

CESI Accelerator
Circular Economy Smart Industry

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Executive Summary

The global industrial economy is still predominantly linear, working according to the take-make-waste principle. This has affected the planet to a concerning amount, which is why the European Union signed the Paris Agreement, committing to a 1,5 to 2 degree scenario of global warming. In order to achieve this, the Netherlands and the European Union established the goal of creating a fully circular economy by 2050.

The private sector plays a crucial role in the transition towards a circular economy. As many organisations are unaware of the value creation opportunities behind circular business models, this report aims at revealing circular value creation opportunities by answering the central question: *How can smart and circular investments lead to sustainable values for Heerema and KPN?*

In order to obtain valuable findings, both companies were interviewed and the interviews were examined in-depth. The research was predominantly concerned with the topics **Circular Business Models**, **Smart Technologies**, the **Created Value**, and **Drivers** and **Barriers** of Heerema and KPN.

Six established Circular Business Models were selected and presented for this research project. Heerema mainly made use of *extending resource value* by reusing steel through an internal marketplace, and *circular supplies* by replacing Diesel with wind energy and liquified natural gas.

Industry 4.0 can be understood as the interplay of nine smart technologies, which were used in this research. Heerema is barely supporting their sustainable projects with smart technologies. There is one simulation centre of an offshore environment and 3D printing is slowly being introduced. KPN is making use of all of the smart technologies, as their initiatives strongly rely on technical support.

Regarding Drivers of circular business, the Circular Value Driver Framework by PACE (Platform for Accelerating the Circular Economy) was used as the main model. The seven 'key considerations' 1. Enter new markets, 2. Reduce cost, 3. Reduce risk and future-proof the business, 4. Trigger innovation capacity, 5. Attract and retain talent, 6. Deliver greater customer value, and 7. Align with public expectations. When evaluating the PACE framework, it stood out that reduce risk and future proof the business is by far the strongest driver for the cases studied in this paper. It is argued that this is a result of a still predominantly linear economy. As circular structures increase and financial incentives shift along with increasing consumer demand for sustainable products, drivers such as reduce cost and deliver greater customer value will become increasingly applicable.

Barriers are circumstances that hinder or obstruct the implementation of circular business models. For Heerema, the main barriers are an aversion to risk and therefore change, and the 20th century company culture, which includes an aversion to new technologies. For KPN, the main challenge is the dilemma between performance and energy savings.

List of Abbreviations

BD – Big Data

CBM – Circular Business Model

CC – Cloud Computing

CE – Circular Economy

CESI – Circular Economy Smart Industry

EMF – Ellen MacArthur Foundation

HR – Human Resources

LNG – Liquefied Natural Gas

PACE -Platform for Accelerating the Circular Economy

SI – Smart Industry

IoT - Internet of Things

IIoT – Industrial Internet of Things

TF – Theoretical Framework

TNO – The Netherlands Organisation for applied scientific research

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1. Introduction

The global industrial economy of the 21st century is increasingly testing the planetary boundaries of the earth, as it relies on the extraction of virgin resources on a large scale. On an international policy level, the critical issue of global warming has been acknowledged by the creation and signing of the *Paris Agreement*, which emerged from the United Nations Framework Convention on Climate Change (UNFCCC). The signatories, including the Netherlands, have committed to keeping global warming below 2° compared to pre-industrial temperatures (UNFCCC, 2015).

The Circular Economy is a concept that offers a contrary approach to global production than the current linear make-take-waste structures. The global economy has been evaluated to currently be 8,6 % circular. The Netherlands is considered a frontrunner on an international level, as it has transitioned towards a circular economy by 24,5% (Circle Economy, 2020).

While having advanced further than others, the Netherlands has committed to transition fully towards a circular economy by 2050 (Government of the Netherlands, 2016), which still presents a circularity gap of 75,5% (Circle Economy, 2020). Closing the gap requires changes in the manufacturing industry, which is challenged heavily by the requirements for a Circular Economy (Blunck & Werthmann, 2017).

In order to reveal value creation opportunities related to smart and circular business, this report will interview two frontrunners in these fields: Heerema and KPN. Heerema is an internationally established and leading marine contractor in the offshore oil and gas industry, as well as in the wind industry (Heerema Marine Contractors, 2020).

KPN has been exclusively using green energy since 2011. Since 2015 the company is operating climate neutral through compensations. In 2017, the company established their very own 'Circular Manifesto', which is a commitment by KPN and eighteen of its' suppliers to design their business operations as circular as possible by 2025 (KPN, 2019).

The main research question of this report examining Heerema and KPN in-depth is therefore: *'How can smart and circular investments lead to sustainable values for Heerema and KPN?'*

The two companies will be interviewed about their circular initiatives and how these created value so far. In order to better understand the different dimensions of the main questions, it will be researched according to the topics **Circular Business Models**, **Smart Industry**, **Created Value** and **Drivers and Barriers**.

Sub question 1) *What is the circular economy and how does it translate into business models?* Will explain the foundation of the topic and further investigate which CBMs are being employed by Heerema and KPN. Secondly, this report will answer the question: *How can smart industry enable circular business models?*. Furthermore, it will be examined *what sustainable values were created by the circular operations of Heerema and KPN*. Finally, this paper will research *what are drivers and barriers related to circular business models?*

2. Theoretical Framework

The theoretical framework of this project consists of literature surrounding the topics **Circular Economy** and circular business models, and **Smart Industry**. Particularly the intersection of Circular economy and Smart industry and their mutual potential to accelerate the other will be of value for this research. Furthermore, literature on **Value cases and sustainable values** as well as **Drivers and Barriers** to circular business will lay the foundation for moving from a pure business case towards the value case, which adds societal and environmental value outcomes to the equation.

2.1 Circular Economy

With growing concerns related to climate change, a global economy which relies on the extraction of finite resources is increasingly being challenged. Emerging as a counter idea, the concept of the Circular Economy has gained considerable traction in the last decade. Designing the global economy to become more circular represents a fundamentally different approach to the way the current linear 'take-make-waste' economy is operating.

The Circular Economy is an industrial economy that is restorative and regenerative by intention and design. Its focus lies extending the lifecycles of products and materials through reusing, refurbishing and recycling. It also aims to strategically design out waste and pollution, while relying on renewable energies. (Ellen MacArthur Foundation, 2013).

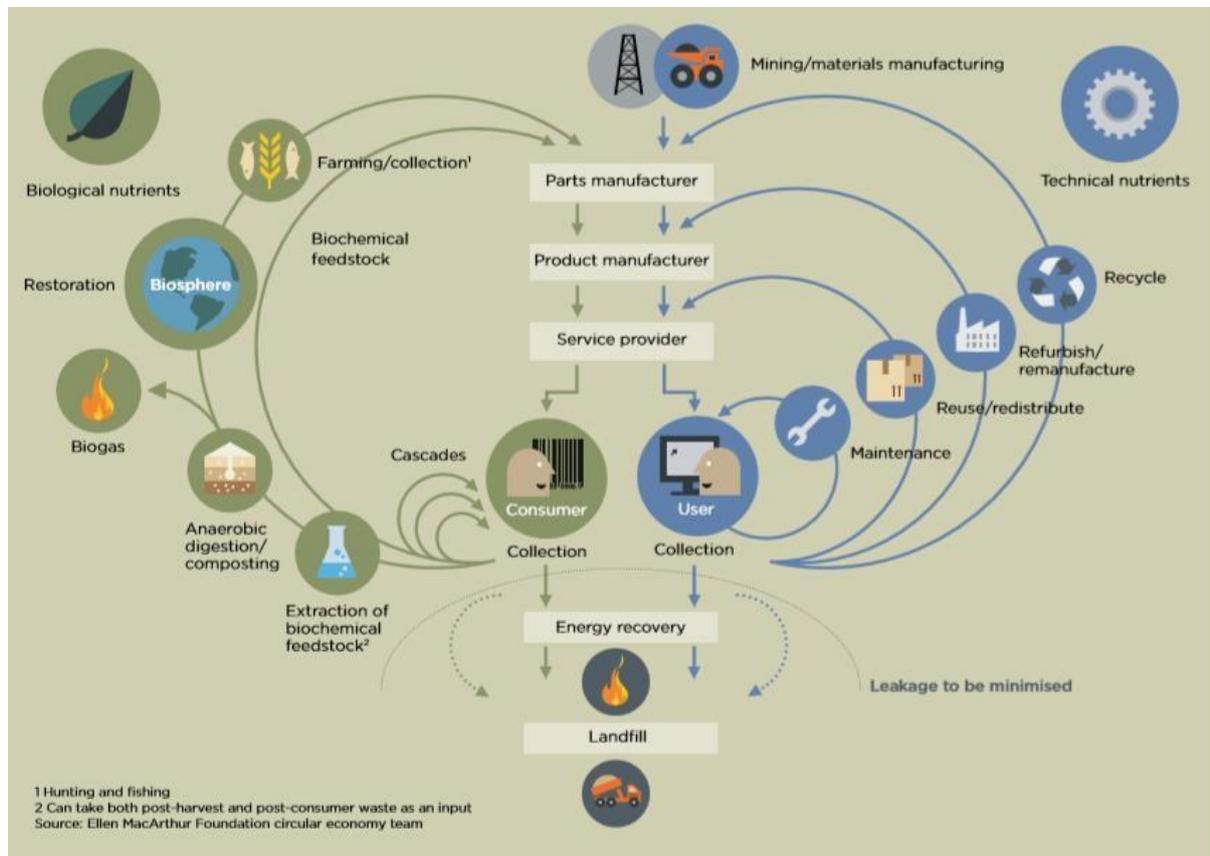
While originally emerging as a theoretical concept, *the Circularity Gap Report NL 2020*, evaluates the Dutch economy to be 24,5% circular. The global economy is estimated to only have transitioned by 8,6% (Circle Economy, 2020). The implementation of a Circular Economy has received organizational support. *Two landmark organizations* in the field which aim to create knowledge and accelerate the transition are the Ellen MacArthur Foundation and the Platform for Accelerating the Circular Economy (PACE).

According to the Ellen MacArthur Foundation, the Circular Economy relies on three core principles:

1. Preserve and enhance natural capital
2. Improve resource efficiency with various use cycles, keeping products, materials and components at the highest value possible
3. Expose and subsequently design out waste and pollution

The Circular Economy has been visualised as a Butterfly Model by the Ellen MacArthur Foundation, distinguishing between biological and technical components:

Figure 1 - Butterfly Model of the Circular Economy (Ellen MacArthur Foundation, 2013)



As the CESI Accelerator project is concerned with the manufacturing industry in South Holland, the focus will lie on the various lifecycles of technical products, materials and components. As portrayed in figure 1, the value of technical nutrients can be preserved by maintenance, reuse or redistribution, refurbishment or remanufacturing, and finally through recycling.

2.2 Circular Business Models

The general concept of a business model can be described as the way a company manages to create, deliver and ultimately capture value (Guldmann, 2016).

When shifting the scope from business models towards circular business models, an organization needs to support their CBM with a circular business case instead of a regular business case. This means that beyond relying on the extraction of raw materials to achieve financial outcomes, the principles of the Circular Economy are taken into consideration. In a CBM, value is therefore created, delivered and captured by the flow of materials through multiple use-cycles (Hofman, 2019, p. 363).

There is thus a fundamental difference in linear and circular value creation. CBMs generally aim at generating financial revenue through slowing, closing or narrowing resource loops (Bocken et al., 2016).

Slowing loops refers to the reuse and extended use of products by initially designing durable products and enabling maintenance, redistribution, and remanufacturing processes. In turn, closing loops represents the continuous flow of materials through recycling. Narrowing resource flows is a third approach which, in contrast to 'slowing' and 'closing', does not involve loops and is therefore not exclusive to CE. It simply emphasizes the reduction of resources used to produce a certain good (Bocken et al., 2016, p. 310).

When designing a Business Model in line with CE principles, thus aiming to slow, close or narrow loops, there are **four main sources of circular value creation** identified by the EMF. These validate the assumption of economic potential in circular business operations and are represented by: 1) the Power of the inner circle; 2) the Power of circling longer; 3) the Power of cascaded use 4) the Power of pure circles (Ellen MacArthur Foundation, 2013).

1) The Power of the inner circle

Generally, a tighter circle is likely to lead to increased cost reduction. Therefore, it is valuable to keep a product in its original cycle and at its highest value for as long as possible. This can be accomplished through intelligent product design and efficient repair and maintenance methods.

2) The Power of circling longer

Extending the usage period of products, materials and components is desirable as this results in a reduced need for resource inflow. Circling longer can be achieved by adding more cycles to a product life cycle or prolonging each use cycle

3) The Power of cascaded use

Cascaded use refers to introducing materials into different product cycles than the initial cycle, before ultimately returning to the biosphere.

4) The Power of pure circles

Finally, the above mentioned three circling powers can be enhanced considerably by introducing pure materials and components. The easier to separate and the less toxic materials are, the more value they have for running through additional cycles. (Ellen MacArthur Foundation, 2013, pp. 30-31)

2.2.1. Types of models

Moving on to the actual conceptualization of Circular Business Models, Bocken et al. (2016) present the six commonly accepted CBMs in academia. Four of them are related to *slowing* resource loops, namely the access and performance model, extending product value, the classic long-life model, and encourage sufficiency. When focussing on *closing* resource loops, extending resource value and industrial symbiosis are viable models.

Slowing Resource Loops

Access and performance model

Leasing all types of products as a service. Ownership is moved from the user to the company, which encourages longer lasting products and maintenance (Bocken et al., 2016, p. 312). It encourages companies to ensure durability and upgradability (Guldmann, 2016). Furthermore, it is likely to reach a bigger market of customer segments, as products which are expensive to own, become accessible cheaper through leasing them as a temporary service (Guldmann, 2016). Examples include the sharing of cars or bikes, and the leasing of technological equipment.

Extending product value

Prolonging a products value through organised collection aimed at carrying out maintenance, repair, refurbishing or remanufacturing. Via subsequent redistribution, a product is then reintroduced to another use cycle (Whalen, 2020, p. 17) . Remanufactured electronics and remanufactured automotive parts belong in this category.

Classic long- life model

Design products, intelligently and carefully, for extreme durability, potentially even aiming at a life-long product life cycle (Bocken et al., 2016, p. 314). Examples for life-long products are washing machines from Miele or Bosch, which are designed to last 20+ years.

Encourage sufficiency

The strategy to encourage sufficiency also relies on long lasting products, however this is while taking a “non-consumerist approach to sales” by encouraging reduced consumption by the end user. Examples are high quality and high durability brands like Patagonia (Bocken et al., 2016, p. 314).

*Closing Resource Loops**Extending resource value*

Collecting products, materials and components to extract their residual resource value, instead of considering them ‘waste’ (Bocken et al., 2016, p. 314).

Circular Supplies

Substitution of raw material sources with renewables (Bocken et al., 2016, p. 314). Electric cars or the German train network, running on 100% green energy are examples.

The Danish Environmental Protection Agency report, ‘Best Practice Examples of Circular Business Models’ (2016) pairs the value creation sources arising from circling, identified by the Ellen MacArthur Foundation, with common circular business models in the graph below (Figure 2)

The best practice examples publication of the Danish Ministry of the Environment comprehensively illustrates which types of business models are fuelled by which types value creation opportunities. However, the 5 formulated circular business models differ slightly from the way business models were predominantly identified by several scholars. Here, circular supplies, resource recovery, product life extension, sharing platforms and product as a service are considered to be relevant CBMs (Guldmann, 2016).

Figure 2- Interplay of EMF value creation sources with CBMs (Guldmann, 2016)

	Circular supplies	Resource recovery	Product life extension	Sharing platforms	Product as a service
Inner circle					
Circling longer					
Cascaded use					
Pure circles					

2.2.2 Building the Business Case for Circular Business Models

When attempting to operate based on a Circular Business Model in practice, PACE, the Platform for Accelerating the Circular Economy, identified two main focus areas related to achieving a CE: 1. Building a business case for circular business models and 2. Enabling the required organizational change to realize new circular models (PACE, 2019).

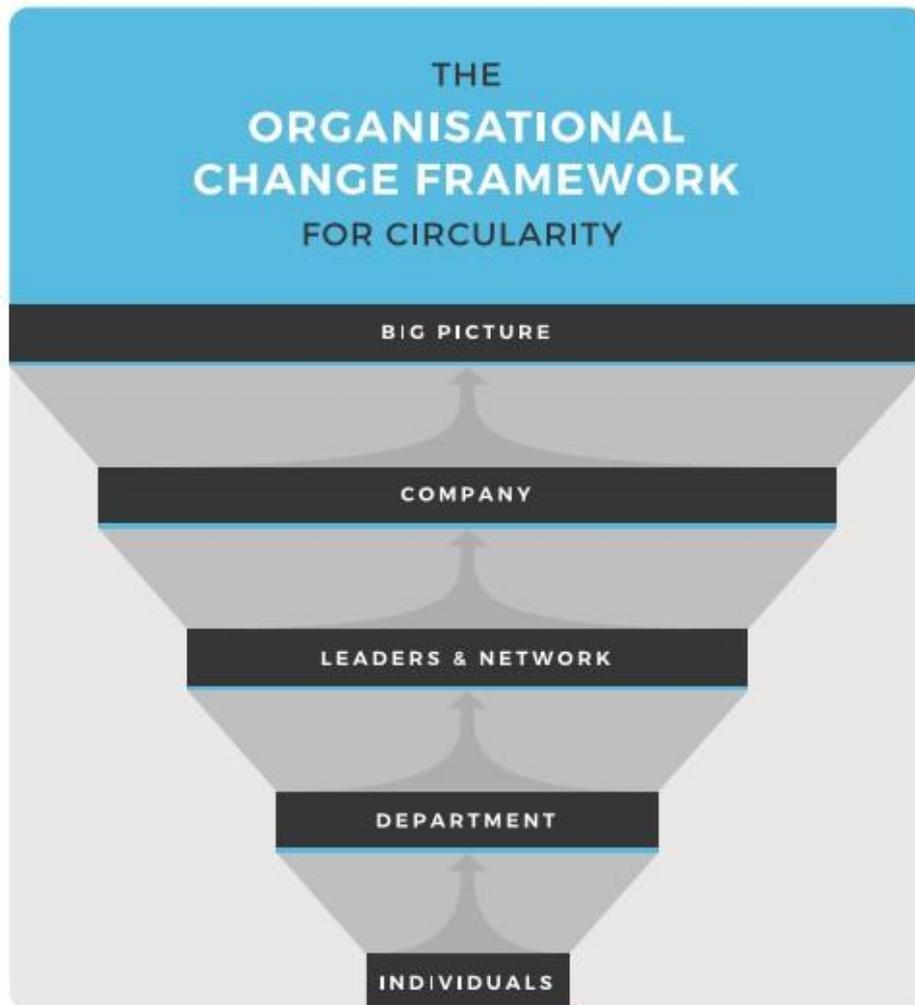
Building a business case implies revealing value creation opportunities which lead to clear financial value, beyond including social and environmental values.

When attempting to build a business case for circular business models, PACE identified 3 scenarios related to financial outcomes: 1) There is a clear and positive financial business case 2) Clear business case, but insufficient ROI or below current cost parity 3) Uncertain business case

Beyond building the business case for circularity, PACE stresses the importance of enabling the required organizational changes. This includes a compelling narrative that tells the story behind the aim for a circular business model (PACE, 2019).

As part of the effort to develop a new narrative, the Organisational Change Framework for Circularity was created:

Figure 3 - The Organisational Change Framework for Circularity (PACE, 2019, p. 10)



The essential part of this framework is the fact that 'Big picture' stands above all other categories. This implies that it is no longer enough to prioritize profits. Social and environmental values have to be included in all business considerations.

Furthermore, when enforcing this framework, PACE found that it is crucial to have motivated leaders at every level, that continue spreading awareness of the new narrative. It is also just as important to recognize circular efforts of individuals in the workplace (PACE, 2019).

2.3 Smart Industry

With global digitalization developing and becoming embedded in almost every aspect of society our means of production are also increasingly turning 'smart'. We are now beyond the fourth industrial revolution, also called Industry 4.0.

From a manufacturing point of view, Industry 4.0 can be defined as *“the intelligent flow of the workpieces machine-by-machine in a factory, on a real-time communication between machines”* (sc. 900).

The conceptualization of Industry 4.0 is discussed in various sources as the interplay of nine key technologies portrayed in figure 4: the Industrial Internet of Things, Big Data, Cloud Computing, Simulation, Autonomous Robots, Horizontal and Vertical Systems Integration, Additive Manufacturing, Augmented Reality and Cybersecurity.

Figure 4 - Key Technologies of Industry 4.0 (BCG – The Boston Consulting Group, 2015)



2.3.1 Industry 4.0 Key technologies

(Industrial) Internet of Things

IoT, the Internet of Things, is defined as the networked connection of physical objects (EMF, 2016, p. 15). Through IoT, products can communicate real-time knowledge about their location, condition and availability (EMF, 2016, p. 30). Adding the industrial dimension, IIoT, the Industrial Internet of Things, is the *“connection of industrial products such as components and/or machines to the internet”* (Alcácer & Cruz-Machado, 2019, p. 900). IoT is considered the support or the ‘backbone’ of Industry 4.0, as it manages all information flows (Saucedo-Martínez et al., 2017).

Big Data

Big Data (BD) is the concept of a huge amount of different types of data, namely structured, semistructured and unstructured data. Big Data can be described with the dimensions of Volume, Variety, Velocity, Veracity, Vision, Volatility, Verification, Validation, Variability and Value (Alcácer & Cruz-Machado, 2019).

The official definition of Big Data by the TechAmerica Foundation defines BD as *“a “term” describing large volumes of high velocity, complex and variable data requiring advanced techniques and techniques to enable the capture, storage, distribution, management and analysis of the information”* (Alcácer & Cruz-Machado, 2019, p. 905).

Most importantly, besides capture, storage, distribution and management, BD is characterized by the fact that the data can be analysed. Without BD Analysis, BD is not of any considerable value (Alcácer & Cruz-Machado, 2019).

Cloud Computing

Beyond communicating data like the IIoT, the cloud can store large amount of data (SaucedoMartínez et al., 2017). A cloud can have four types of access: public, private, hybrid and community (Alcácer & Cruz-Machado, 2019, p. 902).

Cloud related manufacturing offers the possibility to create custom made clouds for companies, based on Service-oriented Architecture (SoA). The existence of Cloud Computing (CC) and the subsequent creation of Cloud manufacturing systems, prevent companies from having to buy their own expensive technological equipment (Alcácer & Cruz-Machado, 2019).

Simulation

Computer simulation is a very useful tool for a manufacturing environment.

“Simulation is defined as an operation imitation, over time, of a system or a real-world process. It uses a system’s artificial history and its observation, drawing inferences over the operational features of the representation of the real system” (Saucedo-Martínez et al., 2017, p. 9).

In other words, simulation validates the design and configuration of products, processes or systems, through the execution of digital experiments (Alcácer & Cruz-Machado, 2019, p. 906). It is considered a major decision-making tool, as it saves time and resources, while validating important business decisions (Saucedo-Martínez et al., 2017).

Autonomous Robots

As the average level of automation in the manufacturing industry is steadily rising, the employment of robots is undergoing a similar growth path (Saucedo-Martínez et al., 2017). An autonomous robot functions beyond a regular robot and can be considered a form of *Artificial Intelligence* (Alcácer & Cruz-Machado, 2019, p. 911). They can be employed to work in a multi-robot system to increase the value of their use. However, besides robot – to robot interaction, there are also so called ‘cobots’ which is a type of robot that is designed to interact with humans (Alcácer & Cruz-Machado, 2019).

Horizontal and Vertical Systems Integration

Horizontal and vertical systems integration describes the organised interplay of engineering, production, suppliers, marketing and supply chain operations based on levels of automation and information flow (Saucedo-Martínez et al., 2017, p. 8). This process serves to determine useful structural changes in real time.

Systems integration can also be described as “Industry 4.0 in action” as it incorporates and harnesses all other eight key technologies of the Smart Industry framework (Saucedo-Martínez et al., 2017, p. 8).

Additive Manufacturing

Additive Manufacturing stands for a technology which might be more widely known as 3D printing. AM technology is defined as “a process of creating a 3D object-based on the deposition of materials on layer-by-layer or drop-by-drop under a computer-controlled system” (Alcácer & Cruz-Machado, 2019, p. 910).

Augmented Reality

Augmented Reality is best described as a type of simulation which pairs physical and virtual elements (Saucedo-Martínez et al., 2017). *“The essential parts of an AR system make use of electronic devices to directly or indirectly view a real-world combination with virtual elements”* (Alcácer & Cruz-Machado, 2019, p. 908).

Cybersecurity

With a steadily increasing amount of data, there is higher exposure to potential threats to the digital system. The purpose of a cybersecurity infrastructure is to decrease the risk of cyberattacks. *“CS is a technology laying on protecting, detecting and responding to attacks”* (Alcácer & Cruz-Machado, 2019, p. 912).

2.4 Smart Industry and Circular Economy

As described in the previous section, given the technological advances of the 21st century, corporations are increasingly using smart technology to generate revenue. While it is not imperative to pair Smart Industry with a Circular Economy, there is hope that it could be used as a major catalyst for circularity. This project will continue the research towards that direction, hence the title CESI (Circular Economy Smart Industry) Accelerator.

The Ellen MacArthur Foundation published a landmark report on the intersection of Circular Economy and Smart Industry in 2016: *Intelligent Assets: Unlocking the Circular Economy Potential*.

This research explores how Intelligent Assets and the Internet of Things can fuel the potential of a Circular Economy.

The Internet of things (IoT) represents “The networked connection of physical objects” (Ellen MacArthur Foundation, 2016, p. 8).

Intelligent asset represent “physical objects that are able to sense, record and communicate information about themselves and/or their surroundings. This definition incorporates IoT objects but also includes assets that are not continuously transmitting information, and things that do not feature wireless communication” (Ellen MacArthur Foundation, 2016, p. 8)

Similarly to the PACE report, *Intelligent Assets* identifies Value Drivers that could drive the creation of financial revenue for both Circular Economy and Intelligent Assets:

The Circular Economy Value Drivers are extending use cycle lengths of an asset, increasing utilisation of an asset, looping an asset through additional cycles and the regeneration of natural capital (Ellen MacArthur Foundation, 2016, p. 31)

When examining possible Value Drivers of Intelligent Assets, their key strength is to provide knowledge of the location, condition and/ or availability of an asset (Ellen MacArthur Foundation, 2016, p. 31).

When pairing these Circular Economy and Intelligent Asset Value Drivers, the following value creations opportunities arise:

Figure 5 - Interactions of Circular Economy and Intelligent Asset Value Drivers (Ellen MacArthur Foundation, 2016)

	INTELLIGENT ASSET VALUE DRIVERS		
CIRCULAR ECONOMY VALUE DRIVERS	Knowledge of the location of the asset	Knowledge of the condition of the asset	Knowledge of the availability of the asset
Extending the use cycle length of an asset	<ul style="list-style-type: none"> Guided replacement service of broken component to extend asset use cycle Optimised route planning to avoid vehicle wear 	<ul style="list-style-type: none"> Predictive maintenance and replacement of failing components prior to asset failure Changed use patterns to minimise wear 	<ul style="list-style-type: none"> Improved product design from granular usage information Optimised sizing, supply, and maintenance in energy systems from detailed use patterns
Increasing utilisation of an asset or resource	<ul style="list-style-type: none"> Route planning to reduce driving time and improve utilisation rate Swift localisation of shared assets 	<ul style="list-style-type: none"> Minimised downtime through to predictive maintenance Precise use of input factors (e.g. fertiliser & pesticide) in agriculture 	<ul style="list-style-type: none"> Automated connection of available, shared asset with next user Transparency of available space (e.g. parking) to reduce waste (e.g. congestion)
Looping/cascading an asset through additional use cycles	<ul style="list-style-type: none"> Enhanced reverse logistics planning Automated localisation of durable goods and materials on secondary markets 	<ul style="list-style-type: none"> Predictive and effective remanufacturing Accurate asset valuation by comparison with other assets Accurate decision-making for future loops (e.g. reman vs. recycle) 	<ul style="list-style-type: none"> Improved recovery and reuse / repurposing of assets that are no longer in use Digital marketplace for locally supplied secondary materials
Regeneration of natural capital	<ul style="list-style-type: none"> Automated distribution system of biological nutrients Automated location tracking of natural capital, such as fish stocks or endangered animals 	<ul style="list-style-type: none"> Immediate identification of signs of land degradation Automated condition assessment, such as fish shoal size, forest productivity, or coral reef health 	

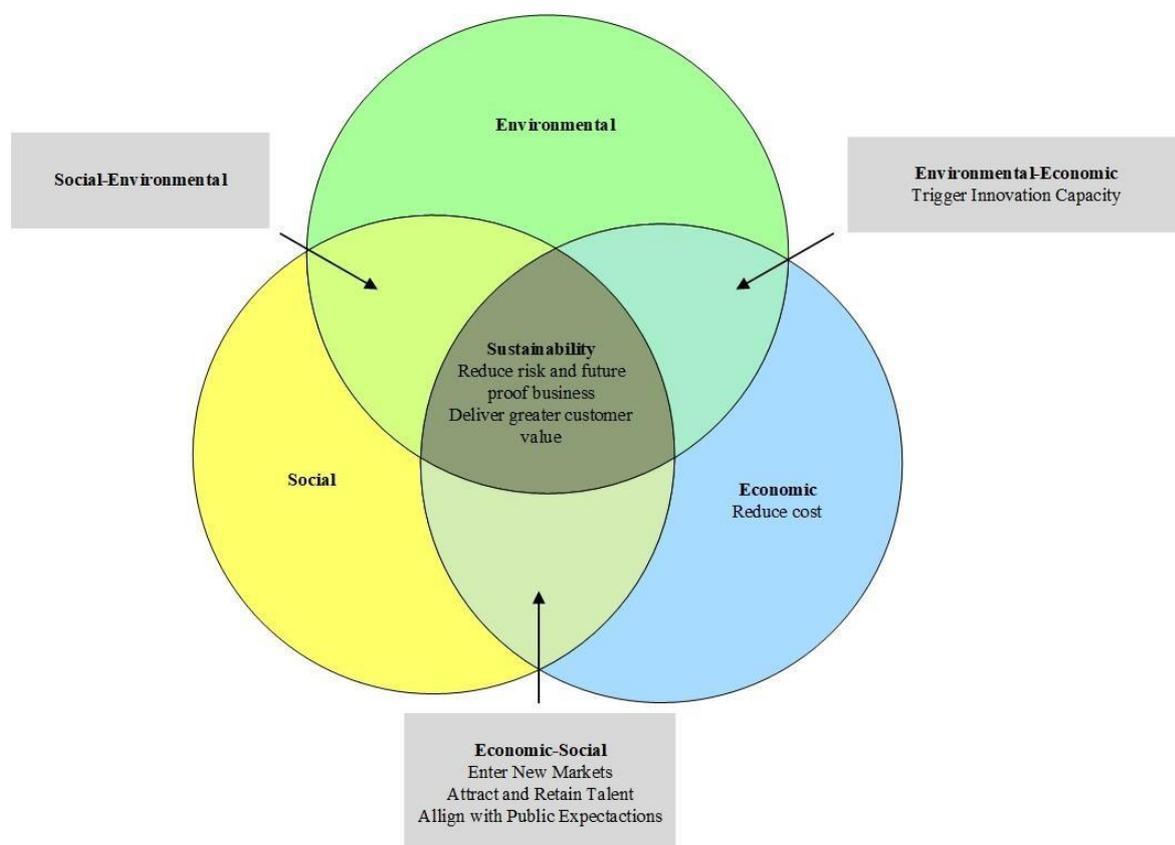
Summarized, the report concludes that there is an enormous financial opportunity to be seized, when combining the value drivers mentioned above. Intelligent Assets could represent the missing link to catalyse an implementation of the Circular Economy. The Barriers identified in this report are the need for data security and trust, in order to harness the full potential of big data. Furthermore, a scalable infrastructure for IoT networks is still missing. Finally, and maybe most

importantly, there is a need for a collective effort to transition among organisations (Ellen MacArthur Foundation, 2016).

2.5 Value cases / sustainable values

When moving from a pure business case towards a value case, 'people' and 'planet' get included besides 'profit' considerations. In other words, financial value outcomes get replaced by sustainable value outcomes. In economic theory, sustainability is now commonly understood to lie at the intersection of the Environmental, Economic and Social realm.

Figure 6 - Venn Diagram Sustainability Circular Value Drivers (den Hoedt, 2020)



In the Venn Diagram above, the value drivers from the Circular Value Driver Framework, have been placed in the sustainability visualization.

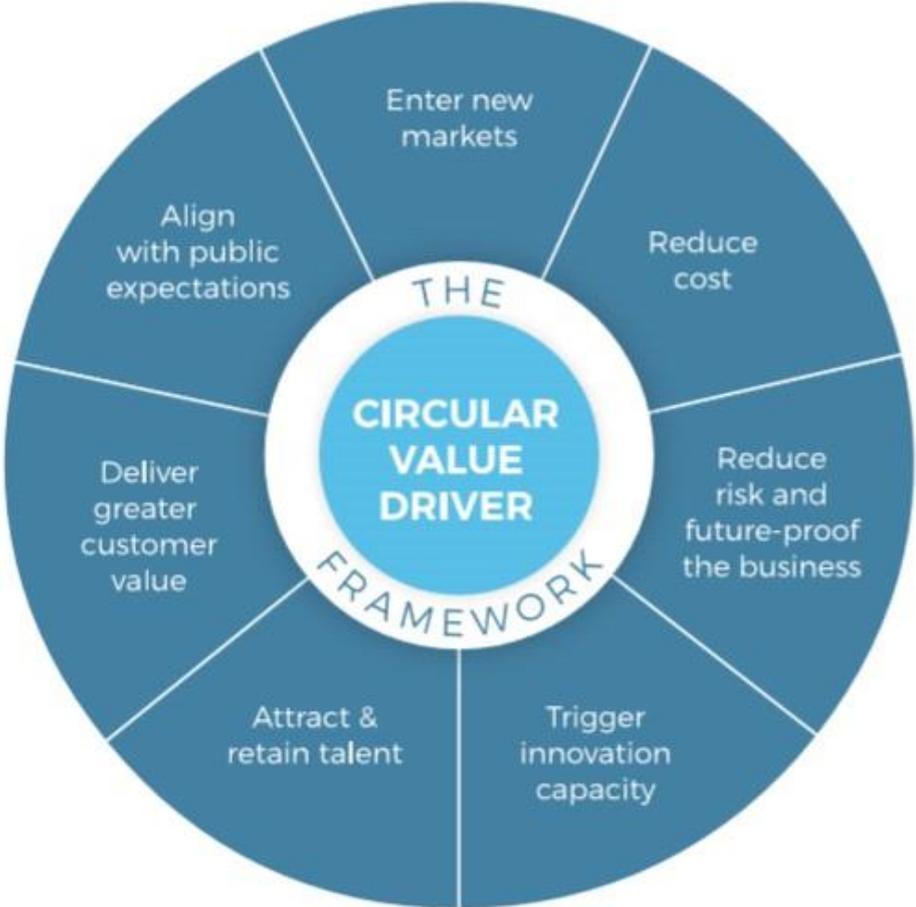
When sustainable and/or circular values get included in the business, a shift from business case towards value case can be created.

2.5.1 PACE Circular Value Drivers

PACE, the Platform for Accelerating the Circular Economy combines more than 50 leaders dedicated to catalyse a Circular Economy on a larger scale. While it is hosted by the World Economic Forum, it is co-chaired by the heads of the Global Environment Facility and UN Environment, as well as the CEO of Royal Philips. The Ellen MacArthur Foundation is one of the trusted knowledge partners (PACE, 2019). The Capital Equipment Coalition is a group of 9 businesses, representing a large product range, formed in January 2018. Their report *Circular Value Creation: Lessons from the Capital Equipment Coalition (2019)*, communicates valuable knowledge from their first year of collaboration, including **the Circular Value Driver Framework**, which has become an essential model when examining *Drivers* of circular business models. The Circular Value Driver Framework will serve as the main model when analysing the circular value creation of Heerema and KPN.

Based on lessons learned redesigning their own business models, The Capital Equipment Coalition developed the Circular Driver Framework, with **seven key considerations** for circular business practices (PACE, 2019).

Figure 7 - The Circular Value Driver Framework (PACE, 2019)



According to the Circular Value Driver Framework portrayed in Figure 6, the identified Circular Value Drivers are:

1. Enter new markets

By understanding companies more as owners of products rather than sellers, new market segments could be entered for instance through using as-a-service models.

2. Reduce Cost

Closing the loop and keeping the value of products, materials and components at the highest possible value throughout their use cycles, can ultimately lead to reduced costs.

3. Reduce risk and future-proof the business

The volatility of raw material prices is expected to rise, as we continue to rely on the extraction of finite resources. Taking future customer demand into account, circular practices can considerably reduce risk, while also future-proofing the business. Beyond each business, a more circular design will lead to the global economy which more restorative, and therefore more sustainable and futureproof as a whole.

4. Trigger innovation capacity

Shifting towards different, more novel business principles in the form of circular value creation represents an ideal space for innovation and creativity.

5. Attract & retain talent

Future employees are expected to place greater value in an organizations' position and actions related to sustainability.

6. Deliver greater customer value

With organization being the owners of products, there is an opportunity for mutually beneficial, long lasting customer relationships. Beyond simplified access to products which are treated as materials, circular concepts are also likely to be more in demand in the future.

7. Align with public expectations

Corporations are increasingly being scrutinized by the public eye regarding their environmental impact and carbon emissions. As public expectations are shifting, the current standard of production could adjust to these developments by progressing to circular models.

(PACE, 2019, pp. 8-9)

The CESI Accelerator Tool aims to further develop the models mentioned above and potentially add further value drivers to the Circular Value Driver Framework. The seven Value Drivers above are mainly related to economic value. While this is essential, as a circular economy can only be achieved

with a clearly formulated business case (PACE), social and environmental values are lacking in this model. They are only broadly included in 'Align with public considerations'. This could be related to the third scenario from PACE when building a business case: the uncertain business case. This implies that product designs and the supply of materials might have to be revised in order to receive a financially beneficial business case, that aims to improve sustainable values.

Regarding the concept of values that go beyond the financial factor, TNO, the Netherlands Organisation for Applied Scientific Research has created a Value Case Methodology for aligning financial and non-financial values in large multi-stakeholder innovation projects (TNO, the Netherlands Organisation for applied scientific research, 2013).

In this method, which aims at bringing stakeholders together, step 1: Value Identification, consists of identifying the precise goals and values of each stakeholder. In step 2: Value Quantification, additional information on quantified measurement, of e.g. impact of a certain value, can be added. Step 3: Value Sensitivity serves to reveal the sensitivity and thereby the level of priority of each value for each stakeholder, in order to prepare the final step. After value sensitivity has been examined, is the time for stakeholders to drop out, if they feel that no alignment can be achieved after the first three steps. Finally, in step 4: Value Alignment is performed by harnessing the identified alignment opportunities following the analysis from step 1-3 (TNO).

2.6 Barriers

In a still predominantly linear industrial economy, there are several barriers to adopting circular business models. Barriers that hinder circular business development can be of various nature. For this research, the distinction made by Vermunt, Negro, Verweij, and Kupp in the paper *Exploring barriers to implementing different circular business models* (2019) will be adopted.

According to Vermunt et al. barriers can be conceptualised in 6 categories, split into internal and external barriers. The internal barrier categories have been identified as *financial*, *organizational* and *knowledge & technology*. External barriers can be related to the *supply chain*, *market*, or of *institutional* nature (Vermunt, Negro, Verweij, & Kupp, 2019, p. 893).

2.6.1. Internal Barriers

Financial

Examples of financial barriers beyond an **unclear business case** can range from the **lack of financial resources** to invest into a new CBM to **high up-front investment costs** or generally **higher costs related to the new CBM** (Vermunt et al., 2019).

Organizational

Organization barriers to implementing circular business models include the possible **administrative burden** and **organization of reverse infrastructures**. Circular business can also lead to **more complex management and planning processes** (Vermunt et al., 2019).

Knowledge and technology

Barriers related to knowledge and technology can be due to **lack of technical know-how and expertise** or **lack of information/data**. Furthermore, **challenges to create durable products** or the **ability to deliver high quality products** can act as a roadblock for circular business developments (Vermunt et al., 2019).

2.6.2 External Barriers

Supply chain

One of the areas of external barriers is the supply chain. **Lack of partners and low availability of materials** or the **lack of information exchange between supply chain actors** are examples of supply chain barriers. **Conflicting interests between actors in the supply chain** or the **lack of consideration on circular design from supply chain actors** can further inhibit circular business models (Vermunt et al., 2019).

Market

Market related barriers could for example be **resistance from stakeholders** with interests in the linear economy. **Low virgin material prices** and **lack of consumer interest/non-acceptance of CBMs** are further instances of market related barriers to CBMs (Vermunt et al., 2019).

Institutional

Institutional barriers can range from **ineffective recycling policies** or **incentives that promote material consumption above services** to a general **lack of awareness and sense of urgency within society** (Vermunt et al., 2019).

2.7 Operationalization Tables

Circular Business Models

Figure 8 - Operationalization Table Circular Business Models

Variable	Definition	Example	Research question
Access and performance model	Leasing all types of products as a service	Car or bike sharing	Did smart investments enable you to.. implement a product as-a-service model?
Extending product value	Prolonging the value of a product through organised collection and maintenance, repair, refurbishing or remanufacturing	Remanufactured electronics or automotive parts	.. establish maintenance, repair, refurbishing or remanufacturing through collection?
Classic long-life model	Designing products for (life-long) durability	Miele washing machines	.. design products for extreme durability
Encourage sufficiency	Encouraging reduced consumption by the end user	High quality and high durability brands like Patagonia	.. encourage the end user to consume less?
Extending resource value	Collecting products, materials and components to extract residual resource value instead of wasting	Interface – collecting and supplying fishing nets as a raw material for carpets	.. extract residual resource value from products, materials or components?
Industrial Symbiosis	Transforming waste outputs from one cycle into feedstock for another cycle	Kalundborg Eco-Industrial Park	.. feed waste outputs from one cycle into another cycle?

Smart Technologies

Figure 8 - Operationalization Table Industry 4.0

Variable	Definition	Example	Research question
Internet of Things (IoT)	The networked connection of physical objects to the internet	widely used in transportation, healthcare or utilities	Did any of your initiatives make use of smart technologies such as... the Internet of Things ..?
Big Data	Large volumes of complex data requiring advanced techniques to enable capture, storage, distribution, management and analysis of information	BD can increase manufacturing competitiveness by improving decision making processes through advanced data analysis	.. Big Data ..
Cloud Computing	enabled through IoT, CC can store large amount of data with varying types of access	a custom-made cloud for a company can fuel cost reduction through the removal of IT infrastructure	.. Cloud Computing ..
Simulation	Validation of the design and configuration of products, processes or systems, through digital experiments	simulation optimization tool that searches for the optimal product design within a given system	.. Computer Simulation ..
Autonomous Robots	A form of AI that is capable of robot-to-robot or robot-to-human communication	robots that perform spray-painting on a car	.. Autonomous Robots ..
Horizontal and Vertical Systems Integration	The organised interplay of engineering, production, suppliers, marketing and supply chain operations based on levels of automation and information flow to determine useful structural changes in real time.	smart production scheduling	.. Horizontal and Vertical Systems Integration ..

Additive Manufacturing	The process of creating a 3D object, based on the deposition of materials on layer-by-layer or drop-by-drop, under a computer-controlled system”	material design of a product through the production of 3D models	.. Additive Manufacturing ..
Augmented Reality	A type of simulation which pairs physical and virtual elements	defects inspection of a e.g. pipe with a virtual 3D image	.. Augmented Reality ..
Cybersecurity	A technology laying on protecting, detecting and responding to cyberattacks	Protecting the smart manufacturing process with appropriate Security Architecture	.. Cybersecurity ..

PACE Value Drivers

Figure 9 - Operationalization Table PACE Value Drivers

Variable	Definition	Example	Research question
1. Enter new markets	The need to maintain original product function as much as possible, based on circular values. This can enable access to new market segments	refurbished products, e.g. phones, which respond to demand from different customer segments than new products	Did the following Circular Value Drivers play a role in the considerations or for the success of your circular initiative ? enter new markets
2. Reduce cost	Reducing cost through reusing products, components, and materials	closed-loop programs	reduce cost
3. Reduce risk and future-proof the business	Treating existing products and components as an alternate source of supply moderates risks related to supply chain disruptions. Future customer demand for circular products and services future proofs the business	replacing regular fuel with a renewable energy source	reduce risk and future-proof the business
4. Trigger innovation capacity	Driving value through CBMs triggers creativity for product and/ or business model design	design a new product through the new circular approach	trigger innovation capacity
5. Attract & retain talent	Younger talent considers purpose driven companies more attractive	Including sustainability in the Human Resources planning	attract & retain talent
6. Deliver greater customer value	Managing the customer relationship throughout the whole lifecycle builds trust	In a product-as-a service model for instance, where the customer can be sure to receive better customer service	deliver greater customer value

7. Align with public expectations	Increasing expectations from the public regarding environmental impacts	less negative externalities such as Co2 emissions	align with public expectations
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Barriers

Figure 10 - Operationalization Table Value Networks

Variable	Definition	Example	Research question
Barrier	Circumstance inhibiting or slowing circular business developments	Conflicting interests between actors in the supply chain	Which barriers or roadblocks did you experiencing in the process of implementing CBMs?

3. Methodology

The CESI Accelerator project aims to reveal sustainable value creation opportunities related to investing in circular and smart solutions, in the case of this report using the examples of Heerema and KPN.

In order to answer the central question, desk research and field research have been performed as part of the project. Each of the four sub question is first answered theoretically in the *Theoretical Framework*. Subsequently, an interview and a survey were performed with two companies: Heerema, a marine service contractor in the offshore oil and gas industry, and the telecommunications company KPN. The results of the interviews with these two frontrunner companies will answer the applied version of each sub question, which will be presented in chapter 4, to then be analysed in chapter 5, using a qualitative case-based approach.

The interview partners for the CESI Accelerator project were selected by TNO, the Netherlands Organisation for applied scientific research. The selection was based on the condition, that the company has at least some experience with investing in smart and circular / sustainable solutions. The interview questions have been created based on the operationalization tables in section 2.8.

Due to the current national measures to prevent the spread of COVID-19, both interviews took place digitally and were recorded using Skype for Business.. The interview sessions were led by two students of THUAS, with the support of Ton Bastein, Senior Scientist Circular Economy, from TNO.

The interview with Jeroen Cox, Senior Manager Energy & Environment, from KPN took place on April 14th 2020, for 60 minutes between 14.00 and 15.00. The interviewee had filled out the survey right before the interview, and subsequently talked our team through the document question by question (Appendix B).

The interview with Heerema took place on April 28th 2020 for 90 minutes between 13.00 and 14.30. The organisation was represented by Vincent Doedée, sustainability manager at Heerema. In this session, the team was able to cover most questions of the interviews by topic, instead of by initiative (Appendix A).

The surveys were sent out via email one or two days before the interview appointment. The preliminary survey was constructed to relieve the topic load of the interview questions. Based on a system where the interviewee could simply tick, which Technologies, parties in the Value Network, phases of the product value chain, Value Drivers and Circular Business Models apply to each sustainable / circular initiative, with the goal to gain additional statistical insights. Throughout

the project, it was decided to exclude the survey, due to the interviewees difficulties with the specific circular business terminology. Ultimately, it turned out more valuable to examine the interviews for **CBMS, Smart Technologies, Drivers** and **Barriers** according to the definitions identified in the theoretical framework, and give them the corresponding label. In the case of KPN the survey results were still marginally used for the topic smart technologies. KPN is using many smart technologies, which were not all mentioned one by one in the interview. Therefore the list with smart technologies is the only information that is being taken from the KPN survey (Appendix C).

Sub question 1) What is circular economy and how does it translate into business models? has been covered by desk research, relying on sources from the Ellen MacArthur Foundation and TNO, as well as other trustworthy academic sources. This sub question was answered in chapter 2.1 Circular Economy and 2.2 Circular Business Models of the theoretical framework. Section 2.1 presents a definition of the circular economy and its core principles. The different types of circular business models are presented in sub chapter 2.2 Circular Business Models. Which CBMs have actually been applied by Heerema and KPN will be presented in the results section 4.1.3 and 4.2.3 and analysed in the analysis section 5.1. All mentions of CBMs in the interviews are presented according to the six business models introduced in the theoretical framework.

Moving from Circular Economy towards Smart Industry, sub question 2) *How can smart industry enable circular business models?*, has been answered by conducting desk research on Industry 4.0 technologies. The findings are presented in 2.3 Smart Industry, which defines smart industry and the nine key technologies, and 2.4 Smart Industry and Circular Economy, which summarizes how smart industry can accelerate the circular economy. Which smart technologies are supporting Heerema's and KPN's circular projects will be presented in results 4.1.4 and 4.2.4 and analysed in chapter 5.2 according to the nine key technologies presented in the TF.

Sub question 3) *What value was created by the circular/ sustainable operations of Heerema and KPN?*, is answered in the results section 4.1.1 and 4.2.1 Circular initiatives and efforts, and 4.1.2 and 4.2.2. Circular Value Creation. Section 4.1.1. and 4.2.1 summarizes the sustainable initiatives and efforts mentioned by the interview partners in the interview or survey. 4.1.2. and 4.2.2 lists all the positives outcomes (value creation) for each project. At the end of chapter 4.2. a table to present all the (sustainable) positive outcomes per initiatives, has been constructed. The analysis of these sections will be presented together with the analysis of overall drivers.

Sub question 4) *What are drivers and barriers related to circular business models?* has also been answered by the quantitative analysis of desk research, in this case related to circular drivers and barriers. This has been performed in 2.5 Value cases / sustainable values, which introduces the central model of this dissertation, developed by PACE (the Platform for Accelerating the Circular Economy), in sub section 2.5.1: *The Circular Value Driver Framework*. Barriers related to circular business models have been presented in the Theoretical Framework in section 2.6. Barriers. Which drivers and barriers related to their CBMs Heerema and KPN reported, will be presented in section 4.1.5. and 4.2.5. Section 5.3 will serve as the analysis section of drivers. Here, the table from section 4.2 is extended, by matching the list of positive value outcomes with the PACE Drivers. Each listed benefit is assigned a driver, based on which category of drivers is most suitable according to the description of the Circular Value Driver Framework by PACE. This analysis gives qualitative case-based insight on the validity of each value driver. It is then further analysed according to the Atlas.ti coding of the interviews. The Barriers are going to be analysed separately in section 5.4.

The entire project is being carried out by a transdisciplinary research team of six students from The Hague University of Applied Sciences. Team 1 (4 students) have conducted research on circular value creation opportunities by interviewing frontrunners and companies, which have at least some experience with sustainable investments. Team 2 (2 students) will then operationalize the data into a comprehensive tool, to be used by SMTE's in South Holland who want to start investing or invest further in smart and sustainable solutions.

This research paper is part of the research of Team 1. In total, 6 interviews of 60 to 90 minutes, based on the questions in the Theoretical Framework, have been held with Heerema, KPN, Lely, HTC Speedgates, SEW Eurodrives and Priva. For this particular paper, only the interview results of Heerema and KPN were taken into consideration.

4. Results

The following results chapter will summarize the interview results with Heerema (Appendix A) and KPN (Appendix B). Furthermore, the preliminary survey structured by topic filled in by KPN (Appendix C), is taken into account. Each interview has been examined for the content of the sub-questions. The following sub-chapters will first present the **Circular Initiatives** mentioned in the interviews and survey. Subsequently, the **Created Value** that the initiatives created, the applied **Circular Business Models**, enabling **Smart Technologies** and **overall Drivers and Barriers** will be listed.

4.1 Heerema

The interview with a representative of the international marine contractor took place on April 28th 2020, via the program Skype for Business. The interviewee was Vincent Doedée, Sustainability Advisor at Heerema Marine Contractors (Appendix A, p. 66).

4.1.1 Circular initiatives and efforts

Vincent Doedée from Heerema described the following sustainable efforts in the interview: Heerema's newest crane vessel, **the Sleipnir**, is powered by liquified natural gas (LNG). LNG is perceived to be a cleaner fuel by the industry. Secondly, **Shore Power Rotterdam** is a project where a vessel can be powered by a wind turbine on shore. Furthermore, Heerema created an **Internal Steel Marketplace**, to re-use steel instead of scrapping it. Beyond these concrete sustainable projects, Heerema has increasingly been **moving towards the wind industry by installing and decommissioning wind turbines and investing in wind assets**. Finally, the **Human Resources (HR) value network** with its few selected pulls, such as the TU Delft offshore engineering faculty, as well as **collaboration with Circo** were described as contributions towards a more circular operation (Appendix A).

4.1.2 Circular Value Creation

This subsection answers which added value was created by each circular/ sustainable operation of Heerema introduced above. The actual value outcomes presented below will be sorted into the PACE framework in the Analysis section.

LNG powered Vessel Sleipnir

Heerema's newest vessel, the Sleipnir, is the largest crane vessel in the world and *"It's running on LNG, perceived to be a cleaner fuel by the industry. No particular matters, no smog, less nitrogen oxides, no sulfur"* (Appendix A, p. 71). The health and safety of workers is also increased by running a vessel on LNG: *"[...] smog on our vessels, that can be a pretty big issue, if there is no wind and the smog actually accumulates on deck, it's not a nice environment to work on, so that's why we're also looking into alternative fuels. And that was also one of the reasons LNG was chosen"* (Appendix A, p. 71). While Heerema is starting to leverage on this investment, a clearer business case and more financial return is expected in the future (Appendix A, p. 75).

Shore Power Rotterdam

In collaboration with Eneco and the Port of Rotterdam, Heerema gas enabled to charge a vessel with sustainable energy, on shore. For the future, Heerema is envisioning to charge the entire fleet in this way (Heerema Marine Contractors, 2020). *"One of the things we're most proud of is, I think Shore Power, in Rotterdam. That's been a project that started in 2016, end of 2016/ 2017. Which is basically, plugging a giant plug into one of our vessels, and having them run on a wind turbine. So 100% green electricity"* (Appendix A, p.66).

Internal Steel Marketplace

"We made a marketplace for reusing steel, looking into ways of expanding that marketplace with other players. [...] in the first weeks it already reused like 6,5 million in kilos of steel" (Appendix A, p. 67). This project was carried out with the support of Circo, a Dutch platform aiming to accelerate the transition towards a CE through circular business design. Heerema has enabled the possibility for *"reusing steel that is laying around and flashing our yard for new projects."* (Appendix A, p. 83). By adding a game character, internal competition was sparked, to re-use more steel than your colleague (Appendix A, p. 84).

In addition to the existing marketplace, the interviewee Vincent Doedée is also considering implementing this concept on a larger scale: *'My ultimate goal is to make something like Dockstr. She is a marketplace for the marine offshore industry, but then Dockstr is more focussed on equipment and rental, so that is really let's say cranes, winches or engines or whatever. And then we could be focused on the building blocks, the materials, the beams, the steel plates, the rigging etc. So different angle, but it is what it is. Marktplaats.nl but then just for the marine industry. So just a marketplace in an online environment'* (Appendix A, p. 84).

Installing and Decommissioning of wind turbines

The interviewee indicated that Heerema is including more and more wind related projects, as oil and gas is collapsing offshore. These activities take place in the form of installing and decommissioning of wind turbines (Appendix A, p.69). Furthermore, Heerema could get involved in the ambitious future plans of the wind industry, which are still theoretical: *“Considering the ambitions of the wind energy industry to install a 12/15 MW wind turbines and more [...] at the moment, the plans they have are technically impossible. [...] Even our biggest crane vessel in the world, which is two years old, can probably not install the types of wind turbines that they have on the drawing board at the moment. [...] We will probably have to do it differently. So there is some great potential in that sector”* (Appendix A, p. 69).

Investing in wind assets

Vincent Doedée indicated that at this moment, already almost three quarters of Heerema’s revenue comes from projects and activities that are not related to oil and gas: *“I would say, and it depends per year, but at this moment almost three quarters of our revenue, a little bit less, is coming from non-oil and gas related activities. So more than half is from wind and cleaning up stuff, decommissioning we call it”* (Appendix A, p. 75).

“So sure we still have quite an oil and gassy footprint and I’m only talking about revenues and not profits, because there is a big difference there, as you know. But I think in term of our outlook towards the future in the coming years, it’s the wind projects that are making our company tick” (Appendix A, p. 75-76).

HR Value Network

So far, Heerema has been able to attract new talent, as it is a company that is operating in a business to business niche and has established several talent pulls, including the TU Delft offshore engineering faculty (Appendix A, p.74). It was further mentioned that students are increasingly taking sustainability into account: *“[...] they look a lot at engineering, although, every one of them has sustainability in a very high regard, and I think there might be a point in which it’s going to be harder to attract talent. HR acknowledges this, but a lot of engineers who have been working here for 30 years, or 20 years or whatever, we call them the clay layer, they all have to realize that not only for the betterment of mankind but also to attract new talent, we have to focus a little bit more on sustainability”* (Appendix A, p.74).

Collaboration (with Circo for instance)

Vincent Doedée indicated that Circo approached him for collaboration regarding circularity in the marine industry (Appendix A, p. 83). *“Without Circo, we never would have had this steel marketplace. So that’s why I believe in collaborations, it gives you room to experiment”* (Appendix A, p. 76).

The table below summarizes the sub-chapter above, by listing all positive outcomes (created value) resulting from Heerema’s circular efforts.

Figure 8 - Circular Value Creation Heerema per initiative

Initiative / Effort	Benefits / positive outcomes / captured value
LNG powered Vessel Sleipnir	Health benefits & Increased safety for workers Less pollution (cleaner fuel: no smog, less nitrogen oxides) Financial return (now possible to leverage and capitalize on that investment)
Shore Power Rotterdam	100 % green energy Zero emissions Less reliance on virgin materials
Internal Steel Marketplace	Less raw material is purchased The resource value is being retained 6.5 million kilos of reused steel so far The shipyard is less clogged with old material Internal competition to re-use more than your colleague Less purchase cost
Investing in wind assets Decommissioning (of wind turbines) Future projects of installing giant wind turbines (not yet feasible)	Less reliance on oil & gas Three quarters of revenue from NON-oil and gas projects A lot of potential in that new sector Heerema will potentially sustain itself due to this market Heerema is the only one who can install current projects (+holding all the knowledge for future projects)

<p>HR value network</p> <p><i>Future: Communicating Heeremas circular ambition</i></p>	<p>Good relationship with students from TU Delft offshore engineering faculty</p> <p>Heerema is an interesting place to work for engineers</p> <p><i>Those students are increasingly taking sustainability into account, so they will respond positively</i></p>
<p>Collaboration (with Circo for instance)</p>	<p>Room to experiment with sustainable processes</p> <p>Access to new business models</p>

4.1.3. Circular Business Models

Heerema is currently mainly employing the circular business models *Extended resource value* and *Circular supplies*. It was however described that the company could technically make use of the *access and performance model*, since it is already a service provider. KPN is making use of elements of various business models. Below, all elements of CBMs of Heerema are listed, according to the interview.

Access and performance model

“I think the circular business models all revolve around providing more or less of a service, or access towards something. It’s not about making a transaction of a resource. In that sense Heerema has some advantage, because we have always simply delivered a service. Yes we have very big assets, but the only thing we do, is we take something from a client and we install it somewhere else. That is sort of what we do, we construct, we are a contractor. [...] So we can quite neatly package that into a circular or a sustainable business model, but we need to change the way we think and the way we send our invoices to the clients (Appendix A, p. 78)”

Extending resource value

With Heerema’s *Internal Steel Marketplace* **the residual value of leftover steel is being captured** by re-introducing leftover steel components as material instead of considering it waste and scrapping it (Appendix A, p.66).

Industrial Synopsis / Circular Supplies

In the *Shore Power Rotterdam* project, **Diesel is being substituted with renewables** in the form of wind-energy. A vessel from Heerema can now be charged with green energy on shore, before embarking on the sea (Appendix A, p.66).

Heerema’s *LNG powered vessel Sleipnir* is running on liquified natural gas, which is perceived to be a cleaner fuel by the industry (Appendix A, p. 71).

The table below presents a summary of all the Circular Business Models used in the sustainable/ circular initiatives and efforts of Heerema:

Figure 9 - CBM's Heerema

Circular Business Model	Application
Access and performance Model	Would be possible in the future
Extending product value	Not applicable
Classic long-life model	Not applicable
Encourage sufficiency	Not applicable
Extending resource value	<i>Internal Steel Marketplace:</i> Leftover steel that was previously being scrapped is now getting collected and re-used
Circular Supplies	<p><i>Shore Power Rotterdam:</i></p> <p>Charging a vessel with wind energy on shore, instead of it running on Diesel</p> <p><i>LNG powered vessel Sleipnir:</i></p> <p>Heerema’s newest vessel, the <i>Sleipnir</i> runs on liquified natural gas, instead of Diesel</p>

4.1.4 Smart Technologies

Smart Technologies are not very prominent in Heerema’s operations. *“Heerema is not as digitally matured as some other companies, and people find it hard to know what they can do with new technologies”* (Appendix A, p. 73). The interviewee indicated that the company has not matured well digitally and is still largely operating as a 20th century company (Appendix A, p. 74). *“We’re trying to work on it but it’s mostly I think human driven, not technology driven, definitely not technology driven”* (Appendix A, p. 73).

Simulation

Heerema has a simulation center simulating an offshore environment. While it is not directly tied in with a sustainable effort, it does reduce risk significantly (Appendix A, p.73).

Additive Manufacturing / 3D Printing

While not connected to a specific initiative, at Heerema, an intern managed to 3D print a crucial metal part, which would have taken months to restock, provided it could even be delivered at all (Appendix A, p. 92): *“Maike went to the vessel and went through all different kinds of materials, all different kinds of parts and then [...] found out that it was a critical part, no substitutes are being made, it cannot be shipped anymore, it is going to take months. So I was like, well this is a goldmine of information. And it was actually around five times less expensive to 3D print it, only talking about product costs, not logistics”* (Appendix A, p. 92). The technology 3D printing is now slowly being introduced, by providing engineers at Heerema with a 3D printer to familiarize themselves (Appendix A, p. 92).

Figure 10 - Smart Technologies Heerema

Smart Industry Technology	Initiative
Internet of Things	not applicable
Big Data	not applicable
Cloud Computing	not applicable
Simulation	Simulation center of an offshore environment
Autonomous Robots	not applicable
Horizontal and Vertical Systems Integration	not applicable
3D Printing	Huge potential, currently slowly introduced

Augmented Reality	not applicable
Cybersecurity	not applicable

4.1.5 Drivers and Barriers

Drivers

The developments around oil and gas dying offshore, drive Heerema to more further towards the wind industry, in order to ensure **survival** (Appendix A, p. 74). Furthermore, what drives Heerema’s sustainable actions, is the **responsibility of the owner** (Appendix A, p. 68).

Furthermore, **personal motivation** was reported to play a big role regarding driving circular business at Heerema (Appendix A, p.70; p.83). *It’s either money, it’s either personal motivation, mostly it’s because people think it’s cool, or should be done, or in case of our owner it’s something that feels important. That’s usually opening up most doors in the end”* (Appendix A p. 73).

Barriers

One of the Barriers that was mentioned during the interview with Vincent Doedée was a general desire to keep things working the way they are. This includes an **aversion to new technologies** (Appendix A, p. 73).

Furthermore, there is an **aversion to risk and therefore change**. *“We are working on our culture and our mentality, but generally speaking people don’t like change, not even when it’s good for them. Because change is perceived, well I think inherently, evolutionary almost, as possibly bad. Especially in our risky environments. So change is difficult, and the first answer is always no, the second also no, and it’s only after some continuation that you can actually open up minds of people”* (Appendix A, p. 73).

Demanding financial structures which are geared towards a linear economy, form another roadblock for Heerema. The pressure of quarterly expected profits and an investment return within three years, inhibit non-traditional approaches to business (Appendix A, p. 77). Unfavourable financial incentives, such as an reimbursement for scrapping steel versus re-using it, prohibited concrete initiatives, such as the internal marketplace, in this case (Appendix A. p. 83).

4.2. KPN

The interview with a representative of KPN took place on April 14th 2020 via the program Skype for Business. The interviewee was Jeroen Cox, Senior Manager Energy and Environment at KPN (Appendix B, p. 95).

4.2.1 Circular initiatives/ efforts

Jeroen Cox from KPN indicated the following initiatives in the preliminary survey, which were subsequently discussed during the interview: The first initiative is **Energy Efficiency Servers**, which entails energy saving modes being applied on IT servers. Secondly, KPN enabled **Network Rationalization**, in the form of replacing older equipment with new more energy efficient equipment. KPN also invested into product design for recycled plastic. Finally, precision farming based on low latency connections in the **5G Lab Drenthe**, and autonomous driving and smart traffic lights in the **5G Lab Helmond** were presented (Appendix C, p. 109-110). In addition, **KPN's Circular Manifesto**, the ambition to become as circular as possible by 2025, signed by eighteen of KPN's suppliers (Appendix B, p. 98), was discussed during the interview.

4.2.2 Circular Value Creation

Circular manifesto

KPN has created a *Circular Manifesto* to streamline their circular efforts, which has now been signed by eighteen suppliers. Signatories commit to redesign the entire business operation towards circularity, as much as is realisable, by 2025 (Appendix B, p.98).

Energy Efficiency Servers

The first presented initiative of KPN were Energy Efficiency Servers realized in collaboration with the municipality of Amsterdam and the Amsterdam Economic board. *"Datacentres are becoming a problem because they use a lot of energy. So there is a lot of focus on whether we can use data in a more energy efficient way. [...] And one of the things we did here is look at two server casings and we set it to the first energy saving level and via those settings we managed to save 7% versus the non-used or other ranks if you like"* (Appendix B, p. 96).

Network Rationalisation

Increasing the capacity of the KPN network is the background of the initiative Network Rationalisation: *"in the last nine years as of 2010, we managed to save 25% of energy consumed by cars, networks and offices. And at the same time the energy we, as a society, used via the KPN network went about 15 times. [...] And that is mainly by replacing old equipment by new and also a process that is called virtualization"* (Appendix B, p. 96).

Design with recycled plastic

The *design with recycled plastic* initiative is one of the projects that is being carried out within the framework of KPN’s *Circular Manifesto* (Appendix B, p. 98). *“So we will introduce in one or two months’ time a new modem and it used to be white on the outside [...] but now it will become black. So it uses recycled plastic, the latest remote control has the bottom cover of recycled plastic, also black* (Appendix B, p. 98). The project has enabled KPN to raise the percentage from 33% to 90% (Appendix B, p. 104).

5G Field Lab Drenthe

The 5G Field Lab Drenthe is one of two research and design initiatives presented in the Interview with KPN: *“So this is [...] a truck that drives across the acker and analyses the acker and looks if it is weed or actual crop. And it will only spray poison on the weed and not on the crop.* (Appendix B, p. 98). This type of innovation is called ‘precision farming’, which uses a lot less water and poison to maintain the acker, enabled by a complex interplay of technologies (Appendix B, p.99).

5G Field Lab Helmond

The other innovative initiative is the 5G Field Lab Helmond, which is concerned with connected driving and smart traffic lights This can for instance enable first aid services to always get priority in form of a green light. Furthermore, it can reduce stop and go moments significantly (Appendix B, p. 99). *“And this also means that you have less exhaust because the stop and go is the most exhausting part [...] and it is using virtual reality as well amongst others. There is people in the cars, but they are driving via a connected protocol”* (Appendix B, p. 99).

The table below summarizes the positive value creation per initiative introduced above:

Figure 11 - Circular Value Creation KPN

Initiative	Created Value
Energy Efficiency Servers: apply energy saving modes on IT Servers	7% savings on energy consumption (early stage, bigger results expected)
Network Rationalisation: Replacing older equipment with less equipment (virtualization) and new more energy efficient equipment	25% energy saving realized in 9 years, despite data usage via KPN Network going up x15

Design with recycled plastic: Top and bottom covers of consumer equipment (modems, TV-receivers, remote controls).	- Less need to buy new plastic - 60% smaller remote controllers
5G Field Lab Drenthe: Precision farming based on low latency connections	Allowing for less use of toxic material for taking out weeds from acres More control of water usage for farming
5G Field Lab Helmond: Autonomous driving and smart traffic lights	- More control over traffic - Increases regular traffic flows (less stop and go), which in turn helps to control exhaust of traffic

4.2.3. Circular Business Models

KPN is making use of elements of various business models. Below, all elements of CBMs of KPN are listed, according to the interview.

Access and performance model

In the *design with recycled plastic* project, KPN maintains ownership of the consumer equipment, which is recollected from the end consumer and re-used to produce equipment with recycled plastic (Appendix B, p. 107).

Encourage sufficiency

The *5G Labs Drenthe and Helmond* encourage sufficiency through precision (Appendix B, p. 99). Furthermore, the initiatives *Energy Efficiency Servers* and *Network Rationalisation* save a lot of energy through efficiency (Appendix B, p. 96).

Extending resource value

The *organised collection of materials components and products* is taking place with the consumer equipment in the *design with recycled plastic* project (Appendix B, p. 98).

Circular Supplies

While none of the initiatives above fall into the definition of circular supplies (*substituting with renewables*), the entire company has been operating on 100% green energy since 2011 (Appendix B, p. 97).

The table below presents a summary of all the Circular Business Models used in the sustainable/circular initiatives and efforts of KPN:

Figure 12 - CBMs KPN

Company	Initiative	CMB
KPN	Energy Efficiency Servers: apply energy saving modes on IT Servers	<ul style="list-style-type: none"> • Encourage sufficiency
KPN	Network Rationalisation: Replacing older equipment with less equipment (virtualization) and new more energy efficient equipment	<ul style="list-style-type: none"> • Encourage sufficiency
KPN	Design with recycled plastic: Top and bottom covers of consumer equipment (modems, TV-receivers, remote controls).	<ul style="list-style-type: none"> • Access and performance model • Extending resource value
KPN	5G Field Lab Drenthe: Precision farming based on low latency connections	<ul style="list-style-type: none"> • Encourage sufficiency
KPN	5G Field Lab Helmond: Autonomous driving and smart traffic lights	<ul style="list-style-type: none"> • Encourage sufficiency

4.2.4 Smart Technologies

KPN indicated the support by several smart technologies for all of their initiatives in the survey (Appendix C). Below, all the applicable Industry 4.0 key technologies are listed, according to each project introduced in the sections above:

Figure 13 - Smart Technologies KPN (Appendix C, p. 2)

Initiative	Technology
Energy Efficiency Servers: apply energy saving modes on IT Servers	<ul style="list-style-type: none"> • Big Data • Cloud computing • Simulation • Horizontal and vertical system integration
Network Rationalisation: Replacing older equipment with less equipment (virtualization) and new more energy efficient equipment	<ul style="list-style-type: none"> • Big Data • Cloud computing • Simulation • Horizontal and vertical system integration
Design with recycled plastic: Top and bottom covers of consumer equipment (modems, TV-receivers, remote controls).	<ul style="list-style-type: none"> • Simulation • Horizontal and vertical system integration
5G Field Lab Drenthe: Precision farming based on low latency connections	<ul style="list-style-type: none"> • Internet of things • Big Data • Cloud computing • Simulation • Horizontal and vertical system integration • Augmented reality
5G Field Lab Helmond: Autonomous driving and smart traffic lights	<ul style="list-style-type: none"> • Internet of things • Big Data • Cloud • Simulation • Autonomous robots • Horizontal and vertical system integration

4.2.5 Overall Drivers and Barriers

Drivers

Jeroen Cox described that the main motivational driver behind all the circular developments of the company was top-down stakeholder involvement (Appendix B, p. 97).

Barriers

The only distinguishable barrier from the interview with KPN is performance versus energy efficiency dilemma. Engineers are trained to thrive to ultimate performance, which can potentially be hindered by energy saving settings (Appendix B, p. 105).

5. Analysis

The following chapter will analyse the Results chapter by topic: Circular Business Models, Smart Technologies, Circular Value Drivers and Barriers. Using the data analysis software Atlas.ti, the interview transcripts from Heerema and KPN were coded according to each category. The analytical tables below are presented and used to interpret the interview results presented in chapter 4.

Research Limitations:

Throughout the research project, it became increasingly clear that the circular business model terminology as well as value case terminology is not yet commonly known. Therefore the survey from Heerema was excluded and the survey from KPN is only being used to a limited extend (see Methodology). Based on the definitions established in the theoretical framework, the interview transcripts were assigned the appropriate label, even if in some instances the interviewee gave the matter a different label.

5.1 Circular Business Models

While not all initiatives could be linked to a specific CBM, all other sustainable projects and efforts that work towards a more circular company have been included.

Figure 14 - CBMs Heerema & KPN (Atlas.ti coding of Appendix A and B)

	Interview Transcript Heerema Gr=77	Interview Transcript KPN Gr=52	Totals
● 1 Access and Performance Model Gr=2	1	1	2
● 2 Extend product value Gr=0	0	0	0
● 3 Classic long-life Gr=0	0	0	0
● 4 Encourage Sufficiency Gr=5	0	5	5
● 5 Extend Resource Value Gr=8	1	7	8
● 6 Circular Supplies Gr=5	5	0	5
Totals	7	13	20

Both companies create value by extracting residual resource value through organised collection of products, materials and components, which is conceptualised as the CBM *Extend Resource Value*.

While Heerema is collecting steel, KPN is collecting plastic in the form of discarded consumer equipment such as modems, remote controls and routers.

The second strongest CBM overall, *Circular Supplies*, the substitution with renewable sources, is Heerema's most applied model. The substitution of Diesel with wind energy and LNG leads to less reliance on virgin materials as well as less pollution and emissions.

Besides extending resource value KPN relies mostly on *Encourage sufficiency* by designing smaller, more energy efficient equipment.

5.2 Smart Technologies

Throughout the research it became very clear that KPN is making considerably more use of smart technologies than Heerema. Every initiative involved more than one SI technology, as indicated in the preliminary survey. For the table below, the interview consisted of going over the survey, and not all applicable technologies were mentioned in the conversation.

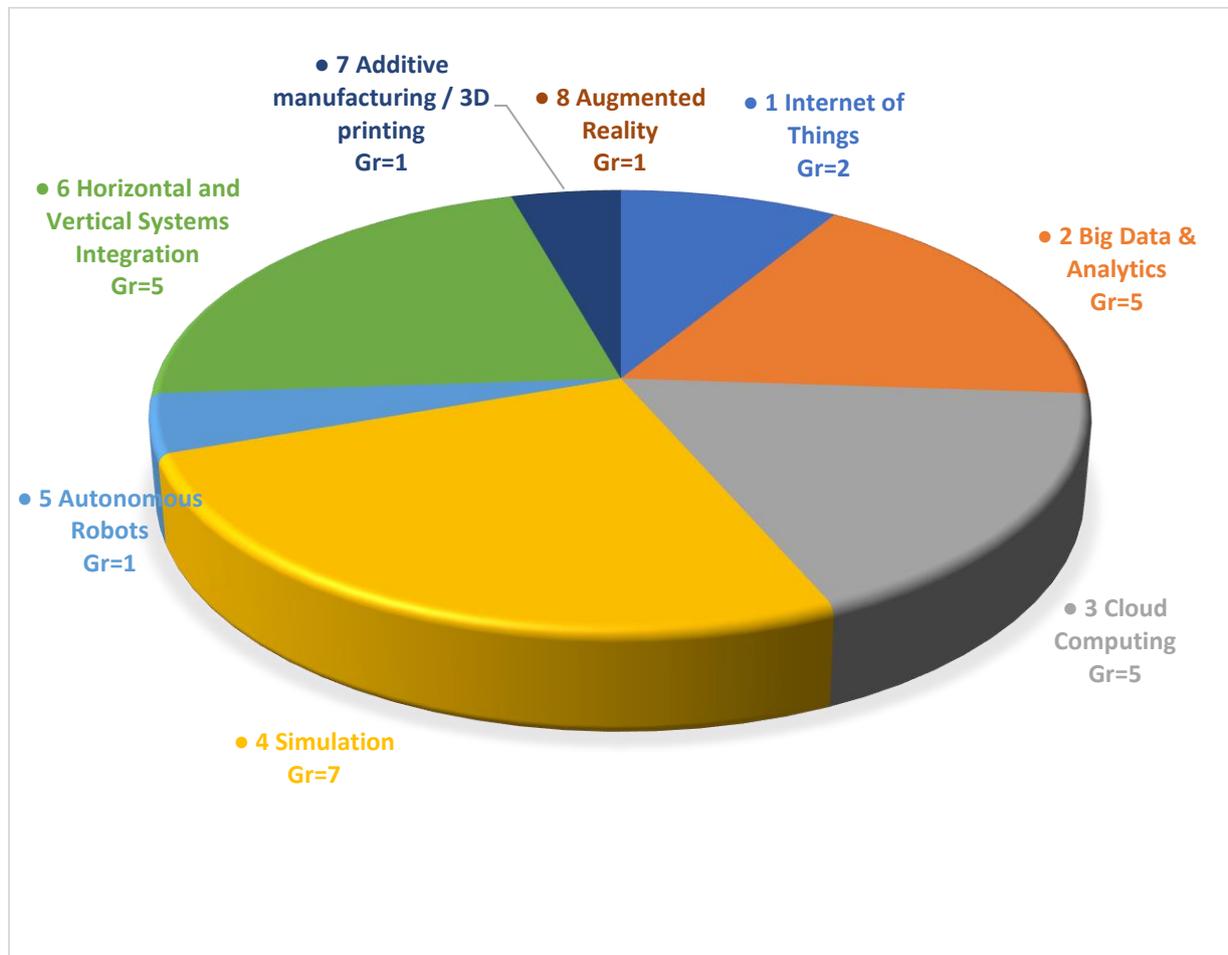
Figure 15 - Smart Technologies Heerema & KPN (Atlas.ti coding of Appendix A and C)

	Clean transcript Heerema Gr=75	Smart Technologies KPN Gr=21	Totals
● 1 Internet of Things Gr=2	0	2	2
● 2 Big Data & Analytics Gr=5	0	4	4
● 3 Cloud Computing Gr=5	0	4	4
● 4 Simulation Gr=7	1	5	6
● 5 Autonomous Robots Gr=1	0	1	1
● 6 Horizontal and Vertical Systems Integration Gr=5	0	5	5
● 7 Additive manufacturing / 3D printing Gr=1	1	0	1
● 8 Augmented Reality Gr=1	0	0	0
● 9 Cybersecurity Gr=0	0	0	0
Totals	2	21	23

Simulation was the most used smart technology. The *validation of the design and configuration of products, processes or systems, through digital experiments* (chapter 2.3.1), is serving KPN in all the circular initiatives. Even Heerema supports their business with *simulation*, in the form of a simulated offshore environment, which significantly reduces risk.

Horizontal and vertical systems integration can be described as “Industry 4.0 in action” (chapter 2.3.1), as it is a process servers that can determine useful structural changes in real time, using and combining almost all other SI technologies. It is the second most used technology by KPN. Without this interplay of technologies, the extremely innovative 5G labs Drenthe and Helmond would not be realisable.

Figure 16 - Pie chart smart technologies Heerema & KPN (ATlas.ti coding of Appendix A and C)



Beyond the numbers, there is a clear trend towards digitization,

KPN is clearly heavily harnessing smart industry technologies for their circular projects. While this may be self-speaking, as it is a telecommunications provider, the 5G labs in Drenthe and Helmond are cutting edge research projects which heavily rely on SI technologies.

Also within Heerema It is crucial to incorporate smart technologies into the transition, as they can serve to reduce cost, in the example of 3D printing by five times (Appendix A, p. 92). 3D printing also suggests great advantages regarding time efficiency and flexibility (Appendix A, p. 88).

5.3 Circular Value Drivers

This section analyses the results subchapters *4.1.2 Value Creation Heerema* and *4.2.2 Value Creation KPN*, as well as *4.1.5 Overall Drivers Heerema* and *4.2.5 Overall Drivers KPN*

For examining drivers of CBMs for Heerema and KPN, the PACE Circular Value Driver Framework was chosen as the main model. PACE describes the drivers as “seven key considerations that member organizations take into account when developing circular business proposals” (PACE, 2019, p. 8). This implies that organizations are expecting a certain value capture that apply to the seven value drivers. When analysing the interviews, however, the interviewees only mentioned a few motivations such as money, personal motivation, or stakeholders. When mapping the actual value that was created by the circular initiatives of Heerema and KPN, as done in results chapter 4.1.2 and 4.2.2, a lot more applicable information is revealed.

Therefore, drivers can be the *expected value capture or motivation*, as well the *actual value capture or benefit*. The **motivational drivers** for Heerema and KPN were presented separately in the results in section 4.1.5 and 4.1.6. The **beneficial drivers**, not yet sorted into the PACE framework, were presented separately in results section *4.1.2 Value Creation Heerema* and *4.2.2 Value Creation KPN*.

In the subsection below, all the collected benefits mentioned in the interviews are sorted into the seven PACE drivers. In the following subsection 5.3.2 the PACE framework is validated using the Atlas coding data.

5.3.1. Application of the PACE Circular Value Driver Framework

The table below lists all the sustainable efforts of the companies that were discussed in the interviews. The benefits or actual captured value of the initiatives are listed according to each initiative, and a PACE value driver is assigned accordingly.

Figure 17 - Value Creation + PACE Driver Heerema per initiative (chapter 4.1.2)

Action	Benefits / positive outcomes / captured value	PACE Value Driver
LNG powered Vessel Sleipnir	Health benefits & Increased safety for workers Less pollution (cleaner fuel: no smog, less nitrogen oxides) Financial return (now possible to leverage and capitalize on that investment)	Reduce risk & future-proof the business Align with public expectations Reduce cost
Shore Power Rotterdam	100 % green energy Zero emissions Less reliance on virgin materials	Align with public expectations Reduce risk & future-proof the business
Internal Steel Marketplace	Less raw material is purchased The resource value is being retained The shipyard is less clogged with old material Internal competition to re-use more than your colleague <i>Less purchase cost</i>	Reduce risk & future-proof the business <i>Reduced cost</i>
Decommissioning (of wind turbines)	A lot of potential in that new sector Heerema will potentially sustain itself due to this market	Enter new markets Reduce risk and future-proof the business
Future projects of installing giant wind turbines (not yet feasible)	Heerema is the only one who can install current projects (+holding all the knowledge for future projects)	Trigger Innovation capacity

Investing in wind assets	Less reliance on oil & gas Three quarters of revenue from NON-oil and gas projects	Reduce risk & future-proof the business Reduce risk & future-proof the business
HR value network <i>Future: Communicating Heeremas circular ambition</i>	Good relationship with students from TU Delft offshore engineering faculty Heerema is an interesting place to work for engineers <i>Those students are increasingly taking sustainability into account, so they will respond positively</i>	Attract & retain talent Attract & retain talent <i>Attract & retain talent in the future</i>
Collaboration (with Circo for instance)	Room to experiment with sustainable processes Access to new business models	Trigger (innovation) capacity Enter new markets

1. Enter new markets

For Heerema, the driver enter new markets is present in the decommissioning and installing of wind turbines. Furthermore, there is new market potential in that sector in the form of future installations of giant wind turbines, which is currently not yet possible. Heerema is the only one who can install current projects as well as holding all the knowledge for future projects. Finally, collaborations, specifically with Circo, give access to new business models.

2. Reduce cost

Reducing cost was only present in the interview in relation to the future of the Internal steel marketplace: the interviewee indicated that there is currently no clear business case, but it is expected that there will be less purchase cost in the future.

3. Reduce risk and future-proof the business

Positive outcomes which fall under the category of reducing risk and future-proofing the business in the case of Heerema were numerous. The LNG powered Vessel brings health benefits and increased safety for workers. The project Shore Power Rotterdam leads to less reliance on virgin materials. Heerema's Internal Steel Marketplace allows resource value to be retained, while the

shipyard is less clogged with old material. Ultimately, this project is expected to lead to less purchased raw material. Engaging with the wind industry by decommissioning and installing wind turbines, as well as investing in wind assets, has created clear value in the form of reduced risk and a future proofed business for Heerema. The organization is relying less on oil and gas, three quarters of revenue currently come from non-oil and gas related projects. Heerema will potentially sustain itself due to this market (Appendix A, p. 75).

4. Trigger innovation capacity

Value creation (opportunities) that can attributed to the driver triggering innovation capacity was mentioned regarding the future installing of giant wind turbines, which are currently being designed. Since it is not yet possible to realize such projects, Heerema's innovation capacity will be triggered by this. They are the only ones who can install current major projects and also holding all the knowledge for innovative future projects.

5. Attract & Retain Talent

The key consideration to attract & retain talent is executed through the HR value network: Heerema has a good relationship with students from the TU Delft offshore engineering faculty, as well as a few other selected pulls. The networking together with the fact that Heerema is an interesting place to work for engineers, has led to attracting and retaining talent so far.

In the future, there will be increased efforts to communicate Heerema's circular ambition. Therefore Heerema expects to continue attracting talent, while acknowledging that aspiring engineering students increasingly take sustainability into account (Appendix A, p. 74).

6. Deliver greater customer value

-

7. Align with public expectations

LNG, liquified natural gas, is perceived to be a cleaner fuel by the industry. Having the Sleipnir as a LNG powered vessel leads to less pollution, no smog and less nitrogen oxides. The ShorePower project has led to 100 % green energy and zero emissions, when charging a vessel with wind energy. Those outcomes can be classified as aligning with public expectations.

Value Capture / creation KPN

Figure 18 - Value creation + PACE driver KPN per initiative (chapter 4.2.2)

Initiative	Benefits (Value capture)	Assigned Pace Value Driver
Energy Efficiency Servers: apply energy saving modes on IT Servers	7% savings on energy consumption	<ul style="list-style-type: none"> - Reduce costs - Reduce risk and future proof the business - Delivery great customer value - Align with public expectations
Network Rationalisation: Replacing older equipment with less equipment (virtualization) and new more energy efficient equipment	25% energy saving realized in 9 years, data growth x 15 in same period	<ul style="list-style-type: none"> - Reduce costs - Reduce risk and future proof the business - Deliver great customer value - Align with public expectations
Design with recycled plastic: Top and bottom covers of consumer equipment (modems, TV-receivers, remote controls).	<ul style="list-style-type: none"> - Less need to buy new plastic - 60% smaller remote controllers 	<ul style="list-style-type: none"> - Reduce risk and future proof the business - Attract retain talent - Deliver great customer value - Align with public expectations
5G Field Lab Drenthe: Precision farming based on low latency connections	<p>Allowing for less use of toxic material for taking out weeds from acres</p> <p>More control of water usage for farming</p>	<ul style="list-style-type: none"> - Enter new markets
5G Field Lab Helmond: Autonomous driving and smart traffic lights	<ul style="list-style-type: none"> - More control over traffic - Increases regular traffic flows (less stop and go), which in turn helps to control exhaust of traffic 	<ul style="list-style-type: none"> - Enter new markets

5.3.2 Validation of the PACE Circular Value Driver Framework

In an ideal scenario, the expected value will translate into actual captured value. However, when only examining the **motivational drivers** from sections 4.1.5. and 4.2.5., there is very little that can be allocated into the 7 key considerations from the PACE framework. Therefore, the **beneficial drivers** have been included, and been assigned a PACE driver in the previous section. As circular value creation opportunities continue being revealed, the **beneficial drivers** of frontrunners (such as Heerema and KPN) can serve as the new **motivational drivers** for newcomers.

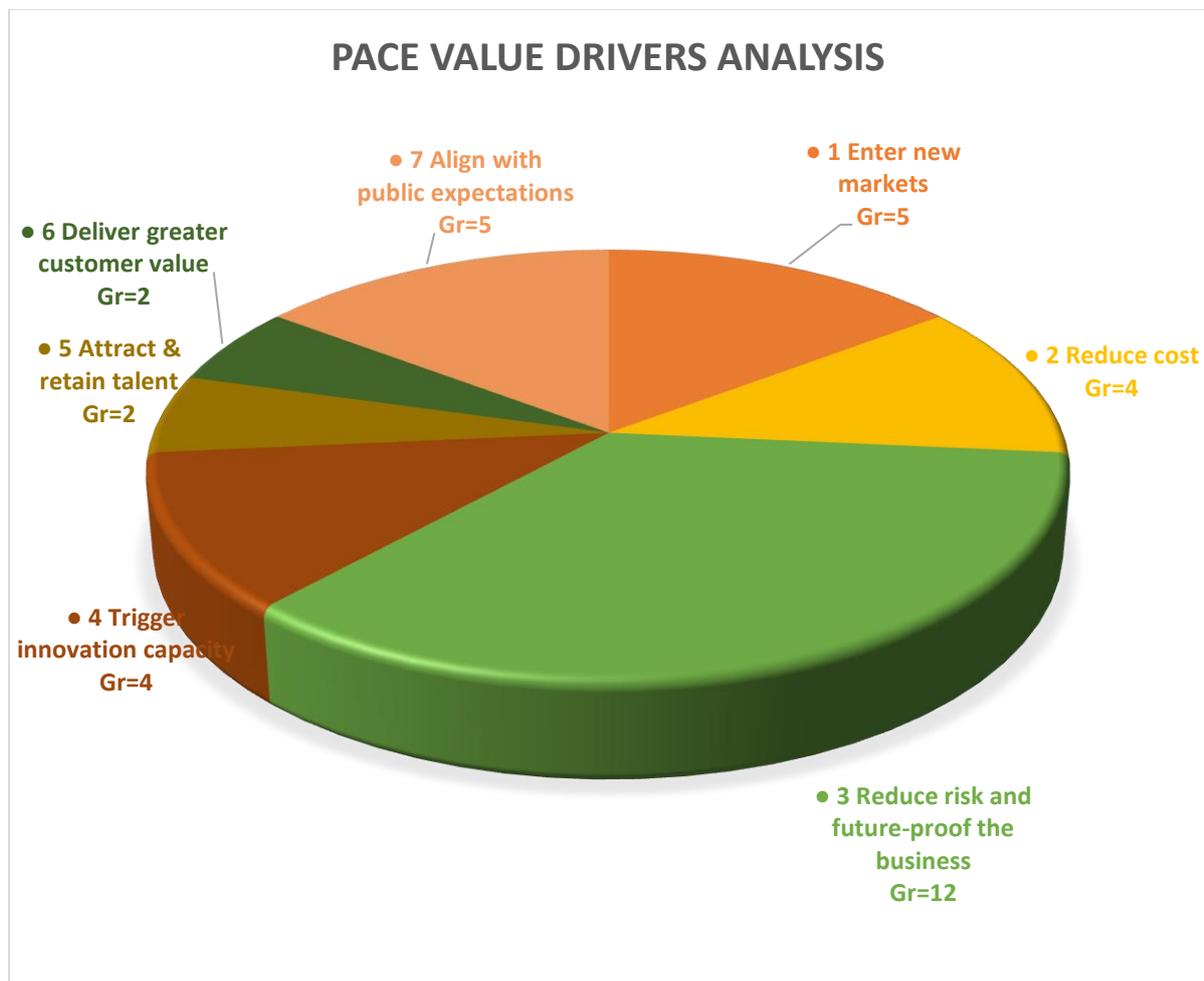
Figure 19 - Atlas.ti coding PACE Value Drivers

	Transcript Heerema Interview Gr=77	Transcript KPN Interview Gr=52	Totals
● 1 ENM Gr=5	3	2	5
● 2 RC Gr=4	2	2	4
● 3 RRFPB Gr=12	6	6	12
● 4 TIC Gr=4	4	0	4
● 5 ART Gr=2	1	1	2
● 6 DGCV Gr=2	0	2	2
● 7 APE Gr=5	2	3	5
● <i>Personal Motivation</i> Gr=6	6	0	6
Totals	24	16	40

For Heerema, *reduce risk and future-proof the business* is the strongest driver together with *personal motivation* (6 times). It is followed by *trigger innovation capacity*, with 4 mentions, and *enter new markets* with 3. *Reduce cost* and *align with public expectations* was mentioned twice, *attract and retain talent* one time and no mentions of *delivering greater customer value*.

For KPN, *reduce risk and future-proof the business* was also the strongest driver with 6 mentions, followed by *align with public expectations* with 3. *Enter new markets*, *reduce cost*, and *delivering greater customer value* came up twice, *attract and retain talent* one time

Figure 20 - Pie Chart PACE Driver Analysis (Atlas.ti coding of Appendix A and B)



According to the Atlas coding the value driver reduce risk and future-proof the business is by far the strongest for Heerema and KPN. This could likely be due to the fact that the current global industrial still has predominantly linear structures. Therefore at the moment the most sustainable value can be attained in the field of future proofing the business. The financial structures are not yet in place for CBMs to have a clearer business case than current models. In the current year of 2020, the Netherlands is only 24,5% circular (Circle Economy, 2020), but is committed to becoming fully circular by 2050 (Government of the Netherlands, 2016). As the economic structures start shifting more and more towards circularity, while raw material prices continue being volatile (EMF, 2016, p.18), and consumer demand continues shifting towards sustainable products and services (PACE, 2019), other drivers such as *reduce cost* and *deliver greater customer value* are likely to become stronger.

The second strongest driver, although only present with Heerema (according to the interviews), is *personal motivation*. It has been added as an additional driver, since it does not fit into the definition of driver 7. *Attract & retain talent*, since it is not directly connected to HR. selection

process. However, it is not necessary to create an additional driver, since in the future it could very well be part of HR. Prospective applicants increasingly include sustainability as a criterion for their workplace. If HR departments acknowledge this, it could be valuable addition to the driver attracting and retaining talent.

5.4 Barriers

During the interview, Heerema and KPN shared many circumstances that obstruct further circular business, which can be categorized as barriers. Both interview transcripts have been examined and coded for barriers of the categories presented in chapter 2.6: Financial, Organizational, Knowledge and technology, Supply chain, Market, Institutional.

Figure 21 - Atlas.ti coding of Barriers (Appendix A and B)

	Interview Transcript Heerema Gr=73	Interview Transcript KPN Gr=51	Totals
○ Barrier 1: Financial Gr=2	1	1	2
○ Barrier 2: Organizational Gr=4	4	0	4
○ Barrier 3: Knowledge and technology Gr=7	4	3	7
○ Barrier 4: Supply chain Gr=0	0	0	0
○ Barrier 5: Market Gr=2	2	0	2
○ Barrier 6: Institutional Gr=0	0	0	0
○ <i>Barrier 7: Risk aversion Gr=7</i>	7	0	7
Totals	18	4	22

The code document table shows that KPN reported significantly less Barriers (4) than Heerema (18). This can likely be explained with the companies’ sector and strategy. Heerema is a marine contractor in the oil and gas industry, and thereby inherently tied to the linear economy by relying on virgin resources. The company recently included the commitment to deliver sustainable values in their mission (Heerema Marine Contractors, 2020). KPN is a telecommunications provider that openly communicates its sustainable ambitions and has committed to becoming fully circular by 2025 (KPN, 2019). It is therefore natural, that KPN has already overcome more barriers, as they have transitioned further towards a circular operation.

The highest total number of barriers for Heerema and KPN was related to knowledge and technology. Following with the same amount is *risk aversion*, which was only mentioned by Heerema, and did not fit into any of the given categories. It was therefore added to the table as an additional barrier. Organizational barriers were also relevant, followed by market and financial

barriers. Heerema and KPN did not indicate any roadblocks related to the supply chain or of institutional nature.

Heerema indicated a severe aversion to the 21st century way of working, including incorporating new technologies. In the category of market barriers, Heerema is directly affected by *low virgin material prices* to the point where the companies existence in 20 years is threatened (Appendix A, p. 74).

For KPN the main aspect hindering further circular development also falls under the category of knowledge and technology, more precisely the **design challenges to create durable products**. This is the case when engineers are confronted with sustainability versus performance (Appendix B, p. 105).

It stood out that there are several barriers to implementing CBMs that KPN already overcame. Most visibly it is the *lack of consideration on circular design from supply chain actors*. KPN pre-emptively overcame this barrier by establishing their Circular Manifesto, which has been signed by eighteen suppliers, committing to transition towards a circular operation by 202 (KPN, 2019).

6. Conclusion

This report examined how smart and circular investments can create sustainable value for Heerema and KPN. It was further examined which CBMs were used, by which technologies they were enabled, which sustainable value the circular initiatives created, and what were the main drivers and barriers for Heerema and KPN.

Heerema is creating sustainable value by replacing Diesel with wind energy and LNG and reusing steel through an internal marketplace. The company is also diverging away from oil and gas towards the wind industry, with already more than half of the revenue coming from wind related projects.

Heerema applied the circular business models *extend resource value* and *circular supplies* without the support of smart technologies. Their circular operations in the form of substituting Diesel with green energy, reusing steel internally, etc. mainly created value in the PACE Value Driver category *reduce risk and future-proof the business*. The second strong driver for HMC, although not part of the PACE framework, is *personal motivation*. It does not belong to the current efforts of HR, which is why it does not belong to aligning with public expectations. However, if HR acknowledges the potential behind intrinsic motivation of employees, this could in the future become part of attracting talent.

The main barriers for Heerema are an aversion towards new technologies along with lack of technological knowledge and experience. Furthermore, an aversion to risk and therefore change is one of the big barriers, especially due to operating in a high-risk environment.

KPN is creating sustainable value through circular such as recycling plastic or designing smaller, more energy efficient equipment. Therefore, the main CBMs that KPN applies are *encouraging sufficiency* and *extending resource value*. The initiatives of the telecommunications provider are heavily supported by smart technologies. The main PACE value for KPN is *reduce risk and future-proof the business*, followed by *align with public expectations*, which in this case refers to the stakeholders.

As roadblocks to KPNs circular operations, the performance versus energy saving dilemma was identified. This is especially the case when confronting engineers with more sustainable suggestions, as they are strongly focused on performance.

When evaluating the PACE Value Driver Framework through the lense of KPN and Heerema's circular efforts, it stands out that reduce risk and future-proof the business is by far the strongest driver.

The hypothesis is presented that this is due to the fact that the economy in the Netherlands is still largely structured to be linear. In 2020, the Netherlands was evaluated to be 24% circular. Therefore, current circular operations mainly create value in the field of future-proofing the business. In the future however, as the economy becomes more circular overall, other drivers such as reducing cost due to volatile raw material prices or delivering greater customer value due to increasing demand for sustainable products will become increasingly applicable.

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Appendices

Appendix A – Heerema Interview Transcript

Interview with Vincent Doedée of Heerema 28-04-2020

All: Let's get started, perfect

Vincent: So you want me to tell something about myself?

Maren: Yes, please

Vincent: Well, I think 3 years ago it started when somebody called me Mr. Sustainability at work, since then we have only progressed. My job, my life is sort of to take what brilliant minds like you come up with and put it to practice, so apply some. Because I think you want to have tangible examples, but one of the things we're most proud of is, I think Shore Power, in Rotterdam. That's been a project that started in 2016, end of 2016/ 2017. Which is basically, plugging a giant plug into one of our vessels, and having them run on a wind turbine. So 100% green electricity. Which is maybe not too circular in that sense, but it's reusing that electricity and it's a very sustainable concept. We're also working on reusing steel, within the framework of Circo, that's actually where it came from. We made a marketplace for reusing steel, looking into ways of expanding that marketplace with other players. So far we have reused, in the first weeks it already reused like 6,5 million kilos of steel. So that's quite a lot of just material being wasted, that we're giving a second life. I'm personally a big fan of the 'Turn- to model', and I'm not sure if that rings a bell?

Jordi: The 'Turn-to model'?

Vincent: Yes, the 'Turn-to model', I'm going to give you a lot of sources and materials to digest as well.

Maren, Jordi: Okay

Maren: Okay

Vincent: But in my opinion, that's the clearest, most definite and closed definition and a way of working in terms of circularity. It's a really easy principle, you know it boils down to one thing and that's giving power and responsibility in the hands of a single person, single entity. So instead of Coca cola giving me a bottle and saying here's your product, and now you go ahead and handle the waste. Actually Coca Cola is still responsible for handling the material itself and giving it back to

mother earth in the end so, everything is in a closed circular loop. So I'm a big fan of that, I always use it. I'm actually working on the new circular, the 'Heerema circular ambition'.

Maren: Okay

Vincent: Yeah it's becoming quite a monster. But were going to focus on plastic and steel. And of course education in design and engineering. Because I think that's the starting point, for a company such as Heerema. Where the ultimate goal is of course produce zero waste. But I don't think people within Heerema are ready for that yet, so we're going to focus on plastic and steel first. That's tangible, that's easier, and then were going to do education of engineers mostly, at the same time.

Jordi: Okay, interesting.

Vincent: So that gives you more of an idea of what Heerema is working on. But before I go into that, do you know what Heerema does?

Maren: Yes, of course. We do know that

Jordi: Yes

Vincent: I usually forget when I talk to people, because I assume they already know but..

Maren: Yes we do know, and we also know about the internal marketplace (for steel) mainly, as a reason for interviewing you. But we are also open to talk about other initiatives of course. So you already started a little bit, I would have just asked you what sustainability means for your organization, but you already started. So it seems like you are very passionate about it, and you are the one who has to sell.. Maybe you can go a little bit more into that, into your role or your struggles or what priority does sustainability have for the company as a whole? Because obviously it's an offshore contractor, so it is also not included in your mission and vision, like for some other companies we interviewed.

Vincent: Well it's funny that you mention that, because the interview would be different in two weeks I think, in that sense.

Maren: Okay

Vincent: But I can't tell you anything..

Maren: Okay

Jordi: Oh that's actually.. okay that's a shame

Vincent: I can neither deny nor confirm, but it's going to change, definitely.

Ton: So what is going to change? The way you talk about sustainability?

Maren: The mission and vision, I think might

Ton: Oh okay..

Vincent: Something is going to change, which I can neither confirm nor deny. The things is, yes we are dirty, we are definitely dirty. We have been so for 50 years and more. We produce quite a lot of emissions, pollution, we use a lot of materials, we create a lot of waste. There is no denying that. But our owner, Pieter Heerema, has always had a clear vision of being a responsible contractor. And if you go back 50/ 60 years ago, the world was a very different place. We were growing quite rapidly after the second world war, and it was all about energy and beating Soviets. So maybe Ton still knows how that was as a student. In the 80s, it was more about different things, it was not about sustainability. Yes in 1972, *the Limits of Growth*, everybody knew that it was unsustainable, now we're just figuring out what the impact is. We humans are remarkable machines, and it's just now that we use our minds to this challenge, but then again, it gives us something to do. It keeps us off the streets. Anyway, so that was the context, and in his terms, Pieter Heerema, the owner, being a responsible contractor meaning supplying energy to the world. In the most, in his terms as well, sustainable way. Because responsible for him was always sustainable. He told me the story one time, he grew up in Venezuela, he was a little boy and he threw something out of the window, like a wrapper or something. And his father actually stopped the car, made him pick it up and walk home. So he was always passionate. And he is also a sailor, he sailed the world alone. He saw, sort of rubbish, just thousands of miles away from anything so, he is really conscious, or I should say we are lucky with having such an owner, because that gives me the mandate to sort of do my job within Heerema.

Ton: The Ellen MacArthur Foundation was sort of saying that as well..

Vincent: There you go, well he reads a lot, so he probably knows about the Ellen MacArthur Foundation I guess. Although he came up, I was already using it but, I should have mentioned before, in terms of maturity on sustainability I would say we have progressed immensely. There are some of the terms like circular economy, circularity, but also the UNSDGs are for some of my colleagues not really on top of their mind. But Pieter Heerema for instance, he came to me with an email saying, 'should we use the UN sustainable development goals or the UN Global compact as sort of a guideline for our sustainability program?'. Which it now is, which I was already implementing but not telling anybody, because they don't know what it is. Which is also circling back to education I think that's a big part of our current agenda. So yeah, we are dirty, we are working on it. I see that we have managed to pivot on activities and projects just in time, before oil

and gas collapses, at least offshore, towards wind, and a little bit of decommissioning. I hope that we can manage to survive in these times, that will be tricky still. But considering our current skills in the marketplace, in the industry, considering the ambitions of the wind energy industry to install a 12/15 MW wind turbines and more. It's really hard to convey this to people without a very specific engineering background that, at the moment, the plans they have are technically impossible. Or not technically impossible, but these vessels have not been made. Even our biggest crane vessel in the world, which is two years old, can probably not install the types of wind turbines that they have on the drawing board at the moment. So the one that was installed on the Maasvlakte, de Haliade, 12 megawatts, that's about the top range of what we can do, I should say, with a certain team. Anything above that is going to be tricky. We will probably have to do it differently. So there is some great potential in that sector.

Jordi: So what is the difference in size, just for my view, what is the difference in size between the wind turbine that has already been installed and the one that they actually want to install?

Vincent: Where do you live?

Jordi: In The Hague

Vincent: The Hague, you have that wind turbine next to the A12, close to sweet lake city, so Zoetermeer. There you have a wind turbine, that is about 80 meters high or something. What they are building now is actually Eiffel Towers rotating. So that is about the size you have to think of, an entire Eiffel Tower with blades almost the same length, which you have to install somehow. I don't know if you have ever been to Paris but the Eiffel Tower is quite large. And it's not about the weight per se, these are very heavy machines, talking thousands of tons. But it's more about the length if you pick up a rod, a few meters high, you have probably done so as a kid, and you walk around, it's quite difficult, you have a very high momentum. So getting that to 180 meters or more, that's going to be a challenge.

Maren: Yeah

V: And our cranes, the limit of our crane capacity is somewhere around that area of 12 megawatts. Maybe we can do conversions, maybe we can make even bigger vessels, maybe we can do it entirely differently like create them on land and install them on shore. The thing is, the traditional approach to.., we're getting into details now so let's wrap it up. The traditional approach for wind turbines has been taking one that is on land and installing it offshore. And now we come to those manufacturers never really talk to the ones installing them, like us. Now we are coming to the limits of what can be done technically, and we have to get into a dialogue, otherwise we can't install these turbines anymore. So it's an interesting development and we'll see where it leads us, but I

see a bright future in that industry. And even in these times, we also luckily see that oil and gas is dying offshore. These industries, well I couldn't say any industry now is flourishing but they are still continuing and moving forward.

M: Okay so maybe you could just go a little more or summarize again what really drives you. So I heard that first of all it's the responsibility of the owner.

Vincent: Yes

Maren: So you're lucky about that, and then secondly it's also survival because oil and gas is dying. Is there anything else that drives you, like is it reduced cost or..?

Vincent: Money

Maren: Yes, money of course, but do you see results or is it in the long term that you are hoping to have financial results or what is the driver behind all of these sustainable efforts?

Vincent: Well, Maren, I think at some point you probably start working within a company, and I think you're going to notice that people are a lot dumber than you think. Vision is scarce, especially within a contractor such as Heerema.

Maren: Okay

V: There have only been a handful, really like less than five people, and I am not even including myself among them, who five years ago said we need to diverge and invest in wind energy, in wind assets, because this is the future. Even two years ago, people within Heerema probably wouldn't have said so.

Maren: Okay

Vincent: It's mostly luck, it's mostly market driven questions, and it's opportunity. And there are just a few people, who actually see this opportunity within Heerema and know how to capture it. And they usually do not have money as an incentive. Like Pieter Heerema has plenty of money, he has a legacy, he has an industry, he has capital, he has assets, he has people working for him, and he is a pretty loyal guy. So he sees opportunity, and he naturally seizes upon that as well, but of course it's driven by economic and financial incentives. So that's what we're struggling with at the moment, so I think any push towards these new markets, in hindsight we can say 'yeah we were fairly well prepared'; but for a company such as Heerema, I want to say don't quote me on this one, because it is being recorded

Ton: No no

Vincent: It is largely luck, that's what it is.

Ton: Do I hear, if I may, do I hear some kind of tension between personal driver and the way that the operation goes and how does that manifest itself? Because it seems that that personal incentive is then not taken up to a full extent in the operations.

Vincent: Zonder wrijving geen glans...there's certainly friction absolutely, always has been. A good example is their newest vessel, again. It's running on LNG, perceived to be a cleaner fuel by the industry. No particular matters, no smog, less nitrogen oxides, no sulfur, so if you ask me if I want to inhale from the exhaust of the Sneipnir, our newest vessel, or one of the oldest vessels, I'll definitely choose the Sneipnir because it's a lot more healthy, I would say. But these decisions for LNG engines, which were made in 2013, cost like 100 million. And there was no financial incentive, there was not operational incentive, there was absolutely no.. Actually everybody said 'don't do it', but Pieter said 'I think this is the way forward, we need to go on this road'. So he did it, and it's his money, and now of course we try to monetize and capitalize and leverage that investment in our new projects, and we see it working out very nicely. But if Operations or anybody else had their way in 2013, we never would have had LNG engines. So that's I think a clear cut example where he just stuck his foot out, so the speak, and he said 'were going this road, It's going to be a sustainable vessel, I think it's important'. Not everybody sees it, recognizes it, or they still don't. They, and I am talking very black and white here, the other people who do not really recognize sustainability or circularity within Heerema, are usually more prone to other incentives, economic incentives, or social incentives, like for instance that smog on our vessels, that can be a pretty big issue, if there is no wind and the smog actually accumulates on deck, it's not a nice environment to work on, so that's why we're also looking into alternative fuels. And that was also one of the reasons LNG was chosen, I bet. These people might not be triggered on the environmental side of sustainability, but they are definitely triggered on the economic or the social side, and you asked about our definition of sustainability and what it is. Sort of, you approached that, or touched upon it, and for us it is simply not only responsibility, it needs to be intrinsically motivated otherwise you're not doing it, or for the wrong reasons, and it's a balance between people, planet, profit. And usually when I start talking about money I am saying 'this is not sustainable because it's not profitable', and people just look at me 'aren't you Mr. Sustainability? Isn't everything green where you come from?', well if it is not profitable, it is not sustainable economically, so it needs to be a balance.

Jordi: Okay

Ton: But as you said with this LNG fired vessel, do the work conditions, or you said it works nicely now, does that mean that the market is more right for that now? So that even economically it does

now make more sense than five years ago? And do you learn from this experience, to convey the message or convince others that these kinds of investments may seem not economic, but in terms of marketing in the end are economic?

Vincent: No, people don't learn about this

Ton: No?

Vincent: No, most don't, definitely. For the Shore Power project, it was an uphill battle. Even, literally the last day, the day of signing the contract, the CFO actually made some valid objections, but even then it was contested. While we're seeing like regulation and everything else being forced to apply shore power. But somehow I think there's, I wouldn't say a generational gap, but especially in the marine industry, the assets, our vessels, are considered sacred. Any change made to the vessel is like an open-heart surgery. It's really difficult, it won't work, and we're talking about people's lives here so that is absolutely true. I have a colleague who is a former captain and that was also about the Shore Power project, we were standing outside, and there was actually a car accident that happened, so we had to perform first aid and stuff, it was quite intense. And then he told me that he lost five people offshore. So there are, well not anymore as much, but there are still people dying offshore, but it's a hazardous environment, so risking people's lives on actually the forefront. So safety, for everybody's daily operations. And this can be considered something new, a rarity, and we don't know the consequences, so that's why people are hesitant, I'm sure. So we still find it difficult, even with examples like LNG, Shore Power, other examples that have proven to be beneficial decisions in the past. Still hard to convey the message.

Maren: It also shows that it's really only in the long term that you can see results, like 5 years or more I guess. Like with the LNG, for example.

Vincent: With those decisions, yeah. Those are of course very.. These types of investments are quite substantial. So then you are talking about years, decades even. But there are other very short-term results that you also see, so there is both.

Maren: Okay

Ton: Just for the record, you talked about this LNG vessel, and.. Shore Power?

Vincent: Yes, Shore Power. Everything I'm saying is also on our website, I'm sure you have touched upon that.

Jordi: You talked a lot about different types of circular initiatives, how does digitalization play a role in them, or doesn't it?

Vincent: It doesn't.. Again, I think that Heerema is not as digitally matured as some other companies, and people find it hard to know what they can do with new technologies. And they are usually amazed with a very complicated Excel spreadsheet. That is like wizardry to them, so there's much to learn. We have a simulation center within Heerema, in which we simulate an Offshore environment. It's really quite nifty. It's really, it's one of the best offshore environments in the world, in the offshore industry. There is a lot of knowledge there, we have all the knowledge in the house I would say. There have a few, very very smart persons within Heerema who really know their way around these kinds of data streams, how to leverage and capitalize on it, but a lot of persons in the fleet, a lot of engineers who are still doing the same things they did 30 years ago, a lot of people can't really handle those intricacies of working with data. We're trying to work on it but it's mostly I think human driven, not technology driven, definitely not technology driven.

Maren: Okay that's very interesting

Jordi: But like people are open to new technologies or..?

Vincent: No

Jordi: So there's a certain culture that they want to keep working the way they have always been doing it?

Vincent: Definitely. We are working on our culture and our mentality, but generally speaking people don't like change, not even when it's good for them. Because change is perceived, well I think inherently, evolutionary almost, as possibly bad. Especially in our risky environments. So change is difficult, and the first answer is always no, the second also no, and it's only after some continuation that you can actually open up minds of people, and usually I can't even figure out what that is. It's either money, it's either personal motivation, mostly it's because people think it's cool, or should be done, or in case of our owner it's something that feels important. That's usually opening up most doors in the end. And then money can be an incentiviser, the social aspects, your better working environment for people, those kinds of things.

Maren: Okay so it seems like it is really resting on the back of a few selected people in your company as well.

Vincent: Not just in our company, that's the world.

Maren: Yeah no of course not, but for example KPN sees attracting talent as very important, in the future as well, and improving their reputation through sustainability. But it doesn't seem like people will apply at Heerema because they know that sustainability is important to them. So how

do you think that is going to play out in the future, like let's say 20 years, when it's about getting appropriate talent to restock the talent that has been there for 30 years?

Vincent: Well I think two things: One, if we survive that long, and I'm not talking about the current circumstances, but it's just anthropy. We have been alright for quite some time, but who knows what is going to happen.

Maren: Okay

V: I have been talking a lot about Black Swans in the last two years, I think the current situation is an excellent example of how, the guy that came up with the Black Swan idea, Nassim Taleb, love his books, he said: 'this is a white swan, this is an outcome you can expect, you don't know what exactly, but you know these type of crises will happen. Everybody knew, not only in hindsight, but in foresight. And there are even like negative oil prices, that totally rock our world. And I would not even have dreamt that a couple months ago, so there are plenty of things to come up with to say that we are not going to survive even 20 years, but that's not the answer that you are looking for. So I would say, if we're lucky, I think in terms of talent and attracting people, every company will almost say the same, we are looking for talent and attracting people, and sustainability is part of attracting people. That's a very nice corporate way to say it. We are privileged, because we are in such a niche, in a sort of business to business niche, that for us attracting talent is very different than for a company like KPN. We have a few pulls, a few selected pulls, like the TU Delft offshore engineering faculty, which I also came from, is one.

Maren: Okay

Jordi: Okay

Vincent: So as long as you have a good, close relationship with these students, you attract that talent. So I believe that that won't be of such an issue and we are still a very interesting company for most engineers. So bottom line, they look a lot at engineering, although, every one of them has sustainability in a very high regard, and I think there might be a point in which it's going to be harder to attract talent. HR acknowledges this, but a lot of engineers who have been working here for 30 years, or 20 years or whatever, we call them the clay layer, they all have to realize that not only for the betterment of mankind but also to attract new talent, we have to focus a little bit more on sustainability. I would not say I'm a lightning rod, attracting these types of persons, so that you know my projects attract young bright minds who want to work on these things. But we actually do quite some interesting stuff, just maybe not enough, or maybe at this point, our wind footprint, so the speak, the projects that we have, is quite small. Because we just started with it, actually last year. So one of our projects in Taiwan is now gearing up. We were supposed to do something in

the United States, but they are not so united anymore, so who knows what is going to happen there. Some other projects are kicking in, so our footprint is increasing, but I'd say if you look back even a few weeks, but in five years it's going to be a totally different company, mostly relying on wind projects, or some other form of offshore construction that we don't know of.

Ton: But on that same topic, not to dwell too much on it, the fact that you are still basically oil and gas platform supporting company, did that withdraw talent from you?

Vincent: The thing is, you can't really measure that, because we don't have two different Heeremas which we can compare in terms of attracting talent. So it's a hard hypothesis to falsify in that sense. I think it did, I think it definitely detracted talent. I actually have one example, and it's just one, so it isn't statistically relevant, but I had somebody from offshore engineering TU Delft, I just made the, it was I think 2018, made a copy of the sustainability report, I put it downstairs as a sort of read area where people can read it. And this guy, which I knew from a project, was dropping by and he said, 'I saw the sustainability report downstairs, and well I first was a little bit hesitant to apply at Heerema, then I thought oh so they do something about sustainability and it's good that they have it lying there'. He almost didn't come for a job interview because he thought, Heerema oil gas, that's bad. But let me ask you about sort of what we do in the oil and gas industry, how much revenue do you think comes from oil and gas at the moment?

Maren: I mean the way you are asking almost sounds like it is less now.. I do know that you have the mobile platforms, because you need to be able to move to a new oil field.

Vincent: Oh we always had those but these are like very large not even ships but floating islands.

Maren: I don't know, Jordi you want to take a guess maybe? Because it sounds like you are saying you can rely on it less now but..

Jordi: I actually don't know, I read about Heerema of course, but I didn't dive into definite numbers.

Vincent: Well maybe you could because I mean just to see what you get there. I would say, and it depends per year, but at this moment almost three quarters of our revenue, a little bit less, is coming from non-oil and gas related activities. So more than half is from wind and cleaning up stuff, decommissioning we call it.

Maren: Okay that's very interesting.

Vincent: So sure we still have quite an oil and gassy footprint and I'm only talking about revenues and not profits, because there is a big difference there, as you know. But I think in terms of our outlook towards the future in the coming years, it's the wind projects that are making our company

tick. And that's going to have a big impact in the way we think because we already see, but this is more of a business analysis, that the processes and the values in the oil and gas industry compared the oil and wind industry are almost diametrically opposed. But previously, in the oil and gas industry, profits margins, it was all about risk, it wasn't about money, there were millions and billions. So it was more about managing risks, and getting it done as soon as possible, which meant high costs. And now the wind industry is all about getting the smallest profit margins, it's all about cost, cost, cost. And those are two very different types of companies. So it's going to be hard for us to change.

Ton: Yeah..

Maren: Yeah, it's extremely interesting to hear that though, that you are actually transitioning towards wind, I mean I don't think we knew that before.

Vincent: Yeah and slightly on our own accord, because I'm giving not enough credit to the business analysts and the few bright minds who work within Heerema who saw this coming and who also informed Pieter on which moves and which areas and which regions and which kinds. But it was also a lot of luck. That we had these vessels, that we are somehow the only ones capable of installing these mega turbines offshore. Not a lot of people can say that.

Jordi: Do you think these initiatives will require intense collaboration with other partners?

Vincent: I wouldn't say intense, but collaboration yes. I think the 21st century way of working is more geared toward collaboration, more geared toward networking, more geared toward online environments, data etc. And I think our company still hinges a lot on the 20th century way of thinking of monopolizing, of IP, of planning so that's mostly due to our people also, we have a lot of, old people I mean, people with a lot of experience within Heerema. They are working 30 / 35 years within Heerema, that means that you work the same way for quite a long time, and collaboration was never really highly on the agenda because we were always very keen on preserving our knowledge and our intellect and the processes. So we do need to learn a lot as an organization now, we do need to learn new things, we do need to do new things, and that means collaborating, I believe, with a lot of different partners. And I'm looking at various different kinds of business models, or collaborations, or.. I'm kind of the yes man in my organization, everybody who asks something in terms of cooperation, I would just say 'okay yes, I need this, what do you need?', and let's see where this ends up. And at some point, like for Circo, you have smaller cooperations which, somehow, tend to do beautiful things. Without Circo, we never would have had this steel marketplace. So that's why I believe in collaborations, it gives you room to experiment. But again, our people, I'm generalizing a lot here, but most of our people don't like to

experiment, because that infers a risk, and that's not what we do as Heerema. We minimize risk in any way we can.

Maren: So would you say that the major roadblocks, or what is slowing things down the most, is within the company culture?

Vincent: The culture, yes. Knowledge, culture, human processes, these are more or less the same aspect. In my opinion, sometimes it's good to split a company. I think there is a business unit split now but maybe we should even do a company split, however we also have Heerema engineering services, for about a year now. Which is part of the Heerema Group with focusing more on data, 21st century technology, engineering, automisation, I think that might be the branch of Heerema that survives the next 20 years. The Heerema Marine Contractors branch is going to have a lot more challenges, I would say.

Maren: Okay

Vincent: I mean it is still our cash engine, and that's what you see with KPN and all these kind of companies that are transitioning. You need that cash engine to leverage the company you are building for 10, 15 years, but most people don't realize that sometimes you have to invest 10 years to make 50 years' worth of money. Like when we went back to the 60s and the 70s when we looked at Heerema, that was the start of the company at the time. And people forget those kinds of mechanisms, that sometimes you need 10, 20 years to really get a good role. So you invest in returns you are going to make in the future. That's also where the word investment comes from, so..

Maren: Yeah

Vincent: I think one of the biggest problems as well, and I am an engineer, so these are not the types of problems that I normally see or recognize, is the financialization of the world. Everything is about gains, returns, profits, but also it's more of an Anglo-Saxon financialization, that most of these companies are geared towards quarterly profits. Every business, or every investment needs to be paid back within 3 years or less, and that's not really a sustainable business model, of course. We all know that somehow, but we don't act upon it.

Ton: Yes, yes

Vincent: But still I think people are both our biggest liability and our greatest asset. And some persons even at the same time. It's really amazing, but that also.. let's just say I learn a lot every day.

Maren: Yeah I can imagine, as the sustainability guy in an oil company..

Jordi: Do you think that these initiatives will cause new business models? Create new business models?

Vincent: Can never know for sure, but I certainly hope so. If you want to put it in a more abstract, broader way, like for instance, if you are sort of referring to 'do you think these circular ways of thinking and sustainability will cause new business models?', then yes, absolutely. It's a new way of thinking, so you get new business models. Will it do so for us, Heerema? Maybe, can't say for sure. I think the circular business models all revolve around providing more or less of a service, or access towards something. It's not about making a transaction of a resource. In that sense Heerema has some advantage, because we have always simply delivered a service. Yes we have very big assets, but the only thing we do, is we take something from a client and we install it somewhere else. That is sort of what we do, we construct, we are a contractor. We are the same as the guys who are building the road here just outside the house, you know. We provide a service for somebody who has the materials and who pays for it.

Jordi: Okay

Maren: Okay

Vincent: So we can quite neatly package that into a circular or a sustainable business model, but we need to change the way we think and the way we send our invoices to the clients. To give you an example, one of the biggest game changers I think we could do, within Heerema, is carbon capture and storage. And I know it's not a very sexy subject, for most environmentalists especially, but to give you an example: how much Co2 do you guys have left, in the Netherlands, before you start emitting more than the 2-degree scenario made in Paris?

Maren: Almost nothing..

Vincent: So let's say we want to be under the 2-degree scenario, or we want to be under the 1,5 actually, but that's almost impossible, but if we want to stay below the 2-degree scenario. Most people, or the Dutch people have only 8 years left, and after 8 years of emitting the levels that we are doing now, give and take Corona, we will be above 2 degrees.

Maren: Yes, and also I know that for the curves, one of the curves that we are thriving for, also requires that something significant changes in 2020. That's also what is scary about those curves.. I mean I don't know exactly about the 2-degree curves, but I do know that there is only 4 curves left that are possible to reach the 1.5 degree target, and that would require a fundamental change in 2020. So that's probably not going to happen.

Ton: I think I showed you the circularity gap report as well, I think some time ago..

V: It is, so either way you look at it, it's not good. So what carbon capture storage can do is create negative carbon flow. So you can actually give yourself more time, or even THE time, to stay well below the 1.5-degree scenario.

Maren: Okay

Vincent And this is one of the best, slightly evil, but for a good purpose, business plans that I came up with. If you have a billion dollars, then you should build a few carbon capture storage facilities, in Europe. And once you have built those, buy all the European trading credits for carbon, from all the other companies so they can't emit Co2 anymore, and then the price of course skyrockets instead of, well it was 15 now it's 20 euros per metric ton of Co2. These companies will probably have to pay 100, 200 euros and more per metric ton of Co2, and then you can actually tell them 'look, I have a way to capture and store your Co2, you just have to pay a lot of money'. So I think that's a way to sort of leverage, in a kind of evil way, the current system. But carbon capture and storage in general, is definitely a market which I think Heerema could do. So that's a new business model, we can actually have people pay per ton of Co2 to store it. But, I think, we as Heerema do not have the way of thinking required to actually make that a viable business concept.

Maren: Okay

Vincent: Well we have the capability and the capacity, we just don't have the [...] sort of. We don't do it, why?

Ton: Is it.. let's say technologically and logistically, it is feasible short-term?

Vincent: Well, the Sneipnir fields, coincidentally called the same (*as Heerema's crane vessel*), in Norway, has been carbon capturing, storing Co2 for almost 15 years now. It's going brilliant, it's perfect actually. Well the more I dive into it, in my opinion it is the only way almost to be certain that carbon is kept away from the atmosphere. For thousands of years, because these gas oil reservoirs have been around for millions of years, if not hundreds of millions of years. So storing it on the ground is, in my opinion, not the same as putting it under a rug, it's putting it under a titanium rug that is going to be stored forever. It's better, in my opinion, than planting trees, because I don't know if that tree is not going to be burned in a few years still. I don't know what is going to happen with the Co2, if I don't put it in the ground. So for me it's very viable and good, especially when we want to buy ourselves more time and a solution to the issue of having too much Co2. It does not take away the cause of the problem, so I'm not saying we should only do that. But

it's technically viable, it's perfectly doable, it's just not economically viable at the moment, because nobody is doing it.

Maren: Okay

Vincent: It's a bit of a chicken and the egg, and the only reason we are not really doing it is because, 'well but that's not what we do, that's not in our culture, we don't do those kind of things'. Well we have all the knowledge and information at our fingertips to do it actually.

Maren: Okay yeah, that's actually very interesting to know, because we need.. I think even in the long term plans of the EU and countries in general, the final phase (*of reducing Co2 emissions*) includes negative carbon emissions. So for now, we are just trying to reduce them but in the end that is the plan.

Vincent: Yes. Microsoft is already looking into a negative carbon flow for the Microsoft company itself, to store, or take away, all the Co2 that Microsoft as a company has ever produced, and take it back from the atmosphere, so a negative carbon flow. I think once that becomes.. especially you, I still count myself as young people, but once Millennials or the generation underneath becomes CEOs, maybe that will be the normal thing to do as a company. Take all the Co2 back from the atmosphere and storing it on the ground again, or something else. But that requires a different way of thinking. Instead of saying 'that's expensive', people should think 'how can we do that as economically viable as possible?'. You shouldn't ask yourself 'can we do it, yes or no?', you should ask yourself 'how do we do it?'.

Maren: Okay well, do you think something significant is going to change before Jordi and I become CEOs? Because we probably don't have that much time..

Vincent: Well I think the problem [might] be solved before 2040, because I believe in non-linear logarithmic scales, which we have only learned about so much recently, we can do a lot more than we think. It's all a matter of costs and then again, especially offshore oil and gas is going to be wrecked by this current crisis. And then we have the option to either chose between the old oil and gas industry, or between the new upcoming renewables industry. And I think investors are now realizing, wait a minute, do we want to be dependent on countries such as Russia and Saudi. I'm going to put it very.. these guys in wigs and costumes, who suddenly decide which on which war and all your investments have gone out of the window, do you really want to be dependent on that?

Maren: On non-democratic structures, yes..

Vincent: Or something like renewables, in which you can also create a lot of jobs, and I would say, Michael Moore did his new documentary, he is a bit wrong in a lot of senses, but he is right about renewables. We still need to think about decommissioning wind turbines, we're also looking into that, promising new market. Decommissioning solar cells, we can't just dump them in Africa and be rid of them. So we need to think circularly about these kind of concepts, absolutely, but it provides so much more business opportunity, job opportunity, growth potential, than all the other industries combined. So I believe people are now more open to seeing it as a business investment, and also investors. Eventually it's all about the money. Unfortunately, it's about one guy having the balls and saying 'I'm going to do this'. And then investors looking at him and saying 'okay well I see he is making a lot of money, so I'm going to put my money in that guy'. But like a pension investor, or hedge funds, or other investors, they are going to scratch their head and be like 'do we really want to invest in oil and gas industry for the next 10 or 20 years?'. I think the answer is no. I think most of these sensible, especially pension funds are going to say, we need to divest away from the oil and gas industry. It has given us tremendous profit and interest for 50 or more years, but now I think it is time to continue. And I'm not saying fuels, or hydrocarbons, or chemical industry, we are going to still need tremendous amounts of hydrocarbons, but they won't be fossil. And I think that is a big difference in the way we are going to consume energy. It will be synthetic, there will be partly hydrogen, but I think mostly just synthetic ammonia, different kinds of biobased fuels. I don't know what is going to be most economically viable, but definitely not fossil fuels.

Maren: Yeah

Vincent: And we're going to still use millions of barrels of hydrocarbons a day, but it won't be coming from a pit from under the seabed.

Ton: Yeah, okay..

Vincent: Okay, agree to disagree, Ton

Ton: Yeah, I'm a bit pessimist or whatever.. I'm looking more to energy agencies' scenarios for upcoming nations, like China, and it's not about being black or negative, I'm just trying to look at the data, and they show that the level of fossil-based energy, coal, won't decrease enormously, because of the enormous increase in the predicted consumption of energy over the next decade. The last scenarios that I saw, they may change, but still they show that the actual level of consumption, and the absolute level also of emissions will more or less be the same. It's just that the desire for energy will decrease accordingly. So new energy will come from renewables. But maybe the level of investments is not even huge for that because [...] but it depends on, you know,

knowledge and information in Saudi Arabia or in the coal [mines] of China. So yes it will be harder xx but I don't expect the actual levels of Co2 , in those kind of scenarios to decrease normally.

Vincent: Time will tell Ton.

Ton: I know, I know

Vincent: I can guarantee to have a look at the newer stuff, because I have been watching the International Energy Agency mostly, but also BP, Shell, the Sky Scenario. It's funny to see how these types of scenarios evolve, because the only thing these agencies never do is, well two things, they never admit that they are wrong and they never look back at how the scenarios looked a few years ago. And you see like a change in those scenarios. Three years ago, when I first looked at the International Energy Agency scenario, it was all fossil. It was like, okay we want to be a little bit less but it was like the year after Paris and it was like we are not going to see it. And now they are growing towards the sustainable model, and already you are seeing, not only due Corona, but like the policy impacts that are being made at this moment and also being made by China, which is, you know, for the better or the worse going to build a factory, just one factory that is going to create as many gigawatts of solar panels per year as Germany has installed ever.

Ton: yeah

Vincent: These types of developments will be that we are thinking linearly, and in that sense we have a big issue, but here in the Netherland we installed about 80% of the entire Slochteren gas network, in the fifties and the sixties, in about six years. In six years almost every Dutch citizen had gas in its house, from nothing, you know, to the system we have at the moment.

Maren: Yes

Vincent: Yes I am a technical optimist, absolutely. But that is also what I try to work for within Heerema. And when I see what can be achieved when people think in these types of ways, also within Heerema, where just a few years ago you had a company that laughed at being in the wind industry, and now we are practically the only hope for the wind industry itself. And still it's a manifestation of destiny in the way things can devolve or evolve quite differently. As I said before, it's a matter of luck as well, so we will see.

Ton: Okay

Vincent: As soon as we have a war or something else, things will change quite a lot as well.

Ton: Can I propose to go back to somewhere around the first five or ten minutes?

Maren: Okay

Ton: If you pick up the time to... A few words for me are Circo, ... and the way that it.. the motivations to do that. And then you talk about the metal exchange platform and the role it plays in your work, or in Heeremas line. And then you also said you were fan of Turn-to maybe you are a personal fan or someone within Heerema.

Vincent: Personal fan

Ton: Aah okay

Vincent: I try to impose it on them, but you know..

Ton: Could you go a bit deeper into the motivations for that metal platform, that exchange platform, or plastics at the moment and steel.

Vincent: Yeah, well only steel.

Ton: Okay steel and you want to do it with some plastics as well, later on.

Vincent: Yes. Well, motivation was what I simply said before. I am kind of the yes man. Any cooperation that is being handed to me, I take it. So a few years ago, I think it was end of 2016 or 2017, somehow I was contacted by Circo about circular design within the marine industry and I thought, you know, why the hell not. Luckily I had some young colleagues, friends of mine actually who were also excited, that's it, excited. We did two of these tracks and this is what came out of it. Nobody else was excited about it in the company until of course we made a platform. Which was also nothing more than a glorified Excel sheet that people could use to actually start doing what they already did, reusing steel that is laying around and flashing our yard for new projects. There were already a few engineers and a few people from procurement etc. were looking into reusing steel, but also only on a personal motivation level. Because they thought, if we have a few million kilos of steel beams lying around in perfectly good condition, then why not use it. And I have actually seen, with one of our biggest projects, about €60 million worth of high-grade steel being scrapped for a dumping price. Because the project manager has already paid for it, the only way that he receives any money on his budget, or his balance sheets is when he scrapes it. He otherwise has no value to it. They go back to the money incentive again. This really needs to change. We need to put value internally in order to make this work, we already proposed, but it was too big of a step I think. That was a big issue, but the moment you start gamifying it, what we did is actually we had a list, it worked, it was brilliant. The list of people who reused the most amount of steel.

Maren: Yeah yeah

Vincent: And then they started battling, all the engineers, with one another. One guy actually sent an email to a colleague, 'can you please update the sheet because I think I am at my million kilograms now and I want to beat that guy'.

Maren: haha, yeah

Jeroen: So that, and making it accessible, plus the economic incentives, which is still lacking but we are trying to make it work. I sent you a link. We already have like a rental and sales equipment on the website, but that is more about equipment. This morning I spoke with Rebel Group, a friend as well, about maybe broadening this kind of concept. My ultimate goal is to make something like Dockstr. She is a marketplace for the marine offshore industry, but then Dockstr is more focussed on equipment and rental, so that is really let's say cranes, winches or engines or whatever. And then we could be focused on the building blocks, the materials, the beams, the steel plates, the rigging etc. So different angle, but it is what it is. Marktplaats.nl but then just for the marine industry. So just a marketplace in an online environment.

Maren: Okay

Vincent: We still have difficulties and the biggest challenge that we are facing at the moment, I would say, is the view of some actually higher ups who think that giving other companies and potentially competitors and peers your equipment, that is how they see it, might provide them with a competitive edge over us.

Maren: Okay

Vincent: I fundamentally disagree, but that is the challenge we have to face

Ton: Just that it's not about steel bars but more intact and entire equipment

Vincent: No,

Ton: to put another level on the metal platform

Vincent: even steel bars and stuff.

Ton: Oh, oh okay

Vincent: And that is the 20e century way of thinking versus the 21e. The 20e century way, as I call it, is guarding, safety, guarding your property. It's about, you know, us versus them. And the 21e century is, you know, if it's not hurting us, it can only benefit us if we do something with it. We will see how it goes.

Jordi: When you take on a project and dismantle, let's say, an oil platform of Shell..

Vincent: Yeah

Jordi: .. Do you then automatically own all the materials of that oil... like, where do you get all your steel from that you save up in Vlissingen?

Vincent: Yeah, we buy it. That is different steel. There are some cases in which we actually get the platform, well get, take ownership, that is part of the contract, scrapping it. In some cases, for instance in Norway, forgot the name, we have a partnership with [...]. And sometimes we actually go to a client who likes to decommission an oil and gas platform and we can tell, we can take it away for you and we can also decommission the platform itself, scrap it down and you don't have to worry about a thing. In that case we take ownership. That's mostly not where the material in Vlissingen comes from though, that's simply from projects that we do. You can imagine for installing something that's quite big, you need some helping or aiding equipment. You need to have slings, you need to have barges you need all sorts of equipment to do so. That is our property. But think, you need some types of equipment, some slings, some rigging. But these are literally beams, I have seen them because I have constructed them as well in Indonesia, beams that are higher than yourself, so two meter high beams that you put the platform on, and they weigh a ton, literally. So it's very big, heavy construction equipment. It's pretty much the same as you can find outside, for construction material but just ten times bigger. And this accumulates over years if you don't do anything with it, then nothing is happening with it. So I am going to send you the Google maps link, that you can actually see the yard itself and what is laying there. There is a wind turbine next to it.

Ton: Okay. And when it accumulates.. is it the cost of having that accumulated in itself not important enough to resell it? Because it would mean something of an asset on your balance sheet.

Vincent: Yes and here is the kicker. First of all the guy was kicked out during a reorganisation so he was concerned about it, because he saw it on his budget. But what does the project manager see? He does not have the cost of storing it. The project manager only has the purchase cost and more importantly, he gets the money when scrapping it.

Maren: Yeah

Vincent: So.. and here we come back to the turn 2 model and why I like it so much. Power and responsibility are separate. If you put them together, so you tell the project manager or the one who is storing it that it's both. So you actually pay a premium or a fee internal or whatever, then you get people to say, wait a minute, I don't want to purchase it and store it, I you want to reuse what he has or I just want to have an internal marketplace, that is where the idea came from, to rent it out from.

Maren: Yeah

Vincent: Then you can store it in Vlissingen but they get money for the storage. So it is I think wrong economic incentives. I am going to send you the link, you can have a look. Next to the windmill there is this huge side where you can see all the stored material. I am not sure what the latest date was when this photo was taken. It's just a big field where they dump materials, out of side and out of mind. This is Vlissingen, we are normally in Leiden, so we never see it. I was supposed to go there tomorrow but that was unfortunately cancelled. So yeah.. we have a lot of material laying around here. The idea now is to link all the materials around, sort of the Netherlands let's say. All these yards have all this construction material laying around. Maybe we can link it up and then create a single, digital dumping place where people can pick their stuff up.

Jordi: And is this new marketplace more efficient? Are the materials still adding up or is it actually decreasing?

Vincent: Can't say

Jordi: Okay

Maren: Okay

Vincent: It can be anybody's guess. We are still doing a lot of projects. It depends on how many projects you do and how much material you receive. But one project can make the difference. We have projects in which we get back steel beams, which weigh, all in all in the order of a million kilo's, thousands of tons. One such a project and you double your storage weigh, so to say. But they are not being used as thoroughly as we would like. If I had to guess, I would say it still accumulates. And that is because we are engineers and our education is, take something new and use it and then dispose it. We are still thinking in a linear term. So that is why I would put my money on saying it accumulates, not decreases.

Ton: Yeah

Maren: Yeah

Ton: And would the... I don't know if you mentioned the fact that you do this.. and it would be less an integral part of thinking that the user of those bars and steel construction, would actually be fed into the design process as well.

Vincent: Exactly, absolutely.

Ton: Because if you design all over again, let's say.. a meter longer thing, 20 centimetres more narrow or whatever. I don't have the picture of what it actually is, that can prevent using that construction that you have, just..

Vincent: Yeah

Ton: I can imagine that it only works if higher up, where there is a connection between the design unit and people doing the project management and even procurement.

Vincent: Absolutely, 100%

Ton: And is that something that in your enthusiasm see coming or do you need more evidence-based data to convince others to align?

Vincent: I would say people within Heerema are not triggered with evidence at least. Well.. it's different. We have a very strong tendency towards cognitive bias. So people believe in what they want to believe and everybody has evidence for their viewing point, which is usually the case weird enough. You can view thing from a differ angle and still be correct.

Maren: Yeah

Vincent: You can look at a six, one guy sees a six and the other sees a nine and they are both correct. So I think that what we are more sensitive to is arguments toward authority, or prisoners dilemma. So if our competitors are doing it, we would be more geared toward doing it.

Maren: Yeah

Vincent: So if we are not going to do it, other people are going to do it for us. So that is more or less the arguments that I use. I don't use a lot of economic arguments, because I have seen that they can backfire. I do try to make them notch towards a more circular way of thinking so that is why I am always progressing with the ZERO tracks, education etc. But it's going to be hard. I put my money more on the Heerema engineering services because they are also thinking about it. And they are exactly making what you were saying Ton. A tool, with which you can do design. It automatically looks through and scans all the databases and sees, this is your design. It is new, but is you just change the two [...] which won't change your bending strength or whatever, than you can actually reuse the material and it is going to be x percent cheaper.

Maren: Yeah

Ton: And another argument that you mentioned before, it was on safety and it was on time.

Vincent: Yeah

Ton: When something is there it might be there with a shorter supply chain or a quicker supply chain than otherwise.

Vincent: Yes exactly. And especially procurement, they don't like trying out new stuff. They probably think I am weird. They think in terms of processes and in terms of existing suppliers. It's their job to procure something. So the circular economy is not something that flows their boat. I think that it is a treat to their existence in a way. A lot of things that I do is a treat to other people's existence. And I am personally inclined to make myself obsolete. So I am even a treat to my own existence in a way, but I think that this is the sustainable way to go. At some point you have a problem, you solve it, done, move on to the next.

Maren: Yeah

Vincent: This way of thinking is harmful to procurement. It's the same for 3D printing which we are looking into. Plenty of examples, plenty of evidence, plenty of academic, but also economic evidence of lead times being decreased significantly when we are using or doing 3D printing. We have a student who actually printed a metal part, than asked for the same part from procurement, and the answer was: It can't be done because the factory is closed down it's going to take months, I have no clue of a supplier. While it is a engine critical part. If it breaks down, we probably have to machine, or built it some other way while she actually 3D printed it in a week.

Maren: Yeah

Vincent: So, plenty of evidence to show that these types of thinking, reusing, 3D printing are better, provide more flexibility, makes you more robust, more antifragile, but we don't do it because we don't know how it works.

Maren: Okay

Vincent: And it's a treat to the existence of some people and to their identity.

Maren: Ok, yeah that is very interesting

Ton: Yeah I am very much triggered. [...] the brochure, booklet issued by the adhoc group of companies who call themselves the Capital Equipment Coalition. It contains next door neighbours such as Lely, but also KPN for instance. and also Phillips and ASML, the deal in heavy equipment. They talked about the drivers of their conservative behaviour, but they also actually wrote a piece about how to stimulate change within big corporates, big corporate environment. If you look at the schedule they do, it was very much about a continues, strong top down commitment. And that basically has to do with what you just said. If you are like a staff member and you [...] of various

function in your organisation than you can fight until you sort it out, or you can have top level commitment. That was actually the story of both.. also the top level and continues commitment in order to align each and everyone's targets. That is essential to achieve this stuff.

Vincent: Well, please forward it to me, it sounds interesting. It sounds like something I need to know.

Ton: Okay Okay

Vincent: Good to hear that you are triggered.

Maren: I feel like you already answered all of the questions pretty much. I mean now of course it is about transforming this information into something that can be useful for SMTE's.

Vincent: I didn't know what it was and I wanted to ask beforehand, but what would you want to get out of this meeting? What would be the perfect situation? What would you like to see?

Maren: I think that we did see it. I mean of course our project is about connecting industry 4.0 investments to circularity, but beyond that we are also looking into circularity in general. Especially the drivers and barriers of those projects. And I think that you explained a lot. Like I think that we got valuable information. Right Ton?

Vincent: Nice. Good to hear.

Ton: Yeah yeah yeah

Maren: Do you agree?

Ton: As I said, we actually do two things together now. I might even ask Vincent whether some of the data can be used in the general report for Zuid-Holland about how the manufacturing industry relates to a circular economy.

Vincent: Yeah

1:25:29 – 1:25:42 Not hearable

Ton: basically what you said, trying to see commonalities between what works and what doesn't. What makes the top tick and what prevents them from doing that. And that is on people, that is on sectors and maybe it's a very big task for students with whom we are doing this together. But I hope that this kinds of aspects play a role. And then of course SMEs

Vincent: SME?

Ton: Small and medium sized enterprise.

Vincent: Well it depends on the definition, but we don't have a lot of people.

1:26:22 – 1:27:20 Small talk about the office in Leiden

Vincent: I think that we have 2000 people worldwide, including fleet, other offices and everything. There are only 500 people working in the office in Leiden.

Maren: Okay

Ton: So in principle, it is a family owned business isn't it?

Vincent: Yeah

Ton: It is not with stock or something?

Vincent: No

Ton: So the owner might exert his influence more than if it were Phillips?

Vincent: Yes, they are still shareholders, they are still a shareholder, but it is a single guy, it's a single spirit. That has both advantages and disadvantages. In this day and age.. well I think in any day and age, if you have a visionary like a.. dictator kind of guy, a good kind of guy, then it can only provide you with benefits because it gives you more decision making. The decision-making process is a lot easier.

Maren: Yeah

Vincent: Same with the energy engines. One guy says we are going to do it. It is my money so deal with it. It takes a lot of headache away. Conversely, if you have a despot, dictator or a guy who only makes the wrong decisions, we also have a lot of these examples these days, then you have a big issue. So it has both pros and cons. But it is just one guy who has all the shares, so that is how you can look at him. Just one shareholder.

Maren: Yeah

Ton: Yeah, therefore interesting also what we said about the Capital Equipment Coalition and their management model and what you said about his very personal conviction I could imagine that [...].

Vincent: Yeah absolutely. I think he is very concerned with a lot of things, also about making money still. He is still a shareholder, but less than a regular shareholder. I think that he has more of an eye open towards protecting legacy, protecting people, protecting his work that he has worked for his entire life. Most shareholders, especially Phillips, ASML, they just want profit. They care about the bottom line, the singular bottom line. That is different, absolutely.

Ton: And even in those situations it very difficult with more or less, first of all risk aversion that you mentioned. And it is up to the knowledge holders to change the direction a bit. And even than it is hard to change their spirit.

Vincent: Rusty is a good word. He has done so much to show his dedication. To an outsider it might look strange, I mean LNG engines, big whoop, still fossil fuels you know. But it makes quite an impact in the industry.

1:31:02 – 1:32:30 Some off topic conversation about the owner

Vincent: It doesn't really matter what he does, the owner. People believe their own worlds. And even those people, when you come to them with an idea that walks their word, makes it better, for instance like a new fuel that creates less smog, then all of the sudden they are hooked. So everybody has an angle.

Ton: Yeah, [...] is that also leading to reluctant behaviour toward these new production technologies?

Vincent: Yes, that is why we are sort of adopting a bottom up approach at the moment. We have one of our students, Maike, she is really doing an amazing job. She is looking into it. I think that the whole process of looking into it really helps. She has good contact with the fleet, with the storekeepers who eventually have to be a big part of the solution. I mean, I have been seeing great potential in 3D printing for years now, and they don't because you know, I have been doing it for years now and that is the second time they hear 3D printing and all they can think of is, I have a store full of material, what the hell do we need a 3D printer for. As I put it, it is an addition to the current supply, to the current equipment. It is a great way of building or maybe fabricating those types of equipment or material that maybe has been obsolete or has not been built in 30 years or maybe the manufacturer broke down and the factory is not existing anymore. It is a great addition to what we already have. We are now starting with the easy stuff. For instance, for lighting you have cover sheets. These are quite expensive, we have to bring them all around the world to get them on board. What if you just print some sheets and put them together yourself? They are excited about these kinds of ideas that never really came up to us. So we are now easing them in with a 3D printer and letting them play with it. That is the same as the Dutch navy is actually doing at the moment. And then those guys will come up with great ideas of using it. The other thing that I am trying to do is getting a foot in the door and giving them a 3D printer which they actually use, which is helpful. That is important, it needs to be helpful, it needs to add value, and then the rest will come with time.

Ton: you do that with less critical parts now?

Vincent: Absolutely, well we are doing it with critical parts at the moment, but we only found out when we did it. Because Maïke went to the vessel and went through all different kinds of materials, all different kinds of parts and then came up with, you know, what is this? The storekeeper was like, well I believe that that is a for the engine. It has been laying around since 2009, please take it. She then went through the whole product process and found out that it was a critical part, no substitutes are being made, it cannot be shipped anymore, it is going to take months. So I was like, well this is a goldmine of information. And it was actually around five times less expensive to 3D print it, only talking about product costs, not logistics.

Ton: yeah no sure, because the size of the order doesn't count for 3D printing.

Maren: well

Vincent: Plenty of benefits there as well.

Ton: Do you have more issues to cover?

Maren: No I mean, I think that we are good. We do have the survey of course. It would be great if we could send that to you and you could maybe fill it out, at least loosely. Because that is also statistical. I mean, we are only doing two interviews but the other group members are doing more so.

Vincent: Sure, just send it to my email address. You have my email now.

Maren: Yes, so we will do that.

Jordi: Could we also send you an email if we have any further questions?

Vincent: Always! Usually I consider email as non-urgent, less important, but I always get back to you.

Maren: Okay

Vincent: I prefer it if you give me a call if it is short. If you need it like written on paper, or you need to look it up, feel free to send me an email. As you noticed, I am quite of a talker. I love talking about these subjects. It is my passions and one of the reasons why I started doing this within Heerema.

Maren: Great, thank you so much.

Vincent: Use and abuse me, that is what I usually say.

1:38:00 – 1:42:11 not hearable

Ton: For me that was it, Jordi, Maren..

Jordi: Yeah for me it was very interesting to listen to what you had to say, and also go a bit in depth on some of these initiatives and to see what the company is planning to do, what drives them and what holds them back. So I would like to thank you for your time and.. Maren?

Maren: Yeah, thank you so much for speaking with us. I am just looking at the survey right now. We also had a 90 minute call which is good, because 60 minutes is sometimes a bit short. So yes, I hope we will be in contact hopefully.

Vincent: Yes sure

Maren: And please keep doing the sustainability work.

Vincent: Let me try, let me try. Stay safe, stay healthy. Bye

Maren: Bye

Jordi: Bye

Ton: Bye

Appendix B – KPN Interview Transcript

Interview with Jeroen Cox of KPN on 14-04-2020

Jeroen: Good afternoon

Jordi: Hi

Maren: Hi

Ton: Welcome Jeroen

Jeroen: It could be that my children will be running around the living room, but so far so good.

Ton: Jeroen, I only take the word now and I want to introduce Jordi Zoun and Maren Flunkert, who are also online and are students from de Haagse Hogeschool. I don't know what the English name is for that, The Hague University of Applied Sciences or so.

Maren: Yes that's what it is.

Ton: Whatever. Together with them and four others we are in the framework of the Smitzhs program. The Smart Industry in South Holland program.

Jeroen: Yes I saw it in the questionnaire

Ton: That is a huge program, basically on the Manufacturing Smart Industry, there is a small side-track for the first time on sustainability and circularity. They are doing a bit of their thesis on actually something that was given by us, a group called The people from the Capital Equipment Coalition, of which you are an active part. By the way, Jordi and Maren, we were actually in a workshop all day last Thursday so it's an active group which participates in these kinds of meetings. So Jeroen, I also like to thank you for participating in this. Jordi and Maren have prepared questions and try to formalise not just your answers but also discussions we will have later on in something that indeed goes deeper into circular value drivers and circular value barriers. And actually you Maren, you said that you of course not just had prepared questions, but that you also had, let's say, an idea on how to approach it. So I would like to give you the floor. Let's have a short introduction round. I have to be in another call at three o'clock by the way. I give you the floor.

Maren: Yes thank you. Before we introduce ourselves, yes we have a list of questions and if the questions have already been answered in a previous question than we are definitely going to skip it. So there is definitely room to elaborate. We have of course a backbone of the questions because that is what we have in our thesis. We need to get an answer to these, but we can also follow it up with an email. It's just about having a conversation. Maybe to introduce, I'm Maren obviously. I'm in my final year of European studies at de Haagse Hogeschool. So we are all from different studies actually. Jordi is about to introduce his to. I used to be, up to this project, in the public stream, so I was researching more the policy approach to sustainability. And for this project I switched to private so I am interested to now study also the business approach to what is actually happening. Yeah.. Jordi.

Jordi: I'm Jordi. I'm also in my final year, but than of the study Finance and Control. The reason that I wanted to join in on this project was that we talk a lot about sustainability during my courses but it

was always kind of abstract and now and now we are really diving deep into sustainability and make it much more practical. So that is what I like about it.

Jeroen: I'm Jeroen. I have been working at KPN for almost 20 years. Previously before that at TNT express. I also have a finance and control background. I graduated as a certified controller a long time ago. Previous to this role I was responsible for the energy and environment at KPN and also was responsible for the logistics at KPN.

Maren: Okay, yeah I mean that is very..

Jordi: For our thesis it would be very practical if we could record this interview, but I don't know if you agree with that.

Jeroen: Yes I agree, and I also what I did was, Jeanette sent me the questionnaire. That was really good actually. It gave me a bit of a head start to think about it. I started preparing it today, so I think it's half filled in now. So at least I came up with five cases and I started categorizing them. And I included some links where you can find some more stuff. Maybe it's a good idea if I share my screen and show you what I have filled in so far, and maybe we can discuss around it.

Maren: Okay

Jeroen: Actually, I can send you the stuff after this. See if I can manage to do this. I would think so.

08:00-12:15 Interruption because the screensharing wouldn't work

Jeroen: So I came up with five examples. I was good to think about it, cause there are all sorts of things you can do naturally. First of all, we are a service company. What we sell are subscriptions on internet and television and we do it in the business marketplace as well. We sell cloud space or security options or things like that. But even though there is a lot of services involved, there is always some equipment behind that. Even though we don't manufacture that ourselves, we do have an active interaction with manufacturers, and we ask them to design their equipment as sustainable as possible. And on the one hand, we already had an emphasis on energy saving. But now since two or three years we are also becoming more circular.

13:38-13:55 Another interruption because of screensharing

Jeroen: So the five, actually I managed to fill it in until question five

Ton: fantastic

Jeroen: I guess that is not too bad

Maren: No, haha

Jeroen: So I selected five, and I selected two on energy saving

Jordi: Yeah

Jeroen: One on applying recycled material and two on innovations of future connectivity, 5G.

Maren: Okay

Jeroen: So it is a nice blend I guess. So the first one is actually a project we are doing together with the municipality of Amsterdam, Amsterdam Economic Board. Datacentres are becoming a problem because they use a lot of energy. So there is a lot of focus on whether we can use data in a more energy efficient way. Equipment is always on and what you tend to see is when you get a server out of the box as an engineer, you move it straight from energy saving mode to high performance mode because your equipment needs to be always on. Your boss basically tells you the machines need to be ultrareliable. The average engineer is not too keen to play around with energy saving options because that might hinder the performance. This is exactly the dilemma of trying to squeeze our foot in the door if you like.

Maren: Yeah

Jeroen: And one of the things we did here is look at two server casings and we set it to the first energy saving level and via those settings we managed to save 7% versus the non-used or other ranks if you like.

Jordi: Okay

Maren: Okay

Jeroen: This is now promising to investigate further and it's actually, you know, only something that we started two months ago. So it's an ongoing investigation. The second one and let's not go over the annual report right now, but there is a graph on page 50 or 51 which is the chapter of the environmental performance of KNP. It shows that in the last nine years as of 2010, we managed to save 25% of energy consumed by cars, networks and offices. And at the same time the energy we, as a society, used via the KPN network went about 15 times. So if you look at your phone, if you look at NU.nl, or you look at YouTube or Netflix the bandwidth is constantly on a rise. The images become more clear and the content has moved from text to pictures to video. So it takes a lot of bandwidth and at the same time we managed to reduce the energy by 25%. And that is mainly by replacing old equipment by new and also a process that is called virtualization. The newer computers are not fully utilized so in software programming you program them as if they are multiple computers. Let's say, in one instance you may need almost 40 pc's versus one that is fully virtualized, so you oversign them if you like. You act as if they are multiple computers. So it's getting rid of old equipment that don't have these sophisticated energy settings and also use a lot

more. And also it's the dialog with your suppliers that you constantly want more energy efficient equipment. So it's those two trends that are showing there. So that's the second one.

Ton: And is there, just a small question on the less equipment. Is in the annual report also shown how much equipment is used less?

Jeroen: Yeh in a sense. You can see not so much how much equipment is used less but you can see how much equipment left KPN. In the measurements, in appendix 7 table 10 you see the number of kilos of equipment that leaves the company.

Maren: Okay

Jordi: And what happens with the old equipment?

Jeroen: Old equipment is either first reused as parts or sold to manufacturers or brokers for recycling, or recycled.

Jordi: Okay

Jeroen: About three quarters of equipment is reused and for our network its over 80% of reused or recycled.

Maren: Okay. You mentioned in the beginning that sustainability has always been there historically and now since two or three years you're trying to be circular, could you maybe explain a little bit more the motivations behind going circular? Is it to be a frontrunner, is it because there is a huge amount of demand or is it because it's actually necessary now to handle all the data? What is your perspective on this?

Jeroen: In our case it came as a top down approach. We annually did stakeholder dialogs and we were involved in using green energy as of 2011 and in 2015 we were already climate neutral for energy. So we did our annual stakeholder dialogs where stakeholders told us that this was the next wave to look at and then it was discussed for about four times in a report, and then we decided that the board in 2016 or 2017 decided that we wanted to be circular. So it was a very top down driven exercise.

Maren: Okay

Jeroen: We did not know yet what it would give us other than reputation and also that it would make sense because as we say, we do use a lot of equipment.

Maren: Yeah

Jeroen And also, all of the drivers that are in your questionnaire as well are applicable for us as well, because I actually drafted those arguments together with Harald Tepper from Phillips.

Maren: Yeah

Jeroen: So most of those arguments I am very familiar with.

Jordi: Yeah

Maren: Okay, fair enough. Jordi do you want to go or not?

Jordi: Yeah I'm just thinking about whether we should finish these five initiatives or not.

Jeroen: Yeah. I think I can keep it brief for the other ones. So the next wave in terms of circular is that we've started.. yet again you want to make impact as soon as possible so we have about eighteen suppliers that have signed our Circular Manifesto, which is not a contract. But basically the first line says "we align with KPN's ambition to become circular as much as possible by 2025" and we started with consumer electronics. So we will introduce in one or two months' time a new modem and it used to be white on the outside, if you look in your cabinet in your home, but now it will become black. So it uses recycled plastic, the latest remote control has the bottom cover of recycled plastic, also black.

Maren: Okay

Jeroen: Because white APS needs to be extremely pure to use recycled plastic.

Maren: Oh okay.

Jeroen: That is why black is easier, you also see less on it, like scratches or cosmetic damages, so its more forgiving. And also the tv receiver, which is with most people next to your tv, has become 60% smaller. Designing smaller also means that you use less. So that is number three. We also learnt from Philips there who did that with coffee machines and vacuum cleaners. And number four and five is yet another type of technology. Number four, and I Included a YouTube movie so you get more context. Number four is basically using high speed connectivity. Maybe Ton you can briefly click on it because then I can show you a few seconds because visually shown its much better. So this is it, in Drenthe. It shows you a truck that dives across the acker and analyses the acker and looks if it is weed or actual crop. And it will only spray poison on the weed and not on the crop.

Maren: Okay

Jeroen: As it takes pictures of the acker in front of it is then calculated on central basis and then the farmer can.. it uses draw technology for example, and then it only sprays fertilizer at the right place. It uses less water and it uses less poison so it's much more precise. So this is a trend called precision farming.

Jordi: Yeah

Maren: Yeah

Jeroen: And then the other example. The final one. And naturally this is not something we do ourselves right, so this is in a consortium with the manufacturer of the truck, and a farmer's corporation, with the University of Wageningen, so it's with a whole group of people. And the second one is next level connected driving. And the connected driving and smart traffic lights in Helmond, which is now on a circuit, closed circuit that means. This is the mayor. It means that in this case that the help services are always getting a green light, so they don't have to stop. Another test is, that is straight after this, is to have two cars exactly following each other.

Maren: Yeah

Jeroen: So therefore they also have less stop and go moments. And this also means that you have less exhaust because the stop and go is the most exhausting part. So here you see two cars following each other. Its actual cars and it is using virtual reality as well amongst others. There is people in the cars, but they are driving via a connected protocol.

Maren: Okay

Jordi: Cool. So a lot of these initiatives have to do with digitalization

Jeroen: Yeah

Jordi: Would you say that digitalization in itself enables sustainability?

Jeroen: Yeah I would think so. Yeah.

Maren: That's what we're trying to prove, right?

Jeroen: I think so because digitalization is a very wide trend. Knowing things, so a more intelligent way of analysing data allows for.. for example with IoT you can look at logistics. The probability that you find a sea container for example increases, so you have to travel less. Or you can use sensors in Schiphol waste bins, so you only drive out to the ones that are full.

Maren: Yeah

Jeroen: You can become much more intelligent about energy settings. Switch off equipment when it is night, or consumers can maybe play around with smart light for example or like in your equipment at home. So maybe you don't want to pull the plug of your coffee machine, but you want to make sure that at night you use less. So there is all sorts of things you can do with digitalization.

Maren: Yeah.. okay yeah that's very good to know.

Jeroen: So I ticked the box off what I thought were applicable per initiative and now we have introduced the initiatives it is probably easier to go through it a bit faster. So what we could do perhaps is we could follow the whole questionnaire by initiative, or do you want to follow it by question?

Maren: No I think by initiative is fine.

Ton: Yeah okay

Jordi: Good idea

Jeroen: Because that way you stay in the context of that initiative. Otherwise you are constantly jumping, for me it's easier but for you guys, you are not familiar yet with the initiatives. So the first initiative was the energy saving on cloud computing, the energy settings on servers.

Maren: Yes it was yeah

Jeroen: So the leap project. So there I felt that data is naturally logical, cause that also means how much data you store on servers so there is definitely a link to that. Cloud computing, our compute power is connected to that as well. You need a bit of simulation in terms of settings. You know, what settings work, what settings don't, which settings, how do you call it?, which will hamper your performance. We did not just select any servers because we were asked around the Christmas period, which is one of the most busy, well prior to Corona, but prior to Corona when life was normal. Then Christmas was one of the most busy weeks in The Netherlands. You know families calling each other etc. So we looked at what we call low impact server. So with less critical data on there.

Maren: Okay

Jeroen: And then you see what works. And finally, it's also something that you cannot do without help of suppliers. So in this case suppliers like Hewlett-Packard and Dell were instrumental in knowing on how to set the perimeters in those servers. It has nothing to do with sensor technology or IoT. It is also not connected to robotization.

Maren: Okay

Jeroen: It's also not connected to 3D printing. There were no AR simulations like virtual server or something like that, or digital twin.

Maren: Okay

Jeroen: And in a sense it could be connected to cyber, because everything we do has to be secure. But it is not aimed to reduce the vulnerability of computers, it is more aimed at.. But if you introduce energy saving and you become more vulnerable then, you know.. But I would not be able to think of an example there. So I did not select that one.

Maren: Okay

Jeroen: So yeah, for the first one I think it is mainly supplier related. So it is not.. you could argue, actually we should tick 8 here, stakeholder, and in this case Amsterdam Economic Board, as they approached us.

Maren: Okay, yeah that is really important

Jeroen: And I did include in the description, on the top, I did include the link to the press release. So that is really showing that it is external driven innovation, stakeholder driven innovation.

33.54 – 33.21 Conversation about how to tick boxes in the survey

Jeroen: So let's carry on. Question 4: I feel that naturally it is by Design as well, because the energy saving feature is only there in the latest equipment. So it is designed if, by, suppliers. I guess I could have ticked Procurement there as well, because we also ask for that in Procurement. But in this case, we had not used it before so, one could argue 'did you really ask for that specific option or more in general?'

Maren: Okay

Jeroen: So manufacturing, it is not manufactured by ourselves but if it is not a sort of manufacturer, then it is not in. The Use one is the most important one.

Maren: Okay

Jeroen: Next, so these are the value drivers

Jordi: Yes

Jeroen: So to me it is not something.. this is not a new entry example. I could see that you reduce cost with this because you use less energy. I could also see that you could, in a way, future-proof

the business, because energy consumption and moving into the 4th Industrial Revolution also triggers a lot of questions by people. For example, 'does it not come at the cost of society this whole modernization?'. So in that way you also need to be involved with that rationale. It is not so much that energy will become exhaust, but at the same time we do need to move towards a more sustainable energy. But in this case, if you look at, there's a model which is called trias energetica, which is basically saying first you need to start using less energy, and then you make it into sustainable energy etc.

Maren: Okay

Jeroen: So, using less energy, that actually, you know, well energy also will become sustainable energy. In that way, it is another way of rationalizing it, but I think more the stakeholder side of it, is probably more upfront than the argumentation. I could also see this as a Customer Value, because in a business market, customers may also pay for the energy themselves. So if you host a data center, you host them with the equipment of customers themselves. They pay for the energy then separately.

Maren: Yeah

Jeroen: And then at the consumer level, one could also argue, if we communicate more about this, this could also lead to more loyal customers. This could lead to a better reputation. And then this number 7 is basically the argument that I also used at number 3, which I felt are somewhat connected in this case.

Maren: Yes

Ton: Can I ask a question there? Also for Jordi and Maren, but also of course for Jeroen, you said that in 2017 the board had embraced circularity. If we take that moment and we would look at these drivers, before or after that period, would they be judged in a different way, or would some arguments be taken on board now, where they were maybe taken less, or not, on board before that moment?

Jeroen: Well..

Ton: I would say the reduce costs might have a top layer or?

Jeroen: Yeah that is true, when you move from energy to circularity, I have also had lengthy discussions on this with Carola Wijdogen, who is going to launch her book on MVO doe je zo. She also teaches at Yale and at Holland Sustainability University, also discusses trades of sustainability managers and professionals. So we talked about the competences between, energy versus

circularity, and energy is something that is much more concentrated in a company, so it is more sort of an intellectual exercise: 'how much do you use?', 'what type of energy do you want to buy?', 'how sustainable really is the energy?', 'how do you report on it?'. And circularity basically touches the whole company. So circularity touches marketing, it touches logistics, design, touches reverse logistics. So in that sense, if you want to become really good at sustainability, everyone always says that you have to integrate into the whole company. And I can tell you that integrating Circular Economy is much more difficult than integrating energy in that sense. And energy is also easier to measure, as you do not have length and width and height and Co2 imprint of everything that you use.

Jordi: Yes

Jeroen: So it is not a sticker on a table, or your chair, or your computer that says 'this was the Co2 imprint and the keynotes of this product'. So that is a bit of a long answer to a short question. But so, if you increase your efforts, which you always try to do naturally as a sustainability manager, you try to involve more and more people and become more and more relevant at board level. Then, by the nature that you have to integrate it more, you also have to work harder, because you have to know the company better, and you have to know the business models better, and you have to really understand where the money is being made and what gets priority. So you have to make sure that it is not a side topic, or it becomes one.

Jordi: If there was a certain initiative, which could sustainability, but would only cost money, do you think that that initiative would be taken a look at?

Jeroen: Well not all of them will pass the bar, but we have had some examples. One example that we have is, we partially drive on biogas cars, and the residual value of those cars is much lower, so the lease is higher. And right now, a third of our fleet is driving in those type of cars. We did have a lot of discussions with Procurement on that. But the manager of our engineers' department basically said, you know, we are shouting out to the market that we are the most sustainable telecom company, and so we have to walk the talk.

Jordi: Okay, good to know.

Jeroen: Okay let's go further up because I think further up we can speed up the other ones, because some are connected as well, as we will see. So if we go to the next question, so we are at 4 I think, and we lacked 5 and 6.

43.14 – 44.04 conversation about screensharing and cameras

Jordi: Well I think it is good that we have taken a really good look at one initiative, but I do not think that the time enables us to do all of them. So my question to you actually is, whether some of these initiatives required a change in business models, and required collaboration with other parties?

Jeroen: Yes, so that is basically related to this question right?

Jordi: Yes

Jeroen: Well then if I speed up this question then, if you look at initiatives side by side, so we are now going to run through one of them. So if you look from number 1, the cloud energy efficiency, to the overall performance of the company on energy.

Maren: Yes

Jeroen: Replacing old equipment with new and getting towards more virtualized infrastructure, you see the same things, because it is all energy related.

Jordi: okay

Jeroen: If you move to number 3, that is using recycled plastic and design, then that is definitely something that we had to work out various types of prototypes, before we selected the right type of plastic. So type of plastic for example you have to look at, stuff is in people's homes, so you don't want flames to get out of it, and you get into the field of for example flame retardance, so you have to select the right plastic. Recycled plastic can be a bit less resistant to heat than virgin plastic. That is also something you definitely have to do together with suppliers in the various positions in the chain. So it could be that you are speaking to the manufacturer of the box, but that box is assembled in China, and materials are also sourced in Europe or in China. So for example for a TV receiver, the first time the recycled plastic came out of Europe, and for the next prototype we managed to get a source in China, so it did not need to be transported from Europe to China.

Maren: Okay

Jeroen: And now we have raised the percentage of recycled plastics from 33% to 90%. So it is constantly revolving in that way. And if you go to initiative 4 and 5, which we just saw the videos on, those are related on sensor technology, communication, computer power, graphic analysis, and also usually in a consortium with various partners and knowledge partners.

Maren: Okay, this is very helpful, thank you so much. This also connects the technologies to the Business Models and to the initiatives, so this is really great. Jordi, do you have a question or otherwise I could ask one?

Jordi: Go ahead

Maren: I was just thinking, you already spoke a lot about the drivers, and obviously you are also very familiar with all of the drivers, could you maybe describe a roadblock that you hit with one of the initiatives, or things that just slowed everything down in general?

Jeroen: Well if we look at the first two ones, the current dilemma is only really just starting. The current dilemma is applying those intelligent energy saving modes versus performance. So it is definitely something that, for most of engineers is a very daunting challenge. Because we used to ask them to speed up the network and deliver the best possible connection to the customer, given a cost budget. And now we suddenly introduced an additional parameter, and for them, they are really not comfortable with it yet. So we are pushing on it top down, we are putting it in our conditions that we set for vendors, so we start with the procurement department, and we start thinking of you know, you can always ask questions right? So you can always ask various things, and then you see whether you get a solution that fits your requirements.

But then we have those, in this case, and they are not using it. So you bought something, it is in the books, but they are not using it. So that is basically a behavioral thing. First you have to know that it is there, so you have to sort of seduce them into this space you know, 'you can make a difference'. And then they have to tell you that it was actually in the books, because you did not know that yourself, and then say 'well, if it is in the books, why don't we use it?'. So then you have to, so the psychology of all of this is really interesting.

Ton: Small question, because of course it is your work Maren and Jordi, but has it something to do also with risk perception?

Jeroen: Yes, for sure

Ton: So any change is a risk, that is one thing. And second, is it also in the organization? Is it, let's call it a fight, a fight for also attention and importance? So you have the marketer, you have the operational guy, and in comes the sustainability guy, and they fight for attention?

Jeroen: Yes, so KPN is a company, where the top lines or the revenue declines faster than the cost line. So there is already a natural tendency to work with less resources and there is constant rounds going on with making the company more lean and more efficient. And so there is also pressure on investment and on cost, so definitely a prioritization is playing a role. It is also not a risk, because the Netherlands is also one of the most competitive countries in telecom. So there is a real push to deliver the highest possible quality. And people years over years have been saying, we as KPN need to deliver the highest possible quality, that is our trust factor with customers, that is the reason why customers come back etc. So that is really sort of engrained in the DNA. And now you are coming from a sustainability point of view and you are introducing a new topic almost. And next to

that: they don't know. So it is also, you are moving from old technology to new, and they also have to familiarize themselves with new features.

Maren: Okay

Ton: But then it works, are other things that are engrained in the DNA aligned with sustainability efficient?

Jeroen: Well sometimes it also works because I try to, you know what I like about engineers, that they usually, as a profession, most of them want to do well. So they like quality and they like.. so the way to introduce it I guess to them, is that you try to enrich their toolbox. So you try to make them curious. Designers and engineers are curious people, they want to solve things. So they are usually much less political than say in sales or in management. So they mean well and they want to.. they have an opinion of their own and they want to investigate things and deliver quality, so you want to be in that sort of vibe. So you are basically introducing that sustainability as a new or an additional form of quality.

Jordi: Would you say that company culture in that department forms a barrier, but on the other hand they want to deliver the best work they can, so that is an enabler?

Maren: Or an opportunity maybe..

Jeroen: Yeah it is very close to, yeah that leadership is very important. So leadership and communication and having an environment that you can make a failure every now and then or that you test things, is very important. So a sort of anti-failure culture is really not going to help you here.

Maren: Especially when becoming circular..

Ton: Small question, so Maren and Jordi on your box 4, it said in the value chain, but if I look at KPN value chain internally, I see that Jeroen did not tick any of the boxes in HR, in Human Resources. So I would talk about things now, do Human Resources play a role in getting or in taking the leadership towards local culture? But then also what was it.. in value drivers?

Jeroen: Yes, so I agree with you too. So I think definitely on initiative 1, 2, 3 then HR is definitely a success factor, and potentially also in the other ones. Because for the latter ones you need top quality people to find all of this out. But yes, success and failure is close to each other in that sense.

Maren: Yes, okay.

Ton: And just another question is the human resource department more or less involved, or at least interested in the sustainability aspect of the company?

Jeroen: Yes, definitely, because it also boosts our reputation, so we can see that our reputation has increased, that is also in the annual report. Every year you see the reputation score going up, and sustainability is one of the 4 or 5 drivers of reputation.

Maren: And also for people to apply at your company?

Jeroen: Yes and also when you have new people at the company, then a lot of times they are much more interested than average. So in order to attract them and retain the best talent, it is also wise to be working on it. The only thing that I am thinking of, what I did not fill in was the last question.

Maren: Is that related to the Circular Business Models?

Jeroen: Question 6 I think, so we discussed so 4 I think I filled in mostly supplier related, that one I filled in and I think we also discussed. And this number, what is number 6, because I did not reach that one yet.

Maren: It is Circular Business Models that are related to the initiative.

Ton: I think it can already more or less be filled in, based on the discussion we had today.

Jeroen: So, the first one I think is relating only perhaps to number 3. But yeah the thing is that when you have a service at KPN, internet or TV, you get the box right, so you don't lease the box. The box is part of the market proposition. The second one, the value or the extending lifetime, is not really applicable I would say, I don't think that recycled plastic lasts longer than virgin plastic. And also durability is also not applicable here.

Ton: It is very much on 4, efficiency, it's very much on..

Jeroen: Yeah. Reduced consumption is number 1 and 2 and 3. Resource value like interface, things like that. Resource value I guess number 3, so less virgin material. Feedstock, we have not fully closed the recycled plastic loop yet. So we have not used our own, like Philips did an example with their vacuum cleaners, we did not opt for that.

But I am missing energy efficiency as a strategy.. The reason, I will tell you actually, it is a nice final remark I guess. When I spoke to Eelco Smit of Philips, who was involved in consumer markets also in vacuum cleaners, on those products. They said that they actually also used energy efficiency as part of their, connected to their, circular strategy. Because if you start really pressing on becoming more energy efficient, then equipment tends to become smaller and also energy is easier to measure than circularity. So they said if you sort of put pressure on energy efficiency, you will also see a trend towards dematerialization.

Maren: Okay

Jeroen: So you are using less material.

Jordi: That is actually very interesting

Jeroen: So actually I found it very useful and actually based on that discussion, solely based on that discussion actually, I then altered our circular strategy and introduced an extra bulb. Because we have like 4 drivers in our annual report: the first one, less material, second one, extending lifetime, the fourth (third) one recycling, and the fourth one is energy efficiency, and this is the reason.

And also there is also a dilemma between energy efficiency and circularity: as we are seeing that the speed in which computers are being replenished for energy efficiency, also means as you also asked in this interview, that you are replacing it. So you are then stuck with the old one. So the dilemma is then also introduced and it is also now described in our annual report, at the same chapter. Because we also want to show that the modern way of reporting on things is also showing your dilemmas. So it fits quite well for me in that sense, so that is why I included it.

Maren: Yes, that is very nice. I mean we are also trying to add more strategies

Ton: The virtualization I think is very interesting in that respect. It is quite difficult to calculate, but still it can be calculated, if you exchange 15 computers for 1 and intensify the utilization of the essence.

Jeroen: Yes, you can do what we have done as well, we have done quick LCA's on it. So we just did a bare metal one, so it just compared the rec, a full rec, I think with 48 computers versus a rec with virtualized computers. And I think the impact, even though the computer times was times 48, I think the actual co2 was 9, and that also had to do that you still have the enclosure in both times, and you still need all of those computers, even though the computer power is much bigger from the versus the other. The use phase is much more visual of the virtualized one.

Maren: Okay

Ton: For me, I have to go into another meeting. I think as a host that that is quite detrimental for the whole... So I will step out.

Jeroen: I would like to thank you enormously for this time and this fantastic preparation. I will leave it to Jordi and Maren to finish off what they can do, because I really have to go now. But you stay connected if I press the red button.

Maren: But you need to finish the recording right? You cannot just leave and then we might lose the recording..

Ton: Okay I stopped the recording

Appendix C – Preliminary Survey KPN

SMITZH Smart & Circular Survey

The CESI Accelerator (Circular Economy Smart Industry Accelerator) is part of the SMITZH project Smart & Circular. In this project, TNO is collaborating with a team of students from The Hague University of Applied Sciences (THUAS), to research the circular value creation potential that can be enabled by investing in smart industry technologies.

By analysing companies that have already invested in circular or sustainable initiatives in the past, the goal is to get insights into the drivers and barriers and values delivered by these initiatives. These insights will ultimately serve as input for a tool that is designed for SMTEs in the manufacturing industry in South Holland. The goal of this tool is to accelerate the move towards circular business models by spreading the awareness of potential value that can be created.

Thank you for agreeing to participate in an interview with TNO and THUAS, and for being a part of this research. Below is a short survey with 5 preliminary questions, aiming to gain an overview of the specifics behind sustainable elements, prior to the interview. Please check the boxes that apply to your companies initiative(s).

-
1. Did you have any initiatives in the field of sustainability in the past? Please shortly describe the main activities below.

#	Name of the initiative	Summary of the initiative
1	Energy Efficiency Servers	LEAP project: apply energy saving modes on IT Servers https://amsterdameconomicboard.com/initiatief/leap-lower-energy-acceleration-program
2	Network Rationalisation	25% energy saving realized in 9 years, data growth x 15 in same period. Replacing older equipment with less equipment (virtualization) and new more energy efficient equipment See page 50 KPN Annual Report https://www.annualreport2019.kpn/
3	Design with recycled plastic	Top and bottom covers of consumer equipment (modems, TV-receivers, remote controls). See also Annual Report

4	5G Field Lab Drenthe	Precision farming based on low latency connections allowing for less use of toxic material for taking out weeds from acres and more control of water usage for farming. https://www.youtube.com/watch?v=iP3GzNWTxKM
5	5G Field Lab Helmond	Autonomous driving and smart traffic lights – more control over traffic increases regular traffic flows (less stop and go), which in turn helps to control exhaust of traffic. https://www.youtube.com/watch?v=LsPWneAeNfU

2. The Smart industry, Industry 4.0, consists of different types of specific digitization in the form of 9 key technologies. These have potential to enable circular developments in the manufacturing industry. Which of these technologies have been implemented in your company (and how does this contribute to the circularity of the company)?

Technology	Initiative 1	Initiative 2	Initiative 3	Initiative 4	Initiative 5
1. Internet of things <i>(The networked connection of physical objects to the internet)</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2. Big Data <i>(Large volumes of complex data requiring advanced techniques to enable capture, storage, distribution, management and analysis of information)</i>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3. Cloud computing <i>(enabled through IoT, CC can store large amount of data with varying types of access)</i>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4. Simulation <i>(validation of the design and configuration of products, processes or</i>	<input checked="" type="checkbox"/>				

<i>systems, through digital experiments)</i>					
5. Autonomous robots (A form of AI that is capable of robot-to-robot or robot-to-human communication)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
6. Horizontal and vertical system integration (The organized interplay of engineering, production, suppliers, marketing and supply chain operations based on levels of automation and information flow to determine useful structural changes in real time.)	<input checked="" type="checkbox"/>				
7. Additive manufacturing (The process of creating a 3D object, based on the deposition of materials on layer-by-layer or drop-by-drop, under a computer-controlled system.)	<input type="checkbox"/>				
8. Augmented reality (A type of simulation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

<i>which pairs physical and virtual elements)</i>					
9. Cybersecurity (A technology laying on protecting, detecting and responding to cyberattacks)	<input type="checkbox"/>				

Please explain briefly:

3) Which parties in your value network were involved in the circular approach of your company and (why are they important to stay circular)?

Parties in the value network	Initiative 1	Initiative 2	Initiative 3	Initiative 4	Initiative 5
1. Suppliers	<input checked="" type="checkbox"/>				
2. Customers	<input type="checkbox"/>				
3. End users	<input type="checkbox"/>				
4. Logistics	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Waste collectors	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Government	<input type="checkbox"/>				
7. Regulators	<input type="checkbox"/>				
8. Other stakeholder, namely...	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Other stakeholder, namely...	<input type="checkbox"/>				

Please explain briefly: _____ 1: AMEC

4) In which phase of the product value chain did the smart and/or circular initiative take place?

Parties in the value network	Initiative 1	Initiative 2	Initiative 3	Initiative 4	Initiative 5
1. Design	<input checked="" type="checkbox"/>				
2. Procurement	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

3. Planning	<input type="checkbox"/>				
4. Manufacturing	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Logistics	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Use	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Recovery	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Reverse logistics	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. HR	<input checked="" type="checkbox"/>				
10. Other, namely...	<input type="checkbox"/>				

Please explain briefly:

5) The Circular Value Driver Framework designed by the Platform for Accelerating the Circular Economy (PACE) is presented as an essential model for assessing the barriers and drivers of a Circular Business Model (CBM). The model highlights seven drivers that companies take into account when developing a CBM.

Which of the following drivers are identified as drivers for your company (and to what extent)?

- 1. Enter new markets
- 2. Reduce costs
- 3. Reduce risk and future proof the business
- 4. Trigger innovation capacity
- 5. Attract retain talent
- 6. Deliver great customer value
- 7. Align with public expectations
- 8. Other, namely....

Value Drivers	Initiative 1	Initiative 2	Initiative 3	Initiative 4	Initiative 5

1. Enter new markets (e.g. segments that can afford renting but not buying)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2. Reduce costs (e.g. less money spent on raw materials)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Reduce risk and future proof the business (e.g. less dependent on external raw materials)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Trigger innovation capacity (e.g. new product or business model ideas)	<input type="checkbox"/>				
5. Attract retain talent (e.g. young talent that considers purpose driven companies more attractive)	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Delivery great customer value (e.g. building trust through managing the relationship throughout the whole lifecycle)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Align with public expectations (e.g. increasing	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

expectations from the public regarding environmental impact)					
8. Other, namely	<input type="checkbox"/>				

Please explain briefly:

6) There are six specific Circular Business Models. Which of these have been implemented in your company or will still be implemented in the future?

Circular Business Models	Initiative 1	Initiative 2	Initiative 3	Initiative 4	Initiative 5
1. Access and performance model (Leasing all types of products as a service, e.g. Felyx scooters)	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Extended product value (Prolonging the value of a product through organized collection and maintenance, repair, refurbishing or remanufacturing, e.g. Fairphone)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

<p>3. Classic longlife model (Designing products for (life-long) durability, e.g. Miele washing machines)</p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<p>4. Encourage sufficiency (Encouraging reduced consumption by the end user, e.g. Patagonia)</p>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<p>5. Extending resource value (e.g. Interface)</p>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<p>6. Industrial Symbiosis (Transforming waste outputs from one cycle into feedstock for another cycle, e.g. Kalund borg eco industrial park)</p>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<p>8. energy efficiency</p>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Please elaborate in which form these models are implemented:
