Sustainable Business and Innovation MSc

Master Thesis

Analysing the stimulation of the Circular Economy from the CO_2 Performance Ladder

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CO_2-PRESTATIELADDER©

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Abstract

Many pressing global sustainability challenges exist, including the onset of climate change linked to increasing carbon dioxide (CO_2) emissions. Moreover, attention has recently fallen on unsustainable resource use in supply chains, which can accelerate resource scarcity.

Businesses have been taking action to alleviate sustainability issues caused by their operations, for example, by managing and measuring their CO_2 emissions. Another sustainability strategy is the Circular Economy (CE), which aims to design waste out of the economy by slowing down resource use and stimulating regeneration of products. Some organisations also use environmental management tools (EMTs) to provide guidance and performance measurement for their sustainability efforts. CE is relatively new and its implementation is only slowly progressing. CO_2 management is comparatively mature and there are EMTs to assist it. Organisational CE and CO_2 management are both important sustainability themes which could be enhanced to transition to a sustainable economy.

It remains unclear how organisations work with CO_2 and CE management and measurement. Furthermore, it is unknown if a CO_2 management tool can stimulate or hinder organisations CE developments. Research was conducted on the aforementioned issues with SKAO, who govern a CO_2 management tool named the CO_2 performance ladder (CO_2PL). Theory was consulted to frame the understanding of environmental management tools and CO_2 and CE management and measurement. Nineteen interviews took place with CO_2PL users to understand their perceptions and the context of CO_2 and CE management and measurement. They were also asked if they feel the CO_2PL stimulates or hinders CE. Results were analysed based on themes from the literature and the results, i.e. a combined deductive and inductive approach.

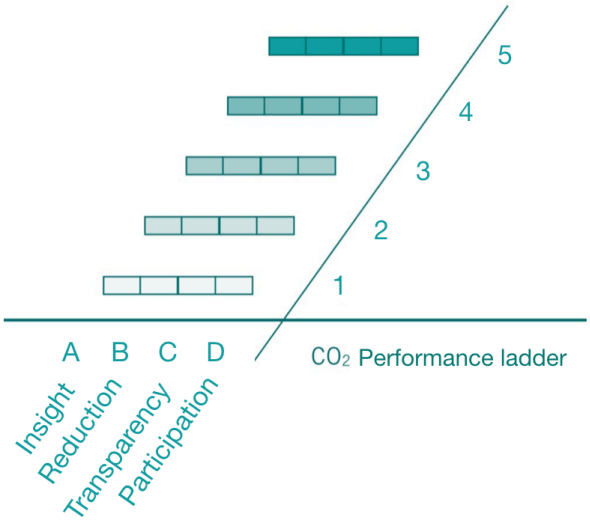
The results found that the maturity and context of CO_2 and CE management can affect how organisations perceive them. There was also mixed understanding of how CE management reduces CO_2 emissions, or increases them. This highlighted the need for organisations to focus on the transition away from fossil fuel use, to create mutual benefits for CO_2 and CE management. Organisations are more mature and stringent regarding CO_2 measurement. They had different methods for measuring CE, but also, some were not measuring. Organisations are conflicted by seeking simple but representative measurements of CO_2 and CE. Many interviewees see the CO_2PL as CO_2-focused, and not directly stimulating CE. Others find the tool encourages them to work better in the supply chain, which has a knock-on effect to CE developments. These findings inspired recommendations for SKAO.

Executive Summary

Introduction
Businesses carry out corporate responsibility to lessen the sustainability impacts of their supply chains. One such sustainability impact is growing CO_2 emissions. This issue has gained international attention in the last forty years due to its link to human-caused climate change.

Environmental management tools have been created to assist businesses in managing and measuring their sustainability strategies. These tools include the Greenhouse Gas protocol and the Life Cycle Assessment (LCA) tool. The CO_2 performance ladder (CO_2PL) is a management tool system which helps organisations reduce their CO_2 emissions, particularly in the Dutch market.

The CO_2PL tool has five progressive levels which organisations can become certified on. Certification at higher levels of the CO_2PL demonstrates organisations increased commitment to CO_2 reduction in their organisation, their sector and their supply chain. Organisations using the tool fulfil requirements at each level based on four themes; Insight, Reduction, Transparency and Participation. The diagram below displays the structure of the CO_2PL.



Another growing topic in corporate responsibility is the Circular Economy (CE). In brief, the Circular Economy aims to eliminate waste in the supply chain, by slowing down the use of resources and reusing materials throughout supply chains. Organisations are currently challenged by operationalising the CE concept as it is multi-faceted, and realising its principles can be difficult in practice. So, while this sustainability concept is promising in terms of impact, CE remains in an early stage of implementation.

CO_2 management and CE are two important sustainability strategies that organisations can employ to reduce their environmental impact. However, there is a lack of information about the context of CO_2 and CE management in companies, and if organisations associate these strategies with each other. Furthermore, can the CO_2PL management tool stimulate CE action in Dutch businesses? Given this context, two research questions (RQ) were formulated. RQ1: How do users of the CO_2PL manage and measure CE and CO_2? And RQ2: Do users of the CO_2PL believe it stimulates or hinders CE activities?

Theory
Literature was consulted to find relevant background information about CE and CO_2 as sustainability strategies (page 12 and 14), environmental management tools (page 15) and the CO_2PL (page 16). Literature noted that CO_2 management consists of well-defined actions, including reduction of energy use, and employing eco-efficiency on technologies and operations. CO_2 management is actionable and

can foster continuous improvement, so it lends itself to corporate sustainability. CE by contrast is less mature and less well-defined. It proposes a set of theoretical principles, but organisations must work out how to realise these e.g. which stakeholders to involve? or what incentives are needed to create a Circular product?

There are connections between CE and CO_2 management. CO_2 emissions are 'embodied' in the production of goods in supply chains, since the burning of fossil fuels for energy production is present throughout a products lifecycle. With linear supply chains, this pattern of consumption is perpetual, which creates increasing CO_2 emissions. Circular economy can reduce this embodied energy, particularly by reducing the need for resource inputs. CE case studies commonly use CO_2 emission reduction to describe impact. Cooper et al., (2017) found that moderate uptake of CE measures in the economy (30-60%) would save 6%–11% of global energy use, having a knock-on effect on CO_2 emissions. However, sometimes operationalising CE can increase CO_2 emissions. Examples of such trade-offs in the literature include the recycling of products and the distance for circular goods to be transported (page 22).

As for measurement, CO_2 is widely acknowledged as a performance indicator to measure impact. Emission factors help to translate the use of fuel, energy and material resources into a CO_2 emission value. Literature describes CO_2 measurement as a good entry point for discussing environmental impacts. On the other hand, there is no one standard way to measure CE. The British Standards Institute launched a management standard for CE in 2017 (CE BS 8001). However, critics note that the measurement advice it provides is vague. This is notable since even a standardisation authority does not specify a particular way to measure CE.

CO_2 emissions can be a representative measurement of other sustainability impacts (including resource depletion and acidification, which can relate to CE). This is particularly true for steel and concrete products and energy production. However, CO_2 emission is one of many impacts, and for example, research suggests that toxicity impacts related to CE cannot be represented well by their CO_2 impact (page 22). Overall in academic literature, the attention on sustainability measurement is moving towards multiple impacts.

Methodology

This research focused on gaining insight into the perception and experience of users of the CO_2PL. It aimed to gather the context of how these organisations are working with CO_2 reduction and CE. Nineteen organisations were interviewed that were either certified organisations on the CO_2PL or commissioning parties that use the CO_2PL. Furthermore, the organisations involved in the study were known to be working on Circular Economy. The sample consisted of organisations from different industry sectors - mainly infrastructure, engineering and waste management (page 27). The interview data was encoded so the responses do not trace to individual companies.

Results

CO_2 and CE management

- The interviews showed that CO_2 management was more mature than CE. Many noted that CO_2 management is expected of companies. Several interviewees felt that the 'quick win' measures for CO_2 management (regarding energy and fuel use) had been executed. To reduce CO_2 emissions even further, extra investments and effort is required. One particular challenge is changing company driving and flying behaviour.
- CE was found to be much less mature. Nonetheless, organisations feel compelled to act. Interviewees mentioned many challenges for enacting CE, for example, flexible design of products to suit functions of future societies. Other challenges included arrangements in project management and procurement and realistically employing the '10R' principle of CE (see page 13 and page 33).
- Companies perceive CO_2 and CE management as separate on how they relate to projects. Interviewees often related CE to their projects, but regarded CO_2 more as 'housekeeping' (page 37).

- The connections that interviewees noted between CO_2 and CE management regarded embedded emissions in the supply chain, and the answers here were of a general nature.
- As for trade-offs between CE and CO_2 management, specific examples were mentioned where CE measures can require more energy and materials, causing more CO_2 emissions (page 40). It was often mentioned that CE measures could cause higher CO_2 emissions now, but less in the long-run comparatively.

CO_2 and CE measurement

- All organisations were quantifying CO_2 impact and monitoring various sources. They found it challenging and imperfect to have to estimate emissions. There was expressed desire to have representative measurements for CO_2 emissions.
- Answers regarding measurement of CE were very varied, but three groups of answers emerged: quantitative methods, qualitative methods and not yet measuring or comparing CE performance.
- There were as many interviewees using the LCA tool to quantitatively measure CE, as those that were not measuring CE. Challenges exist in finding representative data, measuring impacts like social sustainability and conflicts between CE indicators (page 41).
- Qualitative methods included asking questions about the supply chain and characteristics of materials.
- Many organisations tell stories about CE products, rather than quantifying impact, in order to spread the word. Some interviewees were not very concerned with making exact comparisons between different CE activities. Interviewees views were mixed about the use of CO_2 emission factors to measure CE (page 45).

Does the CO_2PL stimulate CE?

- Mixed responses were received and organisations mainly did not perceive a strong stimulation effect. However, they noted that themes from the CO_2PL are useful and can encourage CE. The top result was D: Participation, as interviewees found it important that people are working together in the horizontal and vertical supply chain. CO_2PL levels four and five were also noted as important for the same reason. The other three CO_2PL themes were also mentioned to help encourage CE, with reasons provided on (page 48).
- Many interviewees described the relationship between the CO_2PL and CE as indirect (page 49). Many organisations also felt that they should focus on CO_2 in their audits because the CO_2PL is focused on CO_2.
- To the question 'Does the CO_2PL hinder CE?', the word hinder was said to be too strong. Seven interviewees said the CO_2PL does not hinder, and another seven felt the focus on CO_2 does not particularly stimulate CE (page 55).

Discussion

The discussion section analyses key emergent themes. It was suggested that the maturity of CO_2 and CE management and measurement affects how organisations perceive them.

CO_2 management is ongoing for many years, and quick win, cost saving measures are perceived as completed. To reduce CO_2 emissions further, they have to take more difficult steps in influencing employee's behaviour or pushing investments in green tech. Interviewees had less enthusiasm about CO_2 management than CE, potentially because of this current context of CO_2 management.

CE is seen as an important new development on market. It can provide some excitement to be part of this new development, and to work on gaining expertise tin CE so organisations will be more competitive on the market. This context provides organisations with financial incentive to save resources and become a competitive market player vis-à-vis CE, which could help to explain the enthusiasm of interviewees about CE.

Regarding measurement, the low maturity of CE can also explain why organisations are less strict when it comes to CE measurement, compared with CO_2. Since CE is an emerging topic receiving

attention in academia and on the market, it could be perceived as good for organisations to be doing something towards CE, and that this is worth talking about, whether strict measurements are involved or not.

When discussing measurement, it was analysed that organisations want to describe CE and CO_2 impact in a representative manner, but also, they want to keep measurement simple to make it easier to work with. Interviewees wanted to measure heir CO_2 emissions more accurately, but have to settle for simpler estimates. Furthermore, there were split opinions on usefulness of CO_2 to express CE impact (it can be a simple method for expressing impact, or, it is not representative of the multiple facets of CE). Interviewees wanted to measure CE across multiple indicators, to represent the diversity of the concept, but this approach is hard to operationalise.

Interviewees echoed the trend in literature to act on more wide-ranging impacts of sustainability, and as such, pigeonholed CO_2 as 'just one impact'. However, the mutual benefit of CE and CO_2 management is highly dependent on the use of green energy and fuel needs applied throughout the supply chain. Entire supply chains are embedded with CO_2 emissions and the measures to reduce CO_2 and prevent climate change need widespread attention.

As for the discussion about the second research question "Do users of the CO_2PL believe it stimulates or hinders CE activities?", two key themes were analysed:

1. Taking the CO_2pl at face value
This expression means that something is perceived based on its outward appearance, without interpreting its underlying purpose. In the context of the CO_2PL, its face value is a management tool focused only on CO_2 reduction. Often, interviewees do not associate the CO_2PL with CE because they perceive it only as a tool for CO_2 reduction. Interviewees felt that the CO_2PL can be open to CE, but a strong stimulation was not observed. Examples provided on (page 60).

2. Conditions promoted by the CO_2PL which can stimulate CE
Conversely, many interviewees felt that the CO_2PL helps their organisation take action on sustainability and it improves the way they work, and that this has helped to stimulate CE in their organisations. The word 'conditions' was chosen to represent this theme, as it can be defined as the factors affecting the way in which people work. The CO_2PL themes are perceived as helpful: e.g. for collaborating and gaining insight into CO_2 impact of material use in the supply chain.

Recommendation

- The CO_2PL could have a role in promoting CE more through the existing themes, because it provides conditions which stimulate action in the supply chain. Furthermore, some of the issues which hold back the development of CE are issues that the CO_2PL can influence. For example, a need for more collaboration, a lack of data and transparency about impact, and a need for faster progress to help organisations reach their CE targets.
- It was found that clients are driven to manage wider sustainability impacts and measure impact across multiple indicators for example, social sustainability, material scarcity and water pollution. To reflect these changes in the market, the CO_2PL could be more open to CE and sustainability impacts in a general sense. SKAO could open up the wording in the requirements to take in other sustainability impacts can promote management, measurement and maturation in other sustainability topics, including CE.
- Another recommendation is to focus on improving the perceptions of what CO_2 management entails. The importance of fuel and energy choices should be stressed to organisations, as this underlies the impact of every project and the impact within supply chains. Furthermore, the impact of CE projects also often depends on the underlying use of fuel and energy to transport and transform products. This could be discussed with organisations to understand how they can overcome the challenges of further CO_2 reduction.

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1. Introduction

Since the mid-twentieth century, increasing attention has been brought to the unsustainability of our consumerist economy (The Club of Rome, 1972; UN, 2017; UN WCED, 1987). With population growth, globalisation and improvements in quality of life, greater societal demands on resources have emerged, including the extraction and combustion of fossil fuels for energy generation. The combustion of fossil fuels, such as coal, oil and natural gas, causes emissions of greenhouse gas (GHG), including carbon dioxide (CO_2), which has been linked to the onset of global climate change (Jackson, 2009). Furthermore, there are also great demands on material resources, and reserves are becoming scarcer. Supply chain systems are unnecessarily wasteful with resources, as they perpetuate a linear 'take, make and dispose' pattern (Ellen MacArthur Foundation, 2012). For these reasons, scientists regard resource scarcity, increased GHG emissions and global climate change to be predominantly human-induced problems (Jackson, 2009; Mann, 2013).

There has been growing attention to the role of businesses in intensifying these sustainability issues, since businesses operate in supply chains, which demand energy and material use to create products and services (Charter, 2017; Thorn et al., 2011). Because of this, more businesses are aiming for greater corporate sustainability to address sustainable development within their organisations (Genovese et al., 2017; Johnson & Schaltegger, 2016; Whiteman et al., 2013).

One way for businesses to govern and control their adverse impacts is by reducing the CO_2 emissions related to their work activities. This includes energy and fuel use reduction, use of renewable energy sources and efficient use of materials. Businesses can gain help in making these changes by using environmental management tools (EMTs) (Hörisch et al., 2015b; Johnson, & Schaltegger, 2016). EMTs offer structure and support for organisations to understand, measure and manage their environmental performance. (Finkbeiner et al., 1998; Hjelm et al., 2011; Hörisch et al., 2015a; Wrisberg et al., 2012). Some examples of EMTs for measuring and managing CO_2 emissions include the BSI PAS 2060 carbon footprinting tool and the Greenhouse Gas Protocol (GHG Protocol) (Green, 2010; Laurent et al., 2012). Some EMTs like the Life Cycle Assessment (LCA) tool allow organisations to examine the impact of a product's supply chain according to various indicators (or impact categories) like resource depletion or global warming potential (Lee & Herzig, 2010; Thorn et al., 2011).

In addition to EMTs, organisations can operationalise corporate sustainability by following sustainability concepts, which describe desirable sustainability principles. A sustainability concept which has been gaining popularity in the last decade is the Circular Economy (CE). The CE concept is primarily concerned with unsustainable use of resources linear supply chains. The CE concept aims to reconfigure supply chain systems so that waste is designed out of the economy. This is encouraged by slowing down the use of resources and closing resource loops, for example, by creating more durable products, and reusing materials throughout supply chains *(*Ellen MacArthur Foundation, 2013; Nasir et al., 2017).

There is a business rationale for CE, as it can optimise businesses use of resources, in the face of supply scarcity (Ellen MacArthur Foundation, 2012). However, organisations are currently challenged by operationalising the CE concept, as it is multi-faceted, and realising its principles can be difficult in practice. Because of these challenges, the CE remains in an early stage of implementation. Furthermore, the measurement of CE poses difficulty for businesses, since it can be hard to quantify the impact or choose appropriate indicators (Ghisellini et al., 2016; Saidani et al., 2017).

CO_2 management and CE are two important sustainability strategies that organisations can employ to reduce their environmental impact. However, there is a lack of information about the context of CO_2 and CE management in companies, and if organisations associate these strategies with each other.

Also, as noted above, management tools can help organisations to operationalise sustainability strategies by providing assistance for organisations to manage and measure their impact. Recent literature about the CE indicates that there is a lack of management tools to facilitate the transition towards a CE (Shahbazi & Amprazis, 2017; Veleva et al., 2017). Moreover, it is unknown if existing management tools can play a role in helping to stimulate the management and measurement of CE.

1.1 Problem for the internship organisation

The aforementioned context is relevant to the organisation SKAO (Stichting Klimaatvriendelijk Aanbestegen en Ondernemen, translated as 'the Foundation for Climate Friendly Procurement and Business'). SKAO is an organisation based in Utrecht, The Netherlands that is the scheme owner of the CO_2 Performance Ladder (hereafter CO_2PL). The CO_2PL is an EMT and certification focused on stimulating CO_2 reduction in organisations. The aim of the CO_2PL is to reduce carbon dioxide emissions, improve energy efficiency and encourage sustainable energy use within organisations and their supply chains (Rietbergen, 2015; SKAO, 2015). More detail is provided about the CO_2PL tool in section 2.4.

Although SKAO focus on the topic of CO_2 reduction, they have recognised the emergence of the CE concept in the last few years. They acknowledge that both CO_2 reduction and CE are important to promote sustainable business, improve resource use and mitigate against climate change. SKAO has noticed that some users of the CO_2PL have performed CE activities, and used these towards the CO_2PL certification. Furthermore, some users of the CO_2PL have noted that they have aspirations to apply CE in their business operations. SKAO wants to understand if users of the CO_2PL are stimulated to work on CE because they are influenced by the CO_2PL. They also want to gain insight about organisations management and measurement of CO_2 and CE, to understand what is the current state of CO_2 and CE management and measurement and if organisations relate these topics to each other. Through this research, SKAO will gain insight on whether they have a role to play in stimulating CE through the CO_2PL, and if so, how they can do this.

1.2 Research question and objectives

The following research questions (RQ) have been formulated:

RQ1: How do users of the CO_2PL manage and measure CE and CO_2?

RQ2: Do users of the CO_2PL believe it stimulates or hinders CE activities[1]?

The first research question tries to gain understanding about the current state of CE and CO_2 management and measurement for organisations who use the CO_2PL. It aims to also understand the relative context of CE and CO_2 management and measurement in organisations, and how users of the CO_2PL perceive these sustainability topics. The second research question enquires if the CO_2PL motivates companies to pursue CE activities or not (i.e. stimulating or hindering). It also wants to understand how the users of the CO_2PL perceive it in relation to CE.

CO_2 and CE management and measurement, as well as use of the CO_2PL, are the research objects, which will be referred to during this study. At the end of the research, recommendations will be provided for SKAO, to advise them if it is possible or worthwhile for the CO_2PL to further stimulate CE.

[1] CE activities, CE measures and CE projects are terms used throughout this study to describe actions that align with CE principles (Korhonen et al., 2018)

Previous research has focused on related topics, but it has not specifically examined the topics of this research project. For example, literature exists regarding the relationship between the CE concept and sustainability (Geissdoerfer et al., 2017), the ability of carbon footprint measurements to represent other sustainability indicators (Laurent et al., 2012), policy recommendations for reducing CO_2 emissions and resource extraction (Ekins et al., 2009) and the impact of the CO_2PL in reducing CO_2 emissions (Rietbergen, 2015).

From a scientific perspective, this study holds relevance because it can complement the theoretical knowledge on CE and CO_2 management and measurement. This study can provide practical insight into how organisations work with and perceive CO_2 and CE management and measurement. This exploratory research project has a relevance in understanding how businesses in the Dutch market manage and measure both CO_2 and CE, which can provide valuable insights for SKAO. CO_2 and CE are important sustainability management topics, so this study holds societal relevance in understanding how they relate to each other, and how they can each be optimised to advance the transition towards global sustainability.

The structure of the thesis is as follows. First, there will be research conducted into relevant theory which will help understand the research objects. There will then be a description of the methodology of this study. Subsequently, the results will be presented. A discussion about the key themes from the results will follow. Finally, the study ends with a conclusion, limitations section and recommendation for SKAO.

2. Theory

This chapter sets out theory which will help to understand the research topics. This section begins by reviewing the CE concept, followed by literature on CO2 reduction and a description of Environment Management tools. Subsequently, the relevant details about the CO_2PL are explained. Following this is a section regarding CE and CO_2 management, and then CE and CO_2 measurement. Concepts which emerge from this chapter will be depicted in a theoretical framework.

In this chapter, existing research from academic literature and white papers will be reviewed to gain insight on these aforementioned topics. Academic journals such as Cleaner Production and Industrial Ecology provided much of the theory for this study.

2.1 Circular Economy

The CE concept first emerged in the 1990's, stemming from concepts including Industrial Ecology, Regenerative Design and Cradle to Cradle. However, in the last decade it has gained popularity as way that organisations can manage their sustainability impact (Saidani et al., 2017). Some authors believe that it is important to align CE with the management of business supply chains to stimulate environmental sustainability, especially for energy and material intensive industries (Genovese et al., 2017; Nasir et al., 2017).

CE proposes an alternative to linear supply chain systems. In linear supply chain systems, resources are extracted, processed, manufactured, transported, sold and then disposed of. This approach to organising supply chains is an ineffective use of energy and resources, as valuable materials are disposed of before they have been used to their full potential. Furthermore, by continually disposing valuable materials and not reusing them, this puts more pressure on virgin resource extraction, and exacerbates resource scarcity (Bocken et al., 2016; Ellen MacArthur Foundation, 2012b; Winans et al., 2017).

The name CE arises from the fact it encourages 'closed loop' cycling of materials throughout supply chains (Ellen MacArthur Foundation, 2012). For example, end-of-life products are considered as resources and assets, rather than being perceived as waste. (Lieder & Rashid, 2016; Stahel et al., 2016). CE also promotes the creation of durable products which can last longer and are more fit for purpose than products which are designed to become obsolescent and disposed (Ellen MacArthur Foundation, 2012). Through these principles, CE aims to decouple economic growth from resource throughput in the supply chain system (Ghisellini et al., 2016).

There are many examples of how CE principles can be applied in action. For example, waste copper foil from a circuit board manufacturer can be supplied to an organisation that regenerate scrap metal and supply secondary copper (Wen & Meng, 2015). Moreover, bio-based products can be returned to the environment to replenishes nutrient stocks and can help to restore ecosystem health (Ellen MacArthur Foundation, 2012b; Su et al., 2013). CE also encourages the use of renewable energy sources in place of fossil fuels (Ellen MacArthur Foundation, 2013; EU Parliament., 2017). Furthermore, companies can use modular components to construct products or infrastructure. When there are changes which that need to occur, e.g. repairing the product, it can be easily taken apart, repaired, refurbished and reused, without requiring demolition. Conversely, when products are broken down to feedstock during demolition, the material and product loses its value and can require more energy and material input again to return it to use. Modular products can be re-used again in other applications which forgoes the need for remanufacture. Modular construction also involves the minimisation of product components to limit material waste (Allwood et al., 2011; Otero, 2015). There is diversity in the types of measures which can be applied to follow CE.

Figure 1 overleaf is the conceptual outline of the Circular Economy, showing how resources can be reused in closed-loops throughout supply chains.

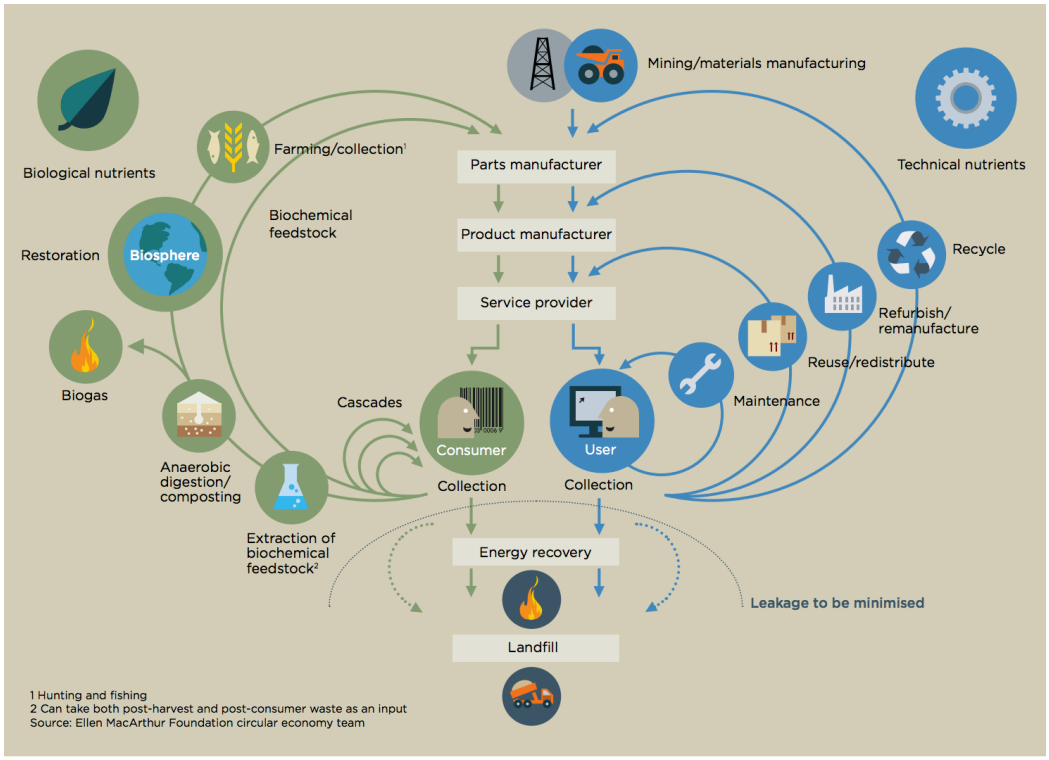

Figure 1: The outline of a Circular Economy (Ellen MacArthur Foundation, 2012)

Furthermore, there are several principles encouraged by CE, including the 10R hierarchy (Cramer, 2017). Figure 2 below depicts this hierarchy of resource use, in which reduction and reuse of goods is favoured over landfill, incineration and energy recovery. Refurbishment activities fall in the middle of the hierarchy. The measures at the top of the hierarchy keep the value of resources high and do not require resource transformation. The measures at the bottom consume more energy, do not keep resources in use or high-value, and can cause environmental externalities e.g. emission of dioxins (ibid).

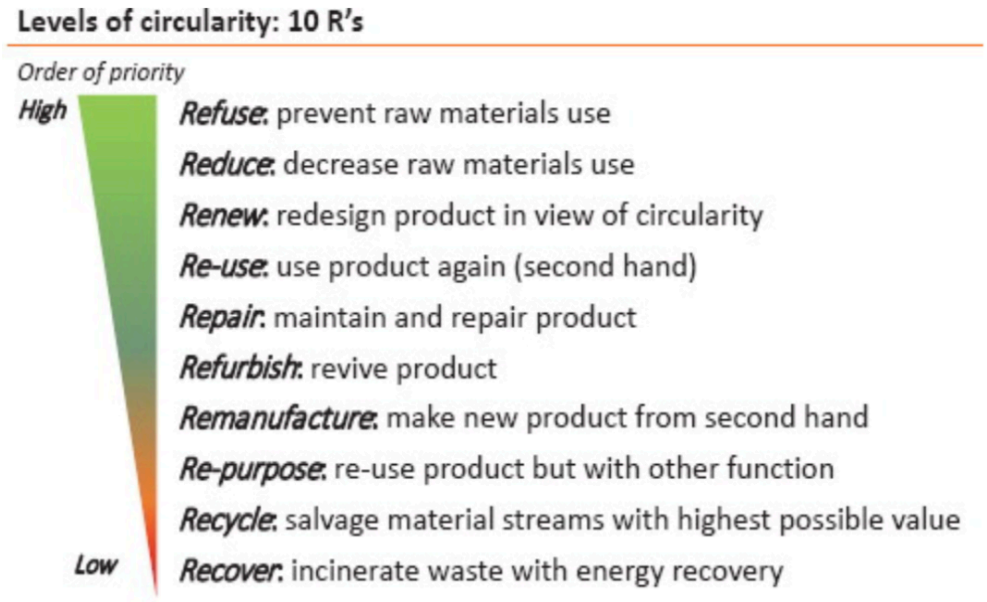

Figure 2: 10R diagram of the Circular Economy (Cramer, 2017)

CE is attractive to businesses, as it can increase revenues, improve business performance and increase competitive advantage (Ellen MacArthur Foundation, 2013; Lieder & Rashid, 2016). CE also encourages new types of business models, for example, providing consumers access to products as services, instead of ownership. This can be advantageous for businesses, as valuable goods remain in their possession after the consumer use phase (Ellen MacArthur Foundation, 2013).

CE is not only about environmental impacts or new economic models, but it also tries to influence social impacts. CE aims to limit environmental externalities, such as air pollution and toxic chemical use, which can harm human health (Ellen MacArthur Foundation, 2012). CE also encourages more cooperation between businesses in the supply chain (Lui et al., 2009; Zhu et al., 2010). This includes trading of products, including waste products, and sharing knowledge to help facilitate the transition to a CE (Ceglia et al., 2017; Shahbazi & Amprazis, 2017).

2.2 CO_2

Since the late-twentieth century, climate scientists have linked the naturally occurring changes in CO_2 concentrations in the atmosphere to long-term variations in climate (Crowley & Berner, 2001; Scheffer et al., 2006). Since this time, there has been growing awareness of increased human-induced CO_2 emissions, leading to unprecedented climate change (Baes et al., 1977; Mann et al., 1999).

Human-induced CO_2 emissions are primarily linked to the combustion of fossil fuels, such as natural gas, oil and coal. Fossil fuel resources are finite, but are combusted in large volumes every day to fulfil societal needs in electricity production, transportation, heating, cooling and lighting of buildings (Cullen & Allwood, 2010). Since the production of goods in various industries requires the use of fuel and energy, CO_2 is embedded in the supply chain of goods and services. According to Davis et al. (2011) 37% of global CO_2 emissions are from internationally-traded fossil fuels and 23% are embodied in traded goods. Many scientists regard significant climate change as unavoidable, unless there is a dramatic decrease in emissions caused by fossil fuel combustion (Covert et al., 2016).

Climate change modifies the composition of earth's atmosphere, which can heighten the absorption of solar radiation towards earth (Belić, 2006). Although CO_2 is only one of a number of Greenhouse gases which cause climate change, CO_2 is recognised as being the most important to control, because of its long-lived nature in the atmosphere, and its effect on global warming (Clark, 2012; Obla, 2009). Figure 3 overleaf is a graph showing the prominent rise in global temperatures since the industrial revolution in the 1900s. The impacts of heightened human-induced CO_2 emissions and resulting climate change are found to have a wide-range of implications. CO_2 emissions cause changes in earth systems, such as ocean warming and acidification, acid rain, melting of ice sheets and sea level rise. These issues can lead to damage and loss to human and ecological environments – e.g. destruction of coral reef and coastal flooding (Steffen et al., 2006). The increase in CO_2 emissions is also linked to public health issues, for example local air pollution and the impact on human respiratory issues. Furthermore, climate change brought on by increasing CO_2 emissions can lead to extreme weather events and alteration of habitats, which can proliferate vector-borne and water-borne diseases such as Malaria (McMichael & Woodruff, 2005).

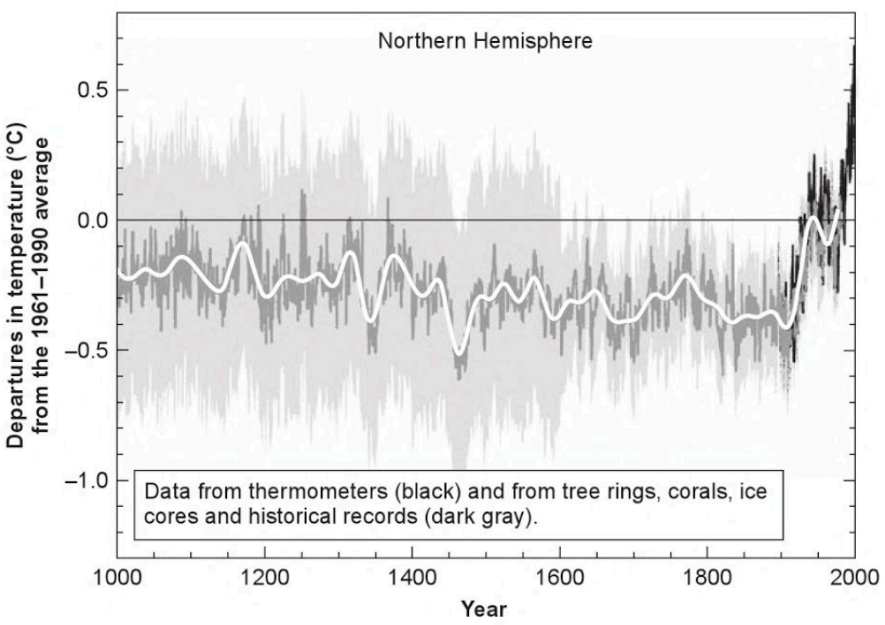

Figure 3: The 'hockey stick' graph, showing temperature anomaly since the year 1000 (Mann, 2013)

Curbing CO_2 production in particular has been a key focus for taking action to combat climate change, and it has received attention through scientific bodies such as the International Panel on Climate Change and climate discussions with global political leaders, for example the Paris Agreement. Because of this work, climate change has become a principal environmental issue in political agendas (Intergovernmental panel on climate change, 2007; Laurent et al., 2012). Given the high confidence of scientists in human caused climate change, leaders in the Paris Agreement in 2015 vowed to limit global warming to 1.5°C (Rogelj et al., 2016).

However, there is still much work to be done on the part of governments, businesses and consumers to reduce their CO_2 emissions (Thorn et al., 2011). National and regional governments have imposed regulations for reporting and limiting carbon emissions (Thorn et al., 2011; Mickwitz et al., 2009). The rise of CO_2 on the political agenda has been filtering into the agendas of businesses, also thanks to a number of management tools and standards for CO_2 management which have emerged on the market in the last past years (Laurent et al., 2012).

Strategies to control CO_2 emissions and fossil fuel extraction include stimulating energy efficiency, fuel economy, regulating emission sources or conversion of natural gas to low-carbon liquid natural gas (Covert et al., 2016; Salameh, 2003). The long-term solution would be a transition away from fossil fuel resources, towards low-carbon renewable energy, which includes solar, wind, nuclear, hydrogen, hydro-electricity and biomass sources (Salameh, 2003). This is important, as a drawn-out transition away from fossil fuels will not prevent climate change (Kern & Rogge, 2016).

2.3 Environmental management tools

Environmental management tools (EMTs) are tools which support managers in reducing their negative environmental impacts, whilst also leveraging positive impacts (Johnson & Schaltegger, 2016). EMTs provide structure to manage environmental impacts. For example, they can help organisations operationalise strategies and coordinate actions (Johnson & Schaltegger, 2016). EMTs can help create awareness in companies and provide decision support, and some also help organisations measure their impact (Gond et al., 2012; Hörisch et al., 2015b; Ilevbare et al., 2016; Johnson & Schaltegger, 2016). Each tool has its own methodology and characteristics which suit the

specific environmental issue it aims to address (Wrisberg et al., 2012). Common aspects of EMTs include:

- Creating insight and understanding
- Setting objectives and targets
- Measuring performance
- Re-designing products
- Communicating and reporting
- Undergoing audit for verification of actions
- Re-considering management of resources, personnel, procedures, structure etc.
- Stimulating improvement

(Fet, 1998; Hörisch et al., 2015b; Johnson & Schaltegger, 2016)

Several management tools have been created over the years (Ilevbare et al., 2016). These include Environmental Impact Assessment (EIA), Life-Cycle Assessment (LCA) and Material Flow Analysis (MFA), Cleaner Production (CP) and Environmental Auditing (Fet, 1998; Finnveden & Moberg, 2005).

The application of environmental management tools is one way to pursue organisational sustainability (Hörisch et al., 2015b; Johnson & Schaltegger, 2016). EMTs can be used by different types of organisations. Although literature often discusses the application of EMTs in corporate businesses (Asif et al., 2011; Hörisch et al., 2015a; Johnson & Schaltegger, 2016). There are a number of reasons why businesses use EMTs. Businesses must make strategic operational decisions and manage activities in their business environment in order to grow and be successful (Ilevbare et al., 2016). Nowadays, there are increasing expectations from customers, governments and other stakeholders regarding the impact of products and services on the environment. These stakeholders are conscious of negative impacts and create demands upon businesses for more sustainable production of products (Fet, 1998; International Organization for Standardization, 2015; Thorn et al., 2011). To shift towards more environmental sustainability, organisations can use EMTs to guide their process of how to initiate changes. The application of management tools can help organisations towards achieving their objectives (Ilevbare et al., 2016). Research has shown that companies that apply EMTs perform better on environmental issues than companies that do not (Henri & Journeault, 2010; Iraldo et al., 2009). Herein, organisations that apply EMTs can demonstrate that they are reactive to market changes, meeting stakeholder needs and acting responsibly (Asif et al., 2011).

Research has found that organisations that apply EMTs are able to improve their environmental performance, due to better housekeeping of their internal operations, but also because they create more sustainable products (Fet, 1998). It has been shown that organisations who use EMTs look past their own organisations boundary, towards controlling the environmental impacts in the supply chain (Darnall et al., 2008). Governments, organisations and customers are embedded in a system, and using an EMT can help to affect the system by demanding for changes in production, consumption and waste management (Wrisberg et al., 2012). Pressing organisations to think along their supply chain is beneficial, as it is not about shifting environmental detriment to another part of the chain (Finkbeiner et al., 2010).

2.4 The CO_2PL

This section describes the background knowledge necessary to understand references to the CO_2PL in the rest of this study.

The CO_2PL is an environmental management tool, certification scheme and procurement tool focused on reducing the carbon dioxide emissions in companies, through their processes, projects and supply chain (SKAO, 2015). The CO_2PL is structured by the capability maturity model, i.e. it contains many levels which indicate an organisations competency (Rietbergen, 2015). The CO_2PL has 5 progressive levels and covers four themes: (A) Insight, (B) Reduction, (C) Transparency and (D) Participation.

Within each theme and stage level, companies must meet a number of requirements to prove their achievement in reducing CO_2 emissions. Companies must meet requirements across all the themes at a particular level. Each increasing level requires increasing commitment to CO_2 emission reduction (SKAO, 2018). Figure 4 below shows the structure of the CO_2PL, and at which levels the organisation focuses on their own emissions, or their supply chain partners emissions. Figure 5 below describes these themes as set out by SKAO in the CO_2PL handbook. The full requirements are in appendix A.

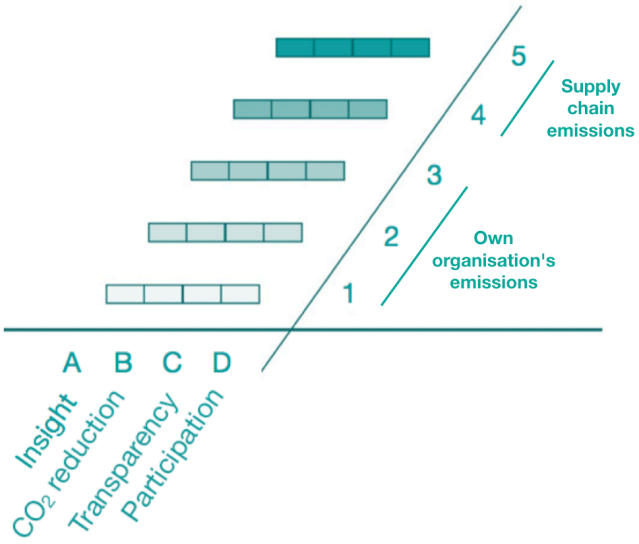

Figure 4: The structure of the CO_2PL. Adapted from SKAO (2015)

CO2PL Theme	Description
A: Insight	Insight makes a company aware of its own CO2 performance, the risks and opportunities that its own CO2 emissions cause and provides the company with information that it can use to formulate effective objectives and measures to reduce its CO2 emissions and what communication and cooperation should be focusing on. Angle A stimulates companies to know their own CO2 emission and that in the value chain. The company realises continuous improvement in the depth, scope and efficiency of insight and the quality of the emission inventory.
B: Reduction	Reduction creates opportunities for reduced energy consumption and CO2 emissions, and encourages cooperation so that the most efficient options for reduction in the value chain are taken on. The company realises continuous improvement of the efficiency of measures, in determining and achieving objectives and indicating progress regarding objectives and measures.
C: Transparency	Through Transparency, a company encourages the creative commitment of its employees, companies are informed about each other's efforts, and a company can be called to account by others for its ambitions and progress. The company realises continuous improvement in the depth and spread of communication and in processing the involvement of internal and external stakeholders.
D: Participation	Through the Participation aspect, a company demonstrates that it is investing in collaboration, in sharing its knowledge and, where possible, using knowledge that has been developed elsewhere for its own operations. The company realises continuous improvement in selecting useful initiatives and applying the knowledge in the company.

Figure 5: Description of the CO_2 performance ladder themes (SKAO, 2015)

The functions of the CO_2PL are described in detail below:

1. The CO_2PL as a management tool and certification

Organisations can opt to use the CO_2PL as a management tool and a certification scheme, to prove their dedication to environmental sustainability. They gain a CO_2 awareness certificate for meeting a particular ambition level (1-5). Companies must continually adhere to CO_2PL requirements and demonstrate goal-setting and improvements to hold onto their certification. Organisations who use the CO_2PL can also witness cost reductions, which is another key motivator for using the CO_2PL (Rietbergen, 2015).

2. The CO_2PL in the tender process

The CO_2PL can be used by companies in the tender process, to give them an advantage towards winning tender bids (SKAO, 2015). There is a tender process in Europe in which tenders are won not only on the best value for money, but also on other desirable criteria e.g. having an ambition level on the CO_2PL. This is called 'Most Economically Advantageous Tender' (MEAT). Commissioning parties can incentivise tendering parties to differentiate themselves as more sustainable than another tendering party through their certification level. Organisations set an ambition level on one of the five levels. Organisations achieving a higher level on the CO_2PL receive a greater (fictitious) financial benefit in the public tendering process, which is a competitive advantage towards winning the tender (Rietbergen, 2015)[2]. This can give up to 10% award advantage on high value projects of sometimes several million (SKAO, 2017). Herein, the CO_2PL facilitates green public procurement between commissioning parties and tendering organisations. In fact, the CO_2PL has been recognised by the OECD as a best practice tool for green procurement (OECD, 2014). Figure 6 below shows how discount is applied in tenders.

Company	Bid	Certificate level	Fictitious discount	Fictitious bid	Contract awarded?
A	100K	3	4%	96.00K	NO
B	103K	4	7%	95.79K	YES
C	101K	2	3%	97.97K	NO

Figure 6: Fictitious discount process. Adapted from Rietbergen (2015)

Many different types of stakeholders are involved in the CO_2PL system. The four main stakeholders listed below are relevant for understanding the CO_2PL in this study:

- SKAO is the scheme owner of the CO_2PL that is in charge of its operation and continual development.
- Certified organisations are organisations that opt to become certified by the CO_2PL management system. They can also participate in tenders where the CO_2PL is a requirement.
- Commissioning parties (in Dutch: opdrachtgever) are organisations that create tenders for companies to perform a work project. They use the CO_2PL as a requirement for tendering companies. There are commissioning parties that are also certified on the CO_2PL.

2 The discount is fictitious because the tender price will appear to have a discount, but the original amount is paid by the commissioning parties.

- An external auditor is an individual from an accredited organisation which is authorised to certify the performance of companies who use the CO_2PL. These organisations are involved so that the CO_2PL is an independently adjudicated system. An auditor performs yearly audits where they visit certified organisations to check if they are still adhering to the requirements of the CO_2PL, at whichever level they are ascribed to. Furthermore, certified organisations must prove to auditors that they are continually getting goals improving in their CO_2 reduction. Auditors can certify that an organisation has increased (or even decreased) in their CO_2PL level.

The company seeking certification must meet all the requirements for a level. Once an organisation believes it meets the requirements for a particular level, it undergoes audits before a certificate can be granted (SKAO, 2015). Organisations draw up a portfolio for the auditor. The portfolio compiles examples of activities, which prove a company's (continued) adherence to the requirements of the CO_2PL at a particular level. Companies undergoing yearly re-certification should show continued target setting, and continuous improvement in CO_2 reduction.

The CO_2PL is built upon several international standards (SKAO, 2015). This includes the Greenhouse gas (GHG) Protocol, which classifies different sources of emissions related to organisations operations. These are named Scope 1, 2 and 3 emissions. Scope 1 accounts for the CO_2 emissions produced in company facilities and company vehicles. Scope 2 includes the emissions caused by purchased electricity. Scope 3 is the emissions from activities that other organisations perform in the supply chain as a result of the reporting companies' business activities (Green, 2010). Figure 7 below depicts the division of activities by their scope.

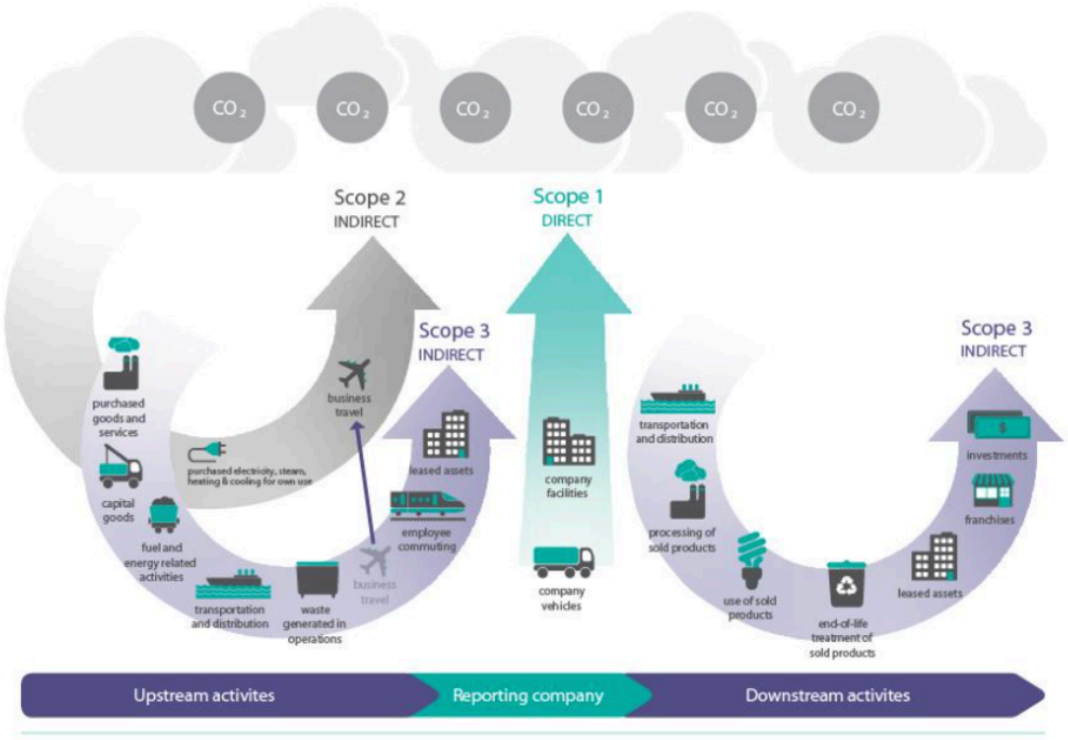

Figure 7: CO_2PL emission scopes, based on the GHG Protocol. Adapted from SKAO (2015)

In the CO_2PL, organisations on levels 1-3 account for their scope 1&2 emissions. In CO_2PL levels 4 & 5, scope 3 emissions are also accounted. For example, for requirement 4A in the Insight theme, companies must make an analysis of CO_2 emissions in one of the supply chains the company participates in. In the CO_2PL, this is named the chain analysis.

Organisations should account for scope 3 emissions that make up >5% of the total. This is the so-

called ‘threshold value for materiality’, and these emissions are known as organisations ‘most material emissions’ (SKAO, 2015).

Companies can access data about emissions from the website emissiefactoren.nl (emissions factors). This website provides emission factors to help estimate CO_2 emissions in the Netherlands. For example, it shows how much CO_2 is produced per kilo of diesel burnt, so to work out emissions from diesel, one should multiply the factor by the number of kilos of diesel used. It was set up by SKAO to ensure everyone uses the same data, in order to make fair comparisons. Every year the website is updated with new factors, which are based on findings from scientific research.

The list of measures (Dutch: maatregellijst) is a document from SKAO which provides examples of the measures organisations can take to reduce their CO_2 emissions. The report is divided into sections for each industry sector. The list of measures does note that organisations can use secondary materials in a circular approach to manage CO_2, but only in a section addressed to waste management organisations.

The CO_2PL has created impact mainly for organisations in the Dutch market, but also in Belgium and Germany. As of January 2018, there are 829 certificates awarded to companies, and more than 75 commissioning parties have implemented the CO_2PL (SKAO, 2017). Previous research into the impact of the CO_2PL found that organisations with a certificate on the CO_2PL reduce their CO_2 emissions by an average of 3.2% per year, while, in the Netherlands, other businesses only reduce their CO_2 emissions by an average of 1.5% annually (Rietbergen, 2015). This demonstrates the influence of the CO_2PL in reducing national carbon emissions.

2.5 CE and CO_2 management

CO_2 management is more mature than CE management. Environmental management has traditionally focused on reducing CO_2 emissions, while the use and preservation of resources (as emphasised in CE) has gained less attention over time (Ellen MacArthur Foundation, 2012; Hill, 2014; Wijkman & Skånberg, 2015).

Management of CO_2 is widely known as an approach to prevent climate change. The understanding of the importance of CO_2 transcends through government targets, business strategy, academic discussion, and public interest (Jacobs, 2016; Laurent et al., 2012; Rugani et al., 2013; Strachan et al., 2008). CE is less mature and less well-known among the public, but it has recently gained popularity in businesses, public authorities and sustainability management literature (Kirchherr et al., 2017; Liu et al., 2009). CO_2 management consists of well-defined actions, including reduction of energy use, and employing eco-efficiency[3] on technologies and operations (Guenster et al., 2011). CO_2 management is actionable and can foster continuous improvement, so it lends itself to corporate sustainability (Korhonen & Seager, 2008).

CE management activities by contrast is less known outside of academic, government and business spheres, and it is less well-defined as a concept (Kirchherr et al., 2017; Liu et al., 2009; Winans et al., 2017). CE is harder to put into action because it puts forward a range of theoretical principles, but organisations must find out for themselves how to realise these principles. For example, realising a post-consumption product take-back system could require the intervention by authorities to create regulations, taxes or subsidies to incentivise. These actions to are not discussed directly by the theoretical concepts of CE (Sauvé et al., 2016). Also, if materials are downgraded in recycling processes, new purposes must be found for these down-cycled materials, in order to keep them in use before disposal (Allwood, 2014). There is thus a stark contrast between the knowledge of what CE and CO_2 management entails, and what actions can be taken to realise them.

[3] Defined as creating increased value with less environmental resources (Guenster et al., 2011).

There are challenges which exist in the context of both CO_2 and CE management. Managing corporate CO_2 emissions can often depend on personnel in organisations, for example, making sure that a fuel-saving culture in the organisation is employed. Organisations may lack control or influence of other actors in their supply chain, and the emissions their operations cause (McKinnon & Piecyk, 2010). It can be challenging to reduce emissions from transport, and it is sometimes described in literature as a "necessary evil", i.e. something which supply chains depend on, but that also create negative environmental effects, such as CO_2 emissions. To lessen these impacts, organisations can for example plan vehicle routing. However, as with the previous example, these challenges depend on the cooperation of employees and other organisations (Treitl et al., 2014).

CE is criticised as being challenging to implement. One reason for this is that it proposes an optimum scenario for supply chains, where resources and energy would be used with 100% efficiency. However, in reality, it is difficult to maintain pure flows of material as contamination of materials is prevalent, and reduces the capacity of resources to be regenerated in a closed loop (Allwood, 2014; Baxter et al., 2017). It is yet to be understood if it is realistic to manage, or just theoretical (Genovese et al., 2017; Pauliuk, 2018).

2.5.1 Managing CE and CO_2 together

There are connections which exist between CE and CO_2 management. CO_2 emissions are 'embodied' in the production of goods in supply chains, since the burning of fossil fuels for energy production is present throughout a products lifecycle (Bruckner et al., 2012; Laurent et al., 2012). With linear supply chains, this pattern of consumption is perpetual, which creates increasing CO_2 emissions. Embodied emissions are particularly present in the chemical, steel, cement and agriculture industries, though also in the production of fuels themselves, and services needed to provide them (Cooper et al., 2017). Circular economy can reduce this embodied energy, particularly by reducing the need for resource inputs (Cooper et al., 2017).

Some literature notes that CE and CO_2 can be managed together. Mainly, CE case studies use CO_2 emission reduction to describe impact (Ellen MacArthur Foundation, 2013; Zhu et al., 2010). Cooper et al., (2017) found that moderate uptake of CE measures in the economy (30-60%) would save 6%–11% of global energy use, having a knock-on effect on CO_2 emissions. Genovese et al. (2017) compared the CO_2 impact of circular supply chains, compared to linear, for a food cooking oil chain and chemical industry chain. The results showed a CO_2 emission reduction of 40% and ~66% respectfully.

The literature has also noted trade-offs between CO_2 and CE management. For example, Ekins et al. (2009) noted that the construction of a nuclear power plant, which could reduce CO_2 emissions compared with fossil fuel energy generation, creates demand for substantial resource extraction, alongside radiation and other atmospheric emissions. Furthermore, regenerating products in recycling can be more energy intensive and cause additional emissions than virgin material production (Allwood, 2014; Genovese et al., 2017). This is also backed up by Gamage, (2007), who argued that recycling magnesium alloys for vehicles can require more energy than virgin production. Furthermore, McIntyre et al., (2009) studied substitution of virgin concrete aggregate with crushed used concrete. They found that using just 20% recycled concrete use was beneficial for CO_2 emissions, when virgin concrete was available locally. However, the ratio of secondary concrete used could be increased if the transport distance for virgin material was greater (McIntyre et al., 2009). The relationship between substitution of virgin materials with recycled materials and CO_2 emissions is complex, due to the variables like production processes and transport requirements. Various modes of transport, types of vehicle, efficiency of fuel use can have a bearing on whether the CO_2 impact of recycling goods is better than use of virgin materials. However, products that make use of renewable energy in the supply chain have significantly less environmental impacts, than products relying on fossil fuel energy. So, switching to renewable energy is important for managing both CO_2 and CE (Laurent et al., 2012). Therefore, these previous examples of connections and trade-offs between CE

and CO_2 management highlight the case-specific nature of the relationship between CE and CO_2 management.

2.6 CE and CO_2 Measurement

CO_2 is widely acknowledged as a performance indicator to measure impact (Laurent et al., 2012), and it is used in diverse studies such as agriculture, oceanography and land use (Bouttes et al., 2016; Durand et al., 2015; Houska et al., 2017). Emission factors help to translate the use of fuel, energy and material resources into a CO_2 emission value. CO_2 is commonly measured by CO_2 footprints or the LCA tool. Authors regard data on CO_2 as easy to access, and a good entry point for discussing environmental impacts (Genovese et al., 2017; Nasir et al., 2017; Weidema et al, 2008).

In contrast, there is much debate in academic literature about CE measurement and no one standard way to measure CE (Camacho-Otero & Ordoñez, 2017). The following paragraphs discuss some of the different methods of CE measurement and the debates therein.

There have been many attempts in literature to create indicators which measure circular potential or performance (Huysman et al., 2017; Park & Chertow, 2014; Verberne, 2016). Indicators created by academia tend to be more complex and rigorously tested with academic methods than indicators which are created in business, which have an applied nature to suit business practice (Saidani et al., 2017). Furthermore, there is a mix of quantitative and qualitative methods for measuring CE, although quantitative is lacking (CE Delft, 2016; Wenbo, 2011). This is problematic since impacts which are easier to quantify are more accepted as methods for measurement (Laurent et al., 2012). Thus, there are different types of indicators and different opinions over what is best to measure.

There is some debate in the literature whether LCA can be used to measure CE, because it is based on a linear economy – cradle to grave. However, the premise of a circular system is cradle to cradle. Some authors argue that LCA can account for avoided production of virgin material as a consequence of circular resource use (Genovese et al., 2017; Guinee et al., 2010; Reap et al., 2008; Scheepens et al., 2016). Other authors say LCA cannot represent CE and it simplifies our understanding of multiple lifecycles, as it assumes pure flows of material and neglects impurities of secondary materials. LCA does however represent many impact categories that CE principles could be measured through, including resource depletion, human toxicity and acidification (Niero & Olsen, 2016).

The British Standards Institute launched a management standard for CE in 2017 (CE BS 8001). However, critics note that the measurement advice it provides is vague. For example, organisations must choose their own indicators to measure CE, and the management standard does not link CE to standardised quantitative tools like LCA (Pauliuk, 2018). This example emphasises that there is no agreed standard on CE measurement, as even a standardisation authority does not specify a particular way to measure CE.

2.6.1 Measurement of CE with CO_2

As discussed previously, energy and emissions are embedded in supply chains, so they can represent much of the overall environmental impact for the majority of products supply chains (Weidema et al, 2008). This is a link which can be made between the measurement of CE and CO_2. Laurent et al. (2012) studied LCAs of products assessed by CO_2 emissions and also multiple other indicators, to see if measuring by CO_2 emissions can be a single indicator for various environmental issues. He found that CO_2 emissions show strong correlation with the total environmental impact of infrastructure products e.g. buildings and wind turbines. They noted that CO_2 emissions correlate with other environmental impacts, when certain processes are present in a product lifecycle. For example, regarding infrastructure, these processes are producing and disposing steel, burning fossil fuels for energy production and transport and production of cement. These are energy and resource intensive

activities, which relates to CO_2 emissions and CE impact. So, in some cases, especially for infrastructure, CO_2 emissions can be an indicator for CE.

However, in the literature CO_2 is sometimes considered a crude approach to measurement of other environmental impacts, which relate to CE. For example, biofuels can have a low carbon footprint, which could suggest it is an eco-friendly product. However, biofuels can be demanding on land use, forest resources and biodiversity, which CE aims to protect (Ellen MacArthur Foundation, 2012; Weidema et al, 2008). Furthermore, Laurent et al. (2012) created a pie chart of the normalised total environmental burdens of infrastructure-related products and services, showing the multitude of impacts a product has, and how comparatively, the climate change indicator (related to CO_2) makes up a small part (figure 8 below). These authors recommend using CO_2 measurement as a 'transition indicator' a move to more holistic measurement approaches. Overall, there is a mixed picture about the ability of CO_2 to relate to other sustainability impacts, including those related to CE.

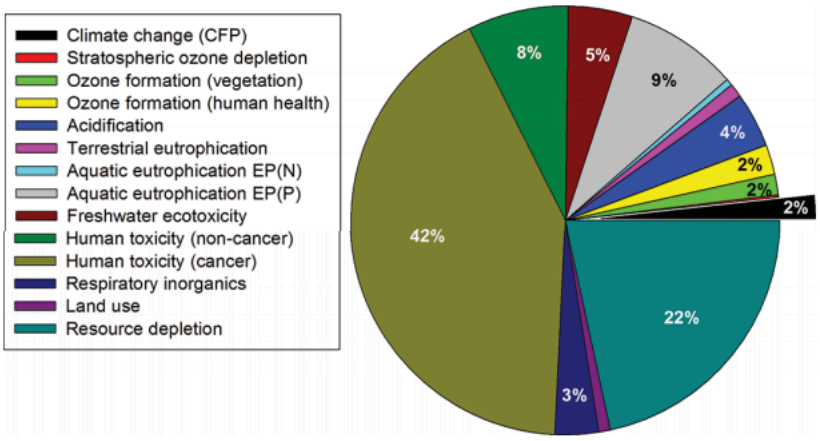

Figure 8: Total environmental burden of infrastructure-related products and services (Laurent et al., 2012)

2.8 Theoretical Framework

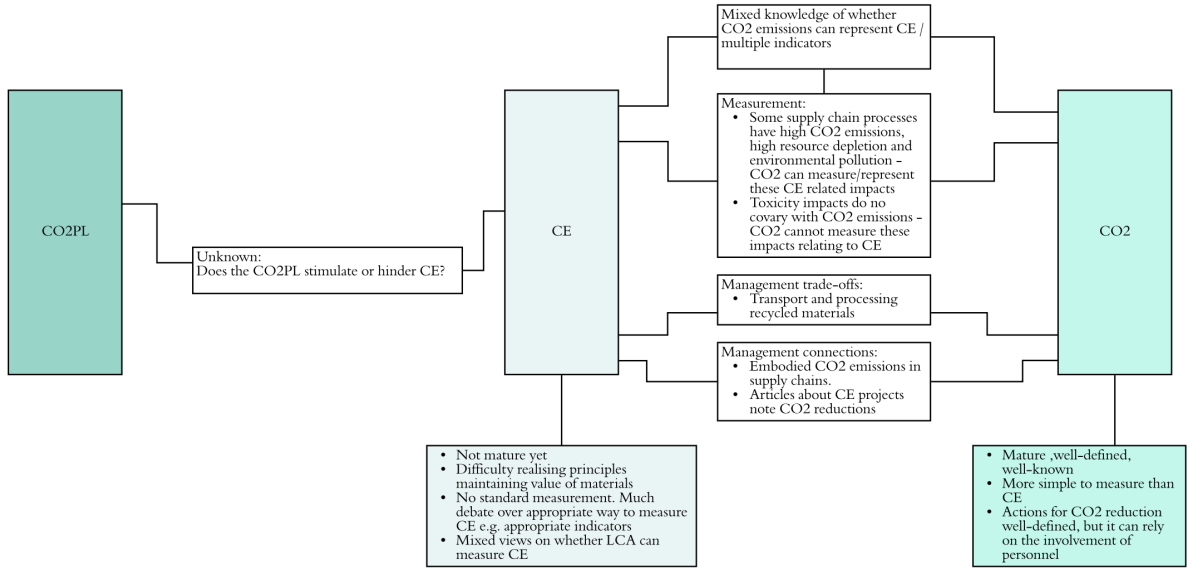

Figure 9: Theoretical Framework

Figure 9 above is the theoretical framework which was compiled from the some of the key themes which were discussed in this chapter, as related to the RQs. The connecting lines between CO_2 and CE, and the CO_2PL and CE show what is known about the relation between these topics. The blue and green boxes connected to CO_2 and CE show what is the relevant context for each of these concepts, related to their management and measurement.

3. Methodology

The methodology outlines the design of the research, including which data was collected, and why. This section also discusses how this data was analysed towards answering the research question and objectives.

3.1 Research Design

This exploratory research looked at how users of the CO_2PL manage and measure CO_2 and CE in their organisations. Through this first research question, the study set out to understand the context of CO_2 and CE management and measurement, including the perceptions of interviewees. This research also set out to discover whether users of the CO_2PL think that it stimulates or hinders CE developments. Perception and experience are therefore central to the epistemology of this research, and this information is used to answer the research questions.

A qualitative approach was deemed more appropriate than quantitative research for this study. This is because the research questions cannot be answered by numerical values and statistics from objective measurements (quantitative methods). Instead, qualitative research was well-suited to this study, since it is situated or contextual, and it gathers a series of representations (Denzin & Lincoln, 2008). A qualitative approach looks more at the subjectivity of experience than objectivity (Stickler & Hampel, 2015). This is fitting to the research as user experience and perception are contextual and not objective.

3.2 Data Collection

Interviews were chosen over questionnaires or group participation methods, for example, since interviews allow for depth of insight and probing for information from individual interviewees. This research involved semi-structured interviews. This meant that there was a set of fixed questions, which was useful for this research, as asking the same questions across interviewees meant that reliable generalisations could be made. Furthermore, un-planned questions could be asked to interviewees to gain insight on their specific area of knowledge. This method helps to inform exploratory research such as this (Cohen & Crabtree, 2006; Edmondson & McManus, 2007).

Nineteen semi-structured interviews face-to-face took place across three months. Interviews were over an hour long. The following sub-sections describe the sample selection process and the interview questions.

3.2.1 Sample Selection

The interview sample contained only organisations that use the CO_2PL, and that are also working on CE activities e.g. performing pilots or projects. Therefore, interviewees had knowledge and experience about the CO_2PL and CE, so they could describe the relationship they perceive. The list of participating organisations was reviewed and company websites were reviewed to find suitable interviewees who had experience both with the CO_2PL and CE in their organisations.

Interviewees were selected to represent the different types of organisations that use the CO_2PL. There are 10 times more certified organisations than commissioning parties using the CO_2PL. In the sample, fourteen certified organisations and five commissioning parties were chosen. Four of the five commissioning parties are also certified organisations on the CO_2PL.

The sample consisted of eleven level 5 organisations, four level 4 organisations, and three organisations certified on level 3[4]. Higher level organisations were chosen because they are familiar with more of the CO_2PL requirements. These organisations also can reflect on several years of experience using the tool. Furthermore, a sample of organisations all above level 3 is quite representative, since few organisations are certified on levels 1 and 2. Figure 10 below shows the number of organisations certified at each CO_2PL level, as of January 2018.

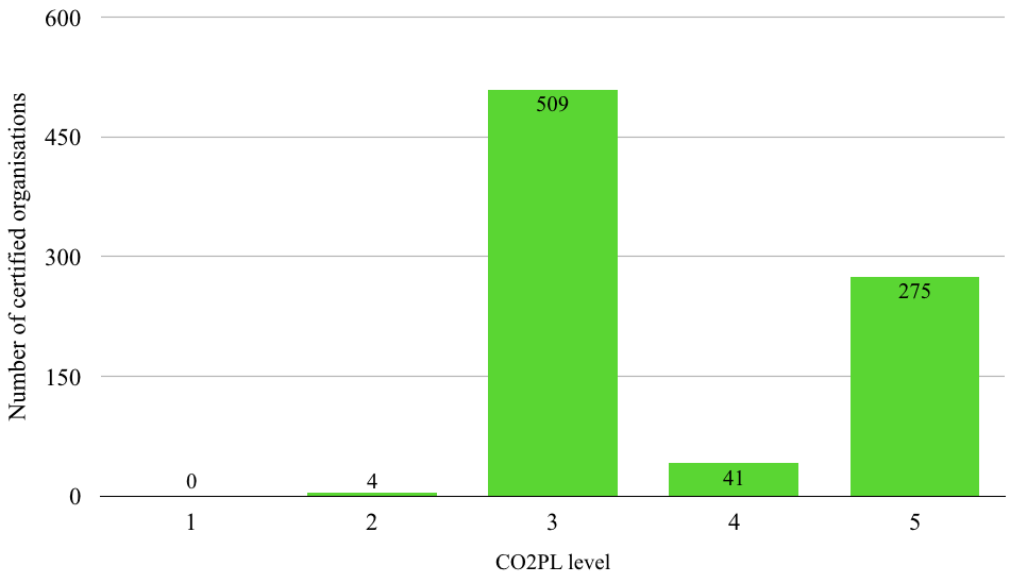

Figure 10: The number of organisations certified at each level of the CO_2PL

Interviewees were selected from Dutch organisations since SKAO predominantly operate in the Dutch market. Interviewees from different types of industry sectors were chosen. This was done to collect different perspectives about how the research objects relate to their company's industry sector.

The number of interviewees chosen from each sector reflected the variety of organisations using the CO_2PL. Interviewees from commissioning parties were chosen from semi-public organisations, public authorities and municipalities[5].

Interviewees from certified organisations came from four sectors. The majority of organisations using the CO_2PL are from the infrastructure sector, so this was reflected in the chosen number of interviewees from this sector (nine organisations). The rest of the sample consisted of four engineering services companies and three waste management companies, one company that works both in infrastructure and waste management and one manufacturing company. This categorisation was based on these company's NACE codes, which is a European industry classification system. Figure 11 overleaf lists the organisations that were interviewed with their industry type.

[4] The total number of certified organisations is 18. See footnote 5.
[5] Four of the commissioning parties are also certified organisations, but in this study, they are named as commissioning parties.

Certified Organisations	Industry Sector
Arcadis	Engineering
BAM	Infrastructure
Dura Vermeer	Infrastructure
GP Groot	Infrastructure and Waste Management
Heijmans	Infrastructure
Pon	Manufacturing
Renewi	Waste Management
Royal Haskoning DHV	Engineering
Suez	Waste Management
Sweco	Engineering
Teeuwissen	Waste Management
Van Der Ende	Infrastructure
Volkerwessels Bouw en Vastgoedontwinkelling	Infrastructure
Witteveen+Bos	Engineering

Commissioning Parties	Industry Sector
Alliander	Infrastructure
Pro Rail	Infrastructure
Rijkswaterstaat	Infrastructure
The Ministry of Infrastructure and Environment	Infrastructure
The Municipality of Amersfoort	Municipal Council

Figure 11: Interview Organisations

The chosen interviewee was in most cases the person responsible for their CO_2PL certification in their organisation. When this was not possible, another employee working with the CO_2PL or CE activities in their organisation was selected.

Interviewees had different roles. Eleven had roles around sustainability consultancy and management. Eight interviewees were working in quality, health, safety and environment departments. Furthermore, one procurement contract manager and one company director made up the interview sample. Two interviews were conducted with two members of organisations, so this explains the total of twenty-one job roles above.

3.2.2 Interview questions

Three sets of interview questions were drawn up, one for commissioning parties, one for certified organisation, and a combined set for organisations that are both a commissioning party and certified organisation. It was necessary to draw up three sets of questions since these parties perform different roles within the CO_2PL system – i.e. procurement using the CO_2PL, certification from the CO_2PL or both. The questions for certified organisations are in Appendix B, with a description of why each question was asked. These questions related to the research questions and the concepts discovered in the theory. The interviewees described the relation between the research objects and their organisation through their own views.

3.2.3 Prompting interviewees on CE activities.

It was acknowledged that CE is just an emerging topic for businesses. Thus, it was expected that interviewees may have different understandings of what CE entails. This could affect how they perceive the relation between the CO_2PL and CE.

To account for this, interviewees were shown a sheet containing different CE activities at the end of the interview[6]. They were asked which of these activities their organisation had performed, so that they would read over the sheet carefully. After this, they were asked if they had further comments on how the CO_2PL stimulated or hindered CE. Figure 12 below is the CE prompt sheet.

Purchasing 'waste' materials instead of raw materials	Used products are traded to other organisations	Reusing products	Repurposing products for different uses	Refurbishing repairing or remanufacturing products
Creating easy to disassemble products (e.g. modular products)	Using products more intensively before they are thrown out	Creating/using durable products	Recycling materials	Establishing better quality waste collection, separation and treatment systems
Products are leased, rented or shared with users/other companies	Incentivised take-back product systems	Pay-per-use' systems	Reduction of energy use	Reduction of hazardous and toxic materials
Using biodegradable products and materials	Greater material efficiency	Use of renewable energy sources	Reducing pollution	Reduction of waste

Figure 12: CE prompt sheet

[6] The CE prompt sheet contained 20 CE activities that were the main activities and business models mentioned in literature. A thorough literature review was conducted to find activities that align with the CE principles. Different sources were chosen to reflect different perspectives about CE, e.g. business and academic. The search stopped when no new concepts were discovered in the literature. Specific activities e.g. 'product repair' were chosen instead of vague principles like 'maintaining value'. There was no double-counting of words, for example, 'restore' and 'refurbish' were counted as one. Appendix C shows the different literature sources from which CE activities were chosen to create the CE prompt sheet.

3.3 Data Analysis

Interviews were manually transcribed to pick up on interviewees tone of expression and hesitations, for example, which could help to indicate perceptions. The average length of transcripts were 5500 words. The transcripts were sent back to interviewees to confirm they were accurate. The transcripts were also discussed with members of SKAO to understand the context of findings.

The interviews were coded (as described below) to extract key themes. The data was split by whether it referred to management or measurement of CE and CO_2 or stimulation and hindrance of CE by the CO_2PL. This helped to divide information by their relevance to each research question. The coded data for each research question was thoroughly read through to find recurring themes to structure the results and discussion chapters.

Furthermore, interview data was collected about whether interviewees thought the CO_2PL should stimulate CE more. This data is presented at the end of the results section, and used towards the recommendation for SKAO, in chapter 8.

3.3.2 Coding interviews

Coding is common practice in qualitative research involving interviews. Saldaña, (2015) stated that "a code symbolises data and attributes meaning to each data for later purposes of pattern detection, categorisation... proposition development… and other analytic processes". The interviews were coded to categorise the information by its usefulness for answering the research question and objectives.

A combined inductive and deductive coding approach was used. In this combined approach, codes originate both from preliminary research on the topic (deductive) and from what emerged commonly in the interview data (inductive). This approach is useful for helping researcher add to the knowledge on the topic (Seale, 2004).

To mobilise this approach in this research, data codes were both pre-formulated from initial literature review, and also were derived from the interview data[7]. A manual coding approach was chosen so that codes were not missed when falling under different terminology. This also allowed for greater understanding of the data set.

Interviewee codes

The names of interviewees and their job role were left undisclosed in this study. Furthermore, the results are encoded so the responses do not trace to individual companies. The companies were encoded based on whether they were commissioning parties or certified organisations.

Commissioning parties were encoded as CP and certified organisations were encoded as PO (for participating organisation). CO was not chosen to represent certified organisation because this may confuse the code 'CO2' with the greenhouse gas 'CO_2'. The numbers in the codes are in a random order for anonymity reasons. Figure 13 overleaf lists the codes of each interviewee.

[7] Examples of data codes which emerged from the literature included 'trade-off' and 'indicator' for RQ1. Codes which emerged from the interviews included 'indirect' and 'chain analysis' for RQ2.

Commissioning parties	Certified Organisations	Certified Organisations	Certified Organisations
CP1	PO1	PO6	PO11
CP2	PO2	PO7	PO12
CP3	PO3	PO8	PO13
CP4	PO4	PO9	PO14
CP5	PO5	PO10	

Figure 13: Interviewee codes

4. Results

The results chapter sets out the findings from the nineteen interviews, split between four subsections. First, the results for how interviewees manage CO_2 and CE in their organisations is presented. The subsequent section describes how interviewees measure CO_2 and CE in their organisations. After this are the results for if and how interviewees viewed the CO_2PL as stimulating or hindering CE. Finally, there is a section on whether the interviewees felt that the CO_2PL should have a role in stimulating CE or not, which will help to inform the final recommendation for SKAO. Each sub-section concludes with a summary of the key points which emerged.

4.1 Management of CE and CO_2

This section provides context about the current state of these CE and CO_2 management in organisations, and how they are perceived by interviewees. It is broken down in subsections regarding CE and CO_2 management maturity, actions taken and challenges, as taken from the literature. Following this there was a discussion about CE and CO_2 management in projects, which was a theme that emerged from the interviews. This subsection ends with the results for how interviewees recognise connections and trade-offs between CE and CO_2 management.

4.1.1 Maturity of the CE and CO_2 management

Most interviewees commented that CO_2 management was more mature than CE management, as they had worked on it for several years more. Some interviewees discussed that they renew their target for CO_2 reduction. Despite the immaturity of CE, a few organisations have set CE goals alongside CO_2 goals in their organisation. For example, (PO1) said:

> *"We set a target for ourselves to be in 2035 energy neutral (zero CO_2 emissions). For CO_2 in my opinion, 2035 is not that ambitious. For CO_2, we have been busy with that for almost 10 years. Circular Economy is just from a few years ago."*

While a few organisations had built up experience with CE in various projects, a quarter of interviewees said that CE is just in a starting phase and that pilots, experiments and investigations are occurring in their organisations, so organisations can understand how CE can be applied in their business. Although it was noted as a difficult topic to apply, as a few interviewees each had comments like "What exactly does it mean?" and "How familiar can you be?". The majority of interviewees noted the market was steering towards CE. They said that clients ask about this topic and their organisations should not neglect it if they want to remain competitive. There was a strong conviction from almost all interviewees about the importance of CE. (PO5) said:

> *"The Circular Economy, that is the 2.0 from sustainability."*

When discussing CO_2 management, the interviewees often spoke about the CO_2PL, since their organisations are users of the CO_2PL. About a fifth of interviewees regarded the CO_2PL as a mandatory requirement for companies in the Dutch market. Many said CO_2 management is expected of organisations. (PO10) noted:

> *"If you have a sustainability report and not having anything about CO_2 in it then I think, yeah, you missed a little bit of history."*

However, some interviewees noted that CO_2 management was not always mature. (PO1) provided a story of how in 2009, the CO_2PL urged a couple hundred of suppliers to provide insight on their CO_2, so it became well-known in the branch. He noted that he met companies and suppliers who had previously never heard about making a CO_2 footprint.

Summary

- *CO_2 management is more mature than CE. Organisations have been renewing targets for CO_2 management, but many have only started to investigate what CE can mean for their organisation.*

- *Interviewees believe CO_2 management is now expected of companies, while 9 years ago, it was more unheard of.*

- *Companies feel compelled to act on CE*

4.1.2 Actions taken to manage CE and CO_2

When asked what CE projects they have worked on, interviewees provided examples mostly regarding developing public spaces and buildings, recycling materials, using recycled material in roads, and turning waste into new office products. Infrastructure companies and waste management companies mainly had performed CE activities related to their core-business (e.g. road building and waste recycling respectfully). By contrast, most engineering companies had items in their offices made from recycled waste, and less circular projects relating to their engineering business.

Interviewees tended to link CO_2 management to energy and fuel use. They considered CO_2 management as reducing unnecessary fuel use in vehicles, use of electric vehicles, energy efficiency and reducing energy use in buildings. (PO2) noted that now they have switched their office and waste processing installations to wind energy, so almost all of their CO_2 footprint (92%) is from truck transport.

Interviewees noted that the existing management of both CE and CO_2 should be improved. For example, about half of the interviewed infrastructure companies noted that many people can tend to focus on recycling, instead of a wider perspective on what CE entails. Some interviewees noted that recycling is well established, but more can be done to not down-cycle materials. For example, secondary asphalt is used for the foundation material for new asphalt roads, but it needs to be reflected on if this is quality high-level reuse. The focus on quality was clarified by two waste management companies, who noted that the waste management market is shifting towards a focus on quality processing, rather than gaining quantity. They noted that it is a challenge to maintain high material quality and guarantee customers will buy secondary materials. This brings across the idea that even the parts of CE we are more familiar/experienced with – i.e. recycling, still need to be optimised for a better working Circular Economy.

Quite a number of organisations noted that the initial 'quick wins' or low hanging fruit for CO_2 management have been taken[8], which generated large reductions without much difficulty. They noted that now the steps to take are about greater commitment. Three quotes are displayed to demonstrate how this topic was discussed:

> *"I see the insight and how easy it is to reduce your carbon dioxide from one company, like 2000tonnes just for [this organisation], that is the same as 210 families, that is easy….*

8 Low hanging fruit or quick wins are defined as actions which can be taken for short-term abatement of an issue which can provide financial savings. However, when quick wins are exhausted, only expensive abatement alternatives, which require more commitment, will remain (Narain & Van't Veld, 2008).

Especially in the beginning, you can do things almost for free. Now we are in the stage that we have to spend money, we get it back in 4 years, ok we do it." (PO9)

In the beginning, it was scope 1 and 2, all about reducing fuel and electricity and gas. But now we can see that is about finished, maybe we can do more wind or solar energy. We already have solar energy on a lot of roofs. But we're quite finished on that program, just a few percent we can reduce on scope 1 and 2, and the big work is scope 3." (PO3)

"You need to look at if you can produce [renewable energy] yourself or invest in projects that actually build new solar fields or wind turbines. But that comes with a price. With that part, we do just a small amount, and that has to do everything to do with costs and investments and payback time. In a listed company, if you say payback for solar panels is 10/12 years. Then people look at you and say no way… [it needs to be ≤2 years]" (PO10)

Summary

- *The CE actions that interviewees have performed varied between projects relating to organisations core-business and use of circular office-ware.*

- *Energy and fuel initiatives dominate interviewees perception of CO_2 management and the actions they take.*
- *Some interviewees noted that CE gets reduced to just recycling, but the concept is much larger. Many noted that higher quality recycling and reuse of materials should be developed.*
- *Many regard the quick win solutions for CO_2 management to have been executed. CO_2 management for the future involves more investment and effort.*

4.1.3 Challenges of managing CE and CO_2

Interviewees discussed the challenges of managing CE and CO_2. For CO_2, this was mainly about changing employee behaviours and cultures to reduce CO_2 emissions, but also the large changes needed to switch away from fossil fuels completely.

Over a third of interviewees commented on how fuel use in vehicles and machines was the dominant CO_2 emission, and this is difficult to change, because it is embedded in the routines and culture of employees. (CP4) and (PO11) stated the following quotes:

"Getting it into the behaviour and making the decision – bike, public transport, car. Some people still choose car, even if you do not get paid for it and you have to pay for it yourself… There is a group here who are doing it differently. But still, 80% are thinking the others will do it" (CP4)

"Our travelling policy is also under construction. If the distance is less than 500km, you may not fly, but still people are getting on a plane to Luxembourg and other cities within the range of 500 km." (CP4)

"I don't know if it has to do with the fact it's kind of a man culture here. But you don't touch another man's car. It has some status that not only for the person itself but also the right that you get a company car and you can go on holiday with it. It is so normal that those rules aren't changed that easily." (PO11)

"Still if you look at it, transport is mainly diesel/fossil. The main things. It is hard to change that. I think the market still has to make big steps." (CP4)

While there are electric cars on the market, it is problematic that specialised machinery and vehicles that organisations work with remain powered by fossil fuels, and the innovations for electric machine or vehicles are not viable or optimised yet. For example, specialist vehicles which pump sewer contents are powered by fossil-fuels. Organisations take measures to reduce the time that vehicles are left running unnecessarily, or to encourage slower driving, but the footprint relating to fuel use is high for the organisations interviewed.

For CE, the challenges which were discussed were about managing CE towards the future, realising CE principles like the 10Rs, and creating new arrangements for management and procurement.

Managing CE towards the future

Four interviewees noted that the CE concept focuses on long-term rather than short-term. However, they noted CE is difficult to manage because it is not possible to predict the functions of the future. However, some interviewees said that future changes to technology and infrastructure design will render the reuse of some products or components obsolete. Therefore, to assure reuse, products may need to be designed flexibly.

As an example, (CP5) explained that they build infrastructure now to suit the situation of the present day – e.g. with traffic capacity. But even through the infrastructure company (CP5) spoke of challenges related to this:

"Then you have the question, how many more roads will we need? Probably not many because there is not much space left for it."

This suggests that even though organisations can try to design goods flexibly, they are concerned about their ability to predict future needs.

The 10Rs

A few interviewees discussed how the CE principle of the 10Rs is sometimes not realistic in practice. (PO11) and (CP5) discussed the imbalance of material coming from used sources vs. the number of new builds which are required. They stated:

"It is nice to reuse used materials, but if you look at all the buildings we have to build in a year and the buildings that have to be taken down, that is not sufficient. You can build everything new with reused materials but there are not enough reused materials. So that is important but not the holy grail." (PO11)

"How do we imagine circularity if something which is built is still there and is not likely to be taken out soon?" (CP5)

A further two noted that achieving higher levels on the 10Rs is unrealistic for some products, as it is blocked by regulations. For example, although incineration is low on the hierarchy, some waste

materials must be incinerated by law (PO13). Also, there are restrictions to the ratio of used asphalt which can be put in the top layer of asphalt (PO4).

Creating new arrangements in management and procurement

Furthermore, it was said by three infrastructure companies noted that it was important that the material can go back to the supplier, when the product is to be demolished, so they can gain the secondary materials to use again. (CP1) confirmed that it normally goes to the contractor, but they have changed this aspect of asset management to help stimulate CE. Also, three interviewees from infrastructure organisations spoke about how it is important to get CE into the minds of their personnel, and not making CE too abstract for them.

It was noted by a few that the procurement process restricts CE. (CP2) said that after the tender is closed, there are restrictions on allowing design changes (e.g. CE measures). On the same topic, (PO12) believed there should be a new way of contracting which involves parties earlier in the procurement process, to help stimulate CE developments. For (PO5), a main problem was budget allocation. He noted that the budget should not be separated by a divided budget for design, building, and asset management, but it should be all-together.

Summary

- *Challenges for CO_2 management regard employees driving and flying behaviour, and the transition towards renewable energy and fuel sources*
- *Several topics emerged about the challenges of managing CE, namely:*
  - *Evaluating unknown future scenarios when operationalising CE projects*
  - *Making the 10Rs principle a reality, when there are challenges in the supply of secondary materials and legislation*
  - *There are suggested changes to occur in procurement processes and management arrangements with other parties in the supply chain, and internally, with employees.*

4.1.4 Managing CO_2 and CE in projects

Projects were an important topic that interviewees used to compare CO_2 and CE management.

Many interviewees shared their concerns that they do not have specific insight into CO_2 emissions and material use or waste produced (related to CE) in each project[9], especially when they work on hundreds of projects per year. To illustrate this (PO6) said:

9 In the CO2PL, CO_2 emissions are calculated for the organisation and all its projects, but not specific per individual project. The reporting for this is allocation by finance. That means finding out how much finance the

"I think it is far more efficient to have one [certificate], than to have different parts of the company, let alone for every project. What we do for the projects at this moment is we don't calculate or measure CO_2 *footprints for every project because there are so many."*

This quote describes how it is easier to report CO_2 emissions as a whole organisation, rather than separately measuring sub-divisions of the organisation. He also noted with the number of projects, it would be difficult to manage and measure CO_2 emissions in each one.

The interviewees often made a distinction between CE and CO_2 management when it comes to projects, because they felt that the CO_2PL was not a project-based tool, but instead, focusing more on facilities and vehicles energy and fuel use[10]. This perception is noteworthy, because fuel, vehicles and electricity are used in organisations projects, but most interviewees did not perceive these impacts as related to their projects. Conversely, many organisations related the materials they use, and the CE impact, to what their project work entails. For example, from (PO11):

"For us as a construction company, the Circular Economy is based on the products we are building and not our own process in our organisation."

Interviewees perceived CE management and CO_2 management as separate, based on how they understood them as relating to projects or housekeeping. Interviewees described housekeeping activities as lighting of offices and fuel for cars, for example. However, a few organisations also noted that to improve their CE management and CO_2 management in the future, they will look into individual project impacts, and gain specific data on CO_2 emissions and CE impact per project. CP2 noted:

"We are trying to set up a way to monitor but we have no really good overview about the waste we produce, yes in the offices and in the stations, but not in the projects…. They are really the major sources of waste. Because on a project level it is being monitored more or less, but having several hundreds of projects - we don't have a complete overview."

(CP1) also spoke about the issue of managing CE and CO_2 in each project. He quoted:

"We are not doing our own CO_2 *performance in projects, I think that is lacking. The main risk is that if we push forward with* CO_2 *performance levels and Circular Economy, there are not enough people really understanding what it is about or doing calculations."*

project is worth compared to total company finances, and allocating CO_2 emissions to a project based on its proportion of the total CO_2 emissions of the organisation. This is a method to try to account for emissions in projects, without the need for measurement in each individual project, which is time-consuming and difficult. The projects which are used in tenders, projects with award advantage, where the CO_2PL is applied, have more requirements than projects without award advantage in the CO_2PL system. For these specific projects, amongst other requirements, CO_2 reducing measures must be documented. However, currently the CO_2PL does not require a specific footprint per project, also not for the projects with award advantage.

10 This was also the finding from Rietbergen, (2017), who conducted research into the water construction (waterbouwer) industry. He found companies did not associate CO_2 management with projects, although 90% of the emissions from organisations in this sector are found in scope 1 and 2.

Summary

- *Companies perceive CO_2 and CE management as separate on how they relate to projects*
- *Interviewees felt that CE was relevant for projects, because they work with materials in their core business.*
- *Although CO_2 emissions are prevalent in organisations' projects. Interviewees did not relate CO_2 management to projects as much, as they seen this as 'housekeeping'.*
- *Some organisations want to understand their impacts regarding CO_2 and CE specifically per project*

4.1.3 The connections and trade-offs between CE and CO_2 management

All interviewees were asked if they thought there was a connection between managing CO_2 and managing CE. The pie chart shows the results. Throughout the interviews, interviewees spoke about the connections, or lack of connection, between the topics, both in theory and practice. Figure 15 overleaf gathers these responses.

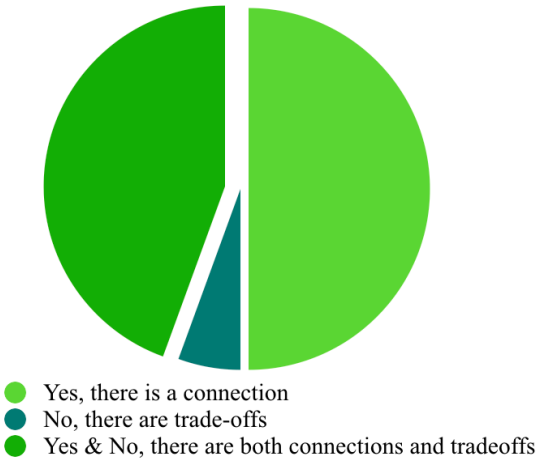

Figure 14: Pie chart showing if interviewees see a connection between CO_2 and CE management

Org.	Connection
CP1	It is never a standalone topic regarding these sustainability themes. A material is always in conjunction with its CO2 performance
CPPO1	Energy measures can maybe help you with your circular goals.
CPPO1	Scope 3 CO2 emissions relate to materials and CE.
CPPO1	When customers ask how we reduce our CO2 footprint, we show them the CE measures we take.
CPPO2	His organisation initially considered CO2 emissions as an indicator for CE in their circular procurement KPI. He said this shows there is a connection.
CPPO2	Raw material mining contributes a lot of CO2 emissions
CPPO3	When you consider resource production, transport, refurbishing, collecting, end-of-life, there is CO2 involved. Once you start measuring and gaining insight into CO2, you can make different decisions (relating to CE).
CPPO3	Reuse is better than throwing away, for CE, CO2 and sometimes costs.
CPPO4	CE can help towards CO2 reduction in development and maintenance of new infrastructure.
CPPO4	In an investigation for the national climate budget, they found CE measures could provide CO2 reduction. These have become very popular measures because they do not cost a lot, but they will potentially provide good CO2 reduction.
PO1	The use of raw materials, use-phase and then disposal and new extraction is CO2 intensive. He said there is definitely a connection
PO4	If you think about design with modular structure, then it also good for CO2 performance.
PO4	The interviewee showed a graph of CO2 emissions for a project. Three quarters of the pie chart was for materials use. The other sections of transport of materials and personnel, and then energy use of machines, then waste only took up a quarter of the graph altogether
PO6	The principles are in the same family. You have to think about design, about the lifecycle of a product or service. If you do that, you'll find there will be positive effect on the CO2 emission for that project. The mind-set of the Circular Economy, that helps of course, if you are willing to invest in it and think about it before you make something, CO2 comes in automatically
PO8	When a supplier is stimulated to have electric cars, to transport goods to you. You are both circular and you reduce co2 emissions, so that is really interesting.
PO10	Large parts of CE can be calculated with CO2. A lower CO2 has a better Circular Economy
PO10	Glass packaging for products can have a huge CO2 advantage over multiple cycles compared to plastic. Glass can be recycled multiple times without much waste.
PO13	The highest level of both [CO2 and CE management] is no use, which is an important similarity.

Figure 15: Examples given by interviewees of connections between CO_2 and CE management

Here it was common that interviewees talked about how CO_2 is produced along the supply chain, and operationalising CE can help to reduce this burden. The connection was more prominent that CE measures can help reduce CO_2 emissions. Overall, the remarks given were quite general, although some interviewees gave more specific examples. Two are described below.

(PO13) talks about the 'highest level' of both CO_2 and CE management as refusing use, referring to the 10R hierarchy principle. Although CO_2 management is not based on principles like CE, this emphasises that the approaches can be compared, as to reduce CO_2 output and reduce stresses on material supply chains, avoiding use of products or materials in the first place is an important principle.

In another example, (PO4) discussed the material-related CO_2 impact for a particular project was dominant. He then compared this with the transport emissions saying:

> *"So, you see how important it is to focus on the materials. To compare with the transport, for this project we talked about manufacturing of locks for shipping, the lock doors are manufactured in China, which we think, ooh dear... but it has rather no impact of* CO_2 *compared to the raw materials. We see it in a lot of projects that the materials are dominant instead of energy or transport."*

Here he conveys the message that even when parts for the construction needed to be shipped from China[11], which initially caused some concern about the CO_2 impacts, in the end, the transport emissions were much less than that of the materials (though it is unclear what this includes).

Summary

- *Interviewees gave general connections between the topics*
- *They noted that CO_2 emissions are embedded throughout the supply chain, and these can be lessened by employing CE measures*
- *More interviewees discussed that CE measures can reduce CO_2, rather than CO_2 reduction measures can align with the CE concept.*

[11] CO_2 emissions from shipping are much less than emissions from road freight per kilometre transported (Olivié et al., 2012).

Conversely, interviewees also talked about how CO_2 management and CE do not connect. Figure 16 below lists examples of trade-offs between CE and CO_2 provided from interviewees.

Org.	Trade-off
CP1	The best material for circularity goals may need to be transported far, for collection or recycling
CP1	Products like PVC may have a worse carbon footprint, but it is chemical waste in its end-of-life phase
CP1	Recycled concrete pavers need extra cement, which creates more CO2 emissions
CP1	There is a bio-based replacement for bitumen for asphalt, but the process is not optimised and uses more CO2 now than 100% recycled asphalt
CP1	The friction of the top layer of asphalt determines the petrol you need in your car. So, a sustainable material choice can increase the petrol usage
CPPO4	There would be more CO2 use now in the present time to create modular infrastructure. There can be hindrance between the two in the short term and the long term.
PO2	There are trade-offs in recycling and reusing materials in a CO2 efficient way
PO3	You have to produce more CO2 to have a Circular Economy. More trucks collecting waste creates more CO2, but better waste separation is better for Circular Economy.
PO4	Reuse of secondary concrete causes more CO2
PO6	I know my head of department said 'Well we can make everything circular but not within the same co2 emissions'
PO8	More transport could be required to reuse a product
PO10	You have to be careful that some processes have a very high CO2 reduction but are not that really circular. You should keep looking at the impact of the choices you make and the impact of calculations. If CO2 is a goal, then CE can be neglected
PO12	Modular constructions are not the best for material use initially. In modular concrete products, you will need to use more steel
PO13	Energy production from bio-based waste material is considered linear, not circular, because once it is used it cannot be used in multiple lifecycles. But in a CO2 perspective, it is good to use non-fossil sources of energy.
PO13	You could choose to bring waste material to a waste to energy (WTE) facility or recycling facility. This choice is difficult when the WTE facility is 5km away and the recycling is 100km away. The fuel needed to transport the material further for recycling will have a larger CO2 emission.
PO13	We are using chemical liquids for cleaning. In the near future, we are considering to do this on a natural basis, with no chemicals so it is better for the environment. However, the cleaning would be powered with, and use a lot of, electricity
PO13	Commissioning parties may be pleased to see a fuel-efficient vehicle on the project, but they lack awareness about the process in the factory, for example if material needed to be incinerated.

Figure 16: Examples given by interviewees of trade-offs between CO_2 and CE management

The connections provided by interviewees were very general, however, many of the trade-offs provided were from specific examples. In the interviews, the most commonly discussed trade-offs were production of recycled concrete, modular construction and transport of reused goods. For recycled concrete and modular construction, they noted that the manufacture or processing of products requires more energy and material input, which cause CO_2 emissions. It was noted by many interviewees that this makes for a difficult decision.

Building on this point, many interviewees discussed the consequences of looking at long-term vs short-term CO_2 emissions, where the trade-off between the two can be increased CO_2 emission in the present time to realise a CE measure, but overall, in the long term, the CO_2 emissions would be less. Interviewees gave examples to articulate this. For example, (CP1) said

> *"One of the innovations in asphalt these days is using bio-based replacement for bitumen component for asphalt. But this is not a process that is optimised. So, the total CO_2 footprint is actually not as good as the footprint of the other 100% recycled materials. But you know that we have to take these steps from 40% bio-based to 50%, 70%, finally maybe 100%. 100% bitumen replacement will have a better CO_2 footprint than the other. So, for now what do you say, the CO_2 footprint is less good with this replacement right now, but in the long run the bitumen will be suboptimal."*

Two interviewees stipulated that in the future, there is potential that the trade-offs between CE management and CO_2 management would be lessened. For example, with development and uptake of technology and innovation, in the future it should be possible to process recyclable material with renewable energy. Although many interviewees stipulate about long-term and short-term CO_2 impacts, there are unknowns about what the actual CO_2 impact will be in any timeframe, as we cannot predict the diffusion of clean energy innovation, and thus how supply chains will function in the coming years.

When comparing figure 15 and 16, it is noteworthy that some interviewees make opposing statements. For example, (CP5) said that modular construction creates more material demand, and more CO_2 in the present day. However, (PO4) said that modular construction is better for CO_2 performance. These conflicting results make it hard to understand the connection between CO_2 and CE, especially if organisations working on the same products find different results for the impact of CE measures on CO_2 impact.

Summary

- *Processing of CE measures can require more energy and materials upfront, causing more CO_2 emissions*
- *It is difficult to be sure of the impact of CE measures on CO_2 emissions*

4.2 Measurement of CE and CO_2

This section describes the current state of organisations CE and CO_2 measurement efforts, their experience in measuring these, and what they perceive as the right way to measure.

This section is broken down into subsections regarding CO_2 measurement and CE measurement. Following this, there is a discussion of interviewees beliefs on what indicators are appropriate for measuring CE, and then a discussion about the function of CO_2 equivalents.

4.2.1 CO_2 Measurement

Almost all interviewees were using the CO_2PL to account for their CO_2 emissions (apart from one commissioning party which was not a certified organisation). When discussing how they measure CO_2, most interviewees could provide details about the sources, their targets, and their reporting on CO_2 emissions. (CP3) stated:

> *"In scope 1 and 2, we have an overview about our energy consumption which is quite good and well monitored, so that we can manage. We know which part of the energy is sustainable and which not, to calculate. We know how to measure the energy savings being made. We have an energy savings program until 2020. Every year is detailed what measures we are going to take. We monitor whether they are going according to plan."*

Many interviewees noted it was fairly simple to monitor electricity use in facilities and diesel use in vehicles. This included real-time sensors on machines uploading CO_2 data to software, or using 'tank-passes' to track the diesel that workers purchase for work vehicles. A quarter of interviewees mentioned that they used LCA, DuboCalc or MKI (Milieu Kosten Indicator/environmental cost indicator) to quantify CO_2 emissions. DuboCalc is a tool based on LCA, and MKI expresses environmental impact as a cost.

4.2.2 CE Measurement

The responses about CE measurement were very mixed. The results below are split by those who were quantifying CE, those who were looking at qualitative measurement, and those who were not measuring or comparing CE performance yet.

Quantitative methods

Below is a list of the most common answers for how interviewees organisations were quantifying CE performance. Interviewees gave more than one answer each.

1. LCA/ DuboCalc (6 responses)
2. Mass of materials (5 responses)
3. CO_2 emissions and energy use (3 responses)
4. MKI (2 responses)
5. A KPI for CE (2 responses)

The discussion around quantitative measurement of CE focused around various challenges. Three interviewees spoke about a lack of data, as well as lack of accessibility and reliability of data. It was noted that it is hard to find (reliable) CO_2 emission factors for materials. (PO1) discussed how an LCA can enable you to see various options, but that the reliability is not good. He said:

> *"In a CE project, we were trying to find the best material for a lamppost, we used some numbers from Dubocalc, but we also read that the* CO_2 *factors for concrete were provided by the concrete industry, and that can be correct, but they have a stake in that. They try to show some optimistic numbers. But the fact that it is hard to find this information in an accessible way, that makes it difficult if you want to make the right choices"*

Three interviewees said their organisations measure CE through CO_2 emissions. Interviewees were also asked in general, outside of their organisation, how they think CE should be measured. Here, five interviewees considered CO_2 emissions as a measurement of CE.

Two interviewees mentioned KPI's, but only in one of these was it already operational, in the other it was being developed. This organisation that already had a KPI described it as a percentage goal for

procurement of recycled and recyclable goods. He noted that the KPI they have now is a simplification of what was initially thought of. At first, concepts of waste elimination and waste treatment were included, but then personnel did not really understand it. The interviewee noted the KPI was simplified in the end, but it is still hard to explain the concept.

Other difficulties that were noted by interviewees was the quantification or economising of impacts like depletion of resources, or value or natural resources, land, water and nature, which are related to the CE concept. (CP5) said that in comparison, they are able to calculate CO_2 in their models, but they are not capable of calculating these aforementioned impacts.

The variety of answers provided is indicative of how there is no set approach for measuring CE activities in organisations.

Qualitative measures

When asked how they measured CE in their organisations, four interviewees proposed questions that should be asked about the products they use. Common elements in their responses was to ask about if materials are reused, where they come from and how are they made? These questions often related to the 10Rs hierarchy. Interviewees listed off many important questions to ask, which are hard to measure. For example (PO2) said:

> *"But there are also things which are not easy to measure. For example, what are the feelings of the customer when they walk through a new circular city? Also, how do we look at lifecycles? How long will it stay in place? How much money is needed to keep it in good condition? No indicator is more important than another one, although that depends on what the client wants. What is the percentage of materials coming back into the company is also important to consider."*

The point that indicators should be made important based on what the client wants was also stated by another few interviewees. This approach is common-sense for businesses who have to please clients in projects. Furthermore, another interviewee (PO12) said that the 10R levels they are nice in theory, but just by giving good arguments for one option in practice, it can be seen as more beneficial than another in the hierarchy. These points illustrate how businesses favour more practical than theoretical approaches to performance measurement.

Not yet measuring or comparing

A third of the interviewees said they were not measuring CE yet, that they were having discussions about this topic and looking for how to compare and/or measure it in the near future.

One quarter of the interviewees said their organisation was communicating to stakeholders about their CE measures, giving examples of products and telling a story about how they were created. Almost all the interviewees from engineering firms said this. They noted that CE is something to inspire colleagues or communicate about. For example, (PO1)'s organisation had items around the office made from recycled fridges, he said this was a nice way to showcase CE to colleagues, so that perhaps they would be inspired to use a CE approach in a project. (PO11) made the relationship between the lack of maturity of CE, and how organisations use CE as a communication measure. According to (PO11):

> *"But it is still, nobody can explain correctly what it is when you're doing it the right way because I always get the idea that if you just shout something and you have a story with it – they will believe it and they will go with it. But there isn't like a consensus in the market like ok, this is good or bad or the way to go. It is still fuzzy and not crystallised yet."*

Some interviewees were asked how they weigh up one circular option as better than another. The interviewees reasons were not strict about making exact comparisons. For example, (PO8) said 'it should close the loop' and (PO6) said:

> *"Nah, I don't think we have to put it in boxes because circularity for me is saving resources, that is good for the money. Of course, you have to put a label on it – 'this is circular', it's also just efficient, it should be logical."*

4.2.3 Indicators

Interviewees were very familiar with LCA and indicators (impact categories) within it. A few interviewees discussed that indicators can conflict with each other when managing CE. For example, if you wanted to build a good quality road that lasts for 30 years instead of 15, this could interfere with an indicator that you want to make it modular (PO12). Another example given by (CP1) was about grass-maintenance. The team working on this said they could harvest the grass to make paper, but then they would need to put extra manure on the grass to increase yields, but ultimately damage bio-diversity. (PO12), from an engineering services company, mentioned that LCA organisations and engineers have different ideas about the best Circular Economy options. He noted that LCA comes in later in the procedure, as design comes first. He said:

> *"If you have a good LCA for example for your window, and then your LCA company would say 'this is a good product, it has a good LCA' but then the designer says, 'But if I designed an overlap over the roof, then it is less affected by the weather circumstances, then your window's lifespan is twice as long' but the LCA is not the impact, it is the end where we look at materials, but the impact is in the beginning."*

(PO12) continued to note that no one measure can be perfect on all counts.

> *"But if you talk about sustainability 10 years ago, we were all searching about "what is sustainability?" and then we had like a phase where we thought we needed everything to be on the highest level. But now we are really in the stage that we accept that you should not have all the indicators at 100% because they influence each other. And that will bring us also to Circular Economy, we also have several indicators but they interfere with each other. So, for every project you should make decisions, what would be the focus for this project".*

(CP3) however noted that indicators can be imperfect, as he himself had worked towards finding a master KPI for CE. He discussed that he found relative indicators and qualitative indicators are problematic:

> *"I'm a big fan of quantity over quality, and a fan of absolute quantities…because we could purchase 40% of our goods circular in 2020, but if we also purchase 40% more in 2020, then still the negative impact is the same. So, absolute indicators can be much more powerful than relative…what if instead you focus on what you did not procure circularly, and how can we make it 0 in ten years. That might be more effective actually."*

Furthermore, qualitative indicators were noted not to work by (CP3), as he said people can be easy on themselves, to award suboptimal effort and results.

These points show that understanding the full picture about CE performance is difficult using indicators. Professionals can have different ideas of what is best, it is difficult to have multiple indicators showing good results, and there are ways that unsustainable results can appear to be good, because of how indicators are measured.

There can be conflicts of interest within CE itself, let alone in combination with another concept such

as CO_2 reduction. Indicators themselves are limited in what they can express in terms of performance measurement.

4.2.4 Measurement of CO_2 and CE using CO_2 emission factors

Despite several interviewees saying CO_2 measurement was fairly simple, a fifth of interviewees said that there is much estimation which goes towards CO_2 emission measurement, and that the outcomes vary depending on the data use. For example, (PO12) said he displayed two engineering company's chain analyses for 100m of road, and one created 10 times more CO_2 emissions than the other. A few said that finding representative CO_2 emission factors is difficult e.g. CO_2 emission factors for materials or for biofuels for ships and airplanes. Waste management company (PO3) said it is complex to relate emission factors to real scenarios. When asked if he did use the emission factors website, he said:

> *"Yes. But one of our stakeholders says it is a big difference if you collect waste from house to house and you stop and go… Collecting waste per tonne in this way uses a lot more fuel than driving from point A-B. So, you have to separate these two. Easy to do? No. We are working on it for 1.5 years and we still do not have to solutions to measure it.*

There were mixed views about expressing CE through CO_2 emission factor values. A few said that presenting CO_2 emission factors of raw materials can help create a CO_2 footprint for the materials they use. They noted that this is helpful as the presence of CO_2 emission factors makes it easier to relate CE to CO_2, and to make it measurable. This is because they can try to quantify the CO_2 impacts of recycling of a material, and avoided CO_2 emissions of virgin material production. Some noted that there is however a lack of data for CO_2 emission factors for materials. (PO11) said that CE is calculable through CO_2, and stated:

> *"Yeah. Because in the end you can take a calculator and you can calculate how much good or bad materials are in there and you can define those and you can calculate how much* CO_2 *reduction is in that. You can calculate how much materials are reused or new. So that's numbers and you can calculate with that"*

However, many interviewees noted that measuring just CO_2 instead of other impacts, is not suitable for CE. (CP3) gave an example that if you do an LCA with CO_2 as the only indicator, then, in his given example, it may be advisable to buy new equipment which is more efficient. However, he said if you do a good LCA with all different impact categories, including land use, toxicity etc. then, it is case dependent, but the conclusions may be different. A third of interviewees associated CO_2 reduction as one topic within the larger framework of CE. Interviewees said that impacts like social sustainability, material scarcity and water pollution, are related to CE and cannot be deduced to CO_2 emissions. It was mentioned from CP3:

> *"I think sustainability in a lot of cases is translated strictly to* CO_2*, and I think that is really a bad development. Sustainability is much broader than* CO_2*."*

(PO6) also said:

> *"Because there are some of the same definitions, like* CO_2 *or* CO_2 [emission factor]*, some people think 'oh! It is based on* CO_2*, then we can use it as well', but that's perception in people's minds. They do not know the method and the systems beneath it."*

Here it seems to be a difference of opinion between interviewees. In one sense, some would like practical, easy measurement of CE, through CO_2 emission factors. For others, they find it unsuitable to express CE through CO_2 emissions.

Summary

- *All interviewees quantify CO_2. Many have goals, monitor different sources and report it. Almost all interviewees are certified on the CO_2PL. Some organisations have systems in place to measure real-time CO_2 emissions*
- *The answers were split between quantitative methods, qualitative methods and organisations not yet measuring or comparing CE performance*
- *There were as many interviewees using the LCA tool to measure CE, as those that were not measuring CE*
- *Challenges exist in finding representative data, measuring impacts like social sustainability and conflicts between CE indicators*
- *Qualitative methods were also popular for measuring CE – e.g. asking questions about the supply chain of materials.*
- *Many organisations tell stories about CE products or projects, rather than quantifying, to spread the word.*
- *Some interviewees were not very concerned with making exact comparisons between the benefits of different CE measures.*
- *A few organisations use CO_2 to measure CE. Five believed CO_2 could be an indicator for CE, in general.*
- *A few interviewees have to estimate their CO_2 emissions and it can be difficult to find CO_2 emissions factors for specific materials or processes.*
- *Interviewees views were mixed about the use of CO_2 emission factors to measure CE*

4.3 The stimulation of CE from the CO_2PL

This subchapter addresses the second research question, and focuses specifically on understanding if there is a stimulating relationship between the CO_2PL and CE. This section also describes why interviewees do and do not associate the CO_2PL with CE.

Several questions in the interview were related to this topic, in order to gain more depth of insight. Interviewees were asked which themes and levels they thought stimulated CE, and also which one single requirement they found stimulated CE the most. They were also asked if they had given examples of CE activities in their portfolio towards CO_2PL certification or an audit. Additionally, they were given the CE prompt sheet (see 3.2.3) and asked to comment on whether the CO_2PL stimulated or hindered these activities. This chapter sets out the results from these questions described above.

4.3.1 Does the CO_2PL stimulate CE?

To the question 'Do you think that the CO_2PL stimulates the Circular Economy?' 9 interviewees answered yes, and variations of yes. 9 interviewees also answered no, and variations of no, was also answered. Thus, there was an even split of views on this question. The pie chart (figure 17) below depicts these results, with 'no' answers on the left and 'yes' answers on the right.

The two most popular answers were 'no' and 'yes in some themes', as a third of the interviewees each said this. Three interviewees gave the response 'not really'. The answer 'yes' was noted by two interviewees. One respondent said yes, but the CO_2PL can do more to stimulate it.

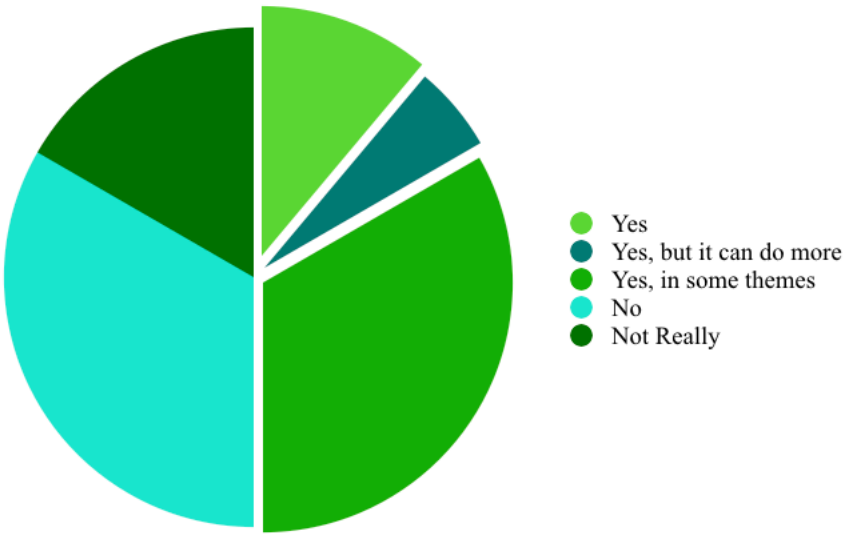

Figure 17: Pie chart showing whether interviewees think the CO_2PL stimulates CE

Participants were asked which CO_2PL themes (out of A: Insight, B: Reduction, C: Transparency, D: Participation) they thought stimulated CE. Interviewees were allowed to give more than one answer. As depicted in figure 18 overleaf, Participation scored highest, with votes from eleven interviewees. This is around double of what the others received, but all themes were mentioned by at least 5 interviewees.

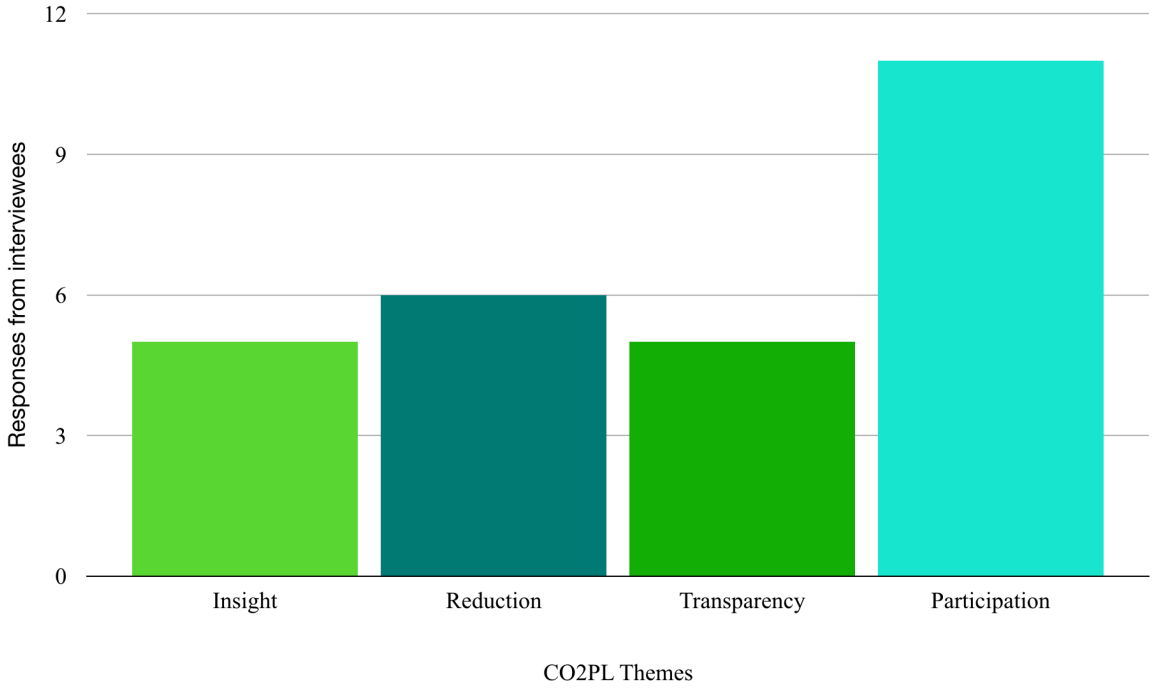

Figure 18: Bar chart showing the CO_2PL themes which interviewees think stimulate CE

Participants were also asked which CO_2PL level they thought stimulated CE the most. Levels 1-3 received no votes. Half of respondents said that levels 4 and 5, where organisations work with scope 3 emissions, are the most important for stimulating CE.

Since 9 interviewees said no or not really, the remaining interviewees answered with at least 2 themes each. Below is a summary of the reasons why each theme stimulates CE

- Most interviewees stated that the Participation theme of the CO_2PL was important for CE, as moving towards a Circular Economy cannot be done alone, and working with other organisations is necessary.
- Six stated that Reduction was important, as CE measures can also bring reduction of CO_2, and the goals you set here are important, as they could relate to both CO_2 and CE.
- Five interviewees said the Insight theme gives organisations the opportunity to see their impacts, and impacts of other partners in the chain, and where they can use CE measures towards this.
- Five noted that Transparency was useful for facilitating dialogue to work together with others – and this could involve CE and CO_2 measures.

The Participation theme was noted here as the most important, as it fosters cooperation between businesses. (PO5) expressed this point:

> *"I think participation in the horizontal and vertical chain*[12]*. I believe that the working together is a must. It looks so simple but it is the main problem. A project that works well – people are working together. A project that goes bad, people are not working together. It's not the asphalt, the concrete, the barrier, no, we can solve that."*

[12] The horizontal chain refers to the number of tiers in a supply chain, whereas vertical chain refers to the number, for example, of suppliers, in each tier (Lambert & Cooper, 2000).

This quote demonstrates that technical material issues which pose challenges can be overcome, and that collaboration is underestimated but important for developing a CE. Interviewees discussed how they work together with organisations on the same goals and share lessons with each other. Several interviewees organisations were working in external participation groups and with other companies to work on developing CE in businesses e.g. the Grondstoffen Akkord (the resource accord).

4.3.2 How do interviewees describe the relationship between the CO_2PL and CE?

This subsection shows how interviewees describe the relationship between the CO_2PL and CE, and why they do or do not think the CO_2PL stimulates CE. The four most common points that emerged are described below.

Indirect relationship

Several interviewees spoke of how the CO_2PL helps in some way to stimulate CE, but that the stimulation is indirect. This is to say, for example, the CO_2PL stimulates companies to communicate more with each other, and within these conversations, organisations may talk about developing CE projects. According to (PO1):

> *"The initiatives and dialogues with other parties, they focus on* CO_2 *but also on sustainability in a broader sense. Circular Economy often pops up in the conversation too. So that is also one of the requirements that helps."*

Furthermore (CP4) noted that the CO_2PL connects to CE because when you gain insight and start taking measurements about CO_2 emissions, this influences organisations decisions on how to pursue sustainability.

Organisational structures for managing CE and CO_2

It was gathered from the interviews that some organisations may work on CE developments in different departments than colleagues working on the CO_2 performance ladder and CO_2 reduction. Thus, the management of both sustainability topics, may not be linked in practice for many organisations. For example, one interview was with two members of an engineering company. One was involved with quality, health, safety, environment and certifications like the CO_2PL, whereas the other was involved with corporate procurement and circular procurement. They had never met and were not working together as an organisation on the CO_2PL and circular procurement. This can be one reason why companies do not link CO_2 to CE, as they are sometimes not dealing with both topics together.

Three interviewees noted that just a few people/groups are working on CE in their organisations currently. (PO1) and (PO7), two engineering organisations, noted that CE activities that occur in their organisation may 'fly under the radar' without recognition. Colleagues may perform circular actions, but do not recognise it with a sustainability advantage, and do not share what they did with others, they find it daily business. So, this meant that stories about CE measures were not always being disseminated in organisations, and this could block connections to be made with CO_2 management and the CO_2PL managers.

Common ties

Three interviewees noted how you could make common ties between the topics. (PO10) noted how ties could be made between the CO_2PL themes and CE - the Reduction theme and green electricity, transparency and showing how choices influence circular behaviour, and participation and working together with clients. (PO12) built on this point by saying:

"Yeah of course there are connections but it is really depending on how you formulate Circular Economy. If you formulate it in such a way that if you have interaction and transparency in your chain, yeah that could be definitely contribute to Circular Economy. Because if you do not have that interaction, you would never have a Circular Economy. Because that is linear."

Furthermore, (PO14) said the CO_2PL is neutral to CE and "you can just as well stay linear.", but if you have another trigger from stakeholders to think about CE, the CO_2PL does not block it.

Reversed relationship

Three interviewees believed that the relationship was not that the CO_2PL stimulates them to act on CE, but that they already take action on CE, and then they can use these activities for the certification. Moreover, (PO6) described this relationship as 'the link from CE towards the CO_2PL is stronger than the link from the CO_2PL to CE'. (PO1) articulated how his organisation applies CE activities on the CO_2PL:

"We do not do this specifically for one of the [CO_2PL] topics, but we help them to motivate – doing it together with other parties, give some more promotion and news and stuff like that. Then afterwards we check if this fits very well here or here on the [CO_2PL]."

Summary

- *Equal numbers of interviewees said that the CO_2PL stimulated CE (at least somewhat), and that the CO_2PL did not (or not really) stimulate CE*
- *Most interviewees said the Participation theme stimulated CE, because collaboration is important for realising CE. The other three themes were also mentioned by at least 5 interviewees.*
- *Interviewees said that levels 4 & 5 were said to be the most important for stimulating CE, as this is where Scope 3 emissions are taken into account.*
- *There were four common remarks that interviewees made to describe the relationship they experience between the CO_2PL and CE. These were:*
  - *The relationship is indirect between the CO_2PL and CE*
  - *Organisations work with the CO_2PL and CE in separate departments*
  - *There are common ties between the CO_2PL and CE*
  - *The relationship is reversed: The CO_2PL does not stimulate CE, but CE activities can be used towards the certification*

4.3.2 Which single CO_2PL requirement stimulates CE the most?

Interviewees were asked to pick one requirement from the CO_2PL that stimulates CE the most. Ten respondents picked out a specific theme and level when asked. The interviewees often initially provided just the names of themes, and needed to be prompted about the levels. Figure 19 below displays the results. The results are plotted by number of responses (x axis), CO_2PL levels (y axis) and theme (legend). For example, requirement 1A (Insight level 1) received 2 mentions.

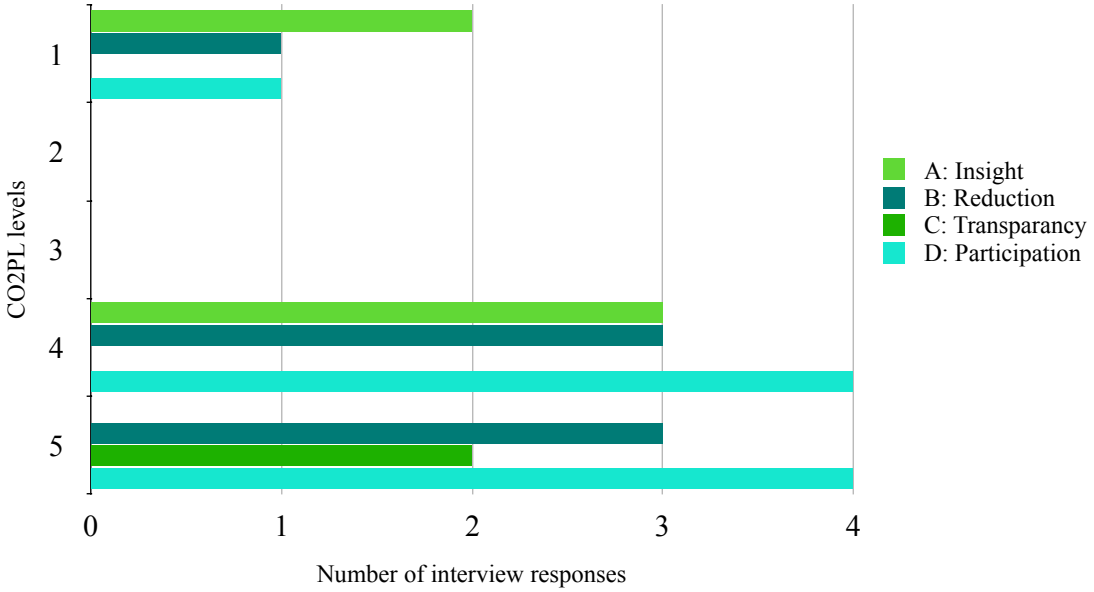

Figure 19: Bar chart showing interviewees views on which single CO_2PL requirement stimulates CE

Requirements 4D and 5D in the Participation theme received most mentions, four each. This is followed by 4A, 4B and 5B. 5C was the only requirement from the Transparency theme that was mentioned. When asked generally which themes stimulate CE, Transparency was noted almost equally to Reduction and Insight, but here, when interviewees were asked for a specific requirement, it was seen as less important than others. Unlike the previous section, requirements from level 1 were mentioned here. 1A received two mentions, and 1B and 1D were mentioned once each. These interviewees said Level 1 was important because they felt it was the starting point for gaining insight into sustainability impacts.

Summary

- *Companies were most stimulated to act on CE by 4D and 5D from the Participation theme. 4A, 4B and 5B were also popular answers.*
- *For some interviewees, level 1 requirements were important because this is the starting point for companies to begin developing sustainability strategies*

4.3.3 Have interviewees used CE activities towards the CO_2PL certification?

This subsection displays the results for whether interviewees used CE activities towards certification on the CO_2PL or a re-certification with an audit.

While most said no (six responses), four said yes and gave examples, and another three were considering it for the future. Other responses mentioned by a few interviewees each were that they had potentially included CE activities on the CO_2PL. Two said that CE activities were used as additional activities during audits. These interviewees did not provide specific examples.

As for those four that said 'yes', figure 20 below shows examples of which CE activities interviewees organisations performed, and which CO_2PL requirement this was applied towards.

Organisation	CE activities these organisations used towards the CO2PL certification, and which requirement they were applied towards	
PO1	5D - Taking an active part in setting up a sector-wide CO2 emissions reduction programme in collaboration with the government or NGO.	Bio-composite lamp
	5C - Transparency. Commitment to a government or NGO CO2 emission reduction programme. Communicating about objectives and realisation of these.	Communication with organisation (Tribu) that make circular office décor
PO2	4A - Chain analysis. Reporting CO2 footprint across the supply chain - Scope 1, 2 and 3 emissions.	Reused concrete, refurbished vehicles, textile bands from cargo made into handbags, waste separation container
	4B Chain initiative. Setting quantitative CO2 reduction objectives for scope 1, 2 & 3 CO2 emissions.	Waste collection initiatives and alternative fuel liquid natural gas (LNG)
PO3	4A - Chain analysis. Reporting CO2 footprint across the supply chain - Scope 1, 2 and 3 emissions.	Plastic recycling
	4B Chain initiative. Setting quantitative CO2 reduction objectives for scope 1, 2 & 3 CO2 emissions.	Generating energy out of waste coffee grounds
	4D - Initiating development projects that facilitate reductions of CO2 in the sector.	New plastics recycling facility
PO4	5C - Transparency. Commitment to a government or NGO CO2 emission reduction programme. Communicating about objectives and realisation of these.	Reused asphalt used in the mix of new asphalt

Figure 20: CE activities which have been applied on the CO_2PL

The main activities that were applied for certification on the CO_2PL were to do with waste separation, waste collection and recycling. This is understandable, since two of the organisations listed above work in the waste management sector.

Interviewees described why they would not use CE activities for the CO_2PL. Two main reasons emerged:

The audit

Some interviewees noted that they did not want to use CE activities towards the audit, as they felt they should focus on CO_2, as these are most relevant. As discussed by (PO7) and (PO11):

"No, I don't think so because in the CO_2pl, it focuses on CO_2, so when we want to choose the projects that we bring in, from the list of all sustainability projects, then we choose the projects that are mostly to do with carbon reduction."

"We just do not want to rattle the cage too much and incorporate something new"

Some interviewees also felt that auditors would not definitely accept CE measures, and that because no auditor asks for CE, there is no drive to mention it in the CO_2PL audit.

The impacts of CE activities are too small

The CO_2PL has a threshold for which emissions should be accounted in the CO_2PL (see 2.4). Some interviewees said that the impact of CE activities they have performed is too low to account for it in the CO_2PL.

For example, an interviewee from an engineering organisation (PO8) noted that they perform CE activities currently in their office supplies, not in engineering projects they create. He noted:

"If we were to construct bridges, then we would have a very practical way that we deal with circularity in our way of doing. For us now indeed [CE] is our office supplies, and this is really important, but of course, we say most of the [CO_2] impact is in projects, then yeah, the connection is maybe a bit lost."

(CP4) recognised the same, as their circular activities are mainly circular procurement for offices. He recognised that the amount of CO_2 reduced with these measures is very small and they do not have to counted in the CO_2PL.

Summary

- *More interviewees said they had not used CE activities on the CO_2PL*
- *Some organisations were planning to use CE activities on the CO_2PL in the future*
- *The CE activities used towards certification were mainly to do with waste separation, waste collection and recycling.*
- *Interviewees had two main remarks about why they did not use CE activities on the CO_2PL. These were:*
  - *They felt that they should focus on CO_2 in the audits*
  - *The impacts of CE activities are too small to be used for certification*

4.3.4 Which CE activities in the CE prompt sheet are stimulated by the CO_2PL?

Interviewees were asked if they felt the CO_2PL stimulates or hinders CE activities that were written on the CE prompt sheet (see 3.2.3). This subsection displays these results.

Four interviewees had no additional comments to make, and another two said the CO_2PL did not really stimulate CE in this detail. As for the rest of the interviewees, the graph below shows which CE activities were mentioned.

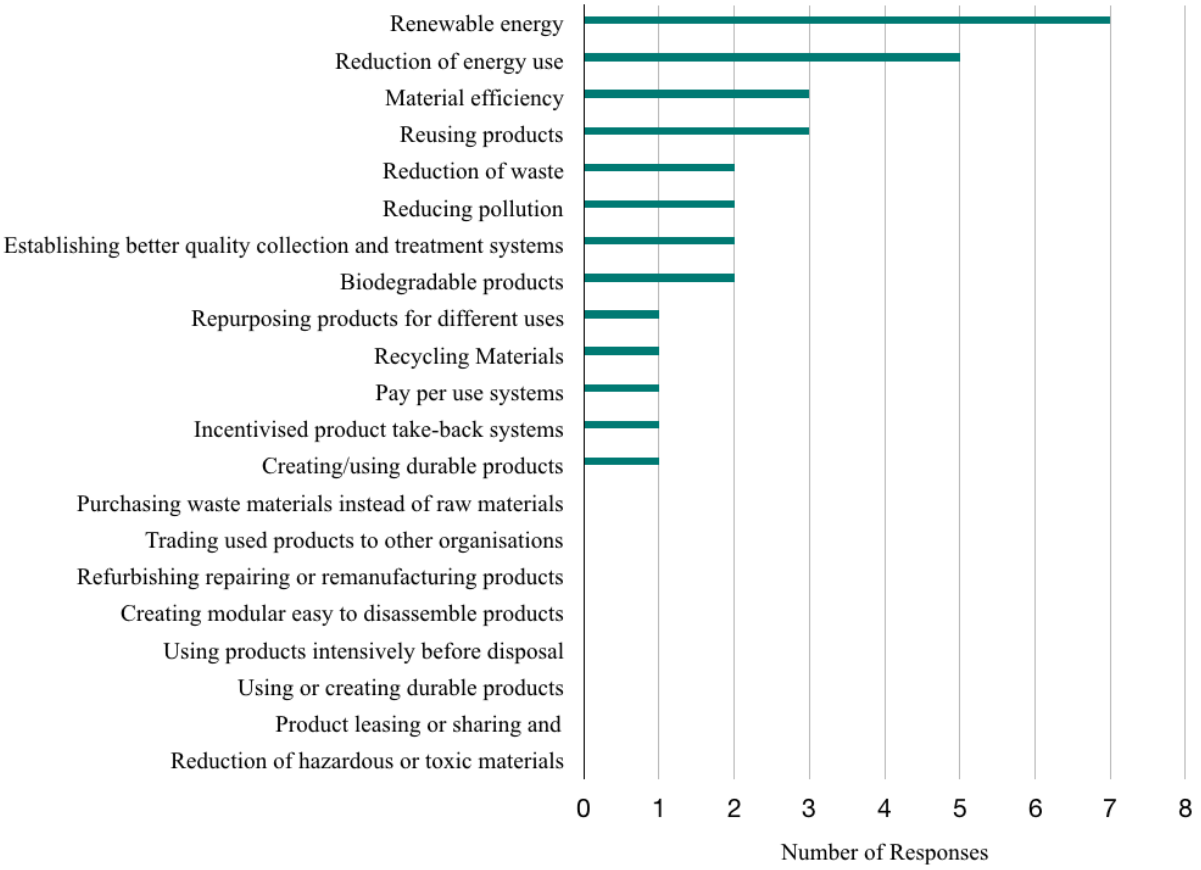

Figure 21: Bar chart showing interviewees views on which CE activities are stimulated by the CO_2PL

Renewable energy and reduction of energy use received most responses. Material efficiency and reuse of products were pointed out by a few interviewees each. Several other different answers were received and discussed by only one or two interviewees.

Most interviewees felt that the stimulation of these CE activities from the CO_2PL was not strong. The following statements help to demonstrate this outlook.

(PO9) noted that the stimulation of these activities depends on the ambition level of the company using the CO_2PL. (PO2) stated they can all be solutions in the chain, but some are more relevant to the CO_2PL than others. Furthermore, (PO11) added

> *"You could explain why it would help the* CO_2 *reduction. You can make a story with every one of those."*

These statements emphasise that it is possible to link these CE activities to the CO_2PL, but they do not find the CO_2PL is encouraging many of these activities specifically.

Summary

- *Three quarters of the respondents made comments on the CE activities that the CO_2PL helps promote.*
- *The most noted activities were energy related. There was a spread of answers across thirteen activities.*
- *Organisations said there could be connections made between these topics and the CO_2PL, but they felt the stimulation was not very evident.*

4.4 The hindrance of CE from the CO_2PL

To the question 'Do you think that the CO_2PL hinders the Circular Economy? Seven interviewees believed that the CO_2PL does not hinder CE. The word 'hinder' however, was stressed as being too strong by many interviewees.

It was noted by another seven interviewees that the focus on CO_2 reduction does not particularly stimulate CE. For example, (PO14) said the CO_2PL asks only for energy reduction. However, he raised the point that the CO_2PL does not ask organisations to use just the same amount of energy as they do currently, but from green sources. He said that there should be no problem if an organisation uses more energy, but instead of fossil fuel energy, organisations go towards using completely green energy.

In another example, waste management organisation (PO3) believed that the CO_2PL wants organisations to reduce CO_2 emissions across scopes 1,2 and 3, and this does not stimulate CE[13]. He said:

> *"Scope 3 is the most important. If we transport more separated waste (2% more fuel use in scope 1&2), then they can recycle more and this is good for CE, and your reduction is 5% in scope 3. But if it is not separated (less fuel in scope 1&2), more is incinerated – but this is a lot of* CO_2 *in scope 3."*

Interviewees noted that they feel the focus of the CO_2PL is on CO_2, not CE, and some said this is because the handbook and other documents are not worded in a way to include CE as part of the system. (PO1) said

> *"The* CO_2 *ladder does not hinder circular activities, but sometimes the description in the scheme is made in such a way that you don't put the circular efforts in the portfolio."*

[13] The CO_2PL list of measures accepts that there can be greater emissions related to the recycling of goods, if the avoided emissions in the virgin production of goods is reported

Summary

- *Interviewees felt the word hinder was too strong to describe the relationship.*
- *The answers for this question were very consistent; only two types of answer were received.*
- *There was a split of answers between 'the CO_2PL does not hinder CE', and 'the focus on CO_2 reduction does not particularly stimulate CE'*

4.5 Interviewees views on whether the CO_2PL should stimulate CE

The final objective of this research is to provide recommendations to SKAO on whether it is possible or worthwhile for them to stimulate the CE through the CO_2PL. To help provide insight for this, interviewees were asked whether they think the CO_2PL should have a role in stimulating the Circular Economy. Several different viewpoints were received.

Over half of the interviewees said yes, because the CO_2PL can stimulate companies to take action. PO8 stated:

> *"I think it would be a good idea to stimulate them to do so. Because the task is big, to have 50% circular by 2030, it is a big challenge. Everything that can encourage Circular Economy can be a great idea."*

Many interviewees noted that the CO_2PL could play an important role in in stimulating CE because it creates awareness about sustainability impacts. Interviewees also noted that the CO_2PL could make companies verify the CE activities they performed and demand data about products from their suppliers. The CO_2PL could ask companies to report on their data, and this could improve the strictness of the way CE is reported. (CP1) stressed that transparency about data is a problem in the progress of CE.

> *"Well what's happening at the moment is you find very large gaps of information which people don't know or don't want to share. There is a big amount of trust with sharing information. It is ridiculous. What's happening at the moment, is there are companies that don't want to be transparent, they're going to be left out, because they won't be trusted."*

In line with this, many interviewees drew on the importance of the Transparency and Participation themes to stimulate communication about CE in the supply chain. (PO12) said:

> *"I think there is a lot to win for CE because you can see Circularity from a material kind of way, but you can see it also in a business opportunities and new business model's way, and therefore transparency very important. So here is a lot of opportunities and similarities."*

However, five interviewees did note they are interested in taking action on broader impacts of sustainability than just CO_2, for example soil, water and air pollution. Interviewees noted that the CO_2PL should be flexible to include in wider sustainability issues, and be more compatible with CE. For example, (PO1) stated

> *"My personal opinion is also that it would be good to make a promotion of the Circular Economy a part of that. If you check what the idea behind the CO_2PL, and it focus, well you can discuss whether Circular Economy should be included in that. Most important at this moment is to make the CO_2PL more Circular Economy compatible."*

There were a couple challenges which interviewees could foresee in incorporating CE more into the CO_2PL. For example, because CE is not mature, it would be difficult for organisations to keep demonstrating improvement in their performance year-on-year. Furthermore, the CO_2PL has five levels which indicate performance, and it may be difficult to make a distinction between organisations based on their CE activities. (PO10) noted this is important because the CO_2PL is tied in with the tender process which decides if organisations are awarded projects or not, which is influenced by their level on the CO_2PL.

However, a few interviewees that said they did not want the CO_2PL to stimulate CE. The reasons were that these interviewees did not want extra requirements in the CO_2PL, as it would make the tool oversized. The other reasons given were that other tools (like DuboCalc) and organisations (like Madaster) are useful for managing and measuring CE, so the market should not become overcrowded with several players trying to integrate CE.

Summary

- *Most interviewees said the CO_2PL should stimulate the CE, as it can encourage organisations to take action, to verify their actions and report their impact using data.*
- *Companies think that the Transparency and Participation themes can help stimulating CE, as they will make organisations work together more in the supply chain*
- *Some said they did not want extra requirement in the CO_2PL, and that other tools and markets are already helpful for stimulating CE.*

5. Discussion

This chapter begins with an interpretation of the key findings from this study and the literature. After this, there is a reflection on the research methods and results. Finally, the chapter concludes with a section that discusses how the findings of the research provide a contribution to theory, practice and society.

5.1 Interpretation of key findings

This section is a narrative description of the key themes from the results and academic literature about the management and measurement of CE and CO_2, followed by the stimulation or hindrance of CE from the CO_2PL. There were some connections which were analysed between the topics of CE and CO_2 management and measurement and the CO_2PL, and these are discussed where applicable in the following sections.

5.1.1 Key findings regarding the management and measurement of CE and CO_2

The maturity of CO_2 and relative immaturity of CE is not a novel finding to emerge from this research. It is described throughout academic literature, for example Obla, (2009), Wijkman & Skånberg, (2015) and Winans et al. (2017).

However, what did emerge from this research, is that the maturity of CO_2 and CE management and measurement affects how organisations perceive them. The different maturities of these topics also provide insight into the context of organisations sustainability management. For example, CO_2 management is much more mature, as companies have been active in CO_2 reduction for many years. Many interviewees perceived that they had reduced a lot of CO_2 emissions, and that the quick wins and cost saving measures have been carried out. The current context of their CO_2 management is that to reduce CO_2 emissions further, they have to take more difficult steps. This includes changing employee driving and flying behaviours and making greater investments towards majority green energy and fuel use, which can be hard to influence as one of a few sustainably-minded personnel in an organisation. This in in line with the findings in literature from McKinnon & Piecyk (2010) and Treitl et al. (2014), who noted the importance of cooperation of personnel in reducing CO_2, and also the challenges of reducing transport emissions. Interviewees had less enthusiasm about CO_2 management than CE, potentially because in this current context of CO_2 management, they are faced with more challenges than quick wins.

Furthermore, the perception from interviewees was that CE is a very important new development on the market, and they were very motivated to begin working to realise a CE. Organisations have become aware of the impact their material use has on the environment. They are keen to hold onto their material resources, as these are considered assets in the context of increasing global resource scarcity. It can provide some excitement to be part of this new development, and to work on gaining expertise and experience in CE so organisations will be more competitive on the market. This context provides organisations with financial incentive to save resources and become a competitive market player vis-à-vis CE, which can help to explain the enthusiasm of interviewees about CE. The interviewees current perception about CO_2 and CE management can be reflective of how interviewees may have the organisation support, or conversely, they have to work to change their organisations behaviours.

The low maturity of CE can also explain why organisations are less strict when it comes to CE measurement, compared with CO_2. Organisations are mature in CO_2 measurement as they continually set CO_2 reduction targets, quantify their results and demonstrate their improvement (as part of the CO_2PL certification). However, interviewees were critical of the accuracy of the CO_2 emissions they report on. For example, (PO3) noted that a waste collection truck that stops regularly will have higher

CO_2 emissions, and stakeholders of their company wanted them to find a way to accurately report this. Furthermore, many interviewees were discontent that estimates had to be made for CO_2 footprints and, for example, measuring the CO_2 performance of the same piece of road could provide greatly different results. These examples show that organisations want to represent CO_2 emissions accurately.

By contrast, many organisations were not strict about quantifying the impacts of CE measures. Some organisations were choosing to just communicate about the benefits of a circular product, and not measure its exact impacts. Some did not have a precise way of making comparisons between multiple circular products to see which is more beneficial. They discussed questions they would ask suppliers to judge a products performance, and also how they could base decision-making on their clients' preferences. This is in line with Saidani et al. (2017), who note that businesses have more practical methods for measuring CE than academic measurement methods. These findings could be related to lack of maturity of CE, and that there is no established method for measuring CE and there is a lack of (reliable) data available. Furthermore, since CE is an emerging topic receiving attention in academia and on the market, it could be perceived as good for organisations to be doing something towards CE, and that this is worth talking about, whether strict measurements are involved or not. These examples show there is a notable contrast between what organisations perceive as appropriate measurement approaches for CO_2 and CE, as related to their maturity.

Interviewees discussed that LCA is useful for quantitatively measuring both CO_2 and CE. However, the choices about indicators (impact categories), data used, assumptions etc., need to be clear to understand the real impact. For example, when measuring the impact of a circular product, it is important to understand if its impact is being measured over multiple lifecycles or just a single lifecycle. Furthermore, a circular product is only beneficial for reducing CO_2 emissions if it is transported within a certain distance. This latter point is supported by the literature from McIntyre et al. (2009). In the results for connections and trade-offs for CE, there were mixed results about how a circular product (e.g. a modular construction) could increase or decrease CO_2 emissions. It was unclear from the interviews if these interviewees were discussing the same type of product, or if the impact was considered over multiple lifecycles, what energy sources were used to recycle the product, or what transport was included in their measurement, for example. This mixed knowledge affects what businesses can know for certain about the impact of CE measures on CO_2 emissions. Thus, the way in which impact is measured for CE activities, can affect how organisations perceive CE and CO_2 management to be connected, or cause trade-offs.

There were some challenges for organisations in measuring CO_2, but CE measurement was noted to be much more difficult. Interviewees were wanting to measure CO_2 emissions in a representative way in individual projects, but this is not simple given the number of projects for example. Regarding CE measurement, challenges included finding reliable data, quantifying impacts and difficulty employing indicators and KPIs. The diversity of different measurement challenges is reflected both in these results, and in the academic literature (Camacho-Otero & Ordoñez 2017; Pauliuk, 2018; Saidani et al., 2017).

Interviewees wanted to represent CE in a holistic and representative way, to mirror the diversity of the concept, but a holistic approach is hard to operationalise. To get around these issues, some interviewees said it is helpful to express CE impact in terms of CO_2 emissions, as a simple way to provide insight into the impacts. However, some interviewees believed this is not representative of CE. This is in line with Laurent et al. (2012), who noted that multiple indicators can sometimes align and be represented with CO_2 emissions, but also that looking only at CO_2 emissions can limit the understanding of a products impact.

With the examples given above, there is a juxtaposition between organisations wanting to describe CE and CO_2 impact in a representative way, but wanting to keep it simple enough to work with for their organisation. For example, (CP3) discussed trying to make a holistic KPI for CE, and how this was not successful. He had created a KPI for circular procurement with several indicators, but in the end,

it had to be simplified to two indicators, so that it could be operational. He reflected that while this procurement KPI is functional and reduces pressure on virgin materials, it is not a full reflection of the CE concept. This idea of representativeness vs simplicity can also explain why some interviewees did not want CE to be included in the CO_2PL. They noted that they did not want the tool to become oversized (favouring simplicity), and that the CO_2PL was not built for the purpose of CE (representativeness).

Interviewees perceived it more beneficial to look at multiple impacts within sustainability, as is set out by the CE concept. In comparison, they perceived CO_2 as just being one part of the bigger picture. Interviewees pigeonholed CO_2 management in their organisations as 'household' activities, such as electricity generation in their facilities and fuel use in their vehicles. They spoke eagerly about CE management being the 'real work' they do with materials. However, these organisations rely on energy and fuel use for their work in projects, and also, each material they use has an embodied CO_2 footprint.

By naming CO_2 emissions as 'only one impact', interviewees gave less importance to CO_2 management. However, in the section regarding trade-off between CE and CO_2 section, it was evident that green energy and fuel needs to be applied throughout the supply chain to improve the impact of CE activities. While CE may look towards multiple impacts, it is problematic to reduce CO_2 management to 'one impact', as this takes away from the notion that entire supply chains are embedded with CO_2 emissions and the measures to reduce CO_2 and prevent climate change need widespread attention.

5.1.2 Key findings regarding the stimulation or hindrance of CE from the CO_2PL

Two key themes were analysed from the results for RQ2. These are named 'Taking the CO_2PL at face value' and 'Conditions promoted by the CO_2PL which can stimulate CE'

Taking the CO_2PL at face value

It can be analysed that many interviewees take the CO_2PL at face value. This expression means that something is perceived based on its outward appearance, without interpreting its underlying purpose. In the context of the CO_2PL, its face value is a management tool focused only on CO_2 reduction. There are several examples below which demonstrate that interviewees do not connect CE with the CO_2PL, because they perceive it as a tool for CO_2 reduction.

Several interviewees said the CO_2PL hindered or did not stimulate CE, because it was focused on CO_2 reduction. Some felt there was no explicit mention of the CE in the CO_2PL handbook or list of measures. Moreover, many interviewees said they did not put CE activities towards certification because the focus of the audit is on CO_2, and it is not appropriate to include CE activities for certification. Also, after seeing the CE prompt, many interviewees did not have additional comments to make or they felt there was not a strong stimulation from the CO_2PL on these specific CE activities. These results could suggest that interviewees do not particularly connect CE with the CO_2PL, as CE is not an explicit focus of the tool.

It is analysed that many interviews feel they can choose to use CE activities for the CO_2PL certification, because there are links between the topics of CE and CO_2 management (which echoes the results about the connections between CE and CO_2 in 4.1.3). For example, interviewees had comments like 'the CO_2PL is neutral to CE', 'the CO_2PL does not block CE' and 'you can potentially use CE in an audit'. Furthermore, many interviewees thought the word hinder was too strong to describe the relationship between the CO_2PL and CE. Interviewees replaced this with 'does not really stimulate'. Moreover, three explanations emerged from the results about the relationship from the CO_2PL to CE, and many organisations felt the relationship was indirect, that common ties could be made and organisations already perform CE activities (rather than being stimulated to do so). These

results show that many interviewees feel the CO_2PL is open to certifying CE activities, because there are links in the topics. However, the stimulation from the CO_2PL to CE is not evident to them. However, there was a half-half split between interviewees responses of 'yes, the CO_2PL can stimulate' and 'no, the CO_2PL does not really stimulate'. Thus, not all interviewees saw the CO_2PL to just focus on CO_2. The following section provides a suggestion for why some organisations feel the CO_2PL stimulates CE.

Conditions promoted by the CO_2PL which can stimulate CE

Many interviewees felt that the CO_2PL helps their organisation take action on sustainability, and it improves the way they work, and this has helped to stimulate CE in their organisation. The word 'conditions' was chosen to represent this theme, as it can be defined as the factors affecting the way in which people work. (CP1) summed up this relationship by saying:

> *"The [CO_2PL themes] which are most helpful are still the way you work in the whole product chain. Making relationships to bring sustainability further you see that companies are also now investing in Circular Economy because of the CO_2 performance level to get the credits for doing something sustainable in the sustainable community. So, it's not directly stimulating, it's more of an indirect thing. There's only so many things you can do directly onto CO_2. It's more the broader aspects that you can take into account to say you're very sustainable and good and do something for this [CO_2PL]."*

Interviewees noted that these types of conditions are encouraging or helpful, in place of stimulating, as stimulating insinuates a more direct relationship. Here, the relationship from the CO_2PL to organisations CE activities is more indirect; Interviewees felt that the themes of the CO_2PL help to trigger action, which can then stimulate CE. For example, they noted it is useful to look into their impacts and supply chain impacts (Insight theme), set targets and create results (Reduction theme), communicate about their actions internally and externally (Transparency theme) and collaborating with other organisations in sustainability initiatives (Participation theme). These conditions which interviewees found useful are also backed up in CE literature. Authors note that the following conditions can stimulate CE: life cycle thinking (Daddi et al., 2015), examining the impact of businesses (including the focal business) in the supply chain (Genovese et al., 2017; Heyes et al., 2017; Park et al., 2010; Wen & Meng, 2015), creating structures for communicating and sharing knowledge with other actors in the supply chain (Ceglia et al., 2017; Krarup et al., 2015).

They also noted that the CO_2PL levels 4&5 are the most useful because at these levels organisations are working together in supply chain, and they felt this is very important for CE. Some interviewees also noted that the levels 1&2 were important, because these stages help to get organisations started in organisational sustainability, and they began to mature from this stage. These examples demonstrate how the CO_2PL has a beneficial impact on the way interviewees organisations work, and this in turn can stimulate them to develop CE.

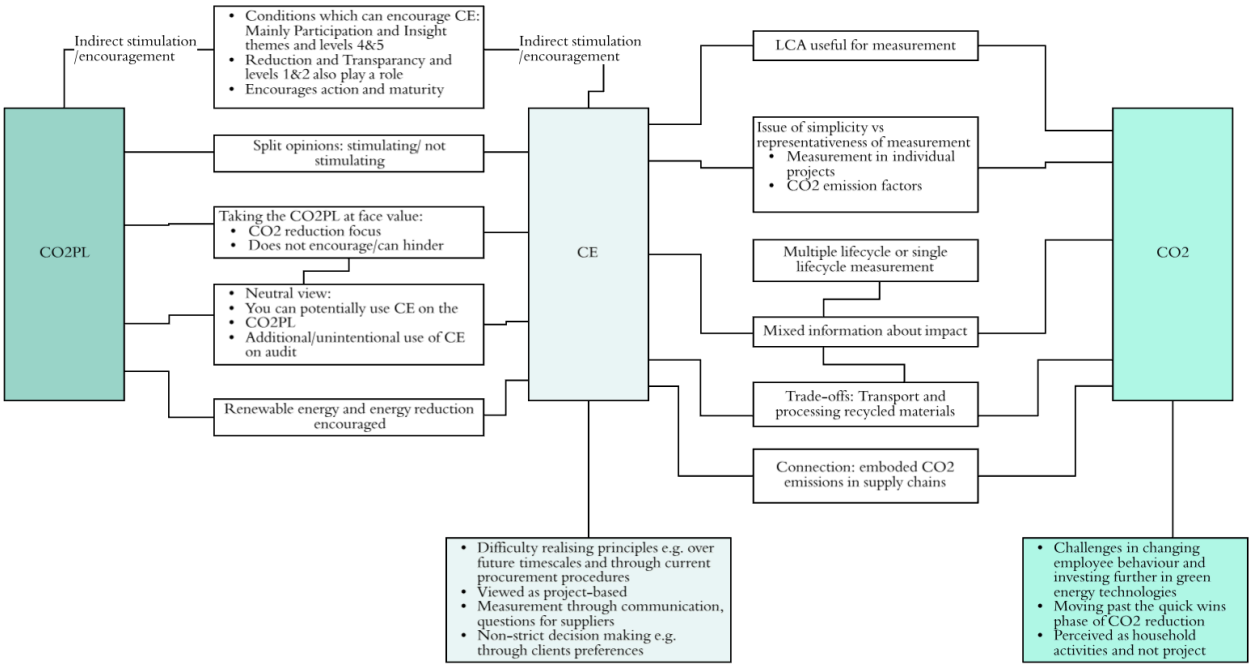

Figure 22: Theoretical framework with results of the research

Figure 22 above is the theoretical framework from this study, which is updated with some of the main findings from the results and discussion sections. Lines between the CO_2PL and CE, and CE with CO_2, represent how interviewees relate these topics. There are some connections between the findings, for example, the mixed understanding about impacts of CE activities on CO_2 can relate to trade-offs with the transport of goods, and the understanding of how many lifecycles an impact is measured over. The blue and green boxes connected to CO_2 and CE describe the individual contexts and perceptions of these topics.

5.2 Reflection on research methods and results

5.2.1 Variation in perceptions and responses across questions

There were different answers received about how the CO_2PL themes, levels and requirements stimulate CE. Interviewees interpret the usefulness of each theme and level differently in how they stimulate or hinder CE.

For example, there were interviewees who said that the Reduction theme hinders, and conversely, that it stimulates CE. Also, the Transparency theme was not stressed as the most important theme for stimulating CE. However, others said the Transparency theme holds the key to where CE could be stimulated, by encouraging validation of companies CE activities. Furthermore, when presented the CE prompt, there was as spread of answers about which CE activities were stimulated by the CO_2PL. Nine of the activities had less than two votes each, which demonstrates that interviewees had different perceptions about the CO_2PL and how it relates to CE. The consequence of this is that generalisation of the results is limited, because themes of the CO_2PL are perceived in opposite ways.

However, this is also an important finding of the research; what one interviewee may find useful, another may find the opposite true. The expression 'beauty is in the eye of the beholder' summarises these finding well. Not only is the CO_2PL perceived in different ways, but also interviewees have different perceptions on what is useful for stimulating CE. Thus, it is a finding of this research that by providing a management tool with four different themes and five levels, the CO_2PL can reach out to companies and personnel with different perceptions.

Another finding from this study was that different responses were recorded across similar questions (See interview questions 14, 15, 16 and 19 in Appendix B). These questions asked if or where the CO_2PL stimulate or hinders CE activities and if there is a connection between CO_2 and CE management.

Only one interviewee had consistent 'no' answers across these questions. The rest of the interviewees did not have consistent answers, e.g. an interviewee said the CO_2PL did not stimulate CE, and in the following question, they said one particular CO_2PL requirement stimulated CE. This could suggest that by asking multiple similar questions, interviewees were probed on the relationship between these topics and they gave a mix of answers which reflected their experiences and their understanding of educated links between topics. This research attempted to understand interview perceptions and experiences, but perhaps this did not come across always in the results. This mix of responses could reduce the validity of data.

5.2.2 The effect of interviewee knowledge and experience on results.

It was acknowledged that interviewees had different roles in their organisation, and they may have different levels of knowledge and experience vis-à-vis the CO_2PL and CE.

The results were reanalysed to try to understand if interviewees level of knowledge and experience about the CO_2PL and CE, had an effect on the answer they gave.

To operationalise this, a 3-point scale with indicators was devised to describe the interviewee and their organisations experience and knowledge. This was compared with their answers for whether they believed the CE was stimulated by the CO_2PL and if there was a connection between CO_2 management and CE. Figure 23 overleaf shows the indicators that were used to assess the interviewees, their organisations and their answers.

	Good	Mediocre	Poor
Indicator for interviewee's involvement with the CO_2PL	Full responsibility over the CO_2PL certification	Responsible for part of the CO_2PL certification (e.g. one theme, or outsourced responsibility to another team)	Not really or not involved with the CO_2PL.
Indicators for interviewee's familiarity with CE	Interviewee could speak about CE principles in depth, including specific challenges of operationalising CE	Interviewee stated they were just investigating CE. Did not discuss the range of CE principles, and not in great depth.	Interviewee stated their uncertainty regarding CE and had basic knowledge.
Indicators for interviewee's organisation experience with CE	Organisation has performed many projects with CE measures. They are trying to stimulate CE in the market	Organisations are performing some projects with CE measures. But are also still just investigating the topic	Organisations are undertaking small pilots, investigations or CE measures for offices, not projects.
	Positive	Mixed	Negative
Indicator for the answer to "Do you see a connection between CO2 and CE management?"	Yes	Yes and No	No, operationalising CE creates more CO_2 emissions
Indicator for the answer to "Does the CO2PL stimulate CE?"	Yes, or yes it does in some parts	N/A	No, or not really

Figure 23: Indicators for assessing interviewees knowledge and experience

Figure 24 below shows the results. Each horizontal row represents one interviewee. The first block are interviewees that were very familiar with the CO_2PL and CE. The middle block is for those interviewees with experience with familiarity of the CO_2PL, but less familiarity with CE. The last block is interviewees with lower familiarity of the CO_2PL.

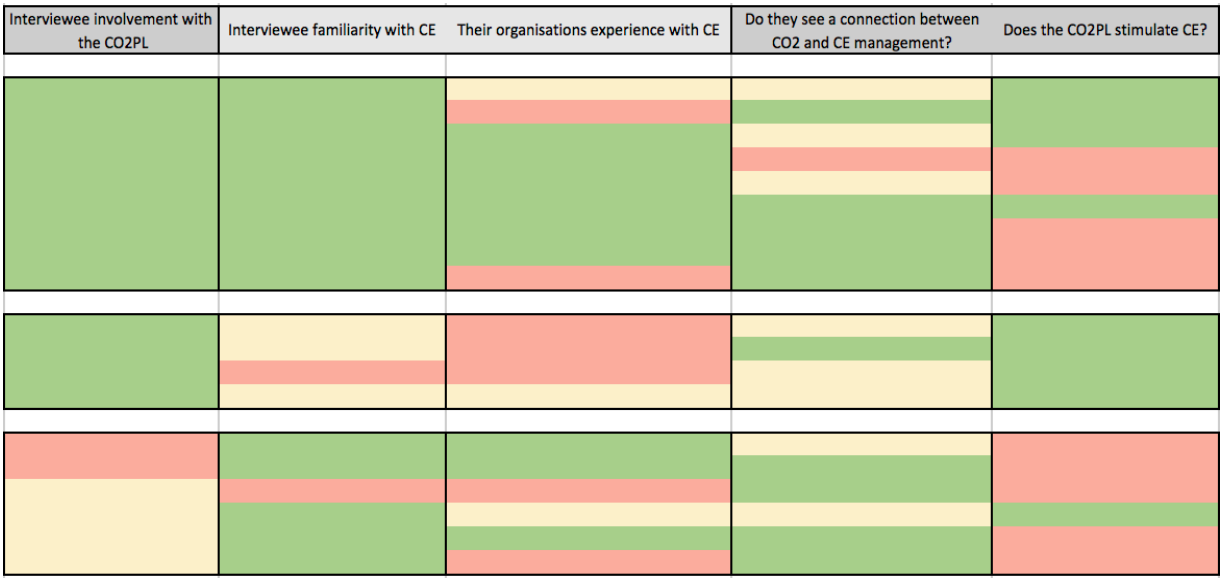

Figure 24: Analysis of interviewee knowledge and experience regarding CE and the CO2PL

There is some relationship which can be seen at the extremes. For example, interviewees with less responsibility using the CO_2PL witness no stimulation from the CO_2PL towards CE. Perhaps this is because these interviewees outsource the work of maintaining certification to other professionals or they only deal with some individual sections, so they are not involved fully in the CO_2PL for it to influence their work on CE.

Furthermore, the middle block of interviewees and the top two interviewees in the first block are familiar with the CO_2PL, but their organisations are not experienced or familiar with CE, see the CO_2PL as having a stimulating effect. To analyse this, perhaps these interviewees see a stimulating relationship because they are just beginning to work on CE, and they see the benefits of CO_2PL in encouraging them to, for example, gain insight, to and create discussions with companies in the supply chain about CE.

The results for 'do they see a connection' are not easily correlated to the interviewees involvement and familiarity with the CO_2PL and CE. Moreover, the results about the connection between CO_2 and CE are mixed between these three blocks.

5.3 Contribution to theory, practice and society

This research has provided insight and critical reflection into the current context of organisations management and measurement of CO_2 and CE in the Netherlands. This research had a unique focusing in trying to understand how and why organisations perceive these topics, and the relationship between them.

This research revealed the sort of conditions which organisations find important for stimulating CE e.g. collaboration, insight. Furthermore, this study also revealed some specific challenges facing the management and measurement of CO_2 and CE. There were especially many results regarding the challenges of realising CE in practice. For example, while CE is not measured with as much diligence as CO_2, false claims could emerge which do not represent the impact of a product, which has negative implications for sustainability. This study will contribute to emerging literature that discusses the challenges of realising CE (Kirchherr et al., 2018; Ormazabal et al., 2018; Roper et al., 2017). It is important to continue research into how organisations are challenged by developing CE, so more awareness is created and plausible solutions can be devised to help make CE a reality. This can have knock on beneficial sustainability effects on supply chains, and slow the resource depletion issue.

It is noted that there is a trend in sustainability and CE literature to aim for impact across multiple environmental issues (e.g. Figge & Hahn, 2004; Hobson & Lynch, 2016; Laurent et al., 2012; Schaltegger & Wagner, 2017). This can create benefits across a range of different pressing issues. However, by focusing on holistic sustainability issues in literature, and in business, attention may be taken away from 'single issues' like CO_2 emissions related to fossil fuel use. This research contributes to the theory and practice by bringing forward the message that before 'jumping onto the CE bandwagon', great strides are needed to transition entirely away from fossil fuel. This study emphasised that energy and CO_2 emissions are embedded in supply chains, and developing more green energy can create more mutual benefit between CO_2 emissions and creating a CE.

This study also showed that there needs to be more transparency regarding the impact of CE. It was found in this study that there is mixed understanding of how CE activities can have an impact on CO_2 emissions. It should be more of a focus in academic papers and business practice to clearly describe the data that was used for measurement, and the underlying assumptions. For example, how many lifecycles the impact is counted over, can this be guaranteed to be in use for the estimated lifetime, and what transport is involved in operationalising a CE activity. This can help provide better comparisons between CE impact and CO_2 emissions.

7. Conclusion

This research project intended to understand if the CO_2 performance ladder stimulates or hinders Circular Economy developments for users of the tool. To gain further insight, this research also explored how users of the CO_2PL manage and measure CE and CO_2 in their organisations. The epistemology of the study was the perceptions and contextual experiences of the interviewees. Semi-structured interviews were conducted to collect information from nineteen organisations who use the CO_2PL system and who have performed CE activities. Results were coded by a combined deductive-inductive methodology – using codes from theory and from the interviews. The results were discussed by the key themes which emerged. This allowed for the research questions to be answered:

RQ1: How do users of the CO_2PL manage and measure CE and CO_2?

The lack of maturity of CE had a bearing on the relationship between CO_2 and CE management and measurement. CE is new and becoming popular, so it can be seen as good to do 'anything' in terms of CE management – e.g. high or low-quality reuse, no strict measurement of impact. Organisations often did not make discerning measurements of CE activities, unlike CO_2. Because of its low maturity and difficulty to measure through suitable data and indicators, CE measurement was more a topic of discussion with suppliers, clients and co-workers. Conversely it was noted that the market requires companies to be active and transparent regarding CO_2 management and measurement.

The perceptions between CE and CO_2 management also relate to maturity. There is much hype about CE, despite an array of challenges for realising its principles. On the other hand, organisations have already employed many quick wins for CO_2 reduction, and now they must make big steps in changing company culture and fostering the renewable energy transition. It appeared that organisations are keener to explore CE, than to optimise their CO_2 management.

Interviewees could relate CE more to CO_2 reduction, rather than vice versa, as CE can forgo the need for virgin production of goods, and embodied CO_2 emissions along the supply chain. However, the trade-offs of CE activities causing increased CO_2 emissions (in the present time) was caused mainly by transport of and reprocessing of goods, which operates on fossil fuel energy sources. Understanding impact between CE measures and CO_2 is difficult however, because it was not understood from interviewees what data was used and whether impacts were being counted over multiple lifecycles.

Following on from this, time is an important factor for the relationship between CO_2 and CE management. For example, realising a CE activity could create greater CO_2 emissions in the present day, but promise long-term use, and perhaps CO_2 benefit in the long run. If you spread impact over multiple lifecycles it looks beneficial, but multi-lifecycle use is not guaranteed. Since we can only predict the long-term impact, it is hard to know what the actual impact will be for CO_2 emissions.

As for measurement, some interviewees want to account for CE and CO_2 impact in a simple way (e.g. by emission factors) because it allows them to demonstrate the impact. However, other interviews want to measure both of these in representative ways (e.g. CO_2 measurements per project or use of multiple indicators for CE). These can be difficult, e.g. because there are too many measurements to take, or it is hard to quantify some impacts. So, there is a juxtaposition between simplicity of measurement and representativeness which challenges both CE and CO_2 measurement.

RQ2: Do users of the CO_2PL believe it stimulates or hinders CE activities?

The words stimulate and hinder were found too strong to describe the relationship. Instead, words like 'encourage' and 'not encourage' were more reflective of the views of the interviewees.

The CO_2PL can encourage CE by making companies active and begin looking at their sustainability impacts. The CO_2PL levels spur conditions which can encourage CE developments. For example, the Levels 4&5 for themes A and D (Insight and Participation) were found to help the most because they encourage businesses to look at their supply chain impacts and cooperate with other businesses. Even though they saw the CO_2PL as indirectly related to CE, it did help many become more mature in organisational sustainability. A strength of the CO_2PL is having four themes, as interviewees viewed the encouragement of CE differently in each theme.

The parts of the CO_2PL which are considered less encouraging are the Reduction theme (B), and the focus throughout on CO_2. Related to this, many organisations did not think of using CE activities towards certification because the focus is on reduction of CO_2 emissions. Furthermore, interviewees sometimes did not want to use CE activities for CO_2PL audit as they did not feel it was appropriate. Herein, interviewees perceive the CO_2PL at face-value – a tool for CO_2 management, so they perceive CE as separate.

8. Limitations

Although 19 interviews provided a large amount of information, the findings were still very mixed, e.g. for CE measurement. There were not majority answers that over three quarters of the interviewees said. Perhaps conducting more interviews would create less mixed results. However, this would not be guaranteed. For example, the infancy of the CE topic, lack of universal knowledge and lack of experience meant that each organisation has their own way of managing and measuring CE. The low maturity of CE helped to contribute to a mix of results. The mixed results also indicated different perceptions could explain the relationships in this study e.g. Taking the CO_2PL at face value or being encouraged to act on CE because of conditions provided by the CO_2PL.

It was clear to the researcher that the interviewees wanted to convey messages to SKAO, via the interviews. The information they provided had to be verified with SKAO, to make sure no misleading information was published. It is recognised that the agenda of both the interviewees and SKAO could come across in the results, and affect the validity of the information provided.

In the discussion, the interviewees were grouped by their knowledge and experience in CO_2PL and CE to identify any pattern with their answers. Although the indicators for CO_2PL provided a distinction between the interviewees responsibilities and involvement, it was harder to judge the interviewees knowledge of CE. Some interviewees who were knowledgeable about CE undersold themselves, and those who knew less, spoke with confidence about CE. When making any sort of judgement with self-created indicators, there are questions of subjectivity. It is for this reason that not all of the results were presented in indicators and compared to interviewee knowledge and experience. However, performing this analysis on the responses of just two of the interview questions highlighted that there could be a chance that experience and knowledge play a role in how interviewees perceived the research topics.

The CE prompt sheet was created by the researcher, based on findings in the literature. Another researcher may have worded the included activities in a different way, or included different activities. Moreover, if the CE prompt would have been given to interviewees before the interview instead of after, the answers may have been different, and this may have affected the results. For example, it is unknown whether interviewees have planned responses indicating messages they wanted to send to SKAO. Moreover, they may have provided educated answers that create links between the topics, or just provided their personal experiences.

Further research can be conducted into this same topic, but on a wider range of industry sectors. This would provide more insight into the context of CO_2 and CE management and measurement, and their relation to the CO_2PL. It would be beneficial to understand how these topics interact with different types of businesses, or if the results would echo the findings in this study.

8. Recommendation for SKAO

The CO_2PL could have a role in promoting CE more through the existing themes, because it provides conditions which stimulate action in the supply chain. Furthermore, some of the issues which hold back the development of CE are issues that the CO_2PL can influence. For example, a need for more collaboration, a lack of data and transparency about impact, and a need for faster progress to help organisations reach their CE targets. The CO_2PL has a role to play here by asking companies to verify and report their actions, to develop initiatives in the supply chain, to insist that organisations suppliers to find and share data about products and to undergo yearly audits to demonstrate continuous improvement and goal setting. Furthermore, SKAO is a link between public and semi-public procurement parties, who work closely with government, and private businesses. SKAO could use this position to change standard practices which hinder CE. For example, they could encourage public and semi-public commissioning parties to make sure the organisations who create infrastructure receive secondary materials at the end-of-life phase to stimulate reuse and recycling.

It was found that clients are driven to manage wider sustainability impacts and measure impact across multiple indicators for example, social sustainability, material scarcity and water pollution. Thus, it is not just CE that the CO_2PL could be more open to, but also sustainability in a general sense. It is worth noting that not all users may want to work on CE or sustainability through the CO_2PL, so there should still be openness for organisations to focus on CO_2 management.

However, many organisations currently associate the CO_2PL solely with CO_2 reduction, so more could be done to make it more open to association with sustainability and CE. This could be done by changes to the wording of the handbook, the requirements and list of measures. For example, the CO_2PL handbook and requirements could promote for example ‘sustainable impacts’ in a general sense instead of speaking specifically about ‘GHG-generating activities in requirement 4B (Appendix A). Also, currently the list of measures only contains CE suggestions in the section intended for waste management organisations. However, some interviewees from other organisations did not notice this. Thus, potential CE measures could be mentioned in other sections referring to different business industries. Since there are some trade-offs between CO_2 emissions and CE, SKAO should clarify its stance on greater emissions in the present day, but CO_2 reduction overall in the long-term, due to enacting CE measure.

To help enable measurement of CE, it would also be a good idea to look at emission factors for some material resources commonly used by the organisations which use the tool. CE measurement is a very complicated topic, as discussed in the results and in the theory. It is not expected that the CO_2PL could solve these issues. However, SKAO could encourage organisations to take steps to improve the strictness of how they measure CE. For example, by analysing data choices or modelling impacts over multiple lifecycle in audits.

Another recommendation for SKAO is to focus on improving the perceptions of what CO_2 management entails. Organisations expressed that they associate CO_2 management as fuel and energy use reduction, but they do not associate CO_2 management as much with the core work in their projects. The importance of fuel and energy choices should be stressed to organisations, as this underlies the impact of every project and the impact within supply chains. Furthermore, the impact of CE projects also often depends on the underlying use of fuel and energy to transport and transform products. Organisations who use the tool are faced with some difficult challenges to change organisational behaviour towards less driving and flying and to transition more thoroughly to the use of biofuel, electric vehicles and renewable energy. SKAO could set up discussions with users of the tool to understand how they could help in stimulating organisations to take these steps in their CO_2 management. For example, the CO_2PL audit could be stricter about awarding certification. Organisations at higher levels of the CO_2PL should prove that they are investing in more clean energy innovations and dedicated to changing organisational behaviours.

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10. Appendix

Appendix A: CO_2PL requirements

6.2.1 Angle A: Insight

Requirement	S/M/L	Aspect	Requirements	Max. score
1A	All	The company has partial insight into energy consumption.	1.A.1. Identification and analysis of energy flows of the company and the projects for which a CO_2-related award advantage has been obtained, have taken place.	10
			1.A.2. All energy flows of the company and the projects for which a CO_2-related award advantage has been obtained, have been demonstrably recorded.	10
			1.A.3. This list is regularly followed up and kept up to date.	5
		Objective: The company knows which types of energy are used.		
2A	All	The company has partial insight into its energy consumption.	2.A.1. All energy flows of the company and the projects for which a CO_2-related award advantage has been obtained, have been quantitatively recorded.	10
			2.A.2. The list is complete, and is regularly - and demonstrably - followed up and kept up to date.	5
			2.A.3. The company has an up-to-date energy assessment for the company and the projects for which a CO_2-related award advantage has been obtained.	10
		Objective: The company knows per type of energy how much is used, differentiated according to the company's various activities.		
3A	All	The company has converted its own energy consumption into CO_2 emission(s).	3.A.1. The company has a detailed and up-to-date emission inventory for its scope 1 & 2 CO_2 emissions in accordance with ISO 14064-1 for the company and the projects for which a CO_2-related award advantage has been obtained.	20
			3.A.2. The 3.A.1 emissions inventory has been verified by a certifying organization to at least a limited degree of certainty.	5
		Objective: The company has a CO_2 administration, where there is no discussion about the amounts and about the method of calculation. The company has insight into the main basic principles for a reduction approach.		
4A	All *	The company reports its CO_2 footprint in accordance with ISO 14064-1 for scope 1, 2 & 3.	4.A.1. The company has a demonstrable insight into the most material emissions from scope 3, and can present at least two analyses of these scope 3 emissions of GHG-generating activities, or value chains of activities.	15
	All		4.A.2. The company has a quality management plan for the inventory.	5
	All		4.A.3. At least one of the analyses from 4.A.1 (scope 3) has been professionally endorsed or commented on by a recognized professional and independent knowledge institute.	5
		Objective: Apart from scope 1 and 2, the company has determined the relative extent of scope 3 emissions. The management is aware of the influence of the company in the various value chains, up- and downstream, in which it performs. On the basis of this knowledge, the company identifies likely energy and CO_2 reduction measures in the value chains, and potential value chain partners for its approach.		
5A	All*	The company has portfolio-wide insight into scope 3.	5.A.1. The company has insight into the material scope 3 emissions of the company and the most relevant parties in the value chain that are involved in this.	10
	All*		5.A.2-1. The company has a portfolio-wide, substantiated analysis of its options to influence material scope 3 emissions.	5
	M/L		5.A.2-2. The company has insight into possible strategies to reduce these material emissions.	5
	M/L		5.A.3. The company must know the specific emission data of direct (and potential) value chain partners that are relevant for the execution of the scope 3 strategy.	5
		Objective: the company broadens and deepens its insight into scope 3 and how the company can reduce emissions in scope 3.		

6.2.2 Angle B: Reduction

Requirement	S/M/L	Aspect	Requirements	Max. score
1B	All	The company investigates opportunities for reducing energy.	1.B.1. The company demonstrably investigates the opportunities for reducing the energy consumption of the company and the projects for which a CO_2-related award advantage has been obtained.	20
			1.B.2. The company has an up-to-date report of an independent internal control for the company and the projects for which a CO_2-related award advantage has been obtained.	5
		Objective: The company knows what can be saved on per energy flow. There are insight per savings model on which activity of the company this concerns.		
2B	All	The company has an energy reduction target, described in qualitative terms.	2.B.1. The company has an objective, described in qualitative terms, for reducing energy and has proposed measures for the projects.	10
			2.B.2. The company has a specified objective for the use of alternative fuels and/or the use of green energy, and has proposed measures for the projects.	10
			2.B.3. The energy and reduction objective and related measures have been documented, implemented and communicated to every employee.	3
			2.B.4. The reduction objective has been endorsed by higher-tier management.	2
		Objective: The objectives are cost effective and ambitious at the same time, and clear information is provided about this. The objectives are concrete. The measures (particularly for the projects) are assigned to those involved in the execution, required to implement the measure, and is communicated broadly within relevant parts of the company.		
3B	All	The company has quantitative CO_2 reduction objectives for its own organization.	3.B.1. The company has drawn up a quantitative reduction objective for scope 1 & 2 emissions of the company and its projects, expressed in absolute values or percentages in relation to a reference year and within a fixed period of time, and has drawn up a related action plan, including the measures to be taken on the projects.	15
			3.B.2. The company has drawn up an energy management action plan (in accordance with ISO 50001 or equivalent), which has been endorsed by higher-tier management, communicated internally and externally, and implemented within the company and on the projects for which a CO_2-related award advantage has been obtained.	10
		Objective: The company formulates an ambitious, substantiated objective for energy and CO_2 emission reduction (scope 1 and 2), where account has been taken of the relative position with respect to companies with similar activities involving the CO_2 performance and/or reduction measures. Innovative developments are also taken into account.		
4B	All *	The company has quantitative CO_2 reduction objectives for scope 1, 2 & 3 CO_2 emissions.	4.B.1. The company has formulated CO_2 reduction objectives for scope 3, based on two analyses from 4.A.1, or on two material GHG-generating activities, or value chains of activities. A related action plan has been drawn up, including the measures to be taken. Objectives are expressed in absolute values or percentages in relation to a reference year and within a fixed period of time.	15
	All*		4.B.2. The company reports at least once every six months, internally and externally, on its progress in relation to the objectives for the company and the projects for which a CO_2-related award advantage has been obtained.	10
		Objective: The company formulates an ambitious, substantiated objective for energy and CO_2 emission reduction in the value chain, where account has been taken of the influence of the company in the value chain, relative position with respect to companies with similar activities and with other initiatives in the value chain and/or sector. Innovative developments are also taken into account.		
5B	All*	The company reports on a structural and quantitative basis the results of the CO_2 reduction objectives for scope 1, 2 & 3.	5.B.1. The company has formulated a strategy and CO_2 reduction objectives for scope 3, on the basis of the analyses in 5.A.2. A related action plan has been drawn up, including the measures to be taken. Objectives are expressed in absolute values or percentages in relation to a reference year and within a fixed period of time.	9
	All*		5.B.2. At least once every six months, the company reports (internally and externally) on its emission inventory scope 1, 2 & 3-related CO_2 emissions, as well as its progress in terms of the reduction objectives, for the company and its projects.	8
	All		5.B.3. The company succeeds in meeting its reduction objectives.	8
		Objective: On the basis of increased insight, the company formulates a further-reaching policy and objectives for energy and CO_2 reductions in scope 1, 2 and 3. The company knows how to adjust on time if the success of objections is in danger, in order to succeed in realising the ambitious reduction objectives.		

6.2.3 Angle C: Transparency

Requirement	S/M/L	Aspect	Requirements	Max. score
1C	All	The company communicates its energy reduction policy on an ad hoc basis.	1.C.1 The company demonstrably communicates internally, on an ad hoc basis, its energy reduction policy for the company and the projects for which a CO_2-related award advantage has been obtained.	20
			1.C.2. The company demonstrably communicates externally, on an ad hoc basis, its energy reduction policy for the company and the projects for which a CO_2-related award advantage has been obtained.	5
		Objective: the company involves all employees in the development of an energy or CO_2 reduction policy, whereby it clearly communicates where the main challenges lie for the company and its own activities.		
2C	All	The company communicates its energy policy internally – to a minimal degree – and possibly externally.	2.C.1. The company communicates its energy policy, internally and structurally, for the company and its projects. The communication includes at least the energy policy and reduction objectives of the company and the measures in the projects for which a CO_2-related award advantage has been obtained.	10
			2.C.2. With regard to CO_2 reduction, the company has an effective steering cycle with designated responsibilities for the company and the projects for which a CO_2-related award advantage has been obtained.	10
			2.C.3. The company has identified the external interested parties for the company and the projects for which a CO_2-related award advantage has been obtained.	5
		Objective: The company works on scope in the company to look for more effective energy and CO_2 reduction measures. The company stimulates its own employees to come up with proposals for improvement and gives feedback on what is happening with these proposals. The company knows which external stakeholders can have an interest in energy and CO_2 reduction in the company. The company's employees who can provide a relevant contribution know what is expected of them.		
3C	All	The company communicates internally and externally on its CO_2 footprint and reduction objectives.	3.C.1. The company communicates, internally and externally, and on a structural basis, its CO_2 footprint (scope 1 & 2 emissions) and the quantitative reduction objectives of the company and the measures in projects for which a CO_2-related award advantage has been obtained. The communications contain as a minimum the energy policy and reduction objectives of the company and the aforementioned measures, opportunities for individual contributions, information concerning current levels of energy consumption and trends in the company and on the projects.	20
			3.C.2. The company has a documented internal and external communication plan with documented tasks, responsibilities and methods of communication for the company and the projects for which a CO_2-related award advantage has been obtained.	5
		Objective: Through communication, the company enables external relevant experts to form a critical opinion about the company's efforts, also with respect to other companies.		
4C	L	The company maintains dialogue with government bodies and NGOs about its CO_2 reduction objectives and strategy.	4.C.1. The company can demonstrate that it maintains regular (at least twice a year) dialogue with interested parties in government and NGOs (at least two) about its CO_2 reduction objectives and strategy for the company and the projects.	20
			4.C.2. The company can demonstrate that areas of concern about the company or projects expressed by the government bodies or NGOs have been identified and addressed.	5
		Objective: The objective of the dialogue is to assess whether the subject really has priority in the company's management and to make suggestions for improvement and taking on new matters.		
5C	M/L	The company is publicly committed to a government or NGO CO_2 emission reduction programme.	5.C.1. The company can demonstrate that it is publicly committed to a government or NGO CO_2 emission reduction programme, for both itself and its projects.	10
			5.C.2. (see 5.C.1) more than one.	5
			5.C.3. The company communicates internally and externally, on a structural basis at least twice a year, on its CO_2 footprint (scope 1, 2 & 3) and the quantitative reduction objectives for the company and the measures in projects for which a CO_2-related award advantage has been obtained. The communications contain as a minimum the energy policy and reduction objectives of the company and the aforementioned measures, opportunities for individual contributions, information concerning current levels of energy consumption and trends in the company and on the projects.	10
		Objective: The company takes on a commitment with a contractual nature for the realisation of specific energy or CO_2 reduction objectives, communicates about this and fulfils this. Objectives that are part of this commitment are at least in line with national and/or sectorial reduction objectives and clearly go beyond legal obligations. The company communicates about its objectives and results regarding energy and CO_2 reduction in the value chain.		

6.2.4 Angle D: Participation

Requirement	S/M/L	Aspect	Requirements	Max. score
1D	All	The company is aware of sector and/or value chain initiatives.	1.D.1. The company is demonstrably aware of sector and/or value chain initiatives for reducing CO_2, which are closely related to its project portfolio.	15
			1.D.2. Sector and value chain initiatives, and their relationship with the company operations and project portfolio, are discussed in management consultations.	10
		Objective: The company knows the development initiatives that potentially can result in measures that are relevant for the company. The management has made statements about possible participation in these initiatives.		
2D	All	The company is a passive participant in initiatives aimed at reducing CO_2 in or outside the sector.	2.D.1. The company is a passive participant in at least one sector or value chain initiative that is closely related to its project portfolio, by signing up to it or paying a contribution or sponsorship fee.	20
			2.D.2. The company plays an active part or limited active part in a sector or value chain initiative that is closely related to its project portfolio.	5
		Objective: The company knows which information can be of use for its projects (linked to 2.B and 2.C) and takes part in an initiative that meets its own knowledge requirements.		
3D	All	The company is an active participant in initiatives aimed at reducing CO_2 in or outside the sector.	3.D.1. Active participation in at least one sector or value chain initiative aimed at reducing CO_2 in its project portfolio, through demonstrable participation in working groups, publicly advocating the initiative and/or providing information for the initiative.	20
			3.D.2. The company has made a specific budget available for this purpose.	5
		Objective: The company contributes to and makes use of the development of new knowledge, in cooperation with others, geared towards potentially effective reduction measures.		
4D	L	The company initiates development projects that facilitate reductions in CO_2 in the sector.	4.D.1. The company can demonstrate that it has initiated development projects that make it easier for the sector to reduce CO_2 when carrying out projects, by linking its name to the initiatives through publications and through the affirmation of co-initiators.	20
			4.D.2. The company has made a specific budget available for this purpose.	5
		Objective: The company takes on a leading role in the development and announcement of new measures for far-reaching energy or CO_2 emission reduction in the sector.		
5D	L	The company takes an active part in setting up a sector-wide CO_2 emissions reduction programme in collaboration with the government or NGO.	5.D.1. The company can demonstrate that it is actively involved in setting up a sector-wide CO_2 emissions reduction programme in collaboration with the government and/or an NGO, and that it makes a relevant contribution to it in the execution of projects.	5
			5.D.2. The company has made a specific budget available for this purpose.	5
			5.D.3. The company is the owner/developer of documents that prove:	
			5.D.3-1. that at least two of these documents have been drawn up by the company.	5
			5.D.3-2. that at least one government body and/or at least one NGO, and at least two other companies are involved in the reduction programme.	5
			5.D.3-3. that the programme is subject to minimum and time-related reduction requirements, in absolute or relative terms.	5
		Objective: The company succeeds in, or has made an effort for a specific period and in different ways to urge other companies in the sector to implement favourable energy or CO_2 reduction measures.		

Appendix B: Interview questions for interviewees for certified organisations

(nb. Many questions were asked to interviewees to provide information for SKAO, and were not solely intended for this research. This includes questions 7, 17 and 18)

1. What is your role in this organisation?

2. Are you familiar with the CO_2 performance ladder (CO_2PL)?
    a. In your personal work, are you involved with the CO_2PL?

3. Are you familiar with the Circular Economy?
    a. In your personal work, are you involved with Circular Economy activities?

4. What is the status of Circular Economy action in your industry sector?

5. What is the status of CO_2PL use in your industry sector?

6. What is the status of CO management in your industry sector?

7. Is the Circular Economy important for your organisation?

8. Has your organisation performed any Circular Economy activities?

9. Did you attempt to have these Circular Economy activities awarded on the CO_2PL?
    a. If so, were they awarded?
    b. On which level and theme? (See attachment with CO_2PL themes and requirements)

10. How do you measure the performance of Circular Economy activities in your organisations' activities? (Provide practical examples if possible)

11. What criteria are important for measuring the Circular Economy?

12. How do you manage CO_2 in your organisation?

13. How do you measure CO_2 in your organisation?

14. In your experience, which CO_2PL requirements stimulate Circular Economy activities? (See attachment with CO_2PL themes and requirements per level)

    a) In the insight theme?
    b) In the CO_2 reduction theme?
    c) In the transparency theme?
    d) In the participation theme?

15. Furthermore, which CO_2PL requirements hinder Circular Economy activities? Provide practical examples if possible. (See attachment with CO_2PL themes and requirements per level)

    a. In the insight theme?
    b. In the CO_2 reduction theme?
    c. In the transparency theme?
    d. In the participation theme?

16. Do you think there is a CO_2PL requirement that is the most important for stimulating the Circular Economy within the CO_2 Performance Ladder?

17. Do you think that performing Circular Economy activities gives your organisation an advantage?
    a. In the tender process?
    b. In general, in your industry?

18. Will Circular Economy be important in the future for your organisation?
    a. Are there any particular Circular Economy activities that you are planning for the future?

19. Do you see a connection between CO_2 management and the Circular Economy? Can you explain your choice?

20. Do you think that the CO_2PL should have a role in encouraging the Circular Economy?

21. [At this point, interviewees were shown the CE prompt sheet (see 3.2.2.1). They were first asked to circle which CE activities their organisation had carried out. They were then asked if they thought the CO_2PL stimulated or hindered these activities.]

22. Any additional comments?

Appendix C: The literature sources used to compile the CE prompt sheet

Chosen literature	Description
Camacho-Otero, J., & Ordoñez, I. (2017). Circularity assessment in companies: conceptual elements for developing assessment tools.	A collection of CE principles chosen by industry experts.
Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the Circular Economy: An analysis of 114 definitions. Resources.	A recently published collective review of academic papers about CE.
Lacy, P., & Rutqvist, J. (2016). Waste to wealth: The Circular Economy advantage. Basingstoke: Palgrave MacMillan.	A diagram from Accenture, a business management consultancy, depicting CE business models.
Ellen McArthur Foundation. (2013). Towards the Circular Economy.	An introduction to the CE concept by an organisation specialising in realising CE.
Winans, K., Kendall, A., & Deng, H. (2017). The history and current applications of the Circular Economy concept. Renewable and Sustainable Energy Reviews, 68, 825-833.	A recent paper describing the CE concept with examples of its application.