Master's thesis

NTNU
Norwegian University of Science and Technology
Faculty of Economics and Management
Department of Industrial Economics and Technology Management

Johanne Sørumsbrenden

Transitioning to a Circular Plastics Economy

A suggestion of indicators for a circular plastics economy in Norwegian enterprise

Master's thesis in MSc Industrial Ecology
Supervisor: John E. Hermansen
June 2019

NTNU
Norwegian University of Science and Technology

Johanne Sørumsbrenden

Transitioning to a Circular Plastics Economy

A suggestion of indicators for a circular plastics economy in Norwegian enterprise

Master's thesis in MSc Industrial Ecology
Supervisor: John E. Hermansen
June 2019

Norwegian University of Science and Technology
Faculty of Economics and Management
Department of Industrial Economics and Technology Management

NTNU
Norwegian University of
Science and Technology

Problem description

The purpose and objective of this study is to establish and propose a set of indicators that will enable an actual transition to a circular plastics economy in Norwegian enterprise.

Main content

- Introduction to the topic and research questions
- Overview of relevant concepts to the study, and a presentation of relevant sustainable development goals (SDGs), status and trends for circular economy in the EU and Norway, nationally and locally
- Presentation of empirical data, reasoning for the linkage between the selected SDGs and a circular plastics economy, and a SWOT analysis for transitioning circular plastics economy in Norwegian enterprise
- Presentation of the proposed indicators elaborated from the abovementioned points
- Discussion of the reliability and validity of the study, conclusion and recommendation for further study

Preface

This study is written and supervised by the Department of Industrial Economics and Technology Management (IØT) during the spring of 2019. This thesis is a continuation of a previous project work written the fall of 2018, and is a final result of the MSc in Industrial Ecology at the Norwegian University of Science and Technology.

This thesis was inspired by an observation that circular economy (CE) had limited development in Norway compared to our neighbour countries and the EU. The study has been conducted under close dialogue with Trøndelag County and Matmortua AS. I would like to thank Per Erik Sørås and Lillian Strand in Trøndelag County for meeting with me several times in the initial phase of this study, providing with insights and information, and for connecting me with Helene Øyangen in Matmortua AS. Then, thank you so much, Helene, for sharing your thoughts and ideas, and for supporting the development of the work throughout the whole time period.

I would like to extend my gratitude to my supervisor John Eilif Hermansen, Associate Professor at IØT, NTNU, for his useful guidance and feedback throughout the process of writing this study. To Paritosh Deshpande for meeting with me, sharing his knowledge and giving inspiration to the shaping of this study. I also have to say a huge thank you to all of the informants responding my e-mails and inquiries for this study, no matter how tired or short of time you were. The study could not have been presented with the same accuracy without you.

Abstract

Circular economy (CE) represents a revolutionary new way of structuring our economies, and is characterized as a climate change mitigation effort that can assure a sustainable future. The work on CE in Norway is barely in its beginnings, and a national circular economy strategy working group was just established after the current Government's political platform, the *Granavolden platform*, in January 2019. Compared to the EU and our neighbour countries, Norway is lagging in its CE transition work. This thesis is a novel approach and a contribution to this CE work, targeting how plastics as material can end up in a closed, economic loop.

As circular economy is a defined key strategy to accomplish a sustainable future, it is of importance to connect the proposed circular plastics economy (CPE) indicators to the UN Sustainable Development Goals (SDGs), which are guiding in sustainable policy making. Whether we are meeting the SDG goals or not is key to understand if the policy efforts are sufficient, and the proposed indicators will be a tool in order to accomplish this. The UN has encouraged the member countries to develop national indicators as a supplement to the indicators developed with the SDGs (Nørgaard et al., 2018). Norway has not developed any national indicators targeting CE so far. This thesis will therefore be a contribution to this, as it suggests indicators for a CPE in Norwegian enterprise.

The proposed set of CPE indicators are sorted under the categories 'production and consumption', 'waste management', 'secondary raw materials', and 'competitiveness and innovation'. They have been developed through close contact with key actors of circular economy development in Norway. The study gives an overview of the status quo of CE in the EU, and nationally and locally in Norway. Concerning the local focus, CE work in Trøndelag is targeted, as the thesis has had close cooperation with Trøndelag County and Matmortua AS, of which the latter is a producer of raw plastics material located in the region. The study thereafter wishes to enlighten the critical factors existing in order to transition a CPE in Norwegian enterprise, which will be presented through a SWOT analysis. The indicators are then presented as a suggestion for how to close the plastics circle in Norwegian enterprise. These will, however, need to be further quantified and revised by the authorities and all enterprise actors, in order to secure a successful CPE transition.

List of content

List of concepts

Concept	Definition
Circular Economy	"An economy in which stakeholders collaborate in order to maximize the value of products and materials, and as such contribute to minimizing the depletion of natural resources and create positive and societal and environmental impact" (Kraaijenhagen et al., 2016)
Bio-economy	Value creation based on sustainable exploitation of renewable biological resources (Trøndelag Fylkeskommune, 2018)
Indicator	An indicator is a descriptive and measurable variable that provides sufficient, relevant and concise information about a phenomenon of reality in space and time, while avoiding problem-shifting.
State of the art	The most advanced and/or best alternative at the market within its field (Det Norske Akademis Ordbok, n.d)
Secondary raw materials	Waste that has been recycled and is injected back into the economy (European Commission, 2017)
Major mineral wastes	Significant quantities of waste from mineral raw materials (Science Direct, 2017)

Acronyms

CE	Circular economy
CPE	Circular plastics economy
EU	European Union
EEA	European Environment Agency
IKS	Intermunicipal company (*Interkommunalt selskap)*
EPR	Extended producer responsibility

List of figures

List of tables

1 Introduction

«2019 will be the year of circular economy» was the proclamation from Norwegian Industry in their CE evaluation study from 2018 (Norsk Industri, 2018). The background for this is the political action on Norwegian CE that has gained its focus with the latest governmental platform (*Granavolden* platform), and the decision on establishing a strategy for CE in Norway. The working group for a Norwegian strategy on CE is in its mere beginnings, and was just established earlier this year (2019). However, the work here will represent a serious follow up on the already existing CE strategies in Europe, where the EU already has been working for some time with establishing a CE framework. CE represents a change of society's economic structures, and has been identified as a climate change mitigation effort, enabling to reach the sustainable development goals. However, there is a long way to go in order for this to happen. This study can be seen as a contribution to strengthen the extending focus on CE in Norway, targeting plastics as a material within the CE, proposing an EU-derived set of indicators for how the CPE strategy could be approached successfully.

In total, it is estimated that between 75 000 and 300 000 tonnes of microplastics are released into the environment each year in the EU (European Commission, 2018 b). While a large amount of microplastics result from the fragmentation of larger pieces of plastic waste, significant quantities also enter the environment directly, making them more challenging to track and prevent. This poses a serious threat to life on earth, and it first got viral public attention with the stranding of a whale dying from eating plastic bags in 2017. There is an urgent need to properly handle the waste, and prevent this from continuing to happen. CPE can be such a solution.

Figure 1. Plastics in a circular economy (European Commission, 2018 b)

1.1 Background

"To save the earth it is essential to change consumption patterns", the Global Policy Forum, a UN consultancy agency, stated rather dramatically in 2012 (Global Policy Forum, 2012). Since then, the UN has developed its Sustainable Development Goals (SDGs) as leading guidance within policy work all around the globe on sustainable development. A realization of our production and consumption patterns, characterized by an over-exploitation of finite resources, led to a public discourse on a need for circular economy thinking. This way of thinking had the aim of 'locking up' the resources within the economy, or closing the loops, and not use and dispose. This transition towards a circular economy can't be limited to certain materials or

sectors. It is a systemic change that affects the entire economy and involves all products and services (European Commission, 2018 c). Measuring whether we are succeeding in moving towards a circular economy is complicated and complex, and finding this measure with only one single unit or score is not possible if the measure were to be concise and correct. The vision of a circular future involves that profitability of efficient resource use drives the development. The interaction between use of market power, and the authorities' role as social developers and policymakers, will be decisive. This will put strong demands to our ways of thinking, and has consequences for how products are shaped, buildings planned and cities developed. It requires also that the authorities need to regulate the market in a way that reflects the needs of a CE (Avfall Norge, 2018).

On land, it takes minimum 400 years for plastics to break down, meaning that all of the plastics ever produced, still exist on our planet (European Commission, n.d. b). In 1950, the plastics production worldwide was estimated to 1,5 million tonnes/year. In 2015, the production was 322 million tonnes/year, illustrating how plastics have exploded to be an essential component of the products on the global market. In every km^2 of the Mediterranean Sea, there are around 40 pieces of marine litter. To make virgin plastic, you need fossil feedstock (oil), water and energy (European Commission, n.d. b). A recent study from GRID Arendal estimates that "at most 9% of all plastic ever produced has been recycled, with an additional 12% incinerated, most of it only having been produced in the last decades" (Marrs et al., 2019). If no action is taken, the plastic remainder will continue to contaminate the environment in dumpsites, landfills, or leak into the ocean. There is an urge to rethink our plastics habits, and CE can be seen as a mitigation effort, both by closing the plastics cycle avoiding pollution, but also with a potential of saving 450 million tonnes CO2/year in Europe (Avfall Norge, 2018).

1.2 Research Questions and Research Issue

This study will address the following research questions:

1) What is status quo for CE commitment in Norway?
2) What are the critical factors in order for a CPE transition to happen in Norwegian enterprise?
3) How could we create a closed plastics loop within the Norwegian enterprise?

The first question will mainly be addressed in the section 3.5, which builds on the pre-work done for this study. This section is divided into an EU-level, Norwegian national level, and a Norwegian local level. This is done due to the fact that Norwegian CE work largely evolves from the EU CE work, and the study sees it relevant and interesting to look at how the frameworks already created for the purpose of facilitating a transition to a circular economy, currently has adapted to the national and local level, where the local focus is on Trøndelag. The second question will be answered through the analysis ending up in a SWOT-analysis, where strengths, weaknesses, opportunities and threats will be presented based on the presented findings.

Lastly, the suggested CPE indicators are made in order to answer the third research question. The EU has developed a set of indicators within a monitoring framework for a circular economy transition. These indicators should ideally "primarily capture trends in preserving the economic value of products, materials and resources as well as trends in waste generation" (European Commission, 2018 a). However, reality is not homogeneous everywhere, which raises the need

to establish and define indicators that work both on a national and regional specific level. The CPE indicators suggested for the Norwegian enterprise in this study, will therefore be a contributing attempt to accelerate this work in Norway and to offer a proposal on closing the Norwegian enterprise plastics loop.

1.3 Structure of Thesis

The study starts by presenting the methodological framework and the evaluation of this in section two, before addressing the different theoretical resources used in the study. Here, especially section 3.1 and 3.5 are elaborated from the project thesis done for this study. These parts are important to include as they are, because they were created having in mind the necessity of providing with a foundation for this thesis' further elaboration. Some adjustments have, however, been made, as a result of findings from the more recent work on this thesis.

Section four presents the empirical data and other relevant documents and/or strategies that have contributed in laying the foundation for both the SWOT analysis in section 5.2, and the indicators proposed in section six. In addition to the SWOT, the analysis section five also gives account for which SDGs that can be connected with the CPE, and thereby the shaping of the CPE indicators.

Section seven presents a discussion on the reliability of the results as well as the validity of the study. Lastly, a conclusion is drawn, and recommendations for further study and elaboration on this study's results is presented.

1.4 Limitations of the proposed indicators

When elaborating and proposing the CPE indicators, the study stresses that the intention has not been to manifest and declare the quantitative aspect of how the indicators are measured, nor to investigate the quality of the data behind the indicators and whether these fit a Norwegian case.

The statistical data behind the EU CE indicators, of which the CPE indicators are inspired by, and the ones made from this study may be differing. The way data is collected in the EU and in Norway, especially within waste management, may vary and/or be incomplete, as also pointed out in Hage (2016). The CPE indicators are elaborated and defined from qualitative research, meant to trigger further research on, and data collection to, support the indicators.

2 Method

2.1 Research model

Although there is a quantitative aspect behind the definitions and presentation of the CPE indicators, this study has a qualitative research model, where all data presented is based on qualitative research. Because of lack of time, availability and, partly, economic reasons, all of the actor contact for this study has been made over phone or e/mail, expect for with Trøndelag County and Matmortua AS.

Positive aspects of a phone interview are that the interview object has a stronger sense of anonymousness (Tjora, 2013), which can have had a positive effect in this study's case. The only

phone interview conducted in this study was with Hamar (2019). The interview had an informal tone, which also reflected the mailing correspondence prior. It was important to state that this study just wanted an insight in the current status quo of CE in Norway, as well as comments on what were the interview object's thoughts on necessary elements of such CE transition to happen. This was the study's approach to all of the actors contacted. Talking loosely about the subject could have made it easier for the interview object to answer more straightforwardly and at the top of his/her mind, instead of evaluating what to say, or put a lot of effort to come up with something 'correct' to say. However, the negative aspects of such an interview is that it is hard to get a real conversation going, as aspects such as body language to follow up on reactions is difficult. Because of this, these interviews also tend to be shorter (Tjora, 2013), which also was the case here.

Mail interviews are beneficial when respondents are geographically distant, however it is much more difficult to get in contact with them (Tjora, 2013). On the other hand, Tjora (2013) stresses that mail interview can function well if the informants are engaged in the specific topic, which undoubtingly also has been the case for this study. Once the mailing correspondence was established, the study either received a useful reply for the study, or was forwarded to another of concern. Here, is either ended up unanswered due to uncertainty around the topic (he/she wasn't able to answer), or it was denied due to lack of capacity. All of the actors considered most interesting for this study, listed in table 1, did reply to the e-mail requests in some way.

After this initial meeting, two meetings have taken place with Sørås, both in September 2018, to catch up on the talks from the first meeting and to make clear the scope and topic for the Master's thesis. The undersigned has also had two meetings with Hermansen, in September and October/November 2018, where relevant reviews, documents and reports have been provided for the work on the project thesis, as well as establishing the scope for the project thesis.

Together with meetings, literature review has been the source of information to the content of this study. Sørås has provided for documents presented in section 3.5.4 and 3.5.5, as well as an idea of what framework, documents and reports that have been of relevance for the County Council's work on a circular economy strategy. This includes an idea of what has been of relevance to present within section 3.5.1 on EU initiatives. Hermansen has provided with relevant documents and reports underlying sections 3.5.3 and 3.5.4, the study's section on indicators, as well as giving an idea of the scope and content for this study. Literature research was then conducted on the basis of this information, and interviews were conducted as a result of the findings from the literature research.

2.1.1 Precursor of the study and its evolution

The work with this study started with a meeting in April 2018 together with Per Erik Sørås (Trøndelag County Council) and John E. Hermansen (supervisor, NTNU) to discuss possible cooperation on this thesis, after establishing the frameworks of this topic in the project thesis. The team around Sørås had been working with establishing plans regarding circular economy transition as a priority area within Trøndelag, and the topic was set to looking at how Trøndelag County Council could follow up on their goals and measure such a transition. This evolved, however, to target CE goals on a national level by developing suitable indicators, but with a local case company. Matmortua AS, being a close dialogue partner of the county, was suggested. As Matmortua AS was pioneering within plastic waste management, especially from marine sector, it became natural to narrow the scope down to CPE indicators for Norwegian enterprise.

Trøndelag county acted as an enabler for establishing contact with Matmortua AS as well as giving relevant information and insights to unpublished documents and possible informants. However, the study has operated on its own after the original meetings in April/September 2018 and January 2019. After this point, the study has evolved based on information from the contacted actors, research literature, and feedback from supervisors.

2.2 Literature Search and Review

The fact that CE in Norway, and CPE to a larger extent, is a novel topic, is reflected in the limited amount of relevant literature and documents addressing it. The fundamental literature and documents used for the CPE elaboration in this study has been governmental and EU political strategies and frameworks, as well as published CE material from Norwegian enterprise. Of special importance for this study have been material from the European Environmental Agency, EEA (Smeets & Weterings, 1999), EU Circular Economy Monitoring Framework (European Commission, u.d. a), EU Plastics Strategy (European Commission, 2018 d), Norwegian governmental documents whereof especially the white paper no. 45 (Regjeringen.no, u.d.), the Granavolden platform (Regjeringen.no, 2019 a), the SSB indicators for UNs SDGs (Nørgaard et.al, 2018) and the CE strategies elaborated by Waste Norway (Avfall Norge, 2018) and Norwegian Industry (Norsk Industri, 2018). In addition to this, Oria, Scopus and Google Scholar have been the sources for literature search and review. Table 1 below will present the documents of most importance for the elaboration on CPE indicators for Norwegian enterprise from these sources. It is also important to stress that a search in the Statistics Norway database for 'circular economy' also was made, but only got two hits and nothing of relevance (SSB, 2018).

Search	**Relevant outcome**
Oria «sirkulær økonomi indikator plastikk Norge»: 0 hits. «circular economy plastics indicator industry Norway»: 134 hits but none targeting this specifically. "circular economy indicator plastics Norway": 143 hits but non targeting this specifically. "indikator sirkulær plast økonomi": 0 hits. "indikator sirkulær økonomi": 1 hit. Not relevant.	Nothing relevant.
Scopus «circular economy indicators»: 290 hits, 2 that was considered relevant, however none with original aspects to study. "Circular economy plastics indicator Norway": 0 hits.	Moraga, et al., 2019 Ngan, et al., 2019.
Google Scholar «circular economy indicators»: 125000 hits. Four relevant. "circular plastic economy indicators": 36600 hits. One relevant.	Kalmykova et.al, 2018 Hahladakis & Iacovidou, 2018 Geng, Fu, Sarkis, & Xue, 2012 Haupt, Vadenbo, & Hellweg, 2016 Smol, Kulczycka, & Avdiushchenko, 2017

«sirkulær økonomi plast Norge»: 231 hits. None relevant.	Huysman, de Schaeepmester, Ragaert, Dewulf, & de Meester, 2017

Table 1. Literature search overview of most relevant articles for study topic.

2.3 Research Design and Data Material

The research design of this study has been composed by literature review, interview through mail correspondence and phone, as well as having a close cooperation with Matmortua AS and Trøndelag County. The study's research questions are of both descriptive and exploratory character. The study argues for a need to try to establish the status-quo of CE development in Norway, in order to be able to more accurately target CPE and propose a set of indicators for such transition within Norwegian enterprise. This descriptive foundation is presented in section 3.5, which is work based on the project thesis, which was made specifically for this thesis. Therefore, the study stresses that the original material from the project thesis was intentionally planned to make up the foundation and framework for this thesis, and is therefore included as a part of this study. However, some changes to the original material have been made as the insights obtained from the work of this thesis have affected some of its character.

Data material has been collected through literature search for published material, and through personal communication and interviews for unpublished material. The main foundation for the analysis, section five, is represented by Norwegian authorities (Ministry of Climate and Environment), the waste management trade organization (Waste Norway), a local waste management company pioneering on plastics recycling (Matmortua AS), and Statistics Norway (SSB). The study argues that these four actors represent the most important key actors for making CE and CPE in Norway possible, as they serve as a wide specter targeted for such societal transition. A further elaboration on the progress of how the interviews and the suggested indicators were made, follow below.

2.3.1 Interviews and personal communication

Several actors considered relevant for the CE/CPE in Norway were contacted via mail or phone to provide with information input for the development of the indicators. Table 2 shows which actors that have been contacted. The green slots are actors that have been contacted and given essential contributing information for the content and development of the CPE indicators. The yellow slots are actors contacted, but have not been able to provide feedback on the study's research topic of significance for this study. Reasons for this have been lack of capacity, or they have not had sufficient knowledge on the topic in order to provide inputs. The study's impression is that this is a result of the novelty CE development poses in Norway. The red slots are actors that have been contacted, but not answered the request.

Actor	**Time communicated**
Ministry of Climate and Environment (CE strategy working group) (Hamar, 2019)	2019: February
Matmortua AS (Øyangen, 2019)	2019: February, April, May
Trøndelag County (Sørås, 2018; Sørås, 2019; Strand, 2019)	2018: April, September. 2019: January, February.

Ministry of Climate and Environment (Section for waste and marine pollution, head of governmental work with CE) (Spillum, 2019)	2019: February, April, May
Sustainability Law expertise (Sjåfjell & Maitre, 2019)	2019: April, May
Statistics Norway (SSB) (Nørgaard, 2019)	2019: March
Waste Norway (Avfall Norge) (Bratland & Wilsgaard, 2019)	2019: April
Packaging Union (Emballasjeforeningen) (Bunes, 2019)	2019: April
Østfold Research (Østfoldforskning) (Stensgård & Raadal, 2019)	2019: April
Standard Norway (Jonassen, 2019)	2019: April
Grønt Punkt Norway (Johansen, 2019)	2019: April

Table 2. Overview actor contact

2.3.2 Making of indicators

The indicators are developed based on the CE indicators proposed by the EU through the Monitoring Framework (European Commission, n.d. a). The suggested indicators for a CPE within Norwegian enterprise is highly inspired by the framing and scope of the EU CE indicators. This due to the importance this study holds that novel work for an adoption of EU work to a Norwegian case should be based on the EU framework for matters of compliance and legitimacy. This has also been pointed out by Waste Norway in their recommendations for further national CE study (Avfall Norge, 2018).

In order to adapt the EU CE indicators to become reliable and valid for a Norwegian case, literature research and interviews with first-hand Norwegian CE actors was therefore necessary. Therefore, based on literature research from the project thesis, feedback from Trøndelag County and supervisors, the actors shown in table 2 above was contacted.

2.4 Evaluation and Reflection of Methods

This section will briefly reflect on and evaluate the abovementioned selected methods for this study, as well as the methodology for elaborating the suggested CPE indicators.

2.4.1 Interview and personal communication

The biggest possible weakness of the study could arguably have said to be the lack of response from some of the contacted actors. This opens up a possibility of not having covered the CE and CPE aspects in Norway thoroughly enough, and not have been able to analyze and present status-quo of Norwegian CE/CPE development in a fully covered way. This will however always be difficult when a study is targeting a topic of novel character where national initial work is under progress (first strategically targeted politically through the Granavolden platform in January 2019). No specific politically decided CE strategies and elementary foundations are yet established as this study is written. The phone interview with Atle Hamar (2019) is therefore of unquestionable strength to this study, as he is the leader of the working group of the national strategy on CE. A confirmation from the responsible section for the Norwegian CE strategy that no documents are yet to be released outside the working group also illustrates the novelty of this study's topic (Spillum, 2019). Close contact and collaboration with Matmortua AS and

Trøndelag county, together with the obtained actor contact has therefore been essential to give this study reliability.

The study argues that it is not possible to address the research questions in a quantitative way. Because the topic addressed is so recent and unexplored in a Norwegian context, it has been important for the study to do a qualitative approach, simply to be able to contribute in providing with an image and overview of Norwegian CE/CPE development. This, in turn, will open up for more accurate targeted quantitative research, as the qualitative descripting and manifestation of CPE, together with the suggested indicators, has been identified.

2.4.2 Making of indicators

This study argues that the possible weakening effect from lack of actor response, does not affect the relevance of content and scope of the indicators proposed. Since no measurement tools or other instruments are elaborated in a Norwegian CE, or CPE, context, this study offers something original to the Norwegian CE debate. Because of the close collaboration with Matmortua AS in the elaboration of the CPE indicators, this study is certain that the indicators answer to the sector challenges, and target a real situation regarding content and scope.

3 Theoretical Resources

This section will present the definitions and concepts used in the study, it will briefly present which UN Sustainable Development Goals (SDGs) that have been considered relevant for a CE, and thereby CPE, transition, before it gives a presentation of the main aspects of Norwegian plastic waste treatment and the CE frameworks creating the foundation for CE/CPE evolution. The study stresses that parts of section 3.1 and 3.5 are a continuation of the project work for this thesis.

3.1 Terms, Concepts and Definitions

Essential in this study is clarifying core aspects of a CE/CPE transition, which is why the terms and concepts of circular economy, indicator, circular business model and Norwegian enterprise will be explained and defined below. The material presented in section 3.1.1 and 3.1.2 is a continuation from the work with the project thesis for this study. Here, a new definition of "indicator" was created, which is valid also for this study.

3.1.1 Circular economy

Circular economy represents a development strategy that entails economic growth without increasing consumption of resources, deeply transform production chains and consumption habits, and redesign industrial systems at the system level (European Commission, 2014). It aims to redefine growth, focusing on positive society-wide benefits. Until now, our economy has been designed to perform in a linear way, meaning that resources initially taken out of the earth ends up as a non-value product, ending its lifetime as a disposed item. Circular economy on the other hand, wishes to transform the linear process into a holistic circle, taking what has ended up considered as waste (non-valuable material), now represents the initial starting point of a new economic value chain, thereof a circle. This means that as much resources as possible need to circulate within the economy (Trøndelag Fylkeskommune, 2018). The principles of circular economy are "reduce, recycle and reuse", aiming at core towards consumption and production patterns and habits in all aspects of society (Banaité, 2016).

This circular economic change relies on technological, social and organizational innovation. Digitalization and new technology are important tools to optimize material flows at producer level, with new business models for products and services that enables sharing, reuse and mending (Trøndelag Fylkeskommune, 2018). It entails gradually decoupling economic activity from the consumption of finite resources, and designing waste out of the system. The Ellen MacArthur Foundation (2017) bases it on three principals: design out waste and pollution, keep products and materials in use, and regenerate natural systems. Below is an excerpt from one of the European Commission's early statements on the circular economy strategy, giving a good explanation of the concept (European Commission, 2014):

> *"Since the industrial revolution, our economies have developed a 'take-make-consume and dispose' pattern of growth — a linear model based on the assumption that resources are abundant, available, easy to source and cheap to dispose of. It is increasingly being understood that this threatens the competitiveness of Europe.*
>
> *Moving towards a more circular economy is essential to deliver the resource efficiency agenda established under the Europe 2020 Strategy for smart, sustainable and inclusive growth (European Commission, 2010, European Commission, 2011). Higher and sustained improvements of resource efficiency performance are within reach and can bring major economic benefits.*
>
> *Circular economy systems keep the added value in products for as long as possible and eliminate waste. They keep resources within the economy when a product has reached the end of its life, so that they can be productively used again and again and hence create further value. Transition to a more circular economy requires changes throughout value chains, from product design to new business and market models, from new ways of turning waste into a resource to new modes of consumer behaviour. This implies full systemic change, and innovation not only in technologies, but also in organisation, society, finance methods and policies. Even in a highly circular economy there will remain some element of linearity as virgin resources are required and residual waste is disposed of"* (European Commission, 2014).

As stated above, a transition to a circular economy requires a new portfolio skills and knowledge, as well as new financial instruments and multistakeholders' involvement. Companies need to design business models that makes this change happen, but in order to do make the market uptake faster, governments need to take lead and make such a change beneficial through policies and finance. As the European Commission also highlights:

> "*Existing infrastructure, business models and technology, together with established behaviour keep economies 'locked-in' to the linear model. Companies may lack the information, confidence and capacity to move to circular economy solutions. The financial system often fails to provide for investment in efficiency improvements or innovative business models, which are perceived as riskier and complex, deterring many traditional investors. Conventional consumer habits can also hinder new products and services development. Such barriers tend to persist in a context where prices do not reflect the real costs of resource use to society, and where policy fails to provide strong and consistent signals for the transition to a circular economy*" (European Commission, 2014).

There can be found several definitions of the concept *circular economy* in literature, but this study argues that a representative range and scope is presented with the definitions below, choosing the definition from Kraaijenhagen et al. (2016) as this study's definition of the concept. Within this definition, listed lastly, both the environmental (waste, disposal), social (human welfare) and market/business perspectives (business models, finance) are represented.

> "Circular economy is explained as an economy where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimized" (European Commission, 2016).
>
> "Circular economy is a framework for an economy that is restorative and regenerative by design" (Ellen MacArthur Foundation, 2017).
>
> "Circular economy means that resources remain within the economy for as long as possible through reduced finite material use, waste, emissions and energy" (Trøndelag Fylkeskommune, 2018).
>
> "Circular economy is defined as 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" (Murray et al., 2015).
>
> "Circular economy (…) An economy in which stakeholders collaborate in order to maximize the value of products and materials, and as such contribute to minimizing the depletion of natural resources and create positive and societal and environmental impact" (Kraaijenhagen et al., 2016)

3.1.2 Indicator

The term indicator comes from the Latin verb *indicare*, meaning "to disclose or point out, to announce or make publicly known, to estimate or to put a price on" (Skaar & Deshpande, 2018). They provide information in a more quantitative form than words or pictures alone, and they also provide information in a simpler form than complex statistics or other kinds of economic or scientific data. Indicators are not an end in themselves, but tools to build support for needed change and guide the actions of management. Indicators communicate information about progress towards stated goals. They thereby consist of statistics used to measure current conditions as well as to forecast trends, be either economic, ecological, social or environmental. Indicators are the basis for quantified management and communication, and the basis for reporting.

A good indicator provides sufficient, relevant and concise information about a phenomenon in space and time, while avoiding problem-shifting. This is not an easy task, and the challenges and aspects in need of concern while formulating them are illustrated well in Hák et al. (2016):

> "*Despite the fact that there is plenty of theoretical work on quality standards for indicators, in practice users cannot often be sure how adequately the indicators measure the monitored phenomena. Therefore, we stress the need to operationalise targets and evaluate the indicators' relevance, the characteristic of utmost importance among the indicators' quality traits. Generally, the conceptualisation of sustainability assessment and operationalisation of goals and targets should follow certain agreed principles.*

However, they are often either too theoretical or mostly of a strict methodological nature. The former doesn't reach the operationalisation level, the latter concentrate on the process of data processing. Indicators' other qualities beyond methodological aspects, in particular relevance, tend to be underdeveloped (…) [This paper] presents a set of selection criteria for the indicators. They should be relevant, methodologically sound, measurable, easy to communicate and access, limited in number and outcome focused. The first criterion – relevance – comprises three different aspects:

> *• Link to the target: The indicator should be clearly linked to one or more targets and provide robust measures of progress towards the target(s).*
>
> *• Policy relevance: The indicator should be relevant to policy formulation and provide enough information for policy making.*
>
> *• Applicability at the appropriate level: For global monitoring, the indicator should be relevant to all countries; for national monitoring, the indicator should be relevant to national priorities*" (Hák et al., 2016).

Requirements for indicators can be divided into two requirement categories; scientific requirements and pragmatic requirements (Skaar & Deshpande, 2018). In order to attempt complying with the abovementioned criteria, an indicator needs to be scientifically valid and robust while at the same time being pragmatic and understandable to the public and the actual realities. Table 3 presents an overview of these requirement categories and which criteria have been selected as to provide for a good and solid indicator. An indicator should provide enough information and accuracy to exclude any doubts that other data or knowledge was needed to provide a more accurate outcome, or indication. The challenge is however to know how to prevent that the requirements list becomes endless, making it somewhat short but sufficient.

INDICATOR REQUIREMENTS

Scientific requirements	**Pragmatic requirements**
- Observable and quantifiable	- Easily understood
- Content validity	- Simple
- Criterion-related validity	- Relevant
- Construct validity	- Timely
- Sensitive to change	- Manageable
- Compatible with other indicators used	- Compelling
- Transparent and meaningful	- Comparable
- Robust against manipulation	- Feasible
- Verifiable	
- Appropriate in scale	

Table 3. Indicator Requirements (Zadek, 2007; Burgherr, 2005; Kjellèn, 2000; Skaar & Deshpande, 2018).

Indicators can also be organized as to what type of aspect or area one wants to measure, and the terminology of these types of indicators can vary (Skaar & Deshpande, 2018). Indicators can be descriptive, related to performance within operation or management, related to measuring of

efficiency, or they can be composite. Table 4 below presents how these indicator types differ in terminology between the ISO-standard on environmental management and its performance evaluation, and the terminology used by the European Environmental Agency, two main actors within work on environmental performance and performance tools.

INDICATOR TERMINOLOGY		
	ISO 14031 terminology	**EEA terminology**
Descriptive	Environmental Condition Indicator (ECI)	State, Pressure and Impacts
Performance: OPI	Operational Performance Indicator (OPI)	State, Pressure and Impacts, linked to targets
Performance: MPI	Management Performance Indicator (MPI)	State, Pressure and Impacts, linked to targets
Efficiency	Not addressed in ISO 14031. The ISO 14045 term is eco-efficiency indicator (ISO, 2012).	Relationships between DPSIR elements (e.g. the relationship between D and P as an eco-efficiency indicator)
Composite indicators	Indexed indicators, aggregated indicators and weighted indicators	Total welfare indicators

Table 4. Indicator terminology (Skaar & Deshpande, 2018).

When defining *indicator* for this thesis, the above mentioned criteria should be considered and tried to be met. Table 5 presents a summary of relevant literature on the subject. However, this study argues that none of the definitions emphasizes the aspect of time and place, and avoiding problem-shifting when using the indicator. Therefore, this study proposes a new definition of *indicator* listed at the end of the table, which will be the preferred definition of the term for this study.

Definition, indicator	**Source**
[An indicator is a] measurable representation of the condition or status of operations, management or conditions.	ISO14001, 2015
Indicator [is a] quantitative, qualitative or descriptive measure.	ISO 37100, 2016
Indicators are required for monitoring the level of achievement towards defined targets and to be well received by national governments stakeholders, these indicators should fully take	Tasaki & Kameyama, 2015

into account circumstances and concerns of each country.	
[An indicator is] a measurable or operational variable that can be used to describe the condition of a broader phenomenon or aspect of reality.	Øien, 2001
Definition made for thesis: An indicator is a descriptive and measurable variable that provides sufficient, relevant and concise information about a phenomenon of reality in space and time, while avoiding problem-shifting.	

Table 5. Indicator definition

The indicators developed in this study are mainly of a performance and descriptive character. A brief additional description of such is therefore explained in the following two sub-chapters.

3.1.2.1 Performance indicators

A performance indicator is a qualitative indicator, which usually is an indicator of change or outcomes (Types, n.d). They are non-numerical factors for determining level of progress towards a specific goal. These indicators therefore answer to information that indicates whether we are achieving the desired outcome or not. "In general, the aim of performance indicators is to provide information which can be used to enhance the effectiveness of decisions regarding policy priorities, strategies and resource allocation" (OECD, 2009).

3.1.2.2 Descriptive indicators

Descriptive indicators show the development of a variable, and describe the actual situation with regard to the target area (Smeets & Weterings, 1999). They are therefore only describing a result of something, or of what we should be obtaining or strive to obtain in order for the realization of a wanted outcome.

3.1.3 Circular business model

A company's business model represents the business' value proposition (what it offers), value creation (how it makes and supplies what it offers) and value capture (how it profits) (Bocken, 2013). The way these three values are characterized in a circular business model can be found in Urbinati et al. (2017) as illustrated in figure 2 below:

(i) Reverse supply chain activities and higher degree of cooperation with the actors of the supply chain	(ii) Transition from a "pay-per-own" to a "pay-per-use" approach	(iii) Higher degree of cooperation between companies and customers	(iv) Payment for use-oriented or result-oriented services
Value network	**Customer value proposition & interface**		

Figure 2. Circular economy in companies' business model (Urbinati et al., 2017)

Figure 2 targets the core of a circular business model, which is to close, slow, intensify, narrow and dematerialize resource loops (Geissdoerfer, Morioka, Monteiro de Cavalho, & Evans 2018). As illustrated in figure 3 below, this distinguishes it from a sustainable business model, which mainly focuses on a sustainability aspect of the business through the three-pillars: economic, environmental and social factors. A key difference is that this does not necessarily address a holistic approach through targeting supply chains, which is key within a circular business model (Geissdoerfer et al., 2018; Urbinati et al., 2017).

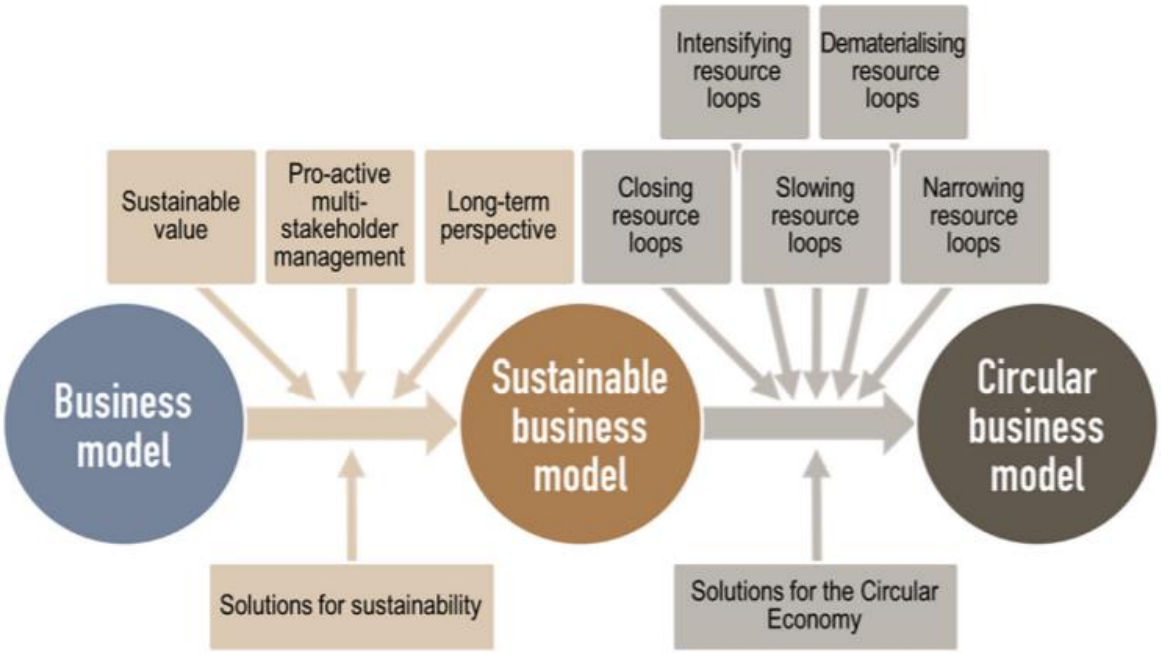

Figure 3. Comparison of traditional, sustainable and circular business models (Geissdoerfer, Vladimirova, & Evans, 2018; Geissdoerfer, Morioka, Monteiro de Cavalho, & Evans, 2018)

3.1.3 Norwegian enterprise

The sector addressed for this study's CPE indicators is Norwegian enterprise, which here is meant as the sector of the Confederation of Norwegian Enterprise (NHO). By saying

'enterprise', the correct reference in Norwegian would be *næringsliv*. NHO consists of the following 16 branches, or sectoral federations, which are therefore targeted by this study's scope (NHO, n.d):

Association of Norwegian knowledge and technology based enterprises (Abelia)
Federation of Norwegian Industries (Norsk Industri)
Federation of Norwegian Building Industries (Byggenæringens Landsforening - BNL)
Norwegian Electricity Industry Association (Energi Norge)
Norwegian Seafood Federation (Sjømat Norge)
Federation of Norwegian Aviation Industries (NHO Luftfart)
Food Drink Norway (NHO Mat og Drikke)
Norwegian Logistics and Freight Association (NHO Logistikk og Transport)
Norwegian Media Businesses' Association (Mediebedriftenes Landsforening - MBL)
Norwegian Association of Motorcar Dealers and Service Organisations (Norges Bilbransjeforbund - NBF)
Norwegian Oil and Gas Association (Norsk olje og gass)
Federation of Norwegian Costal Shipping (NHO Sjøfart)
Norwegian Hospitality Association (NHO Reiseliv)
Norwegian Federation of Service Industries and Retail Trade (NHO Service og Handel)
Nelfo (Energy, electronics, IT)
Federation of Norwegian Transport Companies (NHO Transport)

3.2 Sustainable development goals

The UN Sustainable Development Goals (SDGs), are 17 goals which are "an urgent call for action by all countries, developed and developing, in a global partnership. The goals make part of the 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, providing a shared blueprint for peace and prosperity for people and the planet, now and into the future. They recognize that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality, and spur economic growth – all while tackling climate change and working to preserve our oceans and forests" (UN, n.d). Each of the 17 SDGs consist of targets with following indicators on how to achieve the target. This study has identified which SDG targets considered relevant for a CPE transition, and will propose new indicators based on this.

This study argues that most of the goals are directly or indirectly relatable to the completion of a circular economy, and a circular plastics economy transition. Waste Norway's CE roadmap identifies SDG 8 and 12 to be relevant for the CE. However, this study identifies nine SDGs that are argued to have a clear connection to realize a CPE transition. These SDGs will briefly be presented below, but further discussed and argued for in the analysis section 5.1.

3.2.1 SDG 3 Good health and well being

"Ensure healthy lives and promote well-being for all at all ages" (UN, n.d).

In Norway, the Ministry of Health and Care Services has delegated the responsibility of coordinating the work on achieving the sustainable development goals, both nationally and internationally, to the Directorate of Heath. The Norwegian Helseinstituttet (FHI) possess information for many of the indicators (Nørgaard et al., 2018).

Target 3.9 "By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination" (UN, n.d) has been identified relevant for this study.

3.2.2 SDG 6 Clean water and sanitation

«Ensure availability and sustainable management of water and sanitation for all" (UN, n.d).

At core of this SDG is to secure sustainable water management and access to water and good sanitation for all (Nørgaard et al., 2018). "Too many people still lack access to safely managed water supplies and sanitation facilities. Water scarcity, flooding and lack of proper wastewater management also hinder social and economic development. Increasing water efficiency and improving water management are critical to balancing the competing and growing water demands from various sectors and users" (UN, n.d). The Ministry of Climate and Environment is the responsible coordinator for this goal in Norway.

The following targets have been identified relevant for this study:
- 6.1 "By 2030, achieve universal and equitable access to safe and affordable drinking water for all" (UN, n.d).

- 6.3 "By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally" (UN, n.d).

3.2.3 SDG 8 Decent work and economic growth

«Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all" (UN, n.d).

To create increased growth and new jobs through decent work is a precondition for a sustainable development, and is the biggest challenge for all countries towards 2030 (Nørgaard et al., 2018). "More progress is needed to increase employment opportunities, especially for young people, reduce informal employment and labour market inequality (particularly in terms of the gender pay gap), promote safe and secure working environments, and improve access to financial services to ensure sustained and inclusive economic growth" (UN, n.d). In Norway, the responsible coordinator of this goal is the Ministry of Finance (Nørgaard et al., 2018).

The following targets have been identified as relevant for this study:

- 8.2 "Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors" (UN, n.d).

- 8.3 "Promote development-oriented policies that support productive activities, decent job

creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services" (UN, n.d).

- 8.4 "Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-year framework of programmes on sustainable consumption and production, with developed countries taking the lead" (UN, n.d).

3.2.4 SDG 9 Industry, innovation and infrastructure

"Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation" (UN, n.d).

Investment in transport, irrigation systems, energy and IT are crucial in order to create a sustainable development (Nørgaard et al., 2018). To achieve inclusive and sustainable industrialization, competitive economic forces need to be unleashed to generate employment and income, facilitate international trade and enable the efficient use of resources (UN, n.d). A well-functioning society is reliant upon infrastructure, which in turn increase growth and productivity. Technology and innovation can also contribute in solving environmental challenges that follow the construction of such infrastructure. The Ministry of Trade, Industry and Fisheries is the responsible coordinator for this goal in Norway (Nørgaard et al., 2018).

The following targets are identified relevant for this study:
- 9.4 "By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities" (UN, n.d).

- 9.5 "Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending" (UN, n.d).

3.2.5 SDG 12 Responsible consumption and production

"Ensure sustainable production and consumption patterns" (UN, n.d).

Decoupling economic growth from resource use is one of the most critical and complex challenges facing humanity today. "Doing so effectively will require policies that create a conducive environment for such change, social and physical infrastructure and markets, and a profound transformation of business practices along global value chains" (UN, n.d). At core of this goal is how to better exploit the resources in order to minimize the impact on environment and climate. Out of the 13 indicators, 10 are without any clarified methodology, and therefore not ready to create global aggregates. There exist statistics that can be used for several of the indicators, but many need further development. 12.1, partly 12.4, 12.5, 12.6, 12.7 and 12.8 have no Norwegian data in the UN's SDG indicator database. However, it is possible to provide national data for most of them (Nørgaard et al., 2018).

The following targets are identified as relevant for this study:

- 12.1 “Implement the 10-year framework of programmes on sustainable consumption and production, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries” (UN, n.d).

- 12.2 “By 2030, achieve the sustainable management and efficient use of natural resources” (UN, n.d).

- 12.4 “By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment” (UN, n.d).

- 12.5 “By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse” (UN, n.d).

- 12.6 “Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle” (UN, n.d).

- 12.7 “Promote public procurement practices that are sustainable, in accordance with national policies and priorities” (UN, n.d).

- 12.8 “By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature” (UN, n.d).

3.2.6 SDG 13 Climate action

“Take urgent action to combat climate change and its impacts” (UN, n.d).

Goal 13 on hindering climate change is per now the goal with least indicators based on national statistics (Nørgaard et al., 2018). Currently, only 3 out of 8 indicators have established methodology and standards. The global indicators are largely focused on whether there exist national plans and efforts, and these are accounted for on a global level. There is a lack of statistical measures related to physical aspects on most of the targets except 13.1. some relevant global indicators can however be found in other SDG’s such as for renewable energy in SDG7 and subsidies on fossil fuels in SDG12. The goal addresses the UN Framework Convention on Climate Change (UNFCCC) as the most important international and inter-governmental forum for negotiations on climate change mitigation efforts (Nørgaard et al., 2018).

The following target is identified relevant for this study:
- 13.2 “Integrate climate change measures into national policies, strategies and planning” (UN, n.d).

3.2.7 SDG 14 Life below water

"Conserve and sustainably use the oceans, seas and marine resources for sustainable development" (UN, n.d).

This goal is about conserving and using oceans and marine resources in a way that promotes sustainable development (Nørgaard et al., 2018). Few indicators have been fully developed by 2017, and currently, only the indicator on protected sea areas have been provided for statistically by Norwegian data. "Advancing the sustainable use and conservation of the oceans continues to require effective strategies and management to combat the adverse effects of overfishing, growing ocean acidification and worsening coastal eutrophication. The expansion of protected areas for marine biodiversity, intensification of research capacity and increases in ocean science funding remain critically important to preserve marine resources" (UN, n.d).

The following indicators have been identified relevant for the study:
- 14.1 "By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution" (UN, n.d).

- 14.2 "By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans" (UN, n.d).

3.2.8 SDG 15 Life on land

"Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss" (UN, n.d).

This goal is targeting protection, restoring, and promoting sustainable use of ecosystems, secure sustainable forestry, fight desertification, stop and reverse land deterioration and loss of biodiversity (Nørgaard et al., 2018).

The following target has been identified relevant for this study:
- 15.9 "By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts" (UN, n.d).

3.2.9 SDG 17 Partnerships for the goals

"Strengthen the means of implementation and revitalize the global partnership for sustainable development" (UN, n.d).

"Goal 17 seeks to strengthen global partnerships to support and achieve the ambitious targets of the 2030 Agenda, bringing together national governments, the international community, civil society, the private sector and other actors. Despite advances in certain areas, more needs to be done to accelerate progress. All stakeholders will have to refocus and intensify their efforts on areas where progress has been slow" (UN, n.d).

The following six targets have been identified relevant for this study. However, only 17.14 and 17.16 are considered relevant in their explicit formulation, while the others play an inspirational role for the CPE indicator development:

- 17.14 “Enhance policy coherence for sustainable development” (UN, n.d).

- 17.16 “Enhance the global partnership for sustainable development, complemented by multi-stakeholder partnerships that mobilize and share knowledge, expertise, technology and financial resources, to support the achievement of the sustainable development goals in all countries, in particular developing countries” (UN, n.d).

- 17.10 “Promote a universal, rules-based, open, non-discriminatory and equitable multilateral trading system under the World Trade Organization, including through the conclusion of negotiations under its Doha Development Agenda” (UN, n.d).

- 17.12 “Realize timely implementation of duty-free and quota-free market access on a lasting basis for all least developed countries, consistent with World Trade Organization decisions, including by ensuring that preferential rules of origin applicable to imports from least developed countries are transparent and simple, and contribute to facilitating market access” (UN, n.d).

- 17.6 “Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge sharing on mutually agreed terms, including through improved coordination among existing mechanisms, in particular at the United Nations level, and through a global technology facilitation mechanism” (UN, n.d).

- 17.5 “Adopt and implement investment promotion regimes for least developed countries” (UN, n.d).

3.3 Plastic categories

Plastic is a non-uniform material, which is why it is more correct to refer to it at *plastics*, in plural, rather than plastic, in the singular form. Figure 4 (Deshpande, 2019) shows the different types of plastics that exist, its estimated occurrence in global plastic waste anno 2015 and the level of recycling ease by type. Additional three types of plastics can also be added: degradable plastic, bio-plastic and compostable plastic. Out of these, only the latter is fully plant based, meaning that oil is not a component in production. The figure also shows the level of ease in recycling the different types of plastics, showing that only two out of the seven types are actually easy to recycle (Ese et al., 2018).

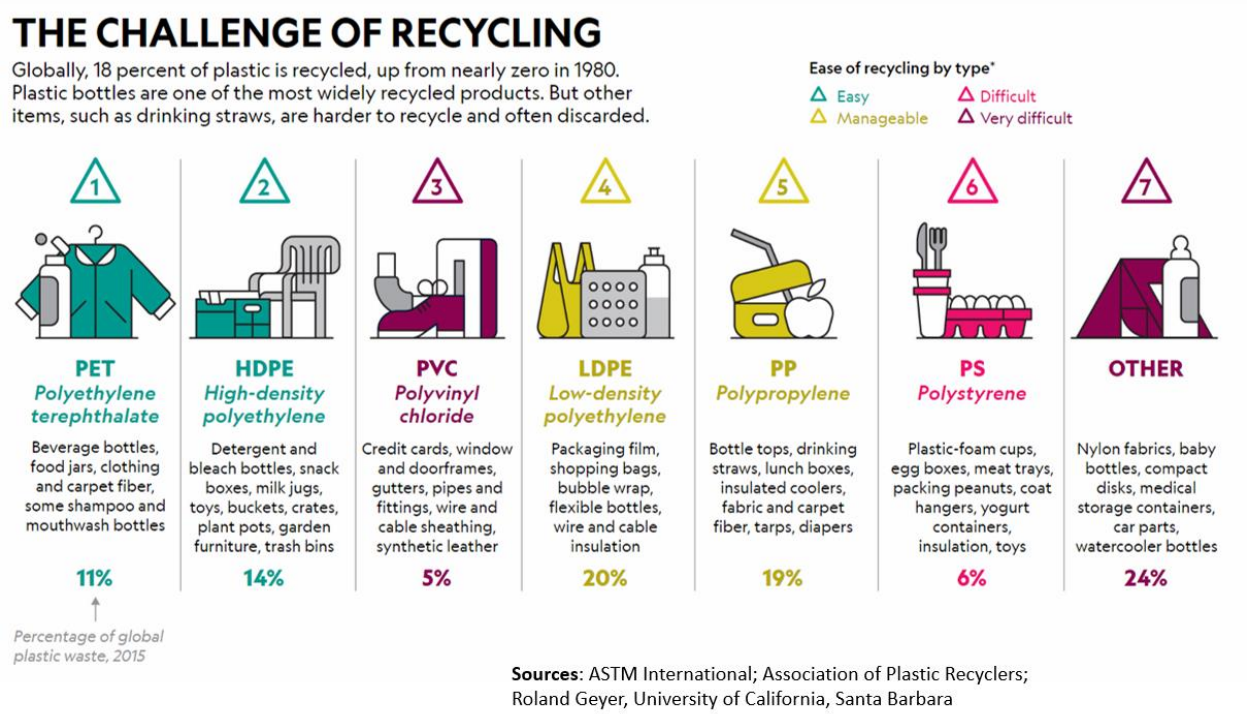

Figure 4. Plastics categories (Deshpande, 2019)

3.4 Plastic waste management in Norway

The plastics management in Norway is fragmented, with no uniform solution in how plastic waste is treated. For household waste, each waste management company, or IKS, can, under the regulations of the Municipal Act, decide the methods for treating the household recycled plastics fractions (Wikipedia.org, 2019). According to *Grønt Punkt Norge*, 39,3% of all sorted plastics waste in Norway is re-used and becomes new plastics (Mathismoen, 2019). According to the latest SSB numbers (2015), 35 717 tonnes of plastics came from Norwegian enterprise (SSB, 2015 a) and 31 000 tonnes from Norwegian industry (SSB, 2015 b) that year (both categories referred to as *enterprise* in this study). 50% of all plastics from Norwegian enterprise is material recycled in the Norwegian town Folldal, while the rest is exported (Mathismoen, 2019). The plastics waste is hard to track and document in the global market, but we know that most ends up in East-Asia, Africa and island states (Mepex, Salt, 2018).

In absence of international regulations for trade of non-hazardous waste, trade in plastics waste has become a gigantic industry worth more than five billion dollars per year (Mathismoen, 2019). Instead of sorting and treating plastics nationally, which is expensive, countries export their plastics waste. 98,5% of collected plastics packaging from Norwegian household is sent to Germany, the rest to Finland. Presumably, no one knows exactly what's being done with the plastics here, other than to believe it's burnt for energy recovery, or sent to Asia (Amundsen, 2018). However, Asia, with China in lead, have recently banned all imports of waste, also other than plastics, raising a debate in Europe on what to do with the waste exported (Djursing, 2019). On May 10th this year (2019), it was known that a Norwegian initiated legislation on rules for global plastics trade was ratified in the Basel-convention (Mathismoen, 2019). This means that

all exports of plastics without a license will be forbidden nearly worldwide, which is quite sensational. Intentionally, this could limit illegal trade of plastics that has been originally been recycled, but has ended up as un-sorted because it contains too much pollution (traces of other materials, greasing, etc.). An example of the new regulation would be that if a French company wants to sell their plastics to a Vietnamese company, authorities in both countries have to affirm the trade to happen. This way there will be a security that the plastics doesn't end up in small, often family driven, companies in South-East Asia like today. These companies often lack of good technological solutions and environmental practise, selecting plastics of good value for further production, while leaving the rest to weathering and dumping other places. However, in a CE perspective, the urge for a need of a well-functioning local plastics waste management can arguably be a means of contributing in closing the plastics cycle.

3.4.1 State of the art

The way Matmortua AS's facilities at Ottersøy produces new plastic material (granulate) from fossil and recycled plastic, can arguably be considered the closest state of the art in Norway regarding a circular plastics economy (Øyangen, 2019). Matmortua AS is the only Norwegian actor to this date that collects and recycles plastic components into new material, which nationally is sold to Plasto in Åndalsnes, where new products are made (Øyangen, 2019; Mepex, Slat, 2018). An on-going research project on the material quality of secondary raw plastics material is happening at Plasto, and is has been documented that recycled plastics maintain a good quality during the longevity. Matmortua AS receives interest and visitors from other waste management companies nationally that wants to explore and develop the same type of plastic waste handling (Øyangen, 2019). This could give an indication that more companies are on the edge of developing the same treatment within near future.

3.4.2 Opportunities and challenges for plastics recycling

Compared to metals and paper, the market for plastics recycling is worse developed (Mepex et al., 2018). Despite a strong increase in the market for plastics, there is still a significant risk that collected plastics, in practice, is not material recycled due to economic or technical circumstances. Or it can be because of reduced environmental gain due to an inefficient return and recycling process. Good returning systems of plastics where it can be traced, and a good coordination of tonnages/economies contributes to secure the environmental beneficence for material recycling. Correspondingly, a malfunctioning return system can result in poor environmental benefit. In the worst case, it only contributes to marine pollution through uncontrolled processes in other countries where both legal and illegal depositing of waste is normal. There is a lack of traceability and documentation of the waste, and there is a lack of demands for reuse and material recycling, which in turn inhibits development and incentives for better technological solutions. Without strict requirements for recycling and recovery, nor will there be a development of good design for recovery. Costly collection and treatment of the waste also leads to the waste possesses not choosing material recycling (Mepex et al., 2018).

The opportunities lie arguably in the increase of plastics material recycling and reuse (Mepex et al., 2018). The market for material recycling needs to contain more local actors that collect and physically re-melts the plastic waste into new raw material (pellets/regranulate), just like

Matmortua AS does. Per now, most of these recyclers are located abroad, mostly Asia, as mentioned above. With the ban on waste imports, there will likely to be an urging need for more local plastics recycling. This requires an established national collective will to create synergies and bigger plastics economies beyond the local initiatives seen today, e.g Matmortua AS and Norwegian Nofir (Mepex et al., 2018; Øyangen, 2019).

3.5 Frameworks for a circular economy transition

This section is a continuation of the project work made for this study, and establishes status quo for CE, and CPE, development in the EU, and in Norway on both a national and local level.

3.5.1 EU initiatives

EU's work towards a strategy on circular economy started in 2015, and is today comprised within the *2018 Circular Economy Package* where a monitoring framework is provided to put out measures on closing the loop of product lifecycles and act on the *EU Circular Economy Action Plan* (European Commission, 2018 a, European Commission, 2018 f, European Commission, n.d. a). Within the circular economy package, EU lays a special focus on dealing with plastics, chemicals in products and critical raw materials. The package also includes a stakeholder platform, an online platform for policy dialogue, sharing of information and best practices on circular economy between stakeholders. Through Horizon 2020, EU's biggest research and innovation programme, the research and innovation aspect of circular economy is targeted through a common coherent framework (European Commission, 2018 a). The EU sets priority on fulfilling its action plan on circular economy through the *Monitoring framework on progress towards a circular economy*. This is the intended toolbox for making the transition happen, and proposes a set of indicators that EU argues capture the main elements of circular economy. An overview of the principles and content behind the monitoring framwork can be seen in figure 5 below.

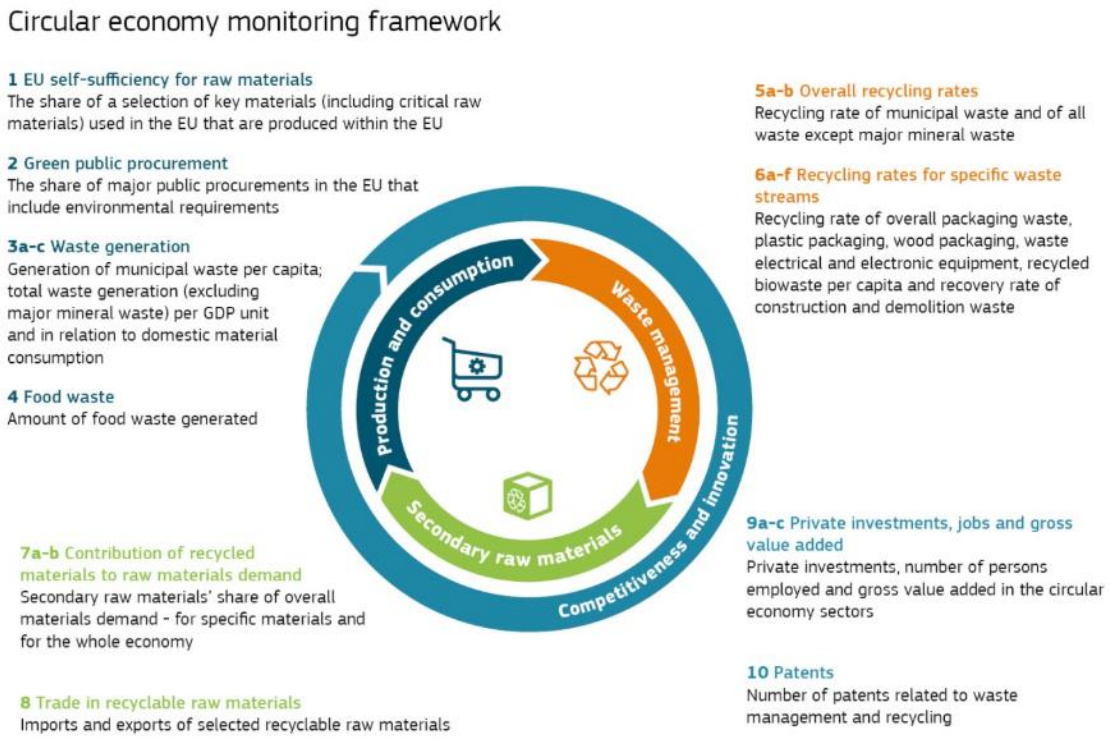

Figure 5. Circular economy monitoring framework (European Commission, 2018 a).

3.5.1.1 EU indicators for a circular economy

The monitoring framework has determined indicators within four categories considered central for a circular economy transition; 'production and consumption', 'waste management', 'secondary raw materials' and 'competitiveness and innovation' (European Commission, u.d. a). These indicators, as shown in Appendix A, are the inspirational foundation for the making of Norwegian CPE indicators proposed in this study.

The work on elaborating indicators is continual, and certain indicators are still under further development, in particular regarding data collection and methodology. This shows within some indicators, as they are not provided for with a functional unit (common unit for measurement). This is a weakness which needs to be provided for if these indicators are to be used for further research at local level. The categories, corresponding indicators and updates on the Norwegian progress related to these is attached in the appendix . As to why these specific indicators have been chosen, EU has the following explanation:

> "*These indicators were selected in order to capture the main elements of a circular economy. The list is constructed to be short and focused. It uses available data while also earmarking areas where new indicators are in the process of being developed, in particular for green public procurement and food waste. About half of the indicators in this framework come from Eurostat; others are produced by the Joint Research Centre (JRC)*[1] *and the Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs (DG GROW)*" (European Commission, 2018 c).

[1] JRC (in Sevilla, Spain) has also been involved with Trøndelag County Council's circular economy action plan.

EU also provides data from member countires, including Norway, on the performance of these indicators. There are lacks of information on several indicators for Norway, especially for 'secondary raw materials' where non of the indicators are provided for according to EU's overview. Tracking of raw materials within our economy chains also seems to be a missing link for EU as a whole, as the European Parliament specifically has called upon the Commission for indicator development within resource efficiency, meaning that resources should not be subject to squandery, but rather aiming for a longlasting lifetime within the economy (European Commission, 2018 a). The monitoring of key trends and patterns is key in order to understand the development of the economy elements over time, with the aim of identifying whether efforts for a circular economy transition have been successful. Measurements of a transitioning progress need to encompass various dimentions at all lifecycle stages of resources, products and services. The results of this monitoring are then to form the basis for setting new priorities and long-term objectives towards a circular economy, not only for policy makers, but should inspire action from all economical actors (European Commission, 2018 a).

3.5.1.2 EU strategy for plastics in a circular economy

In the EU Action Plan for a circular economy, plastics is defined as a key priority, and a *European Strategy for Plastics* was developed in January 2018 (European Commission, 2018). This strategy proposes concrete actions designed to make the vision for a more circular plastics economy a reality. The strategy stresses the importance of targeting plastics throughout the value chain and entire life-cycle. Of the key actions on turning vision into reality, the following areas are highlighted (European Commission, 2018 b; European Commission, 2018 d):

- Improve the economics of plastics recycling and quality of plastics design and recycling
- Boost demand for recycled plastics
- Curbing plastic waste and littering
- Establish a clear regulatory framework for plastics with biodegradable properties
- Drive innovation and investment towards circular solutions
- Harness global action, as opportunities and challenges within this field are increasingly global

The most striking outcome from this strategy so far, is the agreement on banning single-use plastics in the EU from 2021 (European Commission, 2018 e; Naturvernforbundet.no, n.d).

3.5.2 EU law and regulation

With the EU Circular Economy Package follows a legislative waste proposal, which was adopted in July 2018 (European Commission, 2018 a, Cole, 2018). Important indications for a fulfillment of a circular economy has been argued to be illustrated by our production and consumption habits, market of raw materials, whereby waste management and keeping track of waste streams within the economy is key. The following legislations are key when addressing CE/CPE transition: Waste Framework Directive 2008/98, Packaging Directive 2015/720, REACH Regulation EC 1907/2006 (can restrict the use of substances that pose a risk to the environment or health - there are discussions about regulating microplastics), Ecodesign Directive 2009/125 (product requirements including recyclability can influence how much plastics is recycled from electrical appliances and electronic goods), Marine Strategy Framework Directive 2008/56 (marine litter is listed as a pressure/impact to be addressed by Member States in their marine strategy, pursuant article 8) (Sjåfjell & Maitre, 2019).

Regarding the *EU strategy for plastics* and the ban on single use plastics, the Commission suggests the development of new laws focusing on such products, as well as fishing gear, which make up 70% of all marine pollution in Europe. These laws will be designed and developed according to address each of the distinct products in order to achieve the best result possible (Ese, Trætli, & Lonar, 2018; European Commission, 2018 e).

3.5.3 Norwegian law and regulation

As a EEA (European Economic Area) member, Norway is attached to EU's laws and regulations (Regjeringen.no, u.d). Therefore, Norway shares a common EEA framework for waste through EUs directive on waste (2008/98/EF), and several other regulations for specific waste types. Regarding the EU-ban of single-use plastics, Norwegian authorities also decided after a elucidate report to ban all single-use plastics by 2021 (Regjeringen.no, 2019).

The Pollution Control Act (*Forurensningsloven*), and the use of quotas, is essential within the Norwegian regulations relative to waste handling (Klima- og miljødepartementet, 2018). A common regulation on products and chemicals (REACH) is also important in this context (Regjeringen.no, u.d), as well as the law on product responsibility (*Produktansvarsloven*) and the law on product control (*Produktkontrolloven*) (Sjåfjell & Maitre, 2019).

EU	**Norway**
- Waste Framework Directive 2008/98 - Packaging Directive 2015/720 - REACH Regulation EC 1907/2006 - Ecodesign Directive 2009/125 - Marine Strategy Framework Directive 2008/56 - Ban on single-use plastics	- Waste Framework Directive 2008/98 - REACH Regulation EC 1907/2006 - Pollution Control Act - Law on Product Control - Law on Product Responsability - Ban on single-use plastics

Table 6. Summary key laws and regulations for a CE/CPE transition, EU and Norway

3.5.4 Norwegian national initiatives

Circular economy was mentioned for the first time in a Norwegian political platform in January 2019, through the Solberg Government's *Granavolden* platform (Regjeringen.no, 2019 a). It says that the Norwegian Government wants that "Norway shall be a pioneer country in developing a green, circular economy that better exploits resources, and develop a national strategy on circular economy» (Regjeringen.no, 2019 a). This national strategy is in its beginnings, and no political documents related to the strategy have been elaborated and published as this study is written (Hamar, 2019; Spillum, 2019). The roadmaps and strategies from Waste Norway and Norwegian Industry (process industry) can arguably be seen as two of the strongest contributions so far in lifting CE up as a national strategic target area.

The White paper no. 45 *Avfall som ressurs – avfallspolitikk og sirkulær økonomi* is the only Norwegian policy document to this date where 'circular economy' is explicitly and specifically targeted (Regjeringen.no, u.d.). It emphasizes waste prevention, increased reuse and material recycling, and as it also includes a Norwegian strategy on plastic waste, this document is to be

seen as the Norwegian follow-up of the EU Circular Economy Action Plan. However, the document gives an account for by what means the waste policy can be executed (regulations, permits, fees, extended producer responsibility, subsidies and information efforts), but no specific indicators or other measurement tools for a circular economy follow-up. However, in this context, it is relevant to mention the Norwegian follow-up on the EU in banning single-use plastics by 2021, mentioned in section 3.4.

Demand for, and a claim to, strenghten a strategy on a Norwegian circular economy transition has been uttered recently (December 2018) both from Circular Norway, a interdisciplinary organization for circular economy, and from The Confederation of Norwegian Enterprise (NHO) (Circular Norway, 2018, Ulriksen, 2018). The lack of a strategic overview approach from the Norwegian authorities can somehow also be reflected in the National Budget for 2019 (Det Kongelige Finansdepartement, 2018), where 'circular economy' is not mentioned once, nor under relevant points such as 'Chapter 2 The outlook of Norwegian economy', 'Chapter 3 The economic policy', 'Chapter 4 Efforts for increased productivity and a more efficient economy', or 'Chapter 6 Norway's follw-up on the Sustainable Development Goals'.

The EU Circular Economy Package buids on the principles of EU's Smart Specialization platform, which is the origin of Trøndelag County Council chosing circular economy as an important priority area (Sørås, 2018). The "smart specialization" concept will be presented below, before looking at how Trøndelag County Council has approached their circular economy strategy on a locally.

3.7.4.1 "Smart spesialisering som metode for regional utvikling"

Smart specialization as method for regional development (Smart spesialisering som metode for regionalutvikling), is the Norwegian Government's adaptation of EU's launch of smart specialization in 2012 (European Union, 2018), and has been a fundamental strategic document for the shaping of Trøndelag County's commitment on CE (Sørås, 2018). Smart specialization is a method for regions to identify its own strategic areas for economic development through inclusion of stakeholders in order to deploy their regional advantages and possibilities, and thereby tailoring region specific policies (Nakken & Jensen, 2018). To succeed in competing at the global market, the report on smart specialization establishes that countries and regions need to use their local advantages in order to be a region where both people and business can flourish. Therefore, smart specialization is all about elaborating on the competence, business, and the resources already existing in the region, in order to develop new niches and business areas. The strategies for smart specialization shall promote renewal and adaptation by strengthening the business areas where the region is able to connect resources and competence with the market potential in an effective way (Nakken & Jensen, 2018).

Developing new niches and business areas is a long term work. However, the document establishes three specific requirements that make up the foundation for identifying and promote new business opportunities: 1) Throughout analysis of the region and its global positioning, 2) facilitate dialogue processes between business, authorities, scientists/researches, organizations, institutions and investors, and 3) entrepreneurial actors' evaluation of where to find the market opportunities. These three requirements are called entrepreneurial discovery processes (EPD) (European Commission, u.d. c).

The document states the importance, or smartness, of strengthening the region's robustness and adaptability by building on existing advantages in the region (Nakken & Jensen, 2018). There

also needs to be emphasize on the importance of research and competence in order to develop a bigger diversity of businesses. The method is also smart because it's fundament is within scientific research, and is continuously developed further by try and fail between both practically and theoretically.

The Norwegian County Councils are responsible for elaborating strategies on how to execute the smart specialization within their county. The table below illustrates the proposed roles, or measures, the county councils can offer for this specialization process to happen (Nakken & Jensen, 2018):

- Offer analyses of the region's resources, opportunities, advantages and challenges.
- Include all stakeholders and facilitate dialogue and cooperation between them.
- Discuss opportunities and challenges openly – not have the solutions ready beforehand, but listen and further develop on the suggestions from the participating members.
- Take risks by prioritizing to go for undeveloped paths with uncertain outcome.
- Actively support new opportunities through regulation, investments in infrastructure and knowledge, e.g. by providing efforts and tools, participate in strategic alliances.
- Participate in, follow up on, learn by, and evaluate the activities and efforts done.
- Inform stakeholders widely, making it clear and understandable why decisions are made, and what is prioritized.
- Clearly communicate the region's potential and position, both nationally and internationally, to attract competence and capital.
- Include the national's and international's comments and perspectives to see the region within a global context, and the global context within the region.

Table 7. Trøndelag County Council's roles in smart specialization (Nakken & Jensen, 2018)

Table 7 shows the important roles of the County Councils in the smart specialization process, but Nakken & Jensen (2018) state that the cooperation between the public and private sector is the most decisive element in order to succeed with regional business development, which is the goal of the process. The private sector, whose goal is growth and value creation, and the public sector, whose goal is good and liveable societies, need to accept their differences and work together to create beneficial platforms in which both sectors contribute in making a sustainable and liveable regional society. As for the County Councils, it is crucial that they have a holistic ownership to the plan/process, and can show the cohesions between the different business initiatives. As a granting and decisive authority, they need to know what's going on in their region and actively support it. Information about the processes and priorities executed needs to be accessible for all stakeholders. The County Councils have to be willing to enter into long term cooperation with the business actors, stick to the plans and priorities approved, but also cancel the process if necessary. This requires clear leadership, both politically and administratively, and that the County Council is well organized internally and appears as one unit externally. Smart specialization also emphasizes to look outside of their region, as this can challenge their own perspectives and promote innovation and new thinking (Nakken & Jensen, 2018).

3.5.5 Local initiatives (Trøndelag County Council)

Trøndelag County Council (Trøndelag Fylkeskommune) has identified circular economy as an important focus for the region from their elaboration on the smart specialization strategy mentioned in the previous section (Sørås, 2018). EU's Interreg-program, where regions can meet and cooperate on policy areas, sharing knowledge and ideas, has also played, and still plays, an important role for Trøndelag Country Council in shaping and executing its regional focus areas (European Union, 2018, Sørås, 2018). The Interreg-program also provides the regions with tools, e.g. indicators, via the EU Commission's joint research centre (JRC) in Sevilla, Spain (Sørås, 2018, European Commission, 2018 c). To identify and evaluate whether these existing indicators can provide sufficient information, and be adopted specifically for Trøndelag's transition to a circular economy, will be subject to further research.

Two documents provide the founding for Trøndelag region's specialization areas; *Et verdiskapende Trøndelag* (Value Creation in Trøndelag) and *Handlingsprogram 2018-2019 for strategien 'Et verdiskapende Trøndelag*' (Action programme 2018-2019 for the strategy *Et verdiskapende Trøndelag*). These documents will be presented in the following sections.

3.7.5.1 «Et verdiskapende Trøndelag – Strategi for innovasjon og verdiskapning i Trøndelag»

Et verdiskapende Trøndelag (Value creation in Trøndelag) is a strategy for innovation and value creation within the Trøndelag region, and was elaborated from the national document on smart specialization (Trøndelag Fylkeskommune, 2017, Nakken & Jensen, 2018). The strategy is created to elaborate on Trøndelag as a region with competitive businesses nationally and internationally, and as a founding to fulfill the politically decided main goal of the region: "increased sustainable value creation and international competitiveness" (Trøndelag Fylkeskommune, 2017). To achieve this target, the strategy defines Trøndelag's advantages, chosen priority areas of the region, and tools to improve and take advantage of these. It is from this reason that circular economy has been chosen as a research field and topic for this project thesis and later Master thesis. An overview of the startegy is shown in table 8 below.

Main goal: "Increased sustainable value creation and international competitiveness in Trøndelag"	**Tools:** Infrastructure Mobilization Knowledge/competance Research Connections/network Coordination and cooperation Internationalization Public procurement Technology
Advantages: 1) Strong science and technology adjacence 2) Natural resource based businesses/industry	
Priority areas: 1) Bio economy 2) Circular economy 3) Oceans 4) Smart cities/societies 5) Experience economy	

Table 8. Main topics within strategy for innovation and value creation in Trøndelag (Trøndelag Fylkeskommune, 2017)

Two goals for development, with following strategies, have been elaborated for the circular economy priority area in Trøndelag (Trøndelag Fylkeskommune, 2017). These are 'increased regional value creation based on smart resource use' and 'minimize waste from production and consumption'. Three strategies have then been established to accompany the two goals to

develop within the circular economy area: “Develop new business models for resource efficient production and consumption of resources”, “increase utilization of rest raw material through product innovation and business cooperation”, and “replace fosil based products with bio based products” (Trøndelag Fylkeskommune, 2017).

Development goals and strategies for circular economy priority area, summary	
Development goals - increased regional value creation based on smart resource use - minimize waste from production and consumption	**Strategies** - Develop new business models for resource efficient production and consumption of resources - increase utilization of rest raw material through product innovation and business cooperation - replace fosil based products with bio based products

Table 9. Summary of development goals and strategies for circular economy priority area

3.7.5.2 “Handlingsprogram 2018-2019 – for strategien Et verdiskapende Trøndelag»

Handlingsprogram 2018-2019 is an action plan developed for the strategy *Et verdiskapende Trøndelag* described above (Trøndelag Fylkeskommune, 2018). This action plan concretizes the content of the strategy, and identifies specific efforts that need to be made both on a general level for Trøndelag as a business region, but also within each defined priority area, as well as the actors responsible of executing the efforts. The table below gives an outline of Trøndelag’s goals, strategy, efforts and responsible authorities for executing the circular economy priority area.

Goal: - Increased regional value creation based on smart use of resource. - Minimize waste streams from consumption and production.
Strategy: - Develop new business models for resource efficient production and consumption of resources. - Increase the utilized amount of rest raw materials based on product innovation and cooperation between businesses.
Efforts: - Develop tools to map and quantify material flows - Develop public procurement competence to stimulate for circular economy with the purchasing management and suppliers. - Regional knowledge campaign directed towards the younger generations. - Stimulate for co-localization and cooperation between industry businesses in order to exploit resources and logistical units in a more sustainably efficient way. - Initiate, develop and make use of regional, national and international network to bring more competence and financing to the region. - Strengthen relevant regional researchers and academia who work to establish a regional centre for science based innovation. - Strengthen the competence within design and material properties in order to facilitate a circular economy transition. - Increase knowledge on refinement and product development of waste products for use in agriculture and soil improvement. - Increase the value creation of residue/waste materials from the marine sector.

- Facilitate opportunities for sustainable exploitation and management of minerals/mineral resources.
Responsible authorities/actors: - Trøndelag County Council - Businesses - Innovasjon Norge (Innovation Norway) - Research and Educational institutions (FoU-institusjoner) - Municipalities - Innovation actors

Table 10. Trøndelag County Council's action plan on circular economy (Trøndelag Fylkeskommune, 2017).

3.6 Conclusions from section on theoretical resources

This section has presented the nine SDG's identified as relevant for a CE and CPE, the seven different categories of plastic, aspects of plastic waste management in Norway and its opportunities and challenges, before giving an overview of status quo of CE in the EU, in Norway nationally, and how CE has been adopted on a local level in Trøndelag. Through the *2018 Circular Economy Package*, the EU has established a monitoring framework for how to work with CE, where it suggests its CE indicators of which the indicators suggested in this thesis are inspired from. Norway has not developed any known strategies directly from the Monitoring Framework, but has done so from EU's Smart Specialization platform, of which the principles of the EU Circular Economy Package buids upon. The Smart Spcialization platform has thereof been the origin of the local CE startegies developed in Trøndelag County.

4 Empirical data for CPE development

This section will present the main empirical findings based on interviews and insights on CE and CPE development either from or within the Norwegian authorities (ministry and municipality), the waste management sector (Waste Norway), local plastics recycling and recovering facility (Matmortua AS) and CE/CPE status in Norwegian statistics (Statistics Norway).

4.1 Authorities and public sector

This section will present relevant findings from the interview with the leader of the Norwegian CE working group, as well as insights from the CE strategy made by Fredrikstad municipality, the first Norwegian municipality with a strategy on plastics. Fredrikstad has mapped out different aspects of CE/CPE development within their municipality relevant for this context, which is why this study has chosen to present some of its findings.

On key aspects necessary for a CE transition to occur in Norway, Hamar (2019) points at regulation, economic advantages and financing. New regulations are necessary for such transition to happen, and they need to be easily understood by the enterprise sector. They need to understand the regulations, and possibilities within a CE, so that they want to, and see it economically beneficial, to transcend into a circular business model.

CE is conditioned political agreement and an existence of political cooperation. The CE represents a certain revolution, a complete new way of 'doing' in all aspects of society. All sectors need to be included in creating a new, circular, industry. Questions arise on how to do this, but Hamar (2019) mentions the financing sector as key. The mentality within banking and

finance needs to be more pro-circularity, as it is important that this sector believes that CE is beneficial. Again, this leads to financial agreements and mechanisms in society that foster CE. The EPR is an example of this, which can act as a CE key if further elaborated.

The municipality of Fredrikstad (Fredrikstad Kommune, 2018) points at multi-disciplinary cooperation, a common knowledge-bank e.g. for how to approach or manage a circular economy. Loss of microplastics from production is huge, and there is a need for closed treatment facilities. Snow handling is mentioned as an example here. As snow gathers pollutants, the management of snow when melting during spring needs to happen under controlled areas and/or closed systems to avoid spill-off of pollutants into nature before it has been cleansed.

4.2 Matmortua AS

Matmortua AS is the common term for the collocation of Containerservice Ottersøy AS and Norwegian Plastics Recycling (NOPREC) AS in Ottersøy, located in Trøndelag. Matmortua AS is the only facility in Norway that recycles and recovers waste fractions of hard plastics, mainly from aquaculture, into new raw material, and is therefore a pioneering example of how CPE can function (Matmortua AS, n.d).

In order to succeed in closing the plastics loop, we need to target the flow of plastics in the economy, reduce waste, and create new value from 'old', original, material (Øyangen, 2019). Technology is key in such a transition. There is a need for a holistic, fully covered, regulation of plastics for waste management. This needs to imply all sectors, and not only for packaging or selected types of plastics, as for hard plastics, which is the case today.

It has to be economically profitable to recycle plastics and for recycled plastics to re-enter the economy. An example of how todays regulations act as a barrier for enterprise's will to recycle plastics is the current deposit fee. As of now, the deposit fee is lower than the recycling fee, making it economically more beneficial for a company to deposit, than to send it for recycling treatment. Here, the §9-6 in the Pollution Act is characterized as problematic in this regard (Øyangen, 2019; Lovdata.no, 2018). It's mentioned that optimally, a deposit fee for plastics shouldn't have to be an option at all, as all plastics should be recycled in a closed economy, which is the intention of a CE. However, in order for companies to prefer the recycling alternative, getting to such an economy would require the deposit fee to be high and the fee for recycling to be sufficiently low. A relevant discussion in this matter can be directed towards the factors (e.g. discount rates) of determining what's considered economically the best option for society (socioeconomics), which is an underlying parameter for political decision-making. When determining what is socioeconomically the best option, calculation-parameters tend to put a higher weight on the costs of today, rather than the benefits of the future. This often make environmentally sound investments or efforts more expensive and less likely to be chosen, as the cost of today normally is high. Therefore, it is arguable that a circular economy requires rethinking of what's considered socioeconomically beneficial (Jahren & Brattebø, 2018).

4.3 Waste Norway

There is a need to design for material recycling, not for depositing or energy recovery through incineration. The waste management sector would to a larger degree need to focus on treatment

methods as being waste prevention, re-use and recycling, and doing such by communicating solutions and knowledge that contributes to resource efficiency (Avfall Norge, 2018).

In their *Circular Economy Roadmap*, Waste Norway proposes a set of recommendations, and defines what they consider critical factors of success, as well as challenges, for a circular economy transition (Avfall Norge, 2018). Even though this roadmap is directed towards CE as a whole, these findings are highly relevant when narrowing down to targeting CE plastics, and for the elaboration of CPE indicators. The key findings from Waste Norway's Roadmap will be summed up and presented below.

Recommendations for
1. The waste management sector

Increased competitiveness through increased resource efficiency, being e.g. recycled raw material and resource efficient solutions. This has to be done through closer cooperation within the waste management sector itself, as well as external cooperation across private and public sector, and together with actors from the whole value chain (industry, enterprise, agriculture, other producers). To stimulate a CE, it has to be a goal that by 2030 there is zero emission collection and transport, and the sector uses environmental friendly fuels that are a bi-product of material recycling processes. To increase demand for recycled raw materials, the sector should develop standards and common quality demands. This needs to be done together with the actors in the market, such as industry and agriculture (Avfall Norge, 2018).

2. The authorities as
2.1 Claimant

The authorities should create a national strategy for resource efficiency that includes goals for waste reduction, re-use and material recycling, with a clear framework for market actors. This strategy needs to be developed with the EU's proposal for CE action plan as a reference point. While household waste is included in this strategy, it also needs to include waste from the Norwegian enterprise, as well as bi-products from industrial production and aquaculture.

There is a need to evaluate an introduction of extended producer responsibility (EPR) or other tools for a broader range of products and materials than exists today. This due to the need of producer responsibility regarding eco-design, material consumption and increased levels of material recycling. EPR is identified as an enabler for making producers be responsible for their products in the end-of-life (EOL) phase (Watkins et al., 2017). In that way the producer is responsible of a safe and environmentally friendly waste treatment of the product. A study on EPR in the EU Plastics Strategy and Circular Economy concludes with "encouraging more ambitious extended producer responsibility (EPR) to bring about a more sustainable use of plastics, and in particular plastic packaging [..] Increasing recycling and reuse of plastic packaging is crucial to Europe's plastic waste management. EPR has the potential to play a key role in this" (Watkins et al., 2017). In the EU, only a few schemes have more advanced eco-modulation of fees: CITEO in France and CONAI in Italy being the most notable examples. Examples of this type of eco-modulation can be e.g. applying no fee to reusable packaging,

higher fees for non-sortable/non-recyclable packaging, or higher fees for packaging with additives that disrupt recycling. In Norway, NORSIRK is the EPR partner (NORSIRK, n.d). However, EPR in Norway is mainly related with electronic and electrical products (WEEE), batteries, and to a lesser degree all waste recovery and recycling for packaging.

Simultaneously, there is a need to evaluate current schemes in order to develop and adopt these to new, circular ambitions. This arises a need to establish stronger tools for waste prevention and increased material recycling, both within households. Additionally, stock listed companies should be required to report on their waste management, to secure possibilities of tracking the waste, control raw material streams, and strengthen the resource efficiency (Avfall Norge, 2018).

2.2 Driving force

The authorities as a driving force should use the tools available to catalyse changes that the market doesn't achieve as fast on its own. In the regulations for public procurement, there is a need to demand for prioritizing the use of recycled raw materials and resource efficient solutions through both direct requirements and weighting of tender criteria. Additionally, public sector should contribute with earmarked support of investment and exports, that supports technology development and realization of a green competitiveness potential. Examples of this can be through Enova and Innovation Norway. Research funds also need to be allocated as to how they can enable a realization of the circular economy (Avfall Norge, 2018).

2.3 Facilitator

It is critical that there is a market will for a CE development, and the authorities need to facilitate for such development. An example of this could be efforts similar to today's fee for CO2, for instance by having a fee for use of fossil plastics. To secure well-functioning markets with innovation and resource efficiency it is important that the authorities follow up on current regulations, as well as ensuring that offenses have sentencing and sanctions with a preventive effect. It is important that the authorities strive for a ban on monopolies, stimulate competition in the market, and secure a competition where actors compete on the same terms, independently of their ownership.

There is a need to work towards simplifying import and export of recycled raw material and waste for material recycling. The authorities should hereunder further develop and strengthen labelling systems such as the Nordic Swan (Svanemerket) towards a circular direction. Environmental labelling can be used to spread information and facilitate for public and private sector, together with households, making decisions that support the CE. In addition, an introduction of voluntary certification schemes has to be introduced based on international standards (Avfall Norge, 2018).

Critical factors of a CE success

- There needs to be an ambitious strategy with clearly defined goals and requirements for an efficient management of resources.

- Producer needs to be held accountable for the product throughout the whole product life cycle. EPR has been a successful tool to secure collection and material recycling of certain types of waste where the market has not been self-driven to do so.
- Competitiveness on equal terms. Neutral conditions of competitiveness for the actors and an active follow-up from the authorities is a precondition for a well-functioning of the sector according to what has been the initial intention. This will avoid temptation of non-serious actors to bypass the regulations.
- There needs to be a demand for recycled raw materials and CE solutions. This requires a well-functioning market for recycled raw material. The market actors need to compete on equal terms and the positive effects of using recycled material needs to be internalized into the market price, giving gains for producer while being affordable and optimal for consumer. This could be solved through a better standardization of recycled raw material, "green" fee or taxation and other frameworks, which has been mentioned by the Norwegian Green Tax Commission (*Grønn Skattekommisjon*) (Regjeringen.no, 2015).

Challenges for a CE

- Strategy and goals for an efficient management of resources. There is a lack of incentives that promotes further technological development of solutions for material recycling and re-use for the benefit of depositing or incineration of certain types of waste.
- EPR (extended producer responsibility) as a key tool for CE transition. However, today's EPR was established in a time were markets for waste recycling was immature and not adopted new market situations – like the CE represents. Therefore, the EPRs do not necessarily function optimally as the markets, in time, matures. Competition between different sets of schemes can create an insufficient parallel waste collection infrastructure, that hinders effective communication with the waste possesses. In addition, monopoly scenarios could lead to high prices and a lack of technological development for better solutions. It is also a challenge that EPR extends to product types, and not product material.
- Environmental toxins in product life cycles. A varied amount and types of environmental toxins are used, also below regulated allowed limits for hazardous waste. There exist compound products where one individual component can be characterized hazardous, even though the compound product itself is defined non-hazardous as a whole.
- Technological innovation. To increase levels of material recycling, there is a need for development of better solutions in a number of areas. This implies a need for developing resource efficient recycling solutions that assures high levels of support, quality and access to resources from waste (in general). To be successful, this technology needs to accommodate to: 1) handle heterogeneous waste streams, 2) recycle compound products, and 3) in areas where technical solutions for high levels of material recycling are available, this is not commercially beneficial. This is not optimal for a needed change.
- Public finances for research. Research, development and cooperation between actors across value chains is expected to be decisive to solve this type of innovation challenges.

Additionally, it is crucial that the public instruments in this regard align their resource and innovation funds to stimulate for a CE technology development.

4.4 Statistics Norway

Measurement tools specifically defined and related to CE, and thereof CPE, transition is lacking within Statistics Norway (Statistisk Sentralbyrå, 2018; Stensgård & Raadal, 2019). As seen in the appendix A of the EU overview, and of the overview from Nørgaard et al. (2018) on Norwegian statistics towards the SDGs presented in section 5.1, SSB do provide data for some of the CE indicators. However, this only illustrates that there exist Norwegian data for some of the indicators individually, but a strategic overview approach in measuring a CE, and CPE, is absent. In other words, measurement tools defined for CE/CPE in Norway, such as statistics for indicators, is lacking.

4.5 Conclusions from section on empirical data

This section has presented the insights from interviews and document reviews on Norwegian CE work from four key actors of this CE work. Core aspects in order to accomplish a CPE development in Norway and Norwegian enterprise is targeted towards the need of a market for supply and demand of secondary raw plastics material. The market is not likely to achieve this on its own, but needs facilitation on behalf of the authorities. Some key aspects here are pro-CPE regulations, economic benefits related to use of recycled material, solid financing mechanisms, technology development (which in turn needs to be affordable to use), producer responsibility, and collaboration and innovation throughout the whole value chain. If these CE factors are strategically targeted from an authoritative level, measurement tools, such as statistics, can in turn be defined, and Norway could start addressing CE as a statistically defined target area.

5 Analysis

This section will present a reasoning for the connection between the selected nine SDGs and a CPE, before presenting a SWOT analysis of CE/CPE transition in Norwegian enterprise. This SWOT analysis is based on all of the information presented and obtained under the work of this study, and addresses strengths, weaknesses, opportunities and threats towards such transition.

5.1 Connecting SDGs with the circular plastics economy

This study argues for a link between the following SDGs (UN, n.d) and the aspects of achieving a circular plastics economy transition. These aspects are associated with possible consequences of plastic pollution to human and environment, as well as technical and structural necessities of change when facing a circular economy transition. An overview from Nørgaard et al. (2018) on available Norwegian data for these SDG indicators is also presented within each selected SDG, as it is of relevance to know whether Norwegian data already exists or not. However, it is important to stress that the data overview from Nørgaard et al. (2018) only reflects the available data for the originally defined SDGs, and is not necessarily a sufficient data overview for indicators that are necessary for the suggested CPE indicators. The available Norwegian data for each of the EU-indicators in the Monitoring Framework can also be found in the appendix A. By looking at the overview of the data from Nørgaard et al. (2018), it is clear that there is a scarcity on many areas in order for successfully accomplishing the defined targets.

5.1.1 SDG 3 Good health and well being

3.9 By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination[2]

Plastic pollution is a threat towards the ecosystems, and plastics as cause of death has been identified in animals by several occasions. There has not been documented human deaths caused by plastics, but microplastics have been identified in drinking water, food, and in the general human environment, and poses therefore, arguably, a threat to human health (Tandstad, 2019).

The indicators from the UN are related with death rate, but this would not be accurate for measuring threats on humans from plastics pollution. Another functional unit like illness from plastics consuming, or mg of plastic pollution in edible and drinkable units would be a more accurate indicator. Therefore, it is not likely that the data needed for this exist in Norway today.

3.9	Data for Norway in UNs SDG indicator database (by July 2017)	Indicator can be made nationally
3.9.1 Mortality rate attributed to household and ambient air pollution	Yes	Yes
3.9.2 Mortality rate attributed to unsafe water, unsafe sanitation and lack of hygiene (exposure to unsafe Water, Sanitation and Hygiene for All (WASH) services)	Yes	Yes
3.9.3 Mortality rate attributed to unintentional poisoning	Yes	Yes

Table 11. Available SSB statistics for selected SDG 3 indicators (Nørgaard et al., 2018)

5.1.2 SDG 6 Ensure availability and sustainable management of water and sanitation for all

6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all

6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally

The water resources available need to be free from plastic pollutants, as targeted in 3.9 above. However, here, safely managed waters targeting reduction and elimination of pollution in waters is specifically concerned, as well as recycling and safe reuse of water, which will become a scarcity if this is not done to a much larger extent than today. This is essential for documenting pollutants in waters, e.g. plastics fragments, potentially mapping out polluters and providing better regulations to avoid water pollution.

[2] All the quoted excepts in italics of the SDG goals are copied from the page on UN Sustainable Development Goals (UN, n.d).

6.1 + 6.3	Data for Norway in UNs SDG indicator database (by July 2017)	Indicator can be made nationally
6.1.1 Proportion of population using safely managed drinking water services / Tier II	Yes	Yes
6.3.1 Proportion of wastewater safely treated / Tier II	No	Yes
6.3.2 Proportion of bodies of water with good ambient water quality / Tier III	No	Yes

Table 12. Available SSB statistics for selected SDG 6 indicators (Nørgaard et al., 2018)

5.1.3 SDG 8 Decent work and economic growth

8.2 Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors

8.3 Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services

8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-year framework of programmes on sustainable consumption and production, with developed countries taking the lead

A CPE will require increased productivity through resource utilization and a decoupling of resource extraction from economic growth as pointed out in 8.4. Ideally, production of virgin plastics material would be 0 kg/year in a CPE, as this were to be covered by already existing plastics or other environmental beneficial material. An indicator of plastics material footprint per company, or plastics consumption per company per year could be a suitable alternative for the indicators concerning this matter.

As seen in Burger et.al. (2019), the CE sector would lead a heterogeneous working force within labor-intensive supply sectors, as well as an undoubtingly need for technological upgrading and innovation as targeted in 8.2. Policies and financial supporting that encourages and maintains circular plastic growth is also essential if a CPE were to be successful, as is the target of 8.3 (Øyangen, 2019; Hamar, 2019).

8.2 + 8.3 + 8.4	Data for Norway in UNs SDG indicator database (by July 2017)	Indicator can be made nationally
8.2.1 Annual growth rate of real GDP per employed person /Tier I	Yes	Yes
8.3.1	No	Proxyindikator kan lages

Proportion of informal employment in non-agriculture employment, by sex / Tier II		
8.4.1 Material footprint, material footprint per capita, and material footprint per GDP /Tier II	Yes	Yes, but requires development
8.4.2 Domestic material consumption, domestic material consumption per capita, and domestic material consumption per GDP /Tier III	Yes	Yes

Table 13. Available SSB statistics for selected SDG 8 indicators (Nørgaard et al., 2018)

5.1.4 SDG 9 Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

9.4 By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities

9.5 Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending.

Resource-use efficiency and clean environmental technologies are at core of the circular plastic economy (9.4). It fosters an industrial revolution when it comes to the design-phase, use-phase and end of life phase of products, which is crucial.

The number of people working within the circular plastics economy, and the amount of financing directed towards this economy will indicate the scope and importance within the total CPE (9.5). this would therefore also help map-out the involved workforce backgrounds and sectors in a CPE. This could also help quantifying the monetary value added to the sector.

9.4 + 9.5	Data for Norway in UNs SDG indicator database (by July 2017)	Indicator can be made nationally
9.4.1 CO2 emission per unit of value added /Tier I	Yes	Yes
9.5.1	Yes	Yes

Research and development expenditure as a proportion of GDP /Tier I		
9.5.2 Researchers (in full-time equivalent) per million inhabitants /Tier I	Yes	Yes

Table 14. Available SSB statistics for selected SDG 9 indicators (Nørgaard et al., 2018)

5.1.5 SDG 12 Responsible consumption and production

12.1 Implement the 10-year framework of programmes on sustainable consumption and production, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries

12.2 By 2030, achieve the sustainable management and efficient use of natural resources

12.4 By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment

12.5 By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse

12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle
12.7 Promote public procurement practices that are sustainable, in accordance with national policies and priorities

12.8 By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature

The SDG 12 is the most commonly linked SDG to the CE topic, and is so because it has a good connection with the core of aspects of CE (Regjeringen.no, u.d). In Nørgaard's (2018) report however, only three out of thirteen (3/13) indicators determined to measure SDG12 has a clarified developed method, making it one of the slowest developing SDG's in a Norwegian context.

Sustainable consumption and production implies waste prevention, reduction, recycling and reuse, which is specifically targeted within this SDG (12.2, 12.5). In addition, it stresses the need for national and global action plans on management within a CE framework (12.1, 12.2, 12.4,12.7), that needs to be executed both through the public sector (12.7) and the private sector (12.6). The industry within the enterprise sector need to have a desire to step into the CPE. Information and tools to make this a manageable step for the industry could speed up this process (12.8). Having politically decided goals on CPE that needs to be met, and public procurement that is demanding circular plastics material also incentives the business to offer this demand. This could foster a marking system of different types of plastics (what is from recycled, type of treatment), a tracking of plastic waste streams to know where the plastics is going, plastic waste

generated per industry business, which again could lead to a thoroughly documented CP use by and within the sector.

12.1 + 12.2 + 12.4 + 12.5 + 12.6 + 12.7 + 12.8	Data for Norway in UNs SDG indicator database (by July 2017)	Indicator can be made nationally
12.1.1 Number of countries with sustainable consumption and production (SCP) national action plans or SCP mainstreamed as a priority or a target into national policies / Tier II	No	Non-statistical
12.2.1 Material footprint, material footprint per capita, and material footprint per GDP / Tier III	Yes	Yes, but requires development
12.2.2 Domestic material consumption, domestic material consumption per capita, and domestic material consumption per GDP / Tier I	Yes	Yes
12.4.1 Number of parties to international multilateral environmental agreements on hazardous waste, and other chemicals that meet their commitments and obligations in transmitting information as required by each relevant agreement / Tier I	Yes	Non-statistical
12.4.2 Hazardous waste generated per capita and proportion of hazardous waste treated, by type of treatment / Tier III	No	Yes
12.5.1	No	Yes

National recycling rate, tons of material recycled / Tier III		
12.6.1 Number of companies publishing sustainability reports / Tier III	No	Unknown
12.7.1 Number of countries implementing sustainable public procurement policies and action plans / Tier III	No	Unknown
12.8.1 Extent to which (i) global citizenship education and (ii) education for sustainable development (including climate change education) are mainstreamed in (a) national education policies; (b) curricula; (c) teacher education; and (d) student assessment / Tier III	No	Yes

Table 15. Available SSB statistics for selected SDG 12 indicators (Nørgaard et al., 2018)

5.1.6 SDG 13 Climate change

13.2 Integrate climate change measures into national policies, strategies and planning

CE is a new way of managing our societies, and will act as a climate change measure itself. As mentioned, the Norwegian strategy on CE is in its beginnings, as is circular thinking generally in Norway. A CPE should be included in this strategy, aiming meet some of the aspects stressed in the 13.2.1 indicator. This is pointing towards an established or operationalized integrated policy/strategy/plan which increases Norwegian ability to develop into a CPE. The possibilities could be including a national CPE adaptation plan, nationally determined contribution to CPE, national communication on CPE, CPE biennial update report or other.

13.2	Data for Norway in UNs SDG indicator database (by July 2017)	Indicator can be made nationally
13.2.1 Number of countries that have communicated the establishment or operationalization of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of	No	Non-statistical

climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production (including a national adaptation plan, nationally determined contribution, national communication, biennial update report or other) / Tier III		

Table 16. Available SSB statistics for selected SDG 13 indicators (Nørgaard et al., 2018)

5.1.7 14 Life below water

14.1 By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution.

14.2 By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans

It would be an understatement to say that plastics pollution has contributed to shed a light on climate and environmental issues that characterize the present day environmental debate. Especially has the plastic hassle been illustrated by marine littering, illustrated by dense floating plastic debris in unexpected places (14.1). About 80% of the marine plastics come from land-based activities (WWF, n.d) the rest from shipping-activities and fishery. There is a need to document and collect these types of items. Strategies on how to collect or clean the waters from dissolved and/or microplastics is also acquired. This could imply that we need to adopt our product managing systems according to the ecosystems, so that our activities are not going against them, but nourishes them (14.2). These systems approaches should be based on plastic circularity, striving for a closed loop of plastic material in the economy.

14.1 + 14.2	Data for Norway in UNs SDG indicator database (by July 2017)	Indicator can be made nationally
14.1.1 Index of coastal eutrophication and floating plastic debris density / Tier III	No	Unknown
14.2.1 Proportion of national exclusive economic zones managed using ecosystem-based approaches / Tier III	No	No

Table 17. Available SSB statistics for selected SDG 14 indicators (Nørgaard et al., 2018)

5.1.8 SDG 15 Life on land

15.9 By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts

This goal discussed what also was mentioned for the goal 14.2 above, the need to economically develop with and for the ecosystems, not despite them. For a CPE it means not impacting and threaten our environments and the ecosystems surrounding us with plastics pollution. As suggested in the 15.9.1 indicator, this could be done in accordance with the national targets established with Aichi Biodiversity Target 2 of the Strategic Plan for Biodiversity 2011-2020. This is a convention including all countries worldwide except three, the US being one of those exceptions (Convention on Biological Diversity, n.d).

15.9	Data for Norway in UNs SDG indicator database (by July 2017)	Indicator can be made nationally
15.9.1 Progress towards national targets established in accordance with Aichi Biodiversity Target 2 of the Strategic Plan for Biodiversity 2011-2020 / Tier III	No	Non-statistical

Table 18. Available SSB statistics for selected SDG 15 indicators (Nørgaard et al., 2018)

5.1.9 SDG 17 Partnerships for the goals

Systemic issues (policy and institutional coherence)
17.14 Enhance policy coherence for sustainable development

17.16 Enhance the global partnership for sustainable development, complemented by multi-stakeholder partnerships that mobilize and share knowledge, expertise, technology and financial resources, to support the achievement of the sustainable development goals in all countries, in particular developing countries.

Trade
17.10 Promote a universal, rules-based, open, non-discriminatory and equitable multilateral trading system (under the World Trade Organization, including through the conclusion of negotiations under its Doha Development Agenda)

17.12: Realize timely implementation of duty-free and quota-free market access on a lasting basis for all least developed countries, consistent with World Trade Organization decisions, including by ensuring that preferential rules of origin applicable to imports from least developed countries are transparent and simple, and contribute to facilitating market access.

Technology
17.6 Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge sharing on mutually agreed terms, including through improved coordination among existing mechanisms, in particular at the United Nations level, and through a global technology facilitation mechanism

Finance
17.5: Adopt and implement investment regimes for least developed countries

Systemic issues (policy and institutional coherence)

National mechanisms should be in place to enhance policy coherence for transitioning a CPE (17.14). We need collaboration through multi-stakeholder partnerships along the whole value

chain (17.16), also creating a market between each other where plastics is a closed loop material, meaning that there exist a plastics industry within Norwegian enterprise where all rely on each other (intersectoral production cycle: design – use – disposal – design – use - disposal, etc). There should exist a national partnership overview for CPE in Norwegian enterprise. This could be e.g. number of companies listed by sector reporting progress in multi-stakeholder development effectiveness through e.g. monitoring frameworks that support the achievement of a CPE.

Trade

As pointed out in section 3.4, about 50% of plastics from Norwegian enterprise is sent abroad for treatment today. In a circular economy, a trading system would be necessary – even though there should be a major amount of national recycling/treatment plants. A worldwide weighted tariff-average is proposed as a UN-indicator for goal 17.10, which also should be considered to apply for plastics.

Inspired by the 17.12 goal, tariffs/quotas should be considered, on both a national as well as international level, for secondary raw plastics material. This to make the use of recycled plastics as material in products more favorable. This should especially be considered in a starting phase to help escalate the market for secondary raw plastics material more rapidly.

Technology

Inspired by the 17.6 goal, Norwegian enterprise should have inter- and intra-sectoral cooperation on innovation and knowledge-sharing to close the loop of plastics use. This means that companies within e.g. the industrial sector should cooperate with companies within the construction sector, as well as cooperating with other business of their own sector. In addition, Norway should have regional (e.g. Scandinavia) and international cooperation on science, technology, innovation and knowledge sharing for a circular economy transition. Hence to create e.g. science and/or technology agreements and programmes aiming for a circular plastics transition.

Finance

Inspired by the 17.5 goal, there should exist a national financial investment regime for a circular plastics economy transition. This is to make possible and incentivize efforts, both in the public and private sectors, that encourages a Norwegian closed loop of plastics, e.g. re-use of plastics by using of plastics as secondary raw material for new products.

(17.5) + 17.6 +17.10 + (17.12) + 17.14 + 17.16	Data for Norway in UNs SDG indicator database (by July 2017)	Indicator can be made nationally
17.5.1 Number of countries that adopt and implement investment promotion regimes for least developed countries / Tier III	No	Non-statistical

17.6.1 Number of science and/or technology cooperation agreements and programmes between countries, by type of cooperation / Tier III	No	Unknown
17.10.1 Worldwide weighted tariff-average / Tier I	No	Unknown
17.12.1 Average tariffs faced by developing countries, least developed countries and small island developing States / Tier I	No	Unknown
17.14.1 Number of countries with mechanisms in place to enhance policy coherence of sustainable development / Tier III	No	Non-statistical
17.16.1 Number of countries reporting progress in multi-stakeholder development effectiveness monitoring frameworks that support the achievement of the sustainable development goals / Tier II	No	Non-statistical

Table 19. Available SSB statistics for selected SDG 17 indicators (Nørgaard et al., 2018)

5.2 SWOT analysis

The SWOT analysis in table 20 below is a summary of all the information related with a CPE transition presented in this study. The bulk for 'strengths' contain existing characteristics, aspects or frameworks that supports the CE or CPE transition. 'Weaknesses' represent characteristics or aspects today that are damaging for the transition. 'Opportunities' deal with actual or future possible relations that can benefit the transition, while 'threats' are actual or possible relations that affect the CE/CPE transition negatively. The content of these bulks will then be further discussed below.

Strengths	**Weaknesses**
- National strategy on circular economy established politically (through the Granavolden platform) - Waste Norway's roadmap with already defined target points showing a CE transition will within sector - Ratified global legislation on plastic export - Established EU CE monitoring framework with plastics strategy - CE elaborated for national and local foundation	- Scope of EPR today (doesn't extend widely enough, targets product only) - Diverse sector, not strategically defined - Data scarcity - Existing framework and legislation - Uncontrolled and complicated imports/exports (need tracking) - No uniform sorting system - Technical difficulties for recycling - Undeveloped recycling market - Lack of incentives for technical solutions improvement - Product design
Opportunities	**Threats**
- A new 'green era', CE is on the societal agenda - Collaboration through value chains (ex. Matmortua and Plasto) - Already a lot of plastics returned for treatment (forskning.no) - Upcoming law and regulations pro reuse and recyclability - Purer plastics fragments - Norwegian Enterprise high level of adaptability - Norwegian waste management companies well underway of industrializing material recycling processes - Expand EPR - China banning exports, raises need to find new ways to deal with plastics waste - Local actors working on recovery initiatives	- Established market structures (financing, economy needs to support circularity) - Not affordable enough to recycle - Too cheap to produce virgin plastics (from oil) - Too economically beneficial to burn plastics for energy/deposit - Huge variety of plastics material - Poor technology for plastics waste handling worldwide - Lack of plastics documentation/statistics - Low demand for recycled plastics secondary raw material - Existing recycling technology commercially disadvantageous - Lack of political unanimity

- CE and CPE a societal and market revolution - Norwegian Enterprise good conditions for corporate cooperation - Need to follow up on current regulations supporting CE factors - Develop/strenghten labelling systems - Develop/strengthen standards	

Table 20. SWOT analysis of a CE/CPE transition within Norwegian enterprise

5.2.1 Strengths

The existing frameworks presented in section 3.5, being the EU-level *2018 Circular Economy Package* (monitoring framework), the national *Smart specialization as method for regional development* and its local spin-off like *Et verdiskapende Trøndelag*, are the biggest strengths for today's CE development. Nationally, Waste Norway's CE Roadmap, the CE declaration in the Granavolden platform and the white paper no. 45 (*Avfall som ressurs – avfallspolitikk og sirkulær økonomi*) are the strongest current political and market documents pro CE transition. The white paper discuss by what means the waste policy can be executed (through regulations, permits, fees, extended producer responsibility, subsidies and information efforts), which to an extent has been answered in the CE Roadmap from Waste Norway. The abovementioned aspects have led to this year's (2019) formation of the National Strategy on CE which is under development.

The recent global legislation on licencing all plastics waste for export is also strength aiming for CPE transition. It poses a legal framework that can also potentially pave way for a more lucid and controlled plastics market.

5.2.2 Weaknesses

The existing monitoring tools directed towards a circular economy transition have shortages, specifically on the Norwegian national, and thereby local, level. Monitoring key trends and patterns is essential to understand the development of economy elements over time, resulting in a possibility of identifying whether efforts for a circular economy transition have been successful or not. There is a lack of measurement tools, framework and legislation specifically defined and related to CE and a CPE transition, and such need for development is also sought after by the Norwegian business and enterprises. Data scarcity and a political shortage of a strategic approach to a real circular economy can therefore be defining for the current Norwegian case. These factors could arguably also indicate the uncontrolled and complicated import and export market, and illustrates the need for plastics to be accounted for, e.g. through a tracking system.

A CPE transition requires a functioning market for such to happen, which is not the case today. There is a lack of incentives to boost technical development of recycling and material reuse of plastics, and the current solutions are diverse and characterized by trial-and-error approach by

local actors, such as Matmortua AS. The CPE sector has not been identified on an overall level, which could make market development harder. Current functioning tools such as EPR has a potential to move the transition forward by for instance expanding its scope to count for type of material and not type of product, introducing EPR on plastics material making producers accountable for its end of life treatment (Watkins, et al., 2017). If costs of plastics reuse were approximately equal to zero, this could for instance initially lead to product design of cleaner fractions, making products less complicated to recycle than they are today. Compared with metal or paper, the plastics market is undeveloped, with an urging a need to develop good recycling and deposit systems (Mepex, Salt, 2018). However, these systems should encourage product design for preventing to be thrown in the first place, reuse and recycling (upper levels of waste treatment hierarchy), and not for energy recovery and depositing (lower levels of waste treatment hierarchy).

5.2.3 Opportunities

Although the current state of CE and CPE could be considered difficult to perform, many of the weaknesses can be turned into opportunities, as can many of the already existing instruments we have in the Norwegian economy today. Again, the scope of EPR was mentioned as a weakness, but also identified as a huge opportunity if expanded to account for e.g. plastics as material. The Norwegian 'pant'-scheme is a successful example of financing action to curb plastic litter at national level. Beverage containers are here targeted by deposit schemes helping to reduce littering and boost recycling, a scheme that more countries now are adopting (European Commission, 2018). Norway has good systems for household sorting that can be more utterly developed and transferred into the enterprise sector. An important factor here is waste management technology, which is constantly developed by the industry to industrialize the recycling processes. The fact that more of purer plastic fractions are produced and used in products is also a positive sign for the efficiency and outcome of the recycling processes, making them easier to treat.

Market collaboration throughout value chains and ability to change has been identified as key in CE and CPE transitioning, which is something Norwegian enterprise is good at. Historically, Norwegian enterprise has a high level of adaptability, meaning that it has the ability to easily restructure the business and turn towards possibilities (Avfall Norge, 2018). Matmortua AS is an example of willingness existing to share ideas with other actors that wish to treat their plastic waste in the same way as them, as well as being an example of value chain collaboration with Plasto. Value chain collaboration makes a more efficient and synergized market, that potentially can create a pressure and need for developing new standards and labelling systems (such as the Nordic Swan, FSC, etc) adapted to a CPE market.

The Chinese waste import ban can arguably be a sign of a need for CPE thinking as a new, revolutionary approach to waste streams. The ban would imply a need to develop treatment methods more locally, giving opportunities for a stronger market for local national recycling actors that already are working on recycling initiatives, like Matmortua AS. The fact that more laws and regulations will require reuse and recycling and punish activity that doesn't comply with this, enlightened in section 3.5.2 and 3.5.3, is also a giant leap towards achieving a CE and CPE.

5.2.4 Threats

Representing a revolutionary new way of managing our economy, the biggest threats for CE and CPE development are the established market structures and the 'ways of doing' business in modern society. Market structures are defined by the components of its market, such as supply and demand, factors for supply, distribution methods, market competitors, etc. (Finansleksikon, n.d). Financing is key in this context, as businesses, in the end, will do what's economically beneficial for them. Therefore, there needs to be a will to change, and unless there is political agreement to direct the economy towards circularity, with finance mechanisms to back this up, the CPE is hardly to fully be realized. Status quo for CE and CPE is characterized by low maturity, on national and local level.

The fact that linearity in our economy is beneficial, affirms that there are insufficient financing mechanisms and an undeveloped market to support CE/CPE transition. This is illustrated through low cost of virgin plastics production, high cost of recycling, commercially unfavourable to use existing recycling technology, difficulties for reuse, which leads to a general low demand for plastics as secondary raw material (Amundsen, 2018). There are also insufficient plastics handling and treatment technologies, and a lack of tracking plastics e.g. through documentation or other statistics. The many characteristics and types of plastics used in a diverse set of ways could also possibly threat the abilities of transition.

5.3 Conclusions from section on analysis

This section has argued for a connection between 9 out of 17 SDGs and the suggested CPE indicators. Figure 6 below show which of the SDG targets that has been considered relevant for a CPE transition, and which of the proposed CPE indicators that are relevant for complying with the SDG targets. Notice that the CPE indicators will be presented in section six. This section has also demonstrated that there is an extended lack of statistical data to cover the original SDG indicators. As this study now proposes a further elaborated set of CPE indicators, the need to statistically measure the content of these only increases. The SWOT analysis on the other hand, has tried to provide an overview of the biggest strengths, weaknesses, opportunities and threats of a CE/CPE transition in Norwegian enterprise. The analysis gives a picture of an immature market that's not ready for the revolutionary change of which the CE implies. However, societal and political trends both in the EU, and thereof also gradually in Norway, is arguably predicting that our economy will be forced to turn its activities towards a CPE, and CE, sooner or later if the politically decided sustainability targets are to be met. It could therefore be beneficial for the Norwegian businesses to start innovating for a circular business model to meet with the imminent requirements of sustainable development. Because it is likely that stricter regulations related with material use will develop from the EU CE strategies, thereof also affecting Norway, the enterprise could also avoid economic punishments if they adapt early enough.

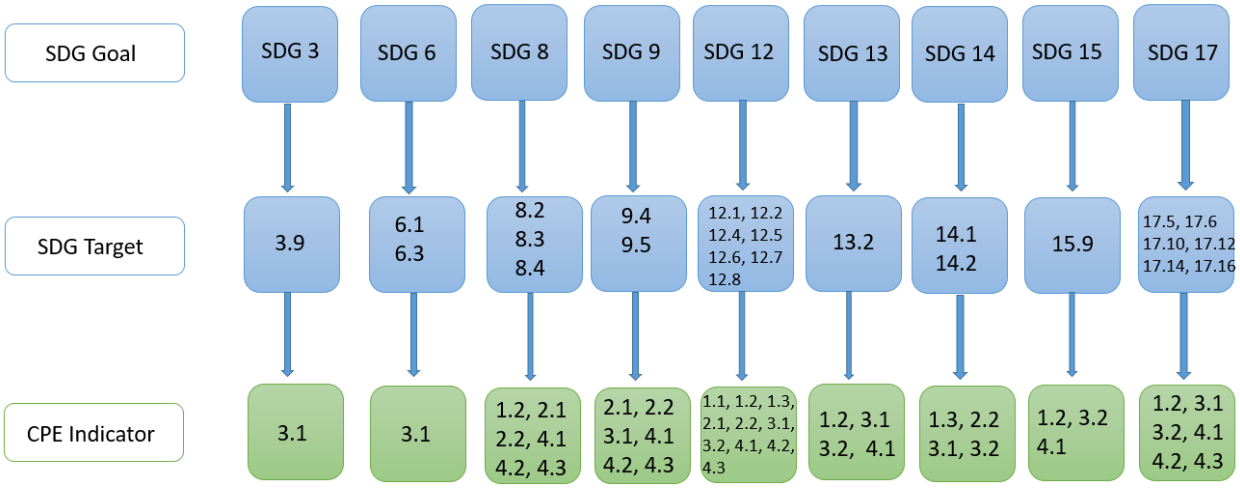

Figure 6. Relevance connection between the selected SDGs and the CPE indicators for Norwegian enterprise

6 Results

6.1 CPE indicators for Norwegian enterprise

Based on the former presented analysis and data provision in this study, this section will present a set of suggested indicators for a CPE transition in Norwegian enterprise. The indicators target a holistic picture around the Norwegian enterprise, illustrating what is argued to affect the actions or abilities of the enterprise to successfully achieve CPE. The indicators are divided into 1) Production and consumption, 2) Waste management, 3) Secondary raw materials and 4) Competitiveness and innovation. This division is equal to the one of EUs indicators for a circular economy in the monitoring framework (European Commission, n.d. a).

1 Production and consumption

1.1 Norwegian self-sufficiency for fossil plastics

The indicator measures how much Norway is independent from the rest of the world for fossil, virgin, plastics as raw material. This provides an overview of the overall scope of the market, giving foundation for further development of policies or instruments.

EU suggests that the indicator is to be expressed in % and is defined as: 1-(net) Import reliance. When Norway is a net exporter, Import Reliance (IR<0) is set to zero. Net Import Reliance is taken as in the formula for the purpose of calculating self-sufficiency. Imports, exports and domestic production are to be expressed in mass unit (European Commission, n.d. a).

1.2 Green public procurement

The indicator measures the share of public procurement procedures above the Norwegian thresholds (in number and value), that include environmental elements.

1.2.1 Recyclable plastics material in green public procurement.

The purpose is to strive for 100% recyclable plastics use in public procurement, creating a favorable market for circular economy plastics.

The indicator can be expressed in % of the total amount of green public procurement. Once accomplished, one should strive for recyclable plastics in all public procurements (% of the total amount of public procurement).

1.2.2 Circular plastics economy market tools and regulations

Governmental regulations and incentives that economically, and legally, favors production and consumption of recycled plastics as use of primary material. Examples of such can be EPR for all plastics containing products (Mepex, Salt, 2018), or lower fees for products that are (certified) made of recycled plastics material.

1.3 Waste generation

1.3.1 Generation of enterprise waste (kg/year)

The indicator measures the waste collected by or on behalf of Norwegian enterprise and disposed of through the waste management system (in mass unit).

1.3.1.1 Generation of enterprise plastic waste (kg/year)

The share of the enterprise waste, from each NHO company member, sorted as plastic waste. The indicator can be expressed by plastic waste divided by total waste generation from the enterprise.

The indicator should measure the waste generated in the production, distribution and consumption of plastics in Norwegian enterprise (in mass unit).

1.3.1.2 Share of plastics from enterprise in mixed waste outside sorted plastic waste

This indicator provides an accounting for the plastics material that is not recycled and sorted as plastic waste, but ends up in the mixed waste. The meaning behind this is to keep track of all plastics, in order to obtain a closed loop. In order to calculate this, new technology might need to be developed, e.g. scanning, or other registering of plastics (e.g. labelling). Proposed functional unit is kg/year.

1.3.2 Generation of plastic waste, per GDP unit (Kg per thousand NOK, chain linked volumes[3])

The indicator is defined as all plastic waste generated by the Norwegian enterprise sector (in mass unit), per GDP unit. The ratio is expressed in kg per thousand NOK (chain linked

[3] Meaning "from the raw GDP data, which reflect changes in both production volume and prices, a series is obtained which reflects only production volume" (Wikipedia.org, n.d)

volumes). However, EUR could be considered as monetary unit in order for aligning data with other EU countries being our trading partners.

In a circular economy, the value of products, materials and resources is maintained in the economy for as long as possible while generation of waste is reduced as much as possible, as reuse and recycling is preferred. “Waste prevention is closely linked with improved manufacturing methods, influencing consumers to demand greener products and less packaging. Here, decreased waste generation is needed while maintaining, or increasing, economic output” (European Commission, n.d. a).

2 Waste management

2.1 Recycling rates

2.1.1 Recycling rate of enterprise waste (%)

The indicator measures the share of recycled enterprise waste from total enterprise waste generation. Recycling includes material recycling, composting and anaerobic digestion. The ratio is expressed in percent (%) as both terms are measured in the same unit, namely kg.

2.1.2 Recycling rate of all plastic waste from enterprise (%)

The indicator is calculated as recycled plastic waste divided by total waste treated multiplied by 100. It is expressed in percent (%) as both terms are measured in the same unit, namely kg. Recycled waste is waste treated, which was sent to recovery operation other than energy recovery and backfilling (referred to as recycling). Waste data needs to be adjusted for waste collected in one country and recycled in another country (European Commission, n.d. a).

The EU suggests that the amount of recycled plastic waste is adjusted as following: waste treated in domestic plants plus waste sent out of the country for recycling minus waste imported and treated in domestic recycling plants (European Commission, n.d. a). The indicator should cover both hazardous (hz) and non-hazardous (nh) plastic waste to/from Norwegian enterprise.

2.2 Recycling/recovery for plastics waste streams

2.2.1 Recycling rate of plastic containing products (%)

The indicator is targeted towards covering of recycling from all types of products containing plastics material. The ratio should be expressed in percent (%) of the total plastics containing waste. This could require a tracking system for plastics used in the economy.

The indicator includes recycling of plastic components in mixed material products in the Norwegian enterprise sector. The intention is to keep track of, and strive to reuse and recycle plastics in products consisting of different types of material (wood, plastics, metallurgic material, etc), as we need to keep track of all plastics within the economy (Di Maio & Rem, 2015).

2.2.2 Recycling rate of plastic packaging (%)

The indicator is defined as the share of recycled plastic packaging waste in all generated plastic packaging waste. Packaging waste covers wasted material that was used for the containment,

protection, handling, delivery and presentation of goods, from raw materials to processed goods, from the producer to the user or the consumer, excluding production residues.

The ratio should be expressed in percent (%) as both terms are measured in the same unit, namely kg (European Commission, n.d. a).

2.2.3 Recycling rate of plastic production residue

The indicator covers the plastic waste that comes from plastics production, as this is not included in 2.2.2. Functional unit could be measured in %, like in 2.2.2.

In a complete circular plastics economy transition, the plastics residue from producer level also needs to be accounted for in order to close the loop.

3 Secondary raw materials

3.1 Contribution of recycled plastics to raw materials demand

The contribution of recycled plastics to the raw materials demand in Norwegian enterprise is represented by two indicators, as suggested by the EU (European Commission, n.d. a):

(3.1.1) End-of- life recycling input rate measures how much of the plastics input into the production system comes from recycling of virgin, fossil plastics.

(3.1.2) Circular plastics material use rate (CMU rate) is defined as the ratio of the circular use of plastics (U) to the overall material use (M) (M = DMC + U).

3.1.1 End-of-life plastics recycling input rates

The indicator measures the amount of plastics raw material input into the Norwegian enterprise (industry production, delivery, etc.) coming from recycled plastics, for example plastics from end-of-life products.

Documenting and keeping track of the use of secondary raw plastics in new products within the economy is necessary in a circular economy.

3.1.2 Circular plastics use rate (%)

The indicator measures the share of plastics material recovered and fed back into the economy by Norwegian enterprise. The intention is saving extraction of primary raw materials for plastic production, preventing new fossil plastics production. The circular plastics material use (CMU) rate is defined as the ratio of the circular use of plastic materials to the overall material use.

> “The overall material use is measured by summing up the aggregate domestic material consumption (DMC) and the circular use of plastics. DMC is defined in economy-wide material flow accounts.
>
> The circular use of materials is approximated by the amount of waste recycled in domestic recovery plants minus imported waste destined for recovery plus exported waste destined for recovery abroad. Waste recycled in domestic recovery plants comprises the recovery operations R2 to R11 - as defined in the Waste Framework

Directive 75/442/EEC. The imports and exports of waste destined for recycling - i.e. the amount of imported and exported waste bound for recovery – are approximated from the European statistics on international trade in goods.

A higher CMU rate value means that more secondary materials substitute for primary raw materials thus reducing the environmental impacts of extracting primary material" (European Commission, n.d. a).

3.2 Trade in recyclable plastics

The indicator measures the quantities of plastics and plastics by-products that are shipped to/from actors of the Norwegian enterprise (plastics treating and/or production industry).

The indicator should include the following variables:

(3.2.1) Import of recyclable raw plastics material from foreign countries

(3.2.2) Export of recyclable raw plastics material from Norway to foreign countries

The intention of this indicator is to track, and know, where the plastics from Norwegian enterprise is managed and treated, knowing status quo of plastic waste streams to/from Norwegian enterprise.

This can in turn raise a debate on most optimal plastic waste treatment from a circular economy perspective. As seen in section 3.4, 50% of Norwegian enterprise plastics waste is exported, with even higher numbers looking at the total plastics waste nationally. Arguably, treating the waste as close to its source as possible is better in a circular economy perspective, as a national recycling loop possibly could prevent more spill than an international one. In turn, this could also create waste management facilities that based their business model on production of recycled plastics from secondary raw plastics material.

The indicators formulated by the EU on this matter are based on International Trade in Goods Statistics (ITGS) published by Eurostat (Eurostat, 2018). The scope of the 'recyclable raw materials' is here measured in terms of relevant product codes from the Combined Nomenclature used in International Trade in Goods Statistics (European Commission, n.d. a). Further research needs to evaluate whether this data set is expedient for Norwegian enterprise.

3.2.1 Plastics imports (to Norway)

Imports to Norwegian enterprise measure the quantities of recycled plastics imported from foreign countries.

3.2.2 Plastics exports (from Norway)

This indicator measures the quantities of recycled plastics exported by Norwegian enterprise outside Norwegian borders.

4 Competitiveness and innovation

4.1 Private investment, jobs and gross value added related to circular plastics economy within Norwegian enterprise (sectors)

The indicator includes *Gross investment in tangible goods containing recycled plastic*, *Number of persons employed* and *Value added at factor costs* in the following two sectors: the plastics recycling sector and the sector of repair and reuse of plastics.

"The circular economy has the potential to contribute to the creation of jobs and economic growth. Innovation and investments on eco-design, on secondary raw materials, on recycling processes and on industrial symbiosis, are a key element of the transition to a circular economy. Specific sectors that are closely related to the circular economy such as the recycling, repair and reuse, are particularly job intensive, and contribute to local employment" (European Commission, n.d. a).

This indicator implies defining and documenting CPE businesses within the Norwegian enterprise sector. EU has suggested a definition of the recycling and repair and reuse sectors approximated in terms of economic activity branches of the NACE Rev. 2 classification, as shown in Appendix B. EU states in their description that "the indicator is collected within the frame of the Structural Business Statistics (SBS), as required in Commission Regulation N° 250/2009" (European Commission, 2018). Further research is required whether this is expedient in a Norwegian enterprise case.

4.1.1 Gross investment in tangible goods containing fossil plastic (percentage of gross domestic product (GDP) at current prices)

Gross investment in tangible goods is defined as investment during the reference year in all tangible fossil plastic containing goods in and from the Norwegian enterprise. Included are new and existing tangible plastics capital goods, whether bought from third parties or produced for own use Investments in intangible and financial assets are excluded.

Arguably, the indicator could foster an accounting system for keeping track of the goods containing plastics that's circulating in the economy. A low investment in products of fossil plastics would indicate a higher amount of recycled plastics used. A low value here is therefore favorable in terms of a circular plastics economy transition.

4.1.2 People employed by means of CPE (percentage of total employment)

Jobs are expressed in number of persons employed related to the circular plastics economy as a percentage of total employment. Number of persons employed is defined as the total number of persons who work in the observation unit, i.e. the firm (inclusive of working proprietors, partners working regularly in the unit), as well as persons who work outside the unit who belong to it and are paid by it, e.g. sales representatives, delivery personnel, repair and maintenance teams.

This indicator will cause a need to determine and map out which type of employment is connected to CE. Burger et.al (2019) state in their article that the previous figures on CE

employment might have underestimated the true size of CE "because most studies focus on the 'green' component of the CE only and neglect the non-green jobs that enable the development of the CE […] Despite the growing number of studies assessing the size, growth and potential of the CE in terms of employment, there is little knowledge of the type of workforce the CE requires. In other words, it is unclear what types of employees will be necessary to accommodate the (potential) future growth of the CE" (Burger, et.al 2019).

4.1.3 Value added at factor cost (percentage of gross domestic product (GDP) at current prices)

Value added at factor cost is the gross income from operating activities related to a circular plastics economy after adjusting for operating subsidies and indirect taxes. "It can be calculated as the sum of turnover, capitalized production, other operating income, increases minus decreases of stocks, and deducting the following items: purchases of goods and services, other taxes on products which are linked to turnover but not deductible, duties and taxes linked to production. Value adjustments (such as depreciation) are not subtracted" (European Commission, n.d. a).

4.2 Number of patents related to recycling of plastics and secondary raw plastic material

The indicator measures the number of patents related to recycling of plastics and secondary raw plastics as sources for new fossil plastic material into the economy (as a replacement of production of fossil plastics).

"The term 'patents' refers to patent families, which include all documents relevant to a distinct invention (e.g. applications to multiple authorities), thus preventing multiple counting. A fraction of the family is allocated to each applicant and relevant technology" (European Commission, n.d. a).

4.3 Research and development expenditure related to circular plastic economy

Public and private funding and finances for CPE development, e.g. circular plastics technology and/or organizational development. This to provide e.g. funds or other support schemes or earmarked grants for businesses and/or organizations that aim to close their own (or societal/national) plastics loops. This will potentially create further circular business models throughout the whole value chain. Functional unit for the indicator could be NOK/year as a proportion of GDP.

6.2 Conclusion from section on results

A summary of the proposed CPE indicators for Norwegian enterprise follow in table 21 below.

1 Production and consumption
1.1 Norwegian self-sufficiency for fossil plastics
1.2 Green public procurement
1.2.1 Recyclable plastics material in green public procurement

1.2.2 Circular plastics economy market tools and regulations
1.3 Waste generation
1.3.1 Generation of enterprise waste (kg/year)
1.3.1.1 Generation of enterprise plastic waste (kg/year)
1.3.1.2 Share of plastics from enterprise in mixed waste outside sorted plastic waste
1.3.2 Generation of plastic waste, per GDP unit (kg/thousand NOK, chain linked volumes)
2 Waste management
2.1 Recycling rates
2.1.1 Recycling rate of enterprise waste (%)
2.1.2 Recycling rate of all plastic waste from enterprise (%)
2.2 Recycling/ recovery for plastics waste streams
2.2.1 Recycling rate of plastic containing products (%)
2.2.2 Recycling rate of plastic packaging (%)
2.2.3 Recycling rate of plastic production residue
3 Secondary raw materials
3.1 Contribution of recycled plastics to raw materials demand
3.1.1 End-of-life plastics recycling input rates
3.1.2 Circular plastics use rate (%)
3.2 Trade in recyclable plastics
3.2.1 Import of recyclable raw plastics material from foreign countries
3.2.2 Export of recyclable raw plastics material from Norway to foreign countries
4 Competitiveness and innovation
4.1 Private investment, jobs and gross value added related to circular plastics economy within Norwegian enterprise
4.1.1 Gross investment in tangible goods containing fossil plastic (% of GDP)
4.1.2 People employed by means of CPE (% of total employment)
4.1.3 Value added at factor cost (% of GDP)
4.2 Number of patents related to recycling of plastics and secondary raw plastic material

4.3 Research and development expenditure related to CPE

Table 21. Summary of suggested CPE indicators for Norwegian enterprise.

7 Discussion

This section will present a reflection on the reliability and validity of the study and its results. Especially in qualitative studies, addressing these aspects is important, as there is a higher risk of the researcher colouring the content of the study. Reliability addresses the internal logics of the process throughout the work of the study, while validity addresses the logical cohesion and context between the design and results of the study, and the research questions (Tjora, 2013).

7.1 Reliability of the results

A central question to be asked to test the reliability of a qualitative study is "would the results be the same if another researcher did the same job? » (Tjora, 2013). The answer doesn't have to be a clear 'yes' in order for the reliability to be high, but the researcher should clarify which factors could point in the direction of how the results became as they did because the study was written by this researcher and these actors or informants were involved. Or, the opposite, clarify to which extent the results would have become the same if the study was done again with different informants or actors (Tjora, 2013). The following paragraphs will discuss the abovementioned statements by looking at 1) how this researcher's position could have marked the outcome of the study and results, 2) what information that comes from generation of data and what is coming from the researcher's own analysis, and 3) how the actors and informants have been selected.

The researcher of this study has not had any pre-knowledge or specific acquaintances within the enterprise sector or authorities that knowingly was related with work on CE or CPE. The initial contact with Trøndelag county was initiated by this study's supervisor, and the collaboration with Matmortua AS was then initiated after conversation with the county. The lack of pre-knowledge of the CE, and potentially CPE, actors could be considered both positive and negative. The positive aspects are that the knowledge obtained from the research process of this study come solely from an objective, outsider-looking approach, with fairly low risks of colouring the research in any way. However, no qualitative research is done with complete neutrality (Tjora, 2013), and the limited literature or impression from the empirical research for the case of CE/CPE in Norwegian enterprise, and in Norway in general, can have affected this researcher's dissemination of a low developed CE focus in Norway. This leads to the possible negative aspects of not having extended pre-knowledge of the topic and its progress. Because, not having insight in the CE field beforehand, could have affected which actors that have been contacted, and the response from those contacted. There is a chance that the time spent to answer the researcher's questions has been shorter and not prioritized due to unfamiliarity, and thereby affecting the answers from the informants as not being as complimentary as they could have been. However, with that being said, this study does arguably stress the accuracy and highly relevance of the actors contacted, and the accuracy of the response content, partly due to the close collaboration with Trøndelag county and Matmortua AS. This study also enjoys first-hand information from the authorities on Norwegian political CE, and therefore CPE, development, as interviews have been conducted with both Hamar (2019) and Spillum (2019). The

abovementioned aspects play a role for the information behind the content of the CPE indicators. The layout and scope of these indicators are closely derived from the EU's monitoring framework, which this study argues to have a strong indication of the objectiveness of the results. Meaning that the results from this study could arguably have been presented in a similar way if done by another researcher. However, the content of the analysis could have had a wider set of informant information if having knowledge to the central actors beforehand. On the contrary, one could also say that a researcher could have obtained less information on the topic if he/she contacted other actors and informants than this study has.

The analysis and data behind the formation and specific content of the CPE indicators presented in section six, is solely based on the empirical gathering of data (section four) and document review. This is also the case for the frameworks presented in the theoretical section (section three). The encounter of the EU CE indicators during the work of the project thesis was also the inspiration of the layout and scope of how this study's CPE indicators for a Norwegian enterprise is presented. On the other hand, the selection of the relevant SDGs and the argumentation of the linkage between the CPE indicators, as well as the SWOT-analysis, are results of the researcher's own analysis.

The actors and informants for this study have been selected based on input from the study's supervisor, Trøndelag county, Matmortua AS, and based on insight gathered from literature research. As mentioned above, the type of actors can to some extent be questioned. However, the study argues that it has covered a reliable width by approaching relevant representatives from the authorities, researchers, the appropriate trade organization (Waste Norway) and a local plastics recycling actor (Matmortua AS). The close collaboration with Matmortua AS can also be considered of high value for the reliability of the indicator relevance and appropriate targeting for the Norwegian enterprise sector itself.

7.2 Validity of the study

Validity is connected to whether the answers found in the study, actually are answering the questions asked in the study (Tjora, 2013). This is said to be a possible complicated affair in descriptive research. Tjora (2013) talks about *communicative* and *pragmatic* validity, where the first one is tested in dialog with the community of researchers, while the latter is tested by asking whether the research leads to a change or improvement. Within social research, the latter is considered relevant for so called *action research*, where the research is seen as a form of work for change. This is undoubtingly the case for this study, as CE in general represents a change of operating the social economy. The communicative validity is tested in dialog with researchers, which in practice means that a study consciously relates to other theory or perspectives on the matter, as well as to research done within the same topic and/or with the same methods. Thereby the results from one's own study, is correlated with findings from related research from others. A study can strengthen its validity by clarifying the choices taken related with e.g. the generation of data and the theoretical inputs to the analysis. The cohesion between the research questions and the choice of data generation and theoretical foundation should also be discussed (Tjora, 2013). The following paragraphs will therefore address the interrelation of the research questions and

the study's choice of data generation. It will also address the relationship between the research questions and the theoretical foundation.

Interviews, contact with the actors that already have made a strategy for CE, and document research have been the selected methods for generating qualitative data in order to answers the study's research questions. The research questions for this thesis have been as follows: 1) What is status quo for CE commitment in Norway? 2) what are the critical factors in order for a CPE transition to happen in Norwegian enterprise? and 3) how could we create a closed plastics loop within the Norwegian enterprise? Addressing the first question, this study's intention was to try to map out and get an overview of previous and current research primarily on CE, and then to see whether plastics had been targeted within the CE field. This resulted in the section 3.5 with the presentation of the frameworks for a CE transition, which was a work initiated by the project thesis for this study. To have established this foundation has been considered important for this thesis, as it present a novel descriptive approach to the topic, necessary in order to answer the following two research questions. Research question number two seeks to answer how this study can contribute in tackling the aspects relevant of an actual CPE transition of the Norwegian enterprise. A SWOT-analysis was therefore chosen to identify critical factors for such a transition, and for further understanding of how these could be taken care of within the indicator suggestion. The research question number three is specifically targeting a tool to help in how a CPE transition of the Norwegian enterprise could happen. This is why this study proposes a set of indicators especially for this. The thought of elaborating indicators in particular as a tool to help such transition, came as a result of initial talks with this study's supervisor, as well as research showing that this was yet to exist.

Research done in the prior project thesis for this study, gave birth to this study's research questions. The work on the framework section and the remaining theoretical foundation, revealed a lack of CE focus in Norway, compared to similar focus in the EU. This is why this study is meant as a novel contribution to the CE transition in Norway, and more specifically, the CPE transition for Norwegian enterprise. This demarcation, considering plastics in Norwegian enterprise, was done due to the actuality of plastics pollution and the possibility to collaborate with Matmortua AS, which is a plastics waste treatment facility that collects great quantities of Norwegian enterprise plastic waste. The close relationship with the sector itself was therefore decisive for the demarcation.

7.3 Conclusions from section on discussion

This section has discussed the reliability of the study's results and the validity of the study itself. This study argues that due to the close collaboration with Trøndelag County and Matmortua AS, the results of this study, being the proposed CPE indicators, are reliable. The indicators proposed in section six are targeting realistic and relevant aspects in order for the Norwegian enterprise to transition such an economy. The research questions for this study were shaped after observing that research of the topic addressed in this study was non-existing in Norway. These three research questions have been specifically addressed and answered through section 3 (research question one), section 5.2 (research question two) and section 6 (research question three).

8 Conclusion

The intention of this study has been to determine and suggest a set of indicators for a circular plastics economy (CPE) in Norwegian enterprise. The proposed indicators are divided into the categories “consumption and production”, “waste management”, “secondary raw materials” and “competitiveness and innovation”. This division of indicators is inspired by the same division made by the EU on their indicators for a circular economy (CE). The indicators are an outcome of, firstly, an elaboration on how CE and CPE currently stands in the EU and in Norway, and, secondly, an evaluation of the critical factors for such a transition to happen.

The study has identified that CE and CPE in Norway is immature and little developed compared to the EU, and that the market changes represented by a circular economy will require new tools and mechanisms in order to transcend business of such an economy. There are businesses cases, such as Matmortua AS, that does business based on circularity, but Norway lacks a superior strategy and unifying coordinator for CE, that strategically can assure circularity in Norwegian economic activities. The newly formed working group on a CE strategy in Norway, could be a positive first step in this direction. The market is not likely to achieve a CPE on its own, and needs facilitation on behalf of the authorities. Key aspects that point in an enabling direction are pro-CPE regulations, economic benefits related to use of recycled material, solid financing mechanisms, technology development (which in turn needs to be affordable to use), producer responsibility, and collaboration and innovation throughout whole value chains. If these CE factors are strategically targeted from an authoritative level, measurement tools, such as statistics, can in turn be defined, and Norway could start addressing CE as a statistically defined target area.

8.1 Recommendations

The study recommends that the findings from this thesis are taken into consideration for further political elaboration and business development for CE and CPE in Norway. The scope of the proposed CPE indicators for Norwegian enterprise should be guiding in how the industry approaches CPE strategies, both nationally and within each company. The indicators also function as a means of compliance with the UN Sustainable Development Goals (SDGs), of which Norway is committed to achieve.

8.2 Further work

The CPE indicators proposed in this study need to be determined quantitatively. There is also a need to revise and quality check the provision of indicator data to fit Norwegian measures. This can potentially also lead to a provision of specifically targeted CE, and CPE, statistics in Norway, which arguably is needed to strengthen the CE progress in Norway

9 References

9.1 Published

Amundsen, B. (2018). *Hva skjer med plast som kastes eller resirkuleres*. Retrieved from forskning.no: https://forskning.no/forurensning-miljo-plast/hva-skjer-med-plast-som-kastes-eller-resirkuleres/1207646

Avfall Norge. (2018, november 1.). *Veikart for sirkulær økonomi*. Retrieved from Avfall Norge: https://www.avfallnorge.no/hva-jobber-vi-med/veikart-for-sirkul%C3%A6r-%C3%B8konomi

Banaité, D. (2016). Towards circular economy: Analysis of indicators in the context of sustainable development. *Social Transformation in Contemporary Society*, pp. 142-150.

Bocken, N. e. (2013). A lvalue mapping tool for sustainable business modelling. *Corp. Gov. Int. J. Bus. Soc. 13*, pp. 482-497.

Burger, M., Stavropoulus, S., Ramkumar, S., Dufourmont, J., & van Oort, F. (2019). The heterogeneous skill-base of circular economy employment. *Research Policy (Elsevier.com)*.

Burgherr, P. (2005). Survey of criteria and indicators. New Energy Externalities Developments for Sustainability (NEEDS). *Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)*.

Circular Norway. (2018, November 1.). *Sirkulærøkonomi*. Retrieved from circularnorway.no: https://www.circularnorway.no/sirkulaerokonomi/

Cole, R. (2018, June 20). *EU Circular Economy Package becomes law* . Retrieved from Resource.co: https://resource.co/article/eu-circular-economy-package-becomes-law-12697

Convention on Biological Diversity. (n.d). *Country Profiles*. Retrieved from cbd.int: https://www.cbd.int/countries/

Det Kongelige Finansdepartement. (2018). *Meld.St.1 (2018-2019) Nasjonalbudsjettet 2019.* Oslo: Regjeringen.no.

Det Norske Akademis Ordbok. (n.d). *State of the art - definisjon*. Retrieved from NAOB: https://www.naob.no/ordbok/state-of-the-art

Di Maio, F., & Rem, P. (2015). A Robust Indicator for Promoting Circular Economy through Recycling. *Journal of Environmental Protection*, pp. 1095-1104.

Djursing, T. (2019). *Kina har stanset importen av plastavfall*. Retrieved from tu.no: https://www.tu.no/artikler/kina-har-stanset-importen-av-plastavfall/456800

Ellen MacArthur Foundation. (2017). *What is circular economy?* Retrieved from Circular Economy: https://www.ellenmacarthurfoundation.org/circular-economy/concept

Ese, M., Trætli, M., & Lonar, I. (2018). *Et hav av plast - Utfordringer og tiltak. En rapport om plast.* Trondheim: Fremtiden i våre hender.

European Commission. (2010, March 3). *European Environment Agency*. Retrieved from Europe 2020: A strategy for smart, sustainable and inclusive growth: https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:2020:FIN:EN:PDF

European Commission. (2011, January 26). *A resource-efficient Europe - Flagship initiative under the Europe 2020 strategy*. Retrieved from European Environment Agency: https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0021:FIN:EN:PDF

European Commission. (2014, May 12). *Towards a circular economy: A zero waste programme for Europe*. Retrieved from Eur-lex: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52014DC0398R%2801%29

European Commission. (2015, December 2). *Proposals on the circular economy - collection*. Retrieved from Commission publications: https://ec.europa.eu/commission/publications/european-commission-proposals-circular-economy_en

European Commission. (2016, Januar 16.). *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the regions - on a monitoring framework for the circular economy*. Retrieved from EUR-lex: https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1516265440535&uri=COM:2018:29:FIN

European Commission. (2017, January 25). *Raw materials*. Retrieved from Environment: http://ec.europa.eu/environment/green-growth/raw-materials/index_en.htm

European Commission. (2018 a, June 15). *2018 Circular Economy Package*. Retrieved from Circular Economy - Implementation of the Circualr Economy Action Plan: http://ec.europa.eu/environment/circular-economy/index_en.htm

European Commission. (2018 b). *A European Strategy for Plastics in a Circular Economy*. Retrieved from Eur-lex: https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1516265440535&uri=COM:2018:28:FIN

European Commission. (2018 c, November). *EU Science Hub*. Retrieved from The JRC in Seville (Spain): https://ec.europa.eu/jrc/en/about/jrc-site/seville

European Commission. (2018 d, October 10). *European strategy for plastics*. Retrieved from Environment - waste - waste streams: http://ec.europa.eu/environment/waste/plastic_waste.htm

European Commission. (2018 e). *Single use plastics: Commission welcomes ambitious agreement on new rules to reduce marine litter*. Retrieved from Press Release Database: http://europa.eu/rapid/press-release_IP-18-6867_en.htm

European Commission. (2018 f, January 10). *Towards a circular economy*. Retrieved from Jobs, growth and investment: https://ec.europa.eu/commission/priorities/jobs-growth-and-investment/towards-circular-economy_en

European Commission. (n.d. a). *Monitoring Framework*. Retrieved from Eurostat: https://ec.europa.eu/eurostat/web/circular-economy/indicators/monitoring-framework

European Commission. (n.d. b). *Plastic Pollution - we can make things better*. Retrieved from Environment, waste: http://ec.europa.eu/environment/waste/pdf/plastic_waste_factsheet.pdf

European Commission. (n.d. c). *What is Smart Specialization?* Retrieved from S3 Platform: http://s3platform.jrc.ec.europa.eu/what-is-smart-specialisation-

European Union. (2018, November Friday). *European Interreg*. Retrieved from European Interreg: https://www.interregeurope.eu/

Eurostat. (2018). *Trade in recyclable raw materials*. Retrieved from eurostat.eu: https://ec.europa.eu/eurostat/tgm/table.do?tab=table&tableSelection=1&labeling=labels&footnotes=yes&layout=time,geo,cat&language=en&pcode=cei_srm020&plugin=1

Eurostat. (n.d). *Annex - List of NACE Rev. 2 codes used for indicator calculation (Private investments, jobs and gross value addedrelated to the circular economy sectors)*. Retrieved from EU Monitoring framework: https://ec.europa.eu/eurostat/documents/8105938/8465062/cei_cie010_esmsip_NACE-codes.pdf

Finansleksikon. (n.d). *Markedsstruktur*. Retrieved from finansleksikon.no: https://www.finansleksikon.no/Regnskap/M/Markedsstruktur.html

Fredrikstad Kommune. (2018). *Handlingsplan Plast.* Fredrikstad: Fredrikstad Kommune.

Geissdoerfer, M., Morioka, S., Monteiro de Cavalho, M., & Evans, S. (2018, April 18). Business models and supply chains for the circular economy. *Journal of Cleaner Production (Elsevier.com)*, pp. 712-721.

Geissdoerfer, M., Vladimirova, D., & Evans, S. (2018, June 22). Sustainable business model innovation: A review. *Journal of Cleaner Production (Elsevier.com)*, pp. 401-414.

Geng, Y., Fu, J., Sarkis, J., & Xue, B. (2012). Towards a national circular economy indicator system in China: an evaluation and critical analysis. *Journal of Cleaner Production (23)*, pp. 216-224.

Global Policy Forum. (2012, March 1). *To save the Earth it is essential to change consumption patterns*. Retrieved from Inequality of wealth and income distribution: https://www.globalpolicy.org/social-and-economic-policy/global-injustice-and-inequality/inequality-of-wealth-and-income-distribution/51367-to-save-the-earth-it-is-essential-to-change-consumption-patterns.html

Hage, I. (2016). *Waste Management in Norway - A study of "ISO 37120 Sustainable Development in Communities - Indicators for city services and quality of life". Master thesis.* Trondheim: NTNU.

Hahladakis, J., & Iacovidou, M. (2018). Closing the loop on plastic packaging matierials: What is quality and what affects their circularity? *Science of Total Environment (360)*, pp. 1394-1400.

Hák, T., Janouskova, S., & Moldan, B. (2016, August 21). Sustainable Development Goals: A need for relevant indicators. *Ecological Indicators 60*, pp. 565-573.

Haupt, M., Vadenbo, C., & Hellweg, S. (2016). Do we have the right Performance Indicators for the Circular Economy?: Insight into the Swiss Waste Management System. *Journal of Industrial Ecology (21:3)*, pp. 615-627.

Huysman, S., de Schaeepmester, J., Ragaert, K., Dewulf, J., & de Meester, S. (2017). Performance indicators for a circular economy: A case study on post-industrial plastic waste. *Resources, Conservation and Recycling (120)*, pp. 46-54.

ISO 37100. (2016). *Sustainable cities and communities - Vocabulary.* Geneva: ISO (International Standard).

ISO14001. (2015). *Environmental management systems - Requirements with guidance for use*. Geneva, Switzerland: ISO.

Kalmykova, Y., Sadagopan, M., & Rosado, L. (2018). Circular economy - From review of theories and practises to development of implementation tools. *Resorces, Conservation and Recycling (135)*, pp. 190-201.

Kjellèn, U. (2000). Prevention of Accidents Through Experience Feedback. *CRC Press 1. edition*.

Klima- og miljødepartementet. (2018, January 1). *Forurensningsloven*. Retrieved from Lovdata.no: https://lovdata.no/dokument/NL/lov/1981-03-13-6

Kraaijenhagen, C., van Oppen, C., & Bocken, N. (2016, January 1). Circular Business. Collaborate and circulate. *Circular Collaboration*.

Lovdata.no. (2018). *Forurensningsloven*. Retrieved from lovdata.no: https://lovdata.no/dokument/NL/lov/1981-03-13-6/KAPITTEL_2#%C2%A79

Marrs, D., Rucevska, I., & Villarrubia-Gomez, P. (2019). *Controlling Transboundary Trade in Plastic Waste.* Arendal: GRID-Arendal.

Mathismoen, O. (2019, May). *80% av alt plastavfall havner på fyllinger og i naturen*. Retrieved from aftenposten.no: https://www.aftenposten.no/norge/i/y3x7o2/80-prosent-av-alt-plastavfall-havner-pa-fyllinger-og-i-naturen-Na-har-Norge-fatt-gjennom-en-ny-global-plastavtale-pa-rekordtid

Matmortua AS. (n.d). *Norwegian Plastic Recycling AS*. Retrieved from matmortua.no: https://matmortua.no/norwegian-plastic-recycling-as/

Mepex, Salt. (2018). *Rapport for Miljødirektoratet. Underlag for å utrede produsentansvarsordning for fiskeri- og akvakulturnæringen.*

Moraga, G., Huysveld, S., Mathieux, F., Blengini, B., Alaerts, L., Van Acker, K., . . . Dewulf, F. (2019, July). Circular economy indicators: What do they measure? *Resources, Conservation and Recycling (Vol.146)*, pp. 452-461.

Murray, A., Skene, K., & Haynes, K. (2015, May 22). The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context. *J Bus Ethics*, pp. 369-380.

Nakken, K., & Jensen, J. (2018). *Smart spesialisering som metode for regional nærignsutvikling.* Oslo: Kommunal og moderniseringsdepartementet.

Naturvernforbundet.no. (n.d). *EU forbyr engangsplast. Hva nå Norge?* Retrieved from Plast: https://naturvernforbundet.no/plast/eu-forbyr-engangsplast-hva-na-norge-article38688-3932.html

Ngan, S., How, B., Teng, S., Promentilla, M., Yatim, P., Er, A., & Lam, H. (2019, September). Prioritization of sustainability indicators for promoting circular economy: The case of developing countries. *Renewable and Sustainable Energy Reviews (Vol. 111)*, pp. 314-311.

NHO. (n.d). *NHO Sectoral Federations*. Retrieved from About: https://www.nho.no/en/english/nho-sectoral-federations/

NORSIRK. (n.d). *Producer responsibility*. Retrieved from norsirk.no: https://norsirk.no/weeerepnorway/producer-responsibility/

Norsk Industri. (2018). *Ringen sluttes: Mulighetsstudie for sirkulær økonomi i prosessindustrien. Økt verdiskapning ved effektiv ressursutnyttelse.* Oslo: Norsk Industri.

Nørgaard, E., Rognerud, L., & Storrud, A. (2018). *Indikatorer til FNs Bærekraftsmål.* Oslo-Kongsvinger: Statistisk Sentralbyrå (SSB).

OECD. (2009). *Governing Regional Development Policy: The Use of Performance Indicators.* Retrieved from OECD iLibrary : https://read.oecd-ilibrary.org/urban-rural-and-regional-development/governing-regional-development-policy/executive-summary-introduction_9789264056299-2-en#page9

Regjeringen.no. (2015). *NOU 2015:15 Sett pris på miljøet - Rapport fra grønn skattekommisjon*. Retrieved from regjeringen.no: https://www.regjeringen.no/no/dokumenter/nou-2015-15/id2465882

Regjeringen.no. (2019 a). *Granavolden-plattformen. Politisk plattform.* Oslo: Regjeringen. no.

Regjeringen.no. (2019 b). *Regjeringen varsler forbud mot engangsartikler av plast innen ett år*. Retrieved from Aktuelt: https://www.regjeringen.no/no/aktuelt/regjeringen-varsler-forbud-mot-engangsartikler-av-plast-innen-ett-ar/id2643870/

Regjeringen.no. (n.d.). *Meld.St. 45 (2016-2017). Avfall som ressurs - avfallspolitikk og sirkulær økonomi*. Retrieved from Meldinger til Stortinget, Regjeringen.no: https://www.regjeringen.no/no/dokumenter/meld.-st.-45-20162017/id2558274/

Science Direct. (2017). *Mineral Waste*. Retrieved from Earth and planetary sciences: https://www.sciencedirect.com/topics/earth-and-planetary-sciences/mineral-waste

Smeets, E., & Weterings, R. (1999). *Environmental indicators: Typology and Overview (Technical report No 25).* Copenhagen: EEA (European Environmental Agency).

Smol, M., Kulczycka, J., & Avdiushchenko, A. (2017). Circular economy indicators in relation to eco-innovation in European regions. *Clean Technologies and Environmental Policy (19)*, pp. 669-678.

SSB. (2015 a). *Avfall handel*. Retrieved from Natur og miljø - statistikker: https://www.ssb.no/natur-og-miljo/statistikker/avfhandel/aar

SSB. (2015 b). *Avfall industri*. Retrieved from Natur og miljø - statistikker: https://www.ssb.no/natur-og-miljo/statistikker/avfind/hvert-4-aar

Statistisk Sentralbyrå. (2018, November). *Treff for "Sirkulær økonomi"*. Retrieved from Søkeområdet: https://www.ssb.no/sok?hovedemner=Natur+og+milj%C3%B8&sok=sirkul%C3%A6r+%C3%B8konomi

Tandstad, B. (2019). *Vi får i oss minst 50 000 plastpartikler i året berre gjennom maten.* Retrieved from nrk.no: https://www.nrk.no/urix/_-vi-far-i-oss-minst-50.000-plastpartiklar-i-aret-berre-gjennom-maten-1.14577847

Tasaki, T., & Kameyama, Y. (2015, October 29). Sustainability indicators: Are we measuring what we ought to measure? *Center for Material Cycles and Waste Management Research, National Institute for Environmental Studies*, pp. 147-153.

Tjora, A. (2013). *Kvalitative forskningsmetoder i praksis.* Oslo: Gyldendal Akademisk.

Trøndelag Fylkeskommune. (2017). *Et verdiskapende Trøndelag. Strategi for innovasjon og verdiskapning i Trøndelag.* Trondheim: Trøndelag Fylkeskommune.

Trøndelag Fylkeskommune. (2018). *Handlingsprogram 2018-2019 - for strategien Et verdiskapende Trøndelag.* Trondheim: Trøndelag Fylkeskommune.

Types, I. a. (n.d). *What are indicators and types of indicators?* Retrieved from M&E studies: http://www.mnestudies.com/monitoring/what-indicators-and-types-indicators

Ulriksen, A. (2018, November 6). *Norge mangler en nasjonal strategi for sirkulær økonomi*. Retrieved from tu.no: https://www.tu.no/artikler/norge-mangler-en-nasjonal-strategi-for-sirkulaer-okonomi/450494

UN . (n.d). *Sustainable Development Goals*. Retrieved from un.org: https://sustainabledevelopment.un.org/sdgs

Urbinati, A., Chiaroni, D., & Chiesa, V. (2017, September 8). Towards a new taxonomy of circular economy business models. *Journal of Cleaner Production*, pp. 487-498.

Watkins, E., Gionfra, S., Schweitser, J., Pantzar, M., Janssens, C., & ten Brink, P. (2017). *EPR in the EU Plastics Strategy and Circular Economy: A focus on plastic packaging.* Brussels: Institute of European Environmental Policy (IEEP).

Wikipedia.org. (2019). *Interkommunalt selskap - definisjon*. Retrieved from https://en.wikipedia.org/wiki/Interkommunalt_selskap

Wikipedia.org. (n.d). *Chained volume series*. Retrieved from wikipedia.org: https://en.wikipedia.org/wiki/Chained_volume_series

WWF. (n.d). *Forsøpling av havet*. Retrieved from wwf.no: https://www.wwf.no/dyr-og-natur/hav-og-fiske/plast-i-havet

Zadek, S. (2007). The Path to Corporate Responsibility. In H. M. Zimmerli W.C., *Corporate Ethics and Corporate Governance.* Berlin: Springer.

Øien, K. (2001). Risk indicators as a tool for risk control. *Reliability Engineering & System Safety 74, 2*, pp. 129-146.

9.2 Unpublished

Deshpande, P. (2019, Mars 20.). *Supply chain of End-of-Life Fishing Gears: Challenges and Opportunities.* BCE Partner meeting, Thurso, Scotland.

9.3 Interview and personal communication

Bratland, H., & Wilsgaard, S. (2019). Input on Norwegian development towards a circular economy of plastics . (J. Sørumsbrenden, Interviewer)

Bunes, K. (2019). Input on Norwegian development towards a circular economy of plastics. (J. Sørumsbrenden, Interviewer)

Hamar, A. (2019, February). Input on CPE indicators. (J. Sørumsbrenden, Interviewer)

Johansen, L. (2019). Input on Norwegian development towards a circular economy of plastics. (J. Sørumsbrenden, Interviewer)

Jonassen, K. (2019). Input on Norwegian development towards a circular economy of plastics. (J. Sørumsbrenden, Interviewer)

Nørgaard, E. (2019). Input on Norwegian statistics for CE indicator development. (J. Sørumsbrenden, Interviewer)

Sjåfjell, B., & Maitre, E. (2019). Input on Norwegian law and regulations in accordance with a circular economy development. (J. Sørumsbrenden, Interviewer)

Spillum, P. (2019). Insight on published and unpublished material from the Norwegian strategy on circular economy. (J. Sørumsbrenden, Interviewer)

Strand, L. (2019). Input local and national CE aspects. (J. Sørumsbrenden, Interviewer)

Sørås, P. E. (2019). Input national and local CE aspects. (J. Sørumsbrenden, Interviewer)

Sørås, P. E. (2018, september). Deciding on topic for Master thesis. (J. Sørumsbrenden, Interviewer)

Øyangen, H. (2019, April 03). Containerservice AS and NOPREC, Matmortua Ottersøy. (J. Sørumsbrenden, Interviewer)

9.4 Lectures and tutorials

Jahren, S., & Brattebø, H. (2018). *TEP 4310 Solid Waste Technology and Resource Recovery. Exercise 2 - Waste Economics.* Department of Energy and Process Engineering. Norwegian University of Science and Technology (NTNU), Trondheim.

Skaar, C., & Deshpande, P. (2018, October 5). *TIØ4195 Environmental Management and Corporate Governance. Performance indicators and reporting & Global Sustainability Frameworks.* NTNU, Trondheim, NTNU IØT / SINTEF Building and Infrastructure.

Appendix A.

Monitoring framework on progress towards a circular economy. EU circular economy indicators with information on Norwegian provision of statistics.

(European Commission, u.d. a)

EU Indicator	EU Definition	Norwegian data available (A) or not available (N.A)
1 Production and consumption	-	
1.1 EU self-sufficiency for raw materials	The indicator measures how much the EU is independent from the rest of the world for several raw materials. The indicator is expressed in % and is defined as: 1-(net) Import reliance. When the EU is a net exporter i.e. IR<0, Import Reliance is set to zero. Net Import Reliance is taken as in the formula for the purpose of calculating self-sufficiency. Imports, exports and domestic production are expressed in mass unit.	N.A
1.2 Green public procurement	The indicator measures the share of public procurement procedures above the EU thresholds (in number and value), which include environmental elements.	N.A
1.3 Waste generation	-	
1.3.1 Generation of municipal waste per capita (kg/capita)	The indicator measures the waste collected by or on behalf of municipal authorities and disposed of through the waste management system. It consists to a large extent of waste generated by households, though similar wastes from sources such as commerce, offices and public institutions may be included.	A

1.3.2 Generation of waste excluding major mineral wastes per GDP unit (Kg per thousand euro, chain linked volumes (2010))	The indicator is defined as all waste generated in a country (in mass unit), excluding major mineral wastes, per GDP unit (in euro, chain linked volumes (2010)). The ratio is expressed in kg per thousand EUR.	A
1.3.3 Generation of waste excluding major mineral wastes per domestic material consumption (percentage)	The indicator is defined as all waste generated in a country (in mass unit), excluding major mineral wastes, divided by the domestic material consumption (DMC) of a country. The ratio is expressed in percent (%) as both terms are measured in the same unit, namely tonnes.	A
1.4 Food waste (million tonne)	The indicator measures the waste generated in the production, distribution and consumption of food (in mass unit)	N.A
2 Waste management	-	
2.1 Recycling rates	-	A
2.1.1 Recycling rate of municipal waste (percentage)	The indicator measures the share of recycled municipal waste in the total municipal waste generation. Recycling includes material recycling, composting and anaerobic digestion. The ratio is expressed in percent (%) as both terms are measured in the same unit, namely tonnes.	A
2.1.2 Recycling rate of all waste excluding major mineral waste (percentage)	The indicator is calculated as recycled waste (RCV_R) divided by total waste treated excluding major mineral wastes (TRT), multiplied by 100. It is expressed in percent (%) as both terms are measured in the same unit, namely tonnes.	N.A

	Recycled waste is waste treated, which was sent to recovery operation other than energy recovery and backfilling (for simplification referred to as recycling). Waste data are adjusted for waste collected in one country and recycled in another country. The amount of recycled waste is adjusted as following: waste treated in domestic plants plus waste sent out of the country for recycling minus waste imported and treated in domestic recycling plants. Waste treated is based in Waste Statistics Regulation and the imports and exports of wastes are based on Foreign Trade Statistics and reported according to the Combined Nomenclature (CN-codes). The indicator covers both hazardous (hz) and non-hazardous (nh) waste from all economic sectors and from households, including waste from waste treatment (secondary waste) but excluding most mineral waste. Major mineral waste is excluded in order to avoid situations where trends in ordinary waste generation can be drowned out by massive fluctuations in the generation of wastes in the mineral extraction and transformation sector. This also permits more meaningful comparison across countries, as mineral waste accounts for very substantial quantities in	

	countries characterized by major mining and construction sectors.	
2.2 Recycling / recovery for specific waste streams	-	
2.2.1 Recycling rate of overall packaging (percentage)	The indicator is defined as the share of recycled packaging waste in all generated packaging waste. Packaging waste covers wasted material that was used for the containment, protection, handling, delivery and presentation of goods, from raw materials to processed goods, from the producer to the user or the consumer, excluding production residues. The ratio is expressed in percent (%) as both terms are measured in the same unit, namely tonnes.	A
2.2.2 Recycling rate of plastic packaging (percentage)	The indicator is defined as the share of recycled plastic packaging waste in all generated plastic packaging waste. Packaging waste covers wasted material that was used for the containment, protection, handling, delivery and presentation of goods, from raw materials to processed goods, from the producer to the user or the consumer, excluding production residues. The ratio is expressed in percent (%) as both terms are measured in the same unit, namely tonnes.	A
2.2.3 Recycling rate of wooden packaging (percentage)	The indicator is defined as the share of recycled wooden packaging waste in all generated wooden packaging waste. Packaging waste	A

	covers wasted material that was used for the containment, protection, handling, delivery and presentation of goods, from raw materials to processed goods, from the producer to the user or the consumer, excluding production residues. The ratio is expressed in percent (%) as both terms are measured in the same unit, namely tonnes.	
2.2.4 Recycling rate of e-waste (percentage)	The indicator is calculated by multiplying the 'collection rate' as set out in the WEEE Directive with the 'reuse and recycling rate' set out in the WEEE Directive; where: • The 'collection rate' equals the volumes collected of WEEE in the reference year divided by the average quantity of electrical and electronic equipment (EEE) put on the market in the previous three years (both expressed in mass unit). • The 'reuse and recycling rate' is calculated by dividing the weight of WEEE that enters the recycling/preparing for re-use facility by the weight of all separately collected WEEE (both in mass unit) in accordance with Article 11(2) of the WEEE Directive 2012/19/EU, considering that the total amount of collected WEEE is sent to treatment/recycling facilities.	A

	The indicator is expressed in percent (%) as both terms are measured in the same unit.	
2.2.5 Recycling of biowaste (kg per capita)	The indicator is indirectly measured as the ratio of composted/methanised municipal waste (in mass unit) over the total population (in number). The ratio is expressed in kg per capita.The underlying assumption is that, by and large, the only reasonable treatment of biowaste is composting or anaerobic digestion.	A
2.2.6 Recovery rate of construction and demolition waste (percentage)	The indicator is the ratio of construction and demolition waste which is prepared for re-use, recycled or subject to material recovery, including through backfilling operations, divided by the construction and demolition waste treated as defined in Regulation (EC) No 2150/2002 on waste statistics. The indicator covers the waste category 'Mineral waste from construction and demolition' (EWC-Stat 12.1). Only non-hazardous waste is taken into account.	A
3 Secondary raw materials (now recycled plastics in the economy)	-	
3.1 Contribution of recycled materials to raw materials demand	The contribution of recycled materials to the raw materials demand is represented by two indicators. (a) End-of- life recycling input rate (EOL-RIR) measures for a given raw material how much of its input into the production	N.A

	system comes from recycling of "old scrap". (b) The circular material use rate (CMU rate) is defined as the ratio of the circular use of materials (U) to the overall material use (M) (M = DMC + U).	
3.1.1 End-of-life recycling input rates (EOL-RIR) (percentage)	The indicator measures, for a given raw material, how much of its input into the production system comes from recycling of "old scrap" i.e. scrap from end-of-life products. The EOL-RIR does not take into account scrap that originates from manufacturing processes ("new scrap").	N.A
3.1.2 Circular material use rate (percentage)	The indicator measures the share of material recovered and fed back into the economy - thus saving extraction of primary raw materials - in overall material use. The circular material use (CMU) rate is defined as the ratio of the circular use of materials to the overall material use. The overall material use is measured by summing up the aggregate domestic material consumption (DMC) and the circular use of materials. DMC is defined in economy-wide material flow accounts. The circular use of materials is approximated by the amount of waste recycled in domestic recovery plants minus imported waste destined for recovery plus exported waste destined for recovery abroad. Waste	N.A

	recycled in domestic recovery plants comprises the recovery operations R2 to R11 - as defined in the Waste Framework Directive 75/442/EEC. The imports and exports of waste destined for recycling - i.e. the amount of imported and exported waste bound for recovery – are approximated from the European statistics on international trade in goods. A higher CMU rate value means that more secondary materials substitute for primary raw materials thus reducing the environmental impacts of extracting primary material.	
3.2 Trade in recyclable raw materials	The indicator measures the quantities of selected waste categories and by-products that are shipped between the EU Members States (intra-EU) and across the EU borders (extra-EU). The indicator includes the following variables: • Imports from EU countries and exports to EU countries of recyclable raw materials (as regards intra-EU trade). • Imports from non-EU countries and exports to non-EU countries of recyclable raw materials (as regards extra-EU trade). The indicator is based on International Trade in Goods Statistics (ITGS) published by Eurostat. The scope of the "recyclable raw materials" is measured in terms of relevant product	N.A

	codes from the Combined Nomenclature used in International Trade in Goods Statistics (see list of codes selected).	
3.2.1 Imports from non-EU countries	Imports from non-EU countries measure the quantities of selected waste categories and by-products imported by EU Member States from third countries. The indicator is based on International Trade in Goods Statistics (ITGS) published by Eurostat. The scope of the "recyclable raw materials" is measured in terms of relevant product codes from the Combined Nomenclature used in International Trade in Goods Statistics (see list of codes selected).	N.A
3.2.2 Exports to non-EU countries	Exports to non-EU countries measure the quantities of selected waste categories and by-products exported by EU Member States to third countries. The indicator is based on International Trade in Goods Statistics (ITGS) published by Eurostat. The scope of the "recyclable raw materials" is measured in terms of relevant product codes from the Combined Nomenclature used in International Trade in Goods Statistics (see list of codes selected).	N.A
3.2.3 Imports from EU countries	Imports from EU countries measure the quantities of selected waste categories and by-products imported by EU	N.A

	Member States from another Member State. The indicator is based on International Trade in Goods Statistics (ITGS) published by Eurostat. The scope of the "recyclable raw materials" is measured in terms of relevant product codes from the Combined Nomenclature used in International Trade in Goods Statistics (see list of codes selected).	
3.2.4 Exports to EU countries	Exports to EU countries measure the quantities of selected waste categories and by-products exported by EU Member States to another Member State. The indicator is based on International Trade in Goods Statistics (ITGS) published by Eurostat. The scope of the "recyclable raw materials" is measured in terms of relevant product codes from the Combined Nomenclature used in International Trade in Goods Statistics (see list of codes selected).	N.A
4 Competitiveness and innovation	-	
4.1 Private investment, jobs and gross value added related to circular economy sectors	The indicator includes "Gross investment in tangible goods", "Number of persons employed" and "Value added at factor costs" in the following two sectors: the recycling sector and repair and reuse sector. The recycling and repair and reuse sectors are defined and approximated in terms of economic activity branches of	A

	the NACE Rev. 2 classification. The following NACE codes have been selected to compute this indicator: (see list of codes selected). The indicator is collected within the frame of the Structural Business Statistics (SBS), as required in Commission Regulation N° 250/2009.	
4.1.1 Gross investment in tangible goods (percentage of gross domestic product (GDP) at current prices)	Gross investment in tangible goods is defined as investment during the reference year in all tangible goods. Included are new and existing tangible capital goods, whether bought from third parties or produced for own use (i.e. capitalised production of tangible capital goods), having a useful life of more than one year including non-produced tangible goods such as land. Investments in intangible and financial assets are excluded.	A
4.1.2 Persons employed (percentage of total employment)	Jobs are expressed in number of persons employed and as a percentage of total employment. Number of persons employed is defined as the total number of persons who work in the observation unit, i.e. the firm (inclusive of working proprietors, partners working regularly in the unit and unpaid family workers), as well as persons who work outside the unit who belong to it and are paid by it - e.g. sales representatives, delivery personnel, repair and maintenance teams. It excludes manpower supplied to the unit by other	A

	enterprises, persons carrying out repair and maintenance work in the enquiry unit on behalf of other enterprises, as well as those on compulsory military service.	
4.1.3 Value added at factor cost (percentage of gross domestic product (GDP) at current prices)	Value added at factor costs is the gross income from operating activities after adjusting for operating subsidies and indirect taxes. It can be calculated as the sum of turnover, capitalized production, other operating income, increases minus decreases of stocks, and deducting the following items: purchases of goods and services, other taxes on products which are linked to turnover but not deductible, duties and taxes linked to production. Value adjustments (such as depreciation) are not subtracted.	A
4.2 Number of patents related to recycling and secondary raw materials	The indicator measures the number of patents related to recycling and secondary raw materials. The attribution to recycling and secondary raw materials was done using the relevant codes in the Cooperative Patent Classification (CPC). (List of CPC codes selected) The term 'patents' refers to patent families, which include all documents relevant to a distinct invention (e.g. applications to multiple authorities), thus preventing multiple counting. A fraction of the family is allocated to each applicant and relevant technology.	N.A

Appendix B.

List of NACE Rev. 2 codes used for indicator calculation (4.1 Private investments, jobs and gross value added related to circular economy sectors).

(Eurostat, n.d)

The recycling, repair and reuse sectors are defined and approximated in terms of economic activity branches of the NACE Rev. 2 classification. The following NACE codes have been selected to compute this indicator:

Proxy NACE Rev. 2 codes for recycling	**Proxy NACE Rev. 2 codes for repair and reuse**
E 38.11 Collection of non-hazardous waste E 38.12 Collection of hazardous waste E 38.31 Dismantling of wrecks E 38.32 Recovery of sorted materials G 46.77 Wholesale of waste and scrap G 47.79 Retail sale of second-hand goods in stores	C 33.11 Repair of fabricated metal products C 33.12 Repair of machinery C 33.13 Repair of electronic and optical equipment C 33.14 Repair of electrical equipment C 33.15 Repair and maintenance of ships and boats C 33.16 Repair and maintenance of aircraft and spacecraft C 33.17 Repair and maintenance of other transport equipment C 33.19 Repair of other equipment G 45.20 Maintenance and repair of motor vehicles G 45.40 Sale, maintenance and repair of motorcycles and related parts and accessories S 95.11 Repair of computers and peripheral equipment S 95.12 Repair of communication equipment S 95.21 Repair of consumer electronics S 95.22 Repair of household appliances and home and garden equipment S 95.23 Repair of footwear and leather goods S 95.24 Repair of furniture and home furnishings S 95.25 Repair of watches, clocks and jewellery S 95.29 Repair of other personal and household goods

NTNU
Norwegian University of
Science and Technology