurate VAT reduction, which can be a problem if the environmental impacts of products under reduction change over time. Longer life cycles of products are not by definition always resource-efficient. The challenge is to develop tools that handle any distortions in the decision between buying new and used.

**Repair Deductions –** Repair deduction is defined as a tax credit for performed repair services. Repair deduction is considered as a good driving instrument but the same problems that are discussed above, concerning the proposal for reduced VAT on repairs is also valid here. The purpose of a repair deduction is the same as the VAT reduction for repairs, but it is considered that it would be easier to control the conditions of repair in a more precise way with repair deductions than is possible for the VAT reduction. This could be a possible advantage but here further investigations are needed to specify what products and what repairs will be included.

**Repayment of charges and bonus malus –** The introduction of charges should not necessarily lead to a larger public sector, just as in the case of green tax reform. A charge is different from a tax in a way that it is a payment to an agency or municipality with the intention to cover the cost referred. Repayment charges are an example of a revenue neutral structure. The charges that are paid are refunded to the companies concerned. Companies pay an amount in proportion to their emissions and refunded in proportion to their production. The net effect of the instrument means that companies with emissions that are higher than average, make net payments to companies that are cleaner than the average.

There are several advantages to pay charges against taxes. Firstly, charges can lead to easier political acceptance as the net charge becomes smaller and in some cases leads to repayments. A further advantage considered is that the charge rates may increase, thus giving even stronger incentives to reduce emissions.

Bonus malus is a kind of system of repayment fees. The concept originated in France, but it has also been used in Sweden. The system is mainly used in new cars where those who purchase a less polluting car get a bonus while those running in fuel-intensive consuming vehicles are punishable by a penalty, which is then used to finance the bonus. Bonus malus thus becomes self-financing.

### 5.1.6 Sustainable Consumption

Consumers in a Circular Economy hold a central role in accepting and adopting changes in business models that promote resource efficiency. In a Circular Economy, the consumer is called to transform its identity from a 'consumer' (a word that implies the destruction or disposal of a product after use) to a 'user' who will have the possibility to use products and services over and over again without losing the value, utility and satisfaction that the product or service intended to deliver.

'Sustainable consumption' is a complex issue that lacks clear definition (Geels et al., 2015; Mont and Dalhammar, 2005) and it is often used as an umbrella term that brings together several key topics relating to human needs, quality of life, consumer safety, and resource efficiency, just to name a few. Consumption can be distinguished in two separate elements: (1) consumption patterns and (2) levels of consumption (Mont and Dalhammar, 2005). While the need to address consumption patterns through greening markets and products finds relatively broad support, dealing with consumption levels encounters wide opposition of numerous stakeholders (Stahel, 2001; Princen, 2003). There is a variety of different views on sustainable consumption from businesses, consumers, NGOs and governments. However, there is no significant government intervention in this area so far, as sustainable consumption is considered a politically sensitive field (Mont and Dalhammar, 2005).

In her paper 'Consumption at the core of the growth engine', Inge Røpke (2010) argues that consumption, as a function of the economy, is reflected within a supportive framework of cognitive understandings and policies. The cognitive understandings include the conception of economic growth as an absolute good, as well as other related conceptions, for instance, that welfare is directly connected to income; economic growth in affluent countries has positive impacts on poor countries through the demand for their products; free trade is good for all involved partners; markets and sound competition work for the common good; technological change is synonymous with social progress; and environmental problems can be solved by more efficient technologies. These ideas are still dominant and strongly reflected in policies such as the promotion of free trade, competitiveness, privatisation and liberalisation of markets, consumer policies focusing on low prices, etc. Røpke (2010) also supports the idea that the effort towards influencing consumption should rely on the significant increase of resource prices.

Mont and Dalhammar (2008) take on the economic perspective that underlies the policy-making process. Policy makers typically employ assumptions grounded in neo-classical economics, which see consumers as utility maximisers with inherent rationality expressing their preferences in a formal market. In policies employing such assumptions, inappropriate price signals and the lack of trustworthy and authoritative information are considered the main barriers to consumers' sustainable behaviour.

In addition to the neo-classical economic assumptions that underlie contemporary policy-making, a so-called technocratic approach is also used widely in policy making processes. Within this technocratic approach, it is assumed that society's environmental problems can be managed by technological innovations, failing to recognise the complex nature of human behaviour and the social interactions among the affected actors. Although technological improvements undoubtedly have large potential to mitigate environmental impacts of current lifestyles, their contribution to sustainable consumption is potentially rather limited (Mont and Dalhammar, 2008).

Human behaviour is indeed very complex. Devising policies aiming at behavioural change requires solid understanding of how people behave in different situations and contexts. However, for a long time, the use of findings of behavioural sciences have not been utilised in a systematic way for policy making purposes. Behavioural sciences, drawing on insights from cognitive and social psychology, stress that humans in fact may behave in a less rational manner, than it is presumed, for example in the neo-classical economics theory. There are significant behavioural biases related to the decision context, which forms the environment in which individuals make choices (Lehner et al., 2016).

Therefore, an opportunity for policy considerations concerning 'sustainable consumption' comes in the area of influencing social norms and consumer behaviour. A recently popularised attempt to devise control mechanisms for inducing change in the behaviour of individuals is called 'nudging'. The idea is to try to lead people in a desirable direction with very 'light' means of intervention, that is, to attempt to influence behaviour without restricting individual freedom of choice. In other words, it is the effort to arrange choices so that the desired decision will be the easiest for the individual to take (Lehner et al., 2016). To achieve this, the effect of 'choice editing' is important. Choice editing describes how the alternative choices are designed or presented and how this design affects public decision-making. The design of choice editing can deliberately 'nudge' the target audience towards a desired behaviour, such as to choose healthier food or adopt a more environmentally friendly behaviour (Lehner et al., 2016). Moreover, there is a need to support 'nudging' with the appropriate infrastructure and institutions so that the desired behavioural changes can also act as a driver for improving existing infrastructures. For example, information about the benefits of cycling to work might increase the interest of cycling in people, but also increases the pressure on the bike lanes and bicycle infrastructure in general. For the 'nudging' effect to be achieved, then the bicycle infrastructure should be expanded, as a response, but also improved in order to attract even more preference from the public and induce further behavioural change. Furthermore, a combination of measures would increase effectiveness in such policies, even for behaviour change interventions (IVA, 2016).

## 5.2 Policy development principles

A transition to a Circular Economy is certainly a process that would not happen overnight. Transition processes are usually long and unpredictable and for this reason a necessary vision and appropriate strategies need to be formulated and supported by well-designed policies. In this context, long-term policy design is coming to prominence (Voß et al., 2009). Meadowcroft (1999) notes that the current generation of long-term policy approaches appears to be more 'reflexive', as it avoids the notion of concrete top-down planning and is well aware that full knowledge of the problems in question in advance is limited, and therefore a dynamic and participatory policy approach would be required.

According to Voß et al. (2009), long-term policy design is the development and implementation of policy strategies that seek to change radically key societal structures. In this sense, long-term policy design needs to be flexible and adaptive, as it needs to cope with the inherent uncertainties of emerging alternative pathways of societal change. A transition to CE consequently would imply a destabilising of existing socio-technical structures as well as supporting the emergence of alternative systems that can take advantage of the opportunities created by this structural change. Ultimately, such a long-term policy that can lead to substantial changes in socio-economic structures would create inevitably winners and losers, as certain business/economic trajectories may not be continued and investments may become stranded.

In a reflexive policy perspective, governing processes and policy analysis are seen as shaping technological, economic and ecological changes, both in terms of innovative actions and structural change. However, each of the actors involved in these processes has only a limited view of the whole, which makes it difficult to comprehend and assess their view in comparison to the view of others, as well as restricted capacities to influence outcomes (Voß et al., 2009).

Therefore, in such processes it is important (1) to achieve extended coordination between the actors involved; (2) to have a holistic view on socio-economic and (parallel) political developments; (3) to prevent unpredictable outcomes; and (4) to sustain a vision for the long-term goals of the policy; without at the same time suppressing diversity; while (5) retaining adaptability towards the complex dynamics of change. In order to constructively deal with all these issues in long-term policy guidance in a short-term context, most approaches to reflexive planning pragmatically combine top-down and bottom-up elements into more or less sophisticated procedural designs for social learning (Voß et al., 2009). This top-down/bottom-up approach is also recognised by Lieder and Rashid (2016) as critical in the design and implementation of strategies for a Circular Economy. They propose a framework, exemplifying the relations of the different actors at different levels in society (Figure 11).

Critical long-term policy design issues include (Bontoux and Bengtsson, 2016; Howlett and Rayner, 2007; Meadowcroft, 2011; Voß et al., 2009):

- First, there should be a firm and we-defined vision for the targeted outcome of the policy. The vision will inform the choices of promising alternative developments and provide support. Effectively, the vision provides an alternative selection environment compared to established socio-technical paradigms.
- Policy design that seeks to institute societal envisioning and experimenting has to be explicit about how decisions of collective concern are to be taken.
- Weak stakeholders are not usually involved; therefore extra care should be taken to address this issue. Weak stakeholders traditionally perceive that they have only limited power and that they cannot influence the outcome of the policy process.
- Should be acting across policy fields and going beyond current agendas and policies. Another critical issue for long-term policy design is the problem of moving away from existing governance patterns and working towards new reflexive policy practices.
- Unforeseen dynamics and unintended consequences that arise when the 'planned' policy designs start interacting with processes 'on the ground'.
- A systemic outlook is required, looking at the EU economy and society as a whole to ensure coherence of action.

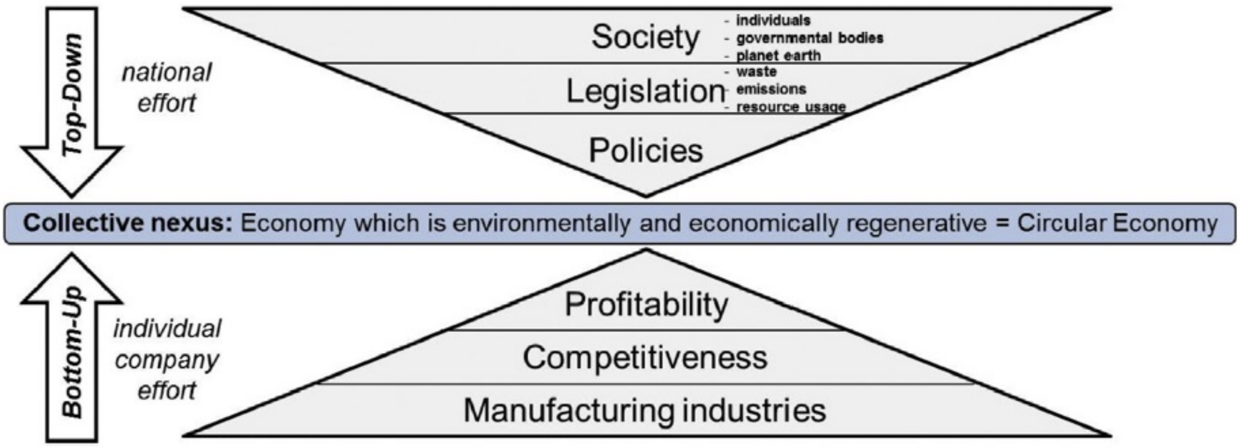


***Figure 11: CE implementation strategy applying top-down and bottom-up approach (Lieder and Rashid, 2016)***

Despite careful steps in the design process of policies, it is impossible to fully predict precisely the outcomes even for the most well designed policy instrument, when it is going out in the 'field'. Even the most sophisticated policy designs can never be made fail-safe against the unpredictable effects of implementation (Voß et al., 2009).

The design of a policy, as it becomes part of public administration, is the result of a distributed agency. There is neither a single inventor, nor a single point in time that denotes the invention. The design takes shape in an extended interaction process which involved scientists and consultants, officials from public administration and a broad range of stakeholders. In the course of this process, shared frameworks are worked out by going from abstract theoretical notions to concrete proposals in policy fields and back again, accommodating also the views of relevant actors whose support is needed to make the policy work (Kemp and Rotmans, 2009).

Policy design is both shaped by, and co-shaping, ongoing policy processes and broader structural change. Consent in the design process is considered necessary and may derive from the way multiple values are accommodated in the diverse commitments being made by that process. This brings in issues of legitimacy and democracy in long-term policy design into prominence (Voß et al., 2009).

Policy *instruments* are the actual tools which governments can utilise for implementing their policies. Policy makers have the opportunity to select from a wide range of instruments in order to address a certain policy problem and achieve a desired outcome. At this point a distinction should be made between the terms 'instruments' and 'tools', as they might be perceived similarly while they are not. Instruments constitute a steering function and provide incentives for achieving a certain policy, while tools can be used to achieve a specific purpose. Therefore, a policy instrument implies some degree of governmental or political intervention (Mont and Dalhammar, 2005).

Policy instruments can be distinguished in three types (administrative, economic, and informative) as concerns their nature and in two types (mandatory, voluntary) concerning their implementation mode (Mont, O. and Lindhqvist, 2003). Table 6 presents the categorisation of policy instruments as well as some indicative examples of a related measure.

***Table 6: Categorisation of policy instruments (Mont and Dalhammar, 2005)***

| | Mandatory | Voluntary |
|---|---|---|
| **Administrative** | e.g. bans, standards, quotas, licences, etc. | e.g. standards, agreements between government and industry, etc. |
| **Economic** | e.g. taxes, fees, tariffs, subsidies, etc. | e.g. GPP, loan guarantees, charges, etc. |
| **Informative** | e.g. reporting requirements (chemicals), labelling, education, etc. | e.g. certification schemes, awareness raising campaigns, EMS, etc. |

Other typologies in literature might include more than three categories and distinguish, for example, voluntary agreements and self-regulation as separate categories (Gunningham et al. 1998).

Concluding, even though policy instruments might be very well designed, targeting specific elements of a desired outcome, they also reflect context specific weaknesses regardless of which type of instrument it is. Therefore, it is usually insufficient to only apply one type of instrument when designing policies which are to deal with complex issues such as a transition to a Circular Economy and it is preferable to adopt a mix of policy instruments. It is usually necessary to adopt a package of carefully designed policies targeting the identified problems (Gunningham et al. 1998).

## 5.3 Development of synergistic policies (policy mixes/policy packages)

Realising the complexity of transition processes and the challenges in policy making for supporting such multi-level and multi-stakeholder long-term processes, as discussed in the previous section, employing an individual policy instrument may prove to be insufficient. Applying just one policy instrument would most likely change an individual driver, but would risk prompting unintended outcomes that change other drivers and ultimately these changes would counteract or even neutralise the intended effect of the policy instrument. As a result a more complex approach would have to be taken also in the policy making field, in terms of developing a mix of policies that is targeting a specific outcome. In order to successfully respond to and be adapted to the specific context of a policy vision, the development of policy mixes needs to consider (Del Rio and Howlet, 2013; Howlet and Rayner, 2007):

- The full range of policy instruments
- The full cost of policies (including implementation costs, transaction costs, compliance costs)
- Preferably avoid negative interactions between single policies (i.e. instruments already in place and new ones) but emphasise mutual benefits with existing policies
- Potentially negative side-effects of policy on target groups (e.g. issues of competitiveness in industry or adverse effects on lower-income households)

- Options to combine instruments to mitigate side-effects (as the two above)
- The political processes during the design and implementation of the mix

A comprehensive policy mix needs to go beyond just combining loosely related or unconnected individual policy instruments. In fact, in a policy mix long-term qualitative objectives and short- to mid-term quantitative targets are combined and set in a time-dynamic approach for effectively achieving the objectives and targets. Therefore, devising a policy mix requires (Ekvall et al., 2016):

- Forward-looking strategic planning, by relating different policy instruments in a time sequence that enables the optimisation of synergistic effects while minimising the unintended negative side-effects
- Consideration of underlying political processes in multi-actor networks and polycentric governance systems in order to be able to monitor the development process and adapt the resulting policy mix in time sequential feedback loops

Designing, implementing, and evaluating policy mixes is much more difficult than individual policy instruments. Actual political processes, affecting the dynamics and path dependencies of legislative periods, pose a virtual barrier in strategic and long-term implementation procedures of policy mixes. In this context, designing a policy mix needs to ensure a good fit between instruments and targets within a single level of policy (horizontal mixing), as well as with institutional framework conditions (vertical mixing) (Howlett and Rayner, 2007).

The more drastic a policy instrument is (or perceived to be by the affected social actors), the lower its implementation feasibility. This applies in particular to top-down, government imposed regulatory instruments. This phenomenon has been one of the main reasons for orienting EU resource policy in recent years towards increasing use of economic instruments, as clearly illustrated in the 'Roadmap to a Resource Efficient Europe' (COM(2011) 571 final) and the Action Plan for CE (COM (2015) 614 final) (Hirschnitz-Garbers et al., 2015).

In order to increase its implementation feasibility, it is necessary to consider both the consistency and coherence of the instruments linked in the policy mix. While consistency refers to the absence of conflicts and contradictions, coherence refers to ensuring synergistic effects and positive interactions between instruments as well as between different policy and administrative levels (Rogge and Reichardt, 2013).

Consistency and coherence in a policy mix can be fostered by combining primary with supportive instruments. Primary instruments are mainly used to achieve a defined policy objective and ideally should be as little controversial as possible, despite the fact that usually there is considerable resistance from societal and economic groups with vested interests in maintaining the status quo. On the other hand, supportive instruments are used to minimise or mitigate unintended negative side-effects of primary measures and, therefore, to increase their acceptability and feasibility (Rogge and Reichardt, 2013).

A similar approach is presented by (Givoni et al., 2013) in the form of a policy package (an alternative term to policy mix, however, in the case of Givoni et al. (2013), a methodology is provided as well to support the theoretical framework of policy packaging). Givoni et al. (2013) define a policy package as a *'combination of policy measures designed to address one or more policy objectives, crated in order to improve the effectiveness of the individual policy measures, and implemented while minimizing possible unintended effects, and/or facilitating interventions' legitimacy and feasibility in order to increase efficiency.'*

Before the packaging process begins, concrete policy goals, aims and objectives must be defined as clearly as possible. This process would require appropriate processes for clarifying the intended policy objective and (ideally) link it to easily measurable qualitative targets (Givoni et al., 2013).

The methodology of policy packaging includes three levels of organisation and policy interactions. Initially, a 'basic package' of policy instruments is created. In this, an inventory of policy instruments is developed and these instruments are evaluated and their relationships and interactions are mapped out. At the second packaging stage, the so-called 'effective package' stage, primary and ancillary instruments are added or removed to enhance the net effectiveness of the package, by maximising the benefits of the policy package while taking into account potential rebound and other unintended effects. The 'effective package' combines synergistic instruments, and aims to minimise unintended and contradictory effects through active modifications. In the final stage, the so-called 'viable package' stage, social and political acceptability are considered, and additional changes are made to account for these. The feasibility of the package is then assessed before completing the packaging process (Givoni et al., 2013).

The primary instruments in the policy package should be as uncontroversial as possible and create positive feedback loops with other instruments, while at the same time they should also be reflexive and allow for adaptability over time. Thus, the central instruments in the 'basic package' will have no contradictory relations, facilitate the largest number of instruments, and have maximum synergistic effects. While the 'basic package' is mostly concerned with direct effectiveness, the 'effective package' is concerned with collateral effectiveness, which means, accounting for unintended direct and indirect effects, including rebound effects. Addressing these effects will improve the collateral effectiveness and thus the net effectiveness of the package (Givoni et al., 2013).

## 5.4 Policies acceptance

Apart from careful policy design, following the principles presented above (section 5.2), and the combination of appropriate instruments for achieving the desired ambition for measures targeting complex and multi-level phenomena, such as a transition to a Circular Economy, another factor which is considered vital in the process of policy making is the acceptance of the proposed policy. Policy instruments and policy packages are more likely to be implementable, effective and legitimate if they are socially (or similarly described as publically) acceptable. Public acceptability of a policy instrument or a policy package does not necessarily guarantee the potential success of a policy initiative (Givoni et al., 2013), but certainly increased acceptability strengthens the potential implementation in several ways. Public acceptability for a given policy instrument or policy objective improves public participation and compliance, while reducing enforcement costs and boosting the overall effectiveness of the policy (Bicket and Vanner, 2016). Although there are several definitions on public acceptability in literature, according to Bicket and Vanner (2016) it is understood as all individuals who are affected by the proposed policy – either directly or indirectly – and all additional interested parties who choose to express an opinion. Givoni et al. (2013) go a step further to emphasise a social aspect of 'public' in the sense that acceptability of a policy should explicitly include the voice of the most adversely affected social groups in the public sphere, resonating environmental justice concerns in their definition, and thus phrasing public acceptance as 'social acceptance'. However, both wordings bear the same connotation in the contents of this report.

Public acceptability of intended policy interventions plays a key role in the political agenda-setting (Drews and van den Bergh, 2015; Page and Shapiro, 1983). In democratic societies, mainstream public discourse and social movements have the ability to steer policy debate and action by providing politicians with the necessary democratic mandate for election and imminent implementation of a policy proposal, or substantiate a threat of non-election and removal from office (Strömbäck, 2012). Ultimately, public disapproval and resistance to proposed policy interventions, or even the fear of such resistance, could obstruct or reverse policy decisions.

Policy acceptability and public support are considered as fundamentally important for managing transitions to sustainability (Geels, 2013). Policies for a transition to a resource efficient Circular Economy are very likely to involve a significant degree of change in behaviour and practices and therefore depends to a large extent on the consent and cooperation of actors at all levels of society, from the individual to the multinational (Bicket and Vanner, 2016).

Moreover, designing politically feasible, but also visionary and ambitious policy interventions, that bear the potential of reconfiguring systems still represents a formidable challenge. This effort becomes even more challenging if policy instruments have to be combined into policy packages in order to address the complex nature of a Circular Economy framework. Therefore, such challenges would relate both to the conceptualisation and assessment of cumulative effects, as well as to reconciling long-term forward-looking policy strategies with political economies of election cycles and diverging interests in a dynamic multi-stakeholder perspective of current democratic political regimes (Ekvall et al., 2016). In the case of policy packages, Givoni et al. (2013) indicate that the first step in evaluating the acceptability of a policy package is to conduct an analysis of the distributional impacts of each policy instrument separately, and then assess the package as a whole.

Policy instrument that could spark or facilitate such a transition would need to be perceived and experienced as meaningful for the recipients (Finnveden et al., 2013). Today's well-working and publicly accepted policy instruments seem to be grounded in a certain kind of reciprocity with the affected actors, as they would expect to receive something back, e.g. when people perceive they give something (i.e. pay taxes) to receive back something else (Shove and Walker, 2010).

The implementation of such policy packages could very likely encounter resistance from incumbent industries in risk of losing profits and from workers' unions that oppose the risk of losing jobs. In such cases, the policy-making process could actually be a good way to create large-scale cooperation between all interested parties. In literature, policy-making is also regarded as a way of negotiating (Gulliver, 1988), so the negotiating parties can be identified as the industry (economic actor), public authorities, and the people, distinguishing the dual role of the people as that of the citizen and that of the more self-interested consumer or producer/employee (Finnveden et al., 2013).

People are more likely to accept policy if they trust the governing institutions (Dresner et al., 2006; Drews and van den Bergh, 2015; Keramitsoglou and Tsagarakis, 2013), while a lack of trust could be linked to lower levels of willingness-to-pay for a perceived cost resulting from a policy intervention (Adaman et al., 2011). The relationship between trust and public acceptance is defined primarily by two components: (1) the confidence of the negotiating parties in an institution's choice of policy design and (2) the capability to implement it effectively. Policies that are perceived to be effective have higher public acceptability (Drews and van den Bergh, 2015). A further trust concern reflects the institution's motivation to enact policy considerations on a particular issue, and whether this process is sufficiently transparent in the public eye or not. Policies that are perceived to have ulterior motives tend to have lower public acceptability. This is particularly evident in cases with instruments that seek to levy a tax, which can be perceived by both the public and businesses as a means to generate additional revenue for the government and the public budget (Dresner et al., 2006).

Additional factors that affect to a large extent public acceptability of policy include the perceived personal costs that a policy might incur to individuals or businesses and the extent to which a policy is fairly distributed among the social and economic actors. The perceived personal cost of a policy, affecting the financial situation, well-being, behaviour and freedom of choice of individuals and businesses alike, is observed to have a particular negative impact on the acceptability of the incumbent policy (Drews and van den Bergh, 2015; Cherry et al., 2012). As a result, there is usually a preference for 'pull'-type policies that in terms of public acceptability act as 'carrot' vs. 'stick' policies, also known as 'push'-type policies. However, the latter can still enjoy high levels of public acceptability if their perceived effectiveness is considered to be high (Dresner et al., 2006). The extent to which a policy is perceived to be fair also appears to be a key factor influencing public acceptability (Bicket and Vanner, 2016). Distributional fairness of costs and environmental burdens as well as procedural fairness are linked to higher public acceptability (Dresner et al., 2006; Drews and van den Bergh, 2015).

A policy that has received public acceptance and is in the implementation stage is also expected to fulfil its function, as public acceptance could be withdrawn in the long run if this policy appears to affect adversely parts of the society that had initially supported its adoption (Finnveden et al., 2013).

Lastly, it would be interesting to look at the results of a recent European research project (DYNAMIX), which investigated the acceptability of EU level resource-efficiency related policies proposed by the project team. The results are presented by Bicket and Vanner (2016), concluding that seven of the proposed policies of the project were rated as highly contentious, meaning that they are likely to cause considerable public concern and lead to attempts to oppose its implementation. These policies include:

- Green fiscal reform: internalisation of environmental costs
- Green fiscal reform: materials tax
- Circular Economy tax trio on extraction, landfill and incineration of virgin materials, and VAT on meat products
- Shift from consumption to leisure
- Product standards
- Extended producer responsibility

The results above are of high interest in the context of the REES programme and especially for policies for REES. The policy proposals listed above seem to be perceived negatively by the public and therefore earn low acceptability in their current form. This means that considerable effort is needed to reframe such policies or abandon them altogether. However, in a policy package, these policies might be accompanied by counterbalancing measures that could improve their acceptability from all affected parties.

# 6 Conclusions

A transition towards a Circular Economy is expected to contribute to a more sustainable economic growth and to create new jobs. This transition would most certainly require significant innovation efforts from all relevant socio-economic actors, ranging from the development of new materials or products to the design of new business models. While a shift towards CE can be facilitated by incremental evolution within the existing systems, such as material-efficient manufacturing or improved recycling technologies, achieving the full potential of a Circular Economy would require a rather holistic and possibly radical change of the existing production and consumption systems. To support the transition to a Circular Economy a coherent policy framework and major policy innovation will be needed.

The EU Circular Economy Action Plan outlines future policy directions for Resource Efficiency that propagate shifting away from the waste-centric approach of the previous years and towards a more holistic approach combining more resource efficient production and consumption approaches. Production-oriented Resource Efficiency legislation (mainly the Ecodesign Directive 2009/125/EC) proved to be rather ineffective in the past in relation to material resources, as it mainly focused on energy efficiency issues and largely disregarded material efficiency in production processes and products. Other types of production- and consumption-related legislation were voluntary in nature and as such failed to bring about any significant results, especially during the recent economic downturn.

In order to surpass the failings of the past, a new approach is needed in the EU and at national level in the Member States. This new approach should not only incorporate more ambitious policy measures but also to combine measures that would effectively tackle the challenges of CE outlined in Chapter 3 of this report. The shift towards a Circular Economy will not be advanced by singular policies, but rather requires the development of policy packages, as highlighted in section 5.3. Indeed, policy packages should be better able to tackle the complexity of systemic challenges, such as the transition to a “new” socio-economic system, i.e. Circular Economy. Furthermore, policy interventions are required in different levels, from local and regional to national and international, to tackle the challenges of CE in the most effective way. For example, innovators that already embrace CE principles in their business models need sufficient assistance from the policy environment they operate in order to scale up and be able to stand competitively at a national/international context. Such a “bottom-up” approach is expected to highlight important issues for future policy research.

Policy instruments that can be utilised – ideally in policy packages – for promoting Resource Efficiency in manufacturing, include a variety of economic measures that support reuse, repair and remanufacturing as well as putting a price on resources. Other measures include standards for remanufacturing and recycling (e.g. for improving traceability of secondary materials). It is also critical to improve secondary markets and collection/reverse logistics of used materials and products. Better policies are also needed for rationalising and streamlining rules for transboundary shipments of waste and clarification of other waste-related definitions. Finally, mandatory requirements for GPP that will enable the integration of higher resource-efficient products in the public sector, as well as measures to scale up procurement and thus increase the demand for resource-efficient products.

However, there is still a big gap in knowledge about appropriate policy instruments for increased Resource Efficiency and their implementation in the society, and more specifically in manufacturing. Although a large arsenal of potential policy measures exists today, their implications and unintended side-effects have not been accounted for satisfactorily in research and further investigation is required, firstly at company level (or sectoral level), case by case, and ultimately at a more generalizable level in the economy.

The most significant research gaps are identified in the inner circles of the Circular Economy, i.e. the shortest loops that retain most of the value in products, namely reuse, repair and remanufacturing. Specifically, research is needed on the definition and implications of repair and durability standards; eco-design requirements for durability and reparability and how these can be devised, as well as on consumer preferences with regards to resource-efficient products. Also, the availability of spare parts and their cost, unhindered movement of products for repair as opposed to waste shipments and intellectual property of remanufactured products, require deeper understanding. Finally, the responsibility for second-hand products on the market and establishing effective take back systems for repair and remanufacturing deserve further attention.

Also the "traditional" approaches to Resource Efficiency, i.e. recycling, require further research in terms of establishing waste markets and identifying conditions for doing so; devising standards and improving the traceability of secondary materials (e.g. for chemicals contents and composite materials); identifying optimal and economic use of waste and conditions for the appropriate employment of alternative waste management options – reuse vs. recycling vs. energy recovery; etc.

On the other hand, there is a large amount of scientific literature available on the potential of the 'Green tax reform' – a system that taxes resource use instead of labour – that could enable a shift to more resource-efficient practices in manufacturing and consumption. However, the use of 'Green tax reform' has so far been very limited both in the EU Member States and in Sweden. Therefore, a potential tax shift to resource use could be interesting to investigate in Sweden. However, the Swedish government seems to be cautious about the Green tax reform as it advises that *'legislative proposals* [for Circular Economy] *should be outside the taxation area'* (*Kommittédirektiv 2016:3)*.

Finally, a careful investigation of potential ways to combine different policy measures into effective policy packages is needed. Ideally, it could be conducted in close collaboration with affected stakeholders, who should be able to formulate the outcomes and to contribute with necessary insights in the process. The REES companies have a very important role to play in this part of the research, by examining and testing the actual policy packages proposal "on the ground".

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