# The transition of Circular Economy in the Dutch housing industry

Noud Slot[a], Silu Bhochhibhoy[b], Berri de Jonge[c], André Doree[d]

*a,c - Plegt-Vos, Sherwood Rangers 1, 7551KW Hengelo, The Netherlands*

*b,d - Department of Construction Management and Engineering, University of Twente, Drienerlolaan 5, 7522NB Enschede, The Netherlands*

ABSTRACT: The concept of circular economy (CE) is getting increasingly more attention from academia, policymakers, and the industry as the solution that should reduce negative environmental impacts and positively contributes to economic growth. The initiating case company, a Dutch housing contractor is noticing this increasing interest in CE in their external environment. The aim of this article is to give insight in the transition of CE in the Dutch housing industry. This article argues in terms of Schumpeter's (1934) business cycle theory that CE has initiated a new business cycle in the Dutch housing sector. Data for this argument is collected through an assessment of the CE strategies with the use of a CE strategy framework. This article concludes that the Dutch housing sector could be positioned at the end of the introduction phase of Schumpeter's business cycle, since there are indicators that the sector is no longer sceptic over CE and there is a general believe that if they do not move, they fall behind with their competitors. However, further transition in CE is impeded by the lack of reverse cycles in the CE strategy of the Dutch housing contractors, particularly due to the difficulty of estimating the residual value of a house.

Key words: Circular Business Models, Circular Economy Strategies, Construction, Housing sector, Business cycles

## 1 Introduction

In the last century, global trade in combination with industrial and technological development has resulted in significant economic growth and has propelled human welfare (ISMA, 2013). In the past four decades, the global economy expanded more than threefold, while the population almost doubled and global material extraction tripled (UNEP, 2016). These expectations should be alarming, knowing that our planet will not be growing along. The current linear model that extracts-produces-uses-dumps materials has become more and more unjustifiable in terms of economic, social and environmental sustainability (Frosch & Gallopoulos, 1989).

Circular Economy (CE) provides an alternative model that strives for closed material cycles and should reduce negative environmental impacts and contribute to economic growth (Ellen MacArthur Foundation, 2013b; European Commission, 2015; European Commission, 2014; TNO, 2013). For instance, McKinsey & Partners calculated that the EU could gain over 1.8 trillion euro's due to switching to a circular model (McKinsey & Partners, 2015).

The idea of a CE dates back to the 18th and 19th century, however, the scientific knowledge base was still largely unexplored a decade ago (Desrochers, 2004; Desrochers, 2002;). In 2016, hundred articles were published on CE, while around thirty articles were

published in 2014 (Geissdoerfer et al., 2017). This sudden increase of interest caused vagueness around the concept of CE (Lieder & Rashid, 2016; Yuan, 2006). In a recent attempt to conceptualize CE, a staggering amount of a hundred and fourteen definitions were found for CE, which indicates that as of yet there is no commonly accepted scientific definition for CE despite recent attempts by Kirchherr et al.(2017) and Prieto-Sandoval et al.(2018).

The lack of consensus on a CE definition has not obstructed the government organizations from pursuing a CE. The European Union has created an action plan for CE as a follow up on their earlier waste directive (European Commission, 2015). In response, the Dutch Government wrote their own report "A Circular Economy in the Netherlands by 2050" with the goal to have a CE by 2050 (Dutch Government, 2016). In this report of the Dutch Government, priority sectors are mentioned that need to be changed. One of those priority sectors is the construction sector. The Dutch Government estimates that the construction sector in the Netherlands accounts for 50% of the raw materials used, 40% of the total energy consumption, and 30% of total water consumption (Dutch Government, 2016). In addition, 40% of the waste production is related to construction and demolition waste and approximately 35% of the $CO_2$ emission (Dutch Government, 2016). Making the construction sector the priority sector where much can be gained in terms of resource preservation.

The concept of CE is increasingly getting more traction in scientific research, politics, and an increasing amount of businesses are also seeing the possible benefits of CE, with several companies across industries pioneering in transitioning towards a CE (Cristoni & Tonelli, 2019). Schumpeter argues that every random period of time a new innovation disrups the eliquilibrium state and excels and changes the economy towards a new business cycle. This new business cycle in turn gets eventually to an eliquilibrium state until a new disrupting innovation appears, as is shown in Fig 1. A new business cycle would set in a new spurt in innovations and economic growth. Could it then be said, in terms of Schumpeter (1934), that CE is changing the equilibrium state of the linear economy by stimulating a new business cycle?

The construction industry is known for their slow adoption of innovations (Davidson, 2013). However, one of the Dutch housing contractors and also initiating case company of this study, is noticing multiple circular developments in their surrounding domain. In order not to fall behind their competitors, this housing contractor is searching for a strategy that suits them to keep up with circular developments. To ensure their continuity they search for a simple framework with possible strategies for CE (Cristoni & Tonelli, 2019; Bocken, 2017).

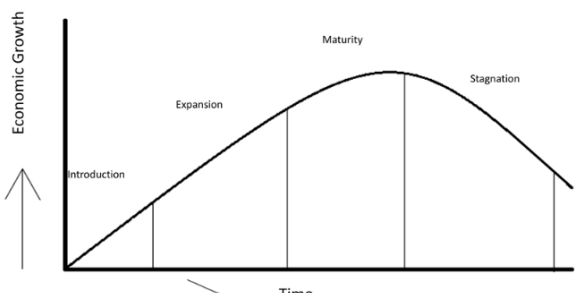

Fig 1: Schumpeters business cycle (Van Gent, 1992)

Based on the described scenario, this article discusses if CE is disrupting the equilibrium state of the linear economy by stimulating a new business cycle in the Dutch housing sector. Moreover, this article assesses the position of the Dutch housing sector in the business cycle. This will be done by assessing the CE strategies that are used by the pioneering Dutch housing contractors with use of a CE strategy framework. The progress of the circular economy transition of the Dutch housing has not been investigated yet.

## 2 Theoretical background

### *2.1 Circular Economy as new business cycle*

Schumpeter's (1934) early work was almost a century ahead of its time. He described the importance of competition through innovation and elaborated on the key role of finance in a time when the role of uncertainty and the theory of finance was barely developed (Shubik & Sudderth, 2015). In his book 'Theory of Economic Development', published in 1934, Schumpeter described economic life as a "circular flow", and compared it to the circulation of the blood in an animal, with a tendency towards an equilibrium position. This ideal state of the equilibrium position is never attained and changes, because companies keep innovating and developing. This changing environment is especially stimulated in a competitive economy, where innovation and development quickly follow each other and lead to the elimination of the previous innovations, also called creative destruction (Schumpeter, 1934). These recurrent business fluctuations that start with an innovation and end with creative destruction are called business cycles (Schumpeter, 1934).

After "Theory of Economic Development", Schumpeter published in 1939 another book, "The Business Cycles", which consisted out of two parts. Here Schumpeters defends his statement that innovations do not emerge regularly, but are more clustered at certain times than at others. As argument Schumpeter uses the findings on long economic cycles of Kondratieff (1935). Kondratieff recorded that innovations tend to "cluster" in the early part of the "upswings" of cycles. Radical innovations like Cotton Textile, Iron and Steam power are seen as cause for the industrial revolution in this theory. Since this is in line with the argument of Schumpeter that innovations are clustered and do not emerge regularly, the findings of Kondratieff were a central part of the book "The Business Cycles". The latest book got a lot of critism of scientist like Kuznets (1940), mainly because Schumpeter did not try to explain the reason behind this clustering of innovations (Kingston, 2006). Schumpeter already defended the book during the introduction calling it "a house which is not finished and furnished" (Kingston, 2006).

The theory that there are long economic cycles, also called Kondratieff cycles that exists out of one or multiple business cycles is interesting for this study. Decades later this theory can still be applied on our economical timeline when looking at economical upswings and depressions (Morone, 2016). Allianz (2013), Morone (2016), and Moody and Nogrady (2010) argue that after the financial crisis in 2009 a sixth Kondratieff has started that is focussed on sustainability.

Schumpeter describes the business cycle as a four phase cycle of prosperity, recession, depression and revival. A more modern view of the business cycle and in a macro environment a business cycle could exists out of the following phases: introduction, expansion, maturity, and stagnation (Dorée, Holmen, & Caerteling, 2003). Each phase

has specific characteristics in terms of structure, behaviour, performance, competition, collaboration and concentration (Dorée, Holmen, & Caerteling, 2003). The characteristics for each phase is summarized in Table 1.

Table 1: Summary of the characteristics of each business cycle phase

| Phase | Summary |
|---|---|
| Introduction | Small scale production and market size with an intensive effort knowledge production process. Strong competitive behaviour with respect to substitutes and high advertising costs. There are losses instead of profit with high probability of failure. Competition is focussed on innovation. |
| Expansion | Increase in production scale and market expansion, with capital intensive production. Competition within own sector based on imitation. Process and product improvement. Profits are made with low selling prices. |
| Maturity | Large scale production and the largest possible market. Product differentiation with a tendency for collaboration and integration. Competitive behaviour leads to takeovers and the competition is based on quality. Profits decrease in this phase with low selling prices and low production costs. |
| Stagnation | Large scale production with decreasing market size. Competition through import with mergers, takeovers and concentration. Looking for other growth cycles. There are lower profits or even losses and market shares are stabilizing. |

This article will refer to the framework of phases and specific characteristics of Dorée, Holmen & Caerteling (2003) to gain insight in the transition of CE in the Dutch housing industry.

### *2.2 Strategy to a Circular Economy*

To assess the strategies, a framework of Cristoni & Tonelli (2019) is adopted as basis for this study as it is the latest research on CE strategies and currently the only CE strategy framework available. Modification of the framework is done in this study to suit into the housing sector better. A complete overview of the CE strategy framework used in this study is given in Fig 2. The framework is constructed with the use of CE principles, CE business objectives, Circular Business Models (CBM), and intervention areas. The detail explanation of the framework is given below:

#### *2.2.1 CE principles*

As mentioned in the introduction, the definition of CE has become an umbrella concept. To prevent confusion on the definition this study refrains from choosing a CE definition and uses the core principles of CE to explain the philosophical meaning of CE.

Cristoni & Tonelli (2019) explain CE with four main principles that are based on the three main principles distinguished by the Ellen MacArthur Foundation (2015). These three CE principles are listed below:

- Preserve and enhance natural capital by controlling finite stocks and balancing renewable resource flows.

- Optimise resource yields by circulating products, components, and materials at the highest utility at all times.

- Foster system effectiveness by revealing and designing out negative externalities.

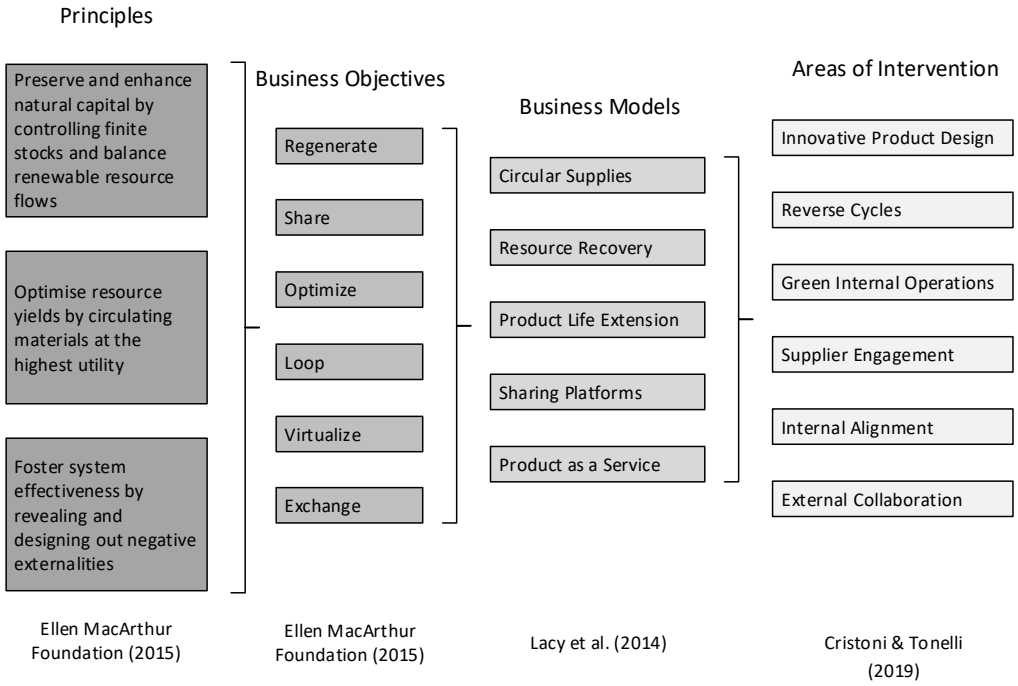


Fig 2: CE strategy framework

The only difference between these CE principles and the four CE principles of Cristoni & Tonelli (2019) is that the optimizing resource yields is split into utilization rate of assets and utilization rate of goods, products and materials. However, because Cristoni & Tonelli (2019) do not explain why they opted for four CE principles instead of three, this study will use the three principles of the Ellen MacArthur Foundation (2015). Furthermore, these three principles are used most into CE definitions according to Kirchherr, Reike, & Hekkert (2017) in the form of Recycle, Re-use, and Reduce.

### *2.2.2 CE Business Objectives*

These three CE principles are translated by the Ellen MacArthur Foundation (2015) into six business objectives that can be prioritized individually or in symbioses. An objective of a company is a key part of a strategy of an organisation, since it prioritizes what a company is striving for. Therefore, these six business objectives are a practical tool for companies to generate a strategy. These six business objectives are also called the ReSOLVE framework and is also used by Cristoni & Tonelli (2019) in their CE strategy framework. Table 2 presents the ReSOLVE framework and gives an explanation for each business objectives.

Table 2: ReSOLVE framework of Ellen MacArthur Foundation (2015)

| Business objectives | Explanation |
|---|---|
| Regenerate | Aim to minimize the environmental impact by switching to renewable materials and energy and restore natural ecosystems. |
| Share | Focus on maximizing product usage through sharing platforms and service models. |
| Optimise | Fine-tune the performance/efficiency of a product and remove waste in the |

| | |
|---|---|
| | production and supply chain. |
| Loop | Keeping products, materials as long as possible within the system through remanufacturing, repair, recycle, etc. |
| Virtualise | Dematerialisation through digitalization e.g. online shopping. |
| Exchange | Replacing outdated materials, products, machines with better, environmentally friendly solutions. |

### *2.2.3 Circular Business Models (CBM)*

A company does not solely switch from a linear model of economy to a circular on ideological reasons alone, the possible economic value creation that could lead to a competitive advantage functions as a reason as well (Ellen MacArthur Foundation, 2013a; Hofmann, 2019; Lacy, et al., 2014). An important part of a strategy that outlines how a company creates and markets value is written down in a business model (Osterwalder, Pigneur, & Tucci, 2005; Oussama & Ouakouak, 2015). A CBM is "the rationale of how an organization creates, delivers and captures value with and within closed material loops" (Mentink, 2014).

In the CE strategy framework of Cristoni & Tonelli (2019) state that the CBM should be tailored to the specific set of capabilities and resources of an organisation. However, it is also possible to design the strategy around the CBM, since this is the part of the strategy that outlines how value is created. Therefore, in this study the CBM's are included in the framework after the business objectives and before the intervention areas, since these are dependent on the CBM.

In the CE strategy framework of Cristoni & Tonelli (2019) present four CBM's macro categories. While these categories are useful categorizing CBM's, they are not practical CBM's themselves, since they do not cover the entire product life cycle and not easy to relate towards the construction sector.

Most recent taxonomy by Lewandowski (2015) systemized all proposed CBM's on the ReSOLVE framework. Lewandowski (2015) indicates that most CBM's are similar and that sometimes there is overlap between them. The CBM's stated by Lacy et al. (2014) are easy to adapt to the construction sector, focus specifically on economic value creation, and are spread over the entire product life cycle, which makes them useful for this study. Table 3 presents the five CBM's of Lacy et al. (2014) with a short explanation.

Table 3: Circular Business Models of Lacy et al. (2014)

| CBM's | Short explanation |
|---|---|
| Circular Supplies | Based on using renewable, recyclable, or biodegradable resource inputs that underpin circular production and consumption system. |
| Resource Recovery | Uses the recovery of embedded value at the end of a product lifecycle to feed another, thus transforming waste to value. |
| Product Life Extension | Extending the product lifecycle by repairing, upgrading, remanufacturing and therefore maintaining value. |
| Sharing Platforms | Increasing product value by increasing the utilization rate of a single product by offering a sharing platform. |

| | |
|---|---|
| Product as a Service | Users of a product lease/rent instead of "buy and own" which results in product longevity, reusability, and sharing that are drivers for a company to generate more value. |

### *2.2.4 Intervention Areas*

A strategy consists out of more than solely a business model. In order to have a consistent strategy throughout a company it is important to describe where a company needs to intervene to successfully make a transition towards CE. Cristoni & Tonelli (2018) have identified six areas of intervention, these six areas are presented and explained in Table 4.

Table 4: The areas of interventions of Cristoni & Tonelli (2018)

| Areas of Intervention | Explanation |
|---|---|
| Innovative Product Design | Innovative design principles are at the base of the organisation CE strategy. Three circular design directions a firm could pursue are green design, durability and design for reverse cycles. |
| Reverse Cycles | Establishing and managing as a company one or multiple flows of materials from the moment they get broken, damaged, or thrown away to their re-introduction into the economic system by repair, re-use, refurbishing, re-manufacturing, or recycling. |
| Green Internal Operations | A company can also adopt the principles of CE onto its own sites and internal operations to gradually reduce environmental externalities. |
| Supplier Engagement | CE opportunities exist throughout the entire supply chain and do not just stop at the selling company. To effectively control flows of materials companies might be required to expand the boundaries and scope by growing the company's current role in the supply chain or by forging new partnerships. |
| Internal Alignment | In a transition towards CE it is important to manage as a company the possible implications that can arise across departments such as R&D, procurement, sales, marketing, and operations. In order to manage such a transition early approval from top management is important. Moreover, managers and employees need to be motivated to embrace the change and strong cross-departmental alignment is key. |
| External Collaboration | Collaboration can bring multiple advantages, for example industry partner associations can act as enablers for sharing best practice examples. Furthermore, NGO and other non-profit organisations can also support business in applying circular principles to their operations, policymakers of all levels can act as catalysts for change by supporting business towards circularity, and research centres and universities can provide a company with technical solutions for the implementation of circular operations. |

## 3 Methodology

The aim of this study is to assess if CE initiated a new business cycle in the housing sector and to position the housing sector in the correct business cycle phase. This was conducted by providing an assessment of the CE strategies that are used by the pioneering Dutch housing construction companies and the barriers and enablers they distinguish. The assessment was executed in two steps. The first being a digital inventory of the general CE goals of the Dutch that are used by the Dutch housing companies in further detail.

### *3.2 First step – Inventory of CE goals in the Dutch housing industry*

To make an inventory of the CE goals in the Dutch housing industry a sample group was created. This sample group was formed by using the latest Cobouw50 (Cobouw, 2018) that, ranks Dutch construction companies based on their annual return. Since the scope of this study is housing contractors, construction companies that focus on other types of construction were removed from this list, which resulted in a list with 34 Dutch housing contractors. Furthermore, five smaller housing companies that specifically focus on modular construction in a production hall were added. Reason behind this is that they are smaller and do not have other side branches their annual profit is lower, thus these companies are not included in the Cobouw50. These five housing companies are interesting, because they should be well equipped to adopt CE in a relatively fast way.

This study opted to examine existing data in the form of websites and news articles to gather enough data on this relative large sample group in an acceptable timeframe. For the reason that this data is used as an indication, the risk of unreliable data could be neglected.

Each housing contractor was examined on their activities and how they resemble with the six business objectives based on the ReSOLVE framework of the Ellen MacArthur Foundation (2015). These six business objectives were explained in section 2 and help a company in formulating a CE strategy by first formulating a shared objective that is in line with the company activities. The gained data was structured with a matrix where on the row side the business objectives where listed and on the column side the sample group companies.

### *3.3 Second step – Assessment of CE strategies used in the Dutch housing industry*

Based on the concluded inventory, multiple CE pioneering housing contractors from the sample group could be indicated. Five CE pioneering housing contractors were selected for this study. With the selected companies an interview was conducted with an commercial director, innovation manager, QHSE manager, and sustainable director of the sampled companies.

The interviews were conducted to assess CE strategies that are used by the Dutch housing contractors. Moreover, the possible barriers and challenges experienced by the housing contractors were also collected. The questionnaire was composed of 25 open questions. The questions were grouped and based on the in section 2 explained six areas of intervention of Cristoni & Tonelli (2018) and the CBM's of Lacy et al. (2014).

The interviewed companies were provided with the same explanation of Circular Economy and of the areas of intervention as mentioned in section 2 in order to ensure that all answers were with the same understanding of CE. The intervention areas and the reason behind the choices the companies made within each intervention area is listed in the rows, this table is shown in appendix II. The data is compiled in the excel sheet and the comparison of the Dutch housing sector and its current position were assessed.

## 4 Results

This section presents how the sampled housing contractors are dealing with CE by analysing three different aspects: 1) Preferred business objective, 2) The CE strategy, 3) The CE barriers and enablers.

### *4.2 Descriptive analysis of preferred business objectives.*

The sample group was inventoried on how their activities fit within the six ReSOLVE business objectives. Out of the 34 housing contractors that form the sample group, 21 mention on their website that they are active with CE. From these 21 companies the preferred business objectives were inventoried and summarized in Fig 3.

The Regenerate objective is used by ten contractors that mostly choose for more bio-based materials within the houses that they build. Wood is the most popular bio-based material among the Dutch housing contractors. The renewable and sustainable properties of wood are used as an argument for this. Furthermore, these companies already have experience with this material. Other companies only mention that they use bio-based materials without specifying which materials are used.

The business objective of Sharing is used by six companies that specialize in constructing movable houses. The companies can re-use the moveable houses by reselling them and moving them to another location. These moveable houses can also be rented or leased, thus making use of a different business model mentioned in detail in section 4.2.1.

The fifteen companies that opted for an Optimize business objective all focus on making their housing concept modular and demountable. By making their housing concept modular their production process has reduced waste and increased performance and efficiency. A couple of these companies have their own production hall which allows them to minimize energy use and material loss.

The business objective Loop is used by seven companies mainly through the re-use of materials. This re-use is organized differently by each company, one of the companies uses a “Circular building hub”, which is a construction hub that gathers and processes re-usable materials outside the city and reuses the materials for other projects in other cities. Other companies lower their material costs by re-using materials such as window frames for renovation projects. A different company works together with an urban miner is specialized in gathering and processing waste of demolished buildings.

The Virtualize business objective is used by nine companies that all make use of Madaster. Madaster is a database that keeps track of all information for each of the materials that are used in a construction project (Madaster, 2018). This makes it easier during the demolition of that building to see which materials could be harvested and re-used. Another adoption of the virtualize objective is the use of a digital marketplace where residual materials of one project are sold to others for a lower price.

The sixth business objectives is Exchange, which is used the least of all objectives, namely three times. The companies that are using Exchange as objective have developed a circular renovation and developed a new isolation material that is composed out of Typha glue, which is received out of a plant. Another company redesigned their window

frame to minimize the material use and make maintenance easier.

As mentioned in section 2, the six business objectives can be used individually or in symbioses. The business objectives that are often used together are the regenerate and optimize objectives, since the modular design direction makes it easier to switch non-environment friendly materials for bio-based materials within the design.

### *4.3 Descriptive analysis of the CE strategies.*

Table 5 provides an overview of CE strategies that are used by the Dutch housing contractors. As mentioned in the theoretical framework, the interview questions were based on the business models of Lacy et al. (2014) and the six areas of intervention of Cristoni & Tonelli (2018). The preference of the interviewed companies for the choices within each intervention area is discussed for each intervention area separately. In Table 5, a specific overview is given for the intervention areas Industrial Product Design (IPD), Green Internal Operations (GIO), and External Collaboration (EC).

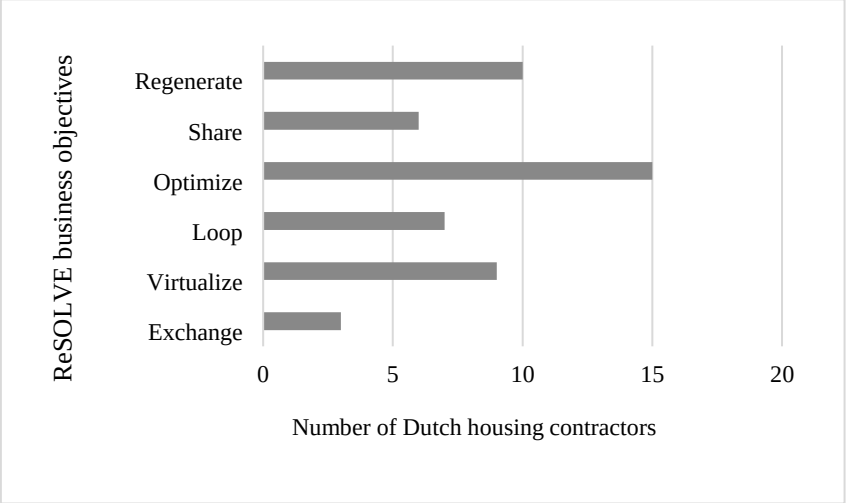


Fig 3: The six ReSOLVE business objectives preferred by the Dutch housing contractors

#### *4.3.1 Circular Business Models (CBM)*

From the companies that were interviewed company B and E had a CBM that was fully developed and in practice. Reason behind this is that both companies have developed a moveable house which is favourable for a service business model, like Product as a Service. A moveable house for example can easily be offered as a service for a government that is in need of temporarily houses. Since the house is able to be moved, it could be transferred to a new location after the service contract is ended, making it also usable for a Product Life Extension CBM.

The other three interviewed companies are using a more traditional earnings model in which profit is made once the housing project is complete. Yet, the companies are using parts of some of the business models to create some competitive advantage. Also, all of the interviewed companies think that CBM's are healthier and more profitable business models than their current linear model.

The study shows that all the interviewed companies are using Circular Supplies shown in Table 5. This is a relatively easy CBM to use, since it only requires to adopt a CE product within a company's own product. The interviewed companies mainly use this CBM, in order to win tenders with CE as criteria. The interviewed companies do not yet have a system in place that allows them to return the CE products back to the supplier at the end of the lifecycle of a house.

Resource Recovery as a CBM is currently only used by company E that has created an online marketplace for residual materials. By using this online marketplace internally, they can save on purchasing new resources and thus create a competitive advantage in tenders.

Table 5: Preference of the interviewed companies in CE strategy on CBM and IPD, GIO, and EC

| CBM's & intervention areas | Options | Companies A | B | C | D | E |
|---|---|---|---|---|---|---|
| Circular Business models | Circular Supplies | X | X | X | X | X |
| | Resource Recovery | | | | | X |
| | Product Life Extension | | X | | | X |
| | Sharing Platforms | | | | | |
| | Product as a Service | | X | | | X |
| Innovative Product Design | Green Design | X | X | | X | X |
| | Durability | X | | X | X | |
| | Design for Reverse Cycles | | X | X | X | X |
| Green Internal Operations | Reducing own footprint | X | X | X | X | X |
| | Process optimization | | X | | X | |
| | CE in office resources | | X | | | |
| External Collaboration | Government | | X | | X | X |
| | NGO's | X | X | X | X | X |
| | Supply chain partners | X | | X | X | X |

### *4.3.2 Innovative Product Design*

Most interviewed companies that focus on Green Design and Durability are doing this primarily, because it is already asked of them by several certificates like ISO 9001 and 14001. To get these certificates a construction company has to meet certain requirements on different topics like durability and environment impact. The companies B, C, and E that have not mentioned Green Design or Durability as focussed design direction, focus now less on these two design directions and more on the design for reverse cycles.

The interviewed companies that focus on the design for Reverse Cycles mainly do this, because they want to standardise and still offer variety in their product by making it modular and thus also demountable. The companies B, C, D, and E do not design their houses specifically to be able to be taken back at the end of the product lifecycle.

### *4.3.3 Reverse Cycles*

This intervention area is not the same as the design direction Reverse Cycles, since this intervention area is about the complete strategy of the company on repairing, refurbishing or return of their products instead of just the design direction.

All the interviewed companies do not provide other services that support Reverse Cycles and thus they do not prolong the life cycle of their house. All the interviewed companies only offer warranty repairs as service to prolong the life cycle of a house. Participant C did mentioned that they are researching the possibilities of offering more services.
The participating companies did not indicate to have a process in place to return the resources at the end of the product life cycle.

### *4.3.4 Green Internal Operations*

Each of the participating companies are focussing on reducing their own footprint. They do this in order to meet requirements for the ISO 14001 certificate, since it is often a selection criteria for tenders. As is shown in Table 5, the companies B and D do more than reducing their footprint. Both these companies have their own production hall and therefore are more effective at process optimization to reduce material and energy use. Company B also implements CE in the office space by using demountable school prefab elements they create as office space.

### *4.3.5 Supplier Engagement*

The participating companies agree with each other that the suppliers are crucial, but not leading in the process of implementing CE. According to them CE requires a different kind of collaboration where it is important to pay attention to each other's goals and also have some shared goals. Without these shared goals it would proof difficult to close the resource loop. However, the participating companies have just started the conversation by sharing visions of CE with their suppliers.

In Fig 4, an overview, based on an estimate of the qualitative results, is given of how the participating companies are engaging with their suppliers. Companies C and E are closely working together with their existing supply chain partners in order to implement CE. They are also looking at which role a demolishing company could have to close the resource loop and thus differentiate themselves from this activity. The other three companies A, B and D keep some of their existing suppliers, but are also looking for new ones to help them further implement CE. These companies are also started with making their own building elements that allow them to be owner over a larger part of the house they construct.

### *4.3.6 Internal Alignment*

The directors of all the interviewed companies were supportive of CE. They are however,

still working to get a real advantage from CE. Each company has a different approach in searching for a CE advantage. Where one company has a dedicated research department that also focusses on CE, another has a dedicated team that focusses on CE next to their daily job.

Gained knowledge on CE is also managed differently. Company A, for example provides its employees with workshops on CE in hope that those employees will recognise CE opportunities at an early stage. While company D has created a knowledge sharing document in which CE is explained to the employees and what the company's vision is on CE.

Between departments, most cooperation for CE exist between the sales, design and innovation, if the company possesses such a department.

### *4.3.7 External Collaboration*

The participating companies noticed that their clients are, in the same way, searching what CE could be and how it translates into value for investments. Changing construction regulations make this difficult, since it causes changes in the value of a house. The participating companies do however feel supported by the government in their CE pilot projects. One of the companies has an agreement with a municipality to temporary rent a piece of empty government owned land for temporary housing.

As shown in Table 5, all the companies are working together with a non-governmental organisation (NGO) to gain answers or possibilities on CE. Some of these companies hope that these NGO's can give some consensus on a definition and measuring method, since they claim that there is no consensus on both. As earlier mentioned in paragraph 4.2.5 "supplier engagement", most interviewed companies are also working together with their existing or new suppliers to find answers or new possibilities for CE.

## *4.4 Descriptive analysis of CE barriers and enablers.*

During the interviews, barriers and enablers for implementing CE were also addressed by the interviewed companies.

The first two barriers that were indicated are lack of experience on CE and no consensus on the definition and measuring method are the two main barriers. The interviewed companies look at the NGO's for the clarity on which definition is leading and how to

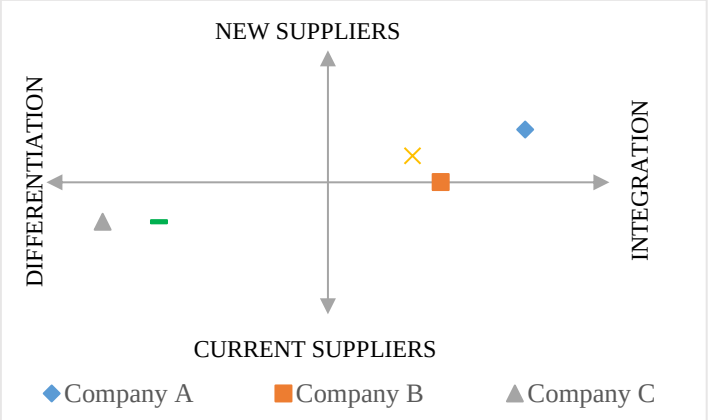


Fig 4: Supplier Engagement overview of the participating companies

measure their CE performance. The contractors do not use the same NGO's and the NGO's are also not working together. Therefore, it is unlikely that the NGO's advice the same definition and measuring method. Without consensus on the definition and measuring methods a couple of interviewed companies mentioned that it is easier to use CE as competitive advantage, because there is no equal playing field.

There is also a difficulty in estimating the residual of a house. The interviewed companies mentioned a couple of causes for this barrier. The first cause is that a house consists out of multiple materials which makes it difficult to determine the overall residual value. The second reason that was mentioned suggested that changing regulations also play a part in creating uncertainty. For example, there could be changes in minimal ceiling height of a house which decreases the left-over value of that house, since it would require adjustments.

To overcome these barriers the interviewed companies also mentioned possible enablers for these barriers. Looking at a house as an object with multiple layers instead of one complex object, could make it easier to estimate the residual value. This principle is the same as the shearing layers theory of Brand (1994). Furthermore, the government could create different categories of houses with different regulations. For example, temporary, semi-permanent and permanent. Both of these enablers make it easier and less risky to estimate the residual value of a house or elements of that house.

Other mentioned enablers give an indication why the housing contractors are striving to implement CE within their organization. For instance, according to the interviewed companies there is a growing demand for CE by clients. Furthermore the interviewed contractors think that CE offers a healthier business model since, it give the possibility to earn money over the entire life cycle of a house instead of just one moment after the completion of the house.

All of the interviewed companies think that future innovations will make the adoption of CE easier, due to more innovation and development of bio-based materials and product design.

# 5 Discussion

The assessment of the CE strategies that are used by the Dutch housing contractors created an understanding of the current situation of the housing sector. This understanding supports further discussion on the possibility that CE initiated a new business cycle within the housing sector. Moreover, in which business cycle phase the Dutch housing contractors could be positioned. In this section a discussion will take place based on the results of the previous chapter and theory mentioned in the second chapter.

## *5.2 Possible new business cycle in the housing sector initiated by CE*

The results indicate that CE is more of an incremental change for the Dutch housing contractors then a fundamental one. Most of the CE strategy choices the contractors have made, like adopting more biodegradable materials, is in line with what they were already doing due to their sustainability orientated certifications. Hofmann (2019) also argues that current CBM's only achieve incremental resource efficiency improvements, which is in line with the findings of this study.

However, if the incremental changes build up to a radical innovation that brings a fundamental change and ends with a creative destruction, then it is still a business cycle. Furthermore, the results of this study do indicate that there could be argument for a sixth Kondratieff cycle, based on sustainability. A Kondratieff cycle exists according to Schumpeter out of multiple smaller business cycles of which CE could be one. With these arguments, CE could very well be a new business cycle that is initiated by a growing need to become more sustainable.

### *5.3 The business cycle phase of the Dutch housing sector*

As mentioned in section 2, in a modern macro view, a business cycle consists out of four phases introduction, expansion, maturity, and stagnation (Dorée, Holmen, & Caerteling, 2003). Each phase has their own characteristics, as explained in section 2.1, and by looking at the results of this study the Dutch housing sector can be positioned in the right business cycle phase (Dorée, Holmen, & Caerteling, 2003).

When looking at the characteristics of the phases the Dutch housing sector mostly resembles the innovation phase, because the market for CE is still relatively small compared to the traditional houses. The same can also be said for the production scale of houses with CE. The houses that are built for CE are not yet being built to take back after the product life cycle, therefore this process will be a work and knowhow intensive process.

Moreover, the contractors use CE product innovations of their suppliers to create a competitive advantage. Often these CE products are more expensive and thus generate less profit then applying traditional products. While the competition does not yet evolves around the innovation of the contractors themselves it does evolves on the innovation of the suppliers. This can be underlined with the statement of the contractors that the suppliers are not leading, but crucial.

Furthermore, all the interviewed contractors collaborating with NGO's and suppliers to gain more knowledge on CE, which is also a characteristic of the innovation phase.

While the results of this study indicate that the Dutch housing sector is at the innovation phase, an argument could be made that they are at end of this phase. As mentioned in the previous paragraph, the CE strategies of the Dutch housing contractors bring only incremental changes, although it could be expected that when the contractors succeed in completing the circle in their CBM's a radical change will be made that will introduce the following phase of expansion.

This expansion phase is characterized with a strong competition within the sector by use of imitation and increased profit. Based on the interview statements of the contractors, mentioned in the results, it could be said that the Dutch contractors are no longer skeptic on CE and believe that if they do not start with transitioning towards CE they will not reach this next phase and thus will be out of business.

### *5.4 Comparison with other countries*

This study indicated that the Dutch housing sector is at the introduction phase in the

business cycle and that they are no longer skeptic on CE. Other studies by Adams et al. (2017) and Ormozabal et al. (2018) that empirically examine CE in Spain and the United Kingdom state that the construction companies in these countries do not think that CE could help them increase their profitability. Moreover, there is no clear business case for the construction companies. It could, therefore, be said that the housing sector in these countries are skeptic on CE and not convinced that they need to transition towards a CE to ensure their continuity. The phase that both these countries are in would then be early in the introduction phase.

### *5.5 Recommendations for further transition of CE in the Dutch housing sector*

As mentioned in sub-section 5.2, the interviewed Dutch housing contractors have not succeeded in closing their loop due to the absence of a reverse cycle in their CE strategy. Currently CE in the Dutch housing sector is mainly done by adopting CE products from suppliers in order to create a competitive advantage. To close the loop reverse cycles need to be included in the CE strategy of the contractors, however they indicate a barrier that is caused by difficulties with estimating the residual value of a house and the materials used in the house. To overcome this barrier more research on how the estimation of residual value of a house could be calculated with the least amount of uncertainty and risk. The indicated enablers by the interviewed construction companies should help with providing a starting direction for these researches.

The CE strategy framework that is adapted in this study is a useful tool for a construction company that started with the transition to a CE, since it gives a good overview of the possible choices a company has. Furthermore, it also indicates the areas within the company that will be affected by the transition.

This study successfully positions the Dutch housing sector in a business cycle phase and points out an crucial barrier that needs to be overcome to transition to the next phase in the business cycle. However, there could also be other smaller barriers that hold back further transition or possible future barriers that come with the new business cycle phases. More research on barriers in the housing sector in relation to business cycles is thus recommended to acquire more practical information that will help further transition of CE.

## 6 Conclusions

The novelty of this paper lies in the assessment of the CE strategies that Dutch housing companies have adopted and the barriers and enablers that they perceive. Furthermore, with Schumpeter's business cycle theory, this study succeeds in defining the progress of the CE transition of the Dutch housing sector, based on the assessment results of the CE strategies.

In order to assess the CE strategies, this research makes use of an existing CE strategy framework that is adopted to be more specific for construction organizations that are in a competitive environment. Construction companies that are formulating their CE strategy could also use this framework to define their choices around CE.

This study discusses that CE initiated a new business cycle in the housing sector and that probably is initiated due to a growing search to become more sustainable as a company. The results of this study support this theory and could also be used as an argument for the sixth Kondratieff cycle that is about sustainability, since the transition to a CE by the Dutch housing sector is currently an incremental change that is encouraged by a search to become more sustainable.

The CE strategies characteristics of the Dutch housing companies resemble the characteristics of the introduction phase. Furthermore, an argument could be made that the sector is at the end of this phase, since there is no scepticism among the interviewed companies and a general believe that if they do not transition, they will fall behind on their competitors. However, the interviewed Dutch contractors have not yet succeeded in closing their loop due to a lack of reverse cycle strategies and difficulties with estimating the residual value of a house and/or the elements within that house.

The difficulty of estimating the residual value could possibly be overcome by making use of the shearing layer concept of Brand (1994) and/or the creation of different regulations by the government for different categories of houses. When this barrier is overcome the contractors also have more incentive to include reverse cycles in their CE strategy, which in turn allows for closed loop CBM's that are healthier and more profitable and cause for the housing sector to transition towards the expansion phase in which higher profits are made and competition is based on imitation.

**Acknowledgements**

I would like to thank the experts at the various companies that took time for taking an interview and providing us with crucial information for this article, including Wietse de Vries, Wilco Lubbers, Jos Roesthuis and Wendeline Besier.

## References

Adams, K. T., Osmani, M., Thorpe, T., & Thornback, J. (2017). Circular economy in construction: current awareness, challenges and enablers. *Waste and Resource Managment (vol. 170)*, 15-24. doi:https://doi.org/10.1680/jwarm.16.00011

Allianz. (2010). *The sixth Kondratieff – long waves of prosperity*. Frankfurt am Main: Allianz Global Investors.

Bocken, N. M., Potting, J., Lifset, R., Olivetti, E., & Cullen, J. (2017). Taking the circularity to the next level: a special issue on the circular economy. *Journal of industrial ecology (vol. 21)*, 476-482.

Brand, S. (1994). *What Happens After They're Built.* Viking Press.

Cobouw. (2018, November 22). *Cobouw50 Ranglijkst: top 50 bouwbedrijven van Nederland.* Retrieved from Cobouw: https://www.cobouw.nl/bouwbreed/artikel/2018/11/cobouw50-top-50-bouwbedrijven-van-nederland-101267081?vakmedianet-approve-cookies=1&_ga=2.197036844.108026868.1557999776-2111253623.1557999776

Cristoni, N., & Tonelli, M. (2018). Perceptions of Firms Participating in a Circular. *European Journal of Sustainable Development (vol. 7)*, 105-118. doi:10.14207/ejsd.2018.v7n4p105

Cristoni, N., & Tonelli, M. (2019). *Strategic management and the circular economy.* New York: Routledge.

Davidson, C. (2013). Innovation in construciton -before the curtain goes up. *Construction Innovation, (vol. 13)*, 344-351.

Desrochers, P. (2002). Regional development and inter-industry recycling linkages: some historical perspectives. *An International Journal (vol. 14)*, 49-65. doi:https://doi-

org.ezproxy2.utwente.nl/10.1080/08985620110096627
Desrochers, P. (2004). Industrial symbiosis: the case for market coordination. *Journal of Cleaner Production (vol. 12)*, 1099-1110. doi:https://doi.org/10.1016/j.jclepro.2004.02.008
Dorée, A., Holmen, E., & Caerteling, J. (2003). Co-operation and competition in the construction industry of the Netherlands. *19th Annual ARCOM Conference* (pp. 817-826). Brighton: University of Brighton .
Dutch Government. (2016). *A Circular Economy in the Netherlands by 2050.* Den Haag: The Dutch Government.
Ellen MacArthur Foundation. (2013a). *Towards the Circular Economy - Part 1; Economic and business rationale for an accelerated transition.* Ellen MacArthur Foundation. Retrieved from https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf
Ellen MacArthur Foundation. (2013b). *Towards the Circular Economy - Part 2; Opportunities for the consumer goods sector.* Ellen MacArthur Foundation. Retrieved from https://www.ellenmacarthurfoundation.org/assets/downloads/publications/TCE_Report-2013.pdf
European Commission. (2014). *Towards a Circular Economy: A Zero Waste Programme for Europe.* Brussels.
European Commission. (2015). *Closing the Loop - An EU action plan for the Circular Economy.* Brussels: European Parliament.
Frosch, R. A., & Gallopoulos, N. E. (1989). Strategies for Manufacturing. *Scientific American (vol. 261)*, 144-152. doi:https://doi.org/10.1038/scientificamerican0989-144
Geissdoerfer, M., Savaget, P., Bocken, N. M., & Hultink, E. (2017). The Circular Economy - A new sustainability paradigm? *Journal of Cleaner Production (vol. 143)*, 757-768. doi:https://doi.org/10.1016/j.jclepro.2016.12.048
Gore, C. (2010). The Global Recession of 2009 in a Long-term Development Perspective. *Journal of International Development (vol. 22)*, 714-738. doi:10.1002/jid.1725
Hofmann, F. (2019). Circular business models: Business approach as driver or obstructer of sustainability transitions? *Journal of Cleaner Production (vol. 224)*, 361-374. doi:https://doi.org/10.1016/j.jclepro.2019.03.115
ISMA Amsterdam for Circle Economy. (2013). *Unleashing the Power of Circular Economy.* Amsterdam: ISMA Amsterdam.
Kingston, W. (2006). Schumpeter, Business Cycles and Co-evolution. *Industry and Innovation (vol. 13)*, 97-106. doi:10.1080/13662710500513474
Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation & Recycling (vol. 127)*, 221-232.
Kondratieff, N. D., & Stolper, W. F. (1935). The Long Waves in Economic Life. *The Review of Economics and Statistics (vol. 17)*, 105-115. Retrieved from http://www.jstor.org/stable/1928486
Kuznets, S. (1940). Schumpeter's Business Cycles. *The American Economic Review (vol. 30)*, 257-271. Retrieved from https://www.jstor.org/stable/1807049
Lacy, P., Keeble, J., McNamara, R., Rutqvist, J., Haglund, T., Cui, M., . . . Buddemeier, P. (2014). *Circular Advantage: Innovative Business Models and Technologies to Create Value in a World without Limits to Growth.* Chicago: Accenture.
Leising, E., Quist, J., & Bocken, N. (2018). Circular Economy in the building sector: Three cases and a collaboration tool. *Journal of Clearner Production (vol. 176)*, 976-989. doi:https://doi.org/10.1016/j.jclepro.2017.12.010
Lewandowski, M. (2015). Designing the Business mModels for Circular Economy - Towards the Conceptual Framework. *Sustainability (vol. 8)*. doi: doi:10.3390/su8010043
Lieder, M., & Rashid, A. (2016). Towards circular economy implementation: a comprehensive review in context of manufacturing industry. *Journal of Cleaner Production (vol. 115)*, 36-51. doi:https://doi.org/10.1016/j.jclepro.2015.12.042
Madaster. (2018). *About us*. Retrieved from Madaster: https://www.madaster.com/en/about-us
McKinsey & Partners. (2015). *Growth Within: A circular Economy vision for a competitive Europe.* McKinsey .

Mentink, B. (2014). *Circular Business Model Innovation: A process framework and a tool for business model innovation in a circular economy.* Delft: Delft University of Technology & Leiden University. Retrieved from http://resolver.tudelft.nl/uuid:c2554c91-8aaf-4fdd-91b7-4ca08e8ea621

Moody, J. B., & Nogrady, B. (2010). *The Sixth Wave: How to Succeed in a Resource-limited World.* Sydney: Random House.

Morone, P. (2016). The times they are a-changing: Making the transition toward a sustainable economy. *Biofuels, Bioproduction & Biorefining (vol. 10)*, 369-377. doi:10.1002/bbb.1647

Murray, A., Skene, K., & Haynes, K. (2017). The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context. *Journal of Business Ethics (vol. 140)*, 369-380. doi:https://doi-org.ezproxy2.utwente.nl/10.1007/s10551-015-2693-2

Ormozabal, M., Prieto-Sandoval, V., Puga-Leal, R., & Jaca, C. (2018). Circular Economy in Spanish SMEs: Challenges and opportunities. *Journal of Cleaner Production (vol. 185)*, 157-167. doi:https://doi.org/10.1016/j.jclepro.2018.03.031

Osterwalder, A., Pigneur, Y., & Tucci, C. L. (2005). Clarifying business models: Orgins, Present, and Future of the concept. *Communications of the Association for Information Systems (vol. 16)*, 1-25. doi:10.17705/1CAIS.01601

Oussama, A., & Ouakouak, M. L. (2015). The Business Model as a Configuration of Value: Toward a Unified Conception. *Journal of Business and Management Sciences (vol. 3)*, 78-84. doi:doi: 10.12691/jbms-3-2-4

Prieto-Sandoval, V., Jaca, C., & Ormazabal, M. (2018). Towards a consensus on the circular economy. *Journal of Cleaner Production (vol. 179)*, 605-615. doi:10.1016/j.jclepro.2017.12.224

Schumpeter, J. A. (1934). *The theory of economic development.* Cambridge, Massachusetts: Harvard University Press.

Shubik, M., & Sudderth, W. D. (2015). From General Equilibrium to Schumpeter. *Journal of Economic Dynamics and Control (vol. 61)*, 269-282. doi:https://doi.org/10.1016/j.jedc.2015.08.009

TNO. (2013). *Kansen voor de circulaire economie in Nederland.* Delft: TNO.

UNEP International Resource Panel. (2016). *Global Material Flows and resource productivity.* New York: UNESCO.

Yuan, Z. (2006). The circular economy: a new development strategy in China. *Journal of industrial Ecology (vol. 10)*, 4-8. doi:http://doi.wiley.com/10.1162/108819806775545321