Room for Circularity

Presenting a Framework to Assess the Circularity of Existing Policies, Laws and Regulations Applied to Amsterdam's Water Sector

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21st of March 2017

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EXECUTIVE SUMMARY

The predominant economic system today can be described as linear: resources are taken from nature, consumed and, finally, disposed. This system has led to a variety of interrelated environmental challenges, such as climate change, food insecurity and water scarcity. Population and consumption levels are expected to continue to increase, making the linear system unsustainable. In recent years, the "circular economy" (CE) has been introduced as a sustainable alternative for the linear economy. The CE can be defined as an economy that is restorative and regenerative by design. It aims to keep products, components and materials at their highest utility and value at all times, to promote their repair, reuse and refurbishment.

The municipality of Amsterdam is one of the most prominent governmental actors actively involved in circular practices; they attempt to be the first to show that the CE is a possible and profitable alternative. However, a transition from a linear to a circular economy does not come about easily. Existing policies, laws and regulations (PLR), formulated corresponding linear ("old") principles, are posing one of the main barriers. To create room for circularity, this thesis developed a framework that facilitates the impact assessment of existing PLR on this transition. This framework was tested and validated by means of the case of Amsterdam's water governance sector. Accordingly, the research question of this thesis reads: *What analytical framework can be used to assess existing policies, laws and regulations regarding their impact on the transition towards a circular economy and how can this framework be applied?*

In the first part of this thesis, a generic framework to assess the impact of existing PLR on the transition towards a CE was developed (see Appendix G). Based on a systematic literature review and interviews with experts 71 criteria grouped in 17 clusters were defined, each focussing on another aspect of the CE across the micro-, meso- and governance levels of our system. The clusters are: product design; input in the production process; output of the production process; use phase; destination after use; closed loops; new business models; waste = food; standardization; urban & industrial symbiosis; level playing field; focus beyond economic gain; long-term design; capacity development; and level of integration.

Based on the analysis of the circularity of the Amsterdam water governance sector, the framework could be specified for this sector (see Appendix H). The case study provided some valuable insights regarding the status quo, opportunities and challenges of circularity in the Amsterdam water governance sector. First, the concept of CE appeared to be an unpopular and ambiguous term in the water sector. Next, while the high quality standards are essential to ensure the trust in and access to safe drinking water, these standards are also an obstacle for a diversification of the water system in which access is provided to water flows of differing qualities. Finally, the water governance actors predominantly focus on waste management (the "second part" of the cycle). In contrast, less attention is paid to the circular adaptation of the first part of the cycle, e.g. the drinking water production process.

In sum, this thesis has provided fundamental theoretical and empirical research that enabled the development of a well-functioning and reliable framework to conduct an impact assessment of existing PLR on the transition towards a CE. It is recommended to conduct further research to refine the framework. Two clear options that would increase its validity and reliability are the enhancement of the application method (e.g. multi-criteria analysis) and the translation of the generic framework to specific again, this time to another policy area. Ultimately, this results in a framework that permits governmental actors to conduct an impact assessment of all existing PLR to, along the way, create room for circularity.

Key words: circular economy; sustainability transition; existing policies, laws and regulations; water governance, impact assessment.

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PREFACE & ACKNOWLEDGEMENTS

Fascinated by the challenges posed by the interdisciplinary nature of environmental issues, I am always seeking to understand, analyse and solve them. While learning more and more about the transition towards the circular economy, I became aware of a variety of challenges of this nature. Given my background in political science, for me one stood out in particular: the ambiguous relationship between on the one hand policies, laws and regulations, and on the other hand circular principles. I was intrigued by the fact that many people seemed to be aware of the difficulties this leads to, yet no concrete measures are taken. With my thesis, I hope to contribute to the undertaking of concrete action regarding this dichotomy.

I would like to thank all the people and organizations that contributed to this research. It was a great opportunity for me to be able to write my thesis in collaboration with the AMS Institute in Amsterdam. The vibrant working environment was always inspiring and motivating for the research process. Furthermore, a special thanks to all interviewees that took the time to discuss the transition towards a circular economy. This thesis could not have come about without them.

My sincere thanks also goes to my thesis supervisor Bas van Vliet. He provided me with valuable input time and again, and the constructive discussions during our meetings always brought me further. I hope his saying "the biggest impact of a thesis occurs during the research process itself" proves to be true.

A final word of thanks goes to Hans Buis and Steven de Jong. They provided me with continuous feedback, both on paper and oral. They were a perfect critical sounding board, even when their personal schedules were packed.

I wish you an enjoyable and informative read.

Sincerely,

Yael Aartsma

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LIST OF ABBREVIATIONS

AGV	Amstel, Gooi, Vecht
AWS	Amsterdam Water Science
BBE	Biobased economy
C2C	Cradle to Cradle
CE	Circular economy
DW	Drinking water
EC	European Commission
EMF	Ellen MacArthur Foundation
EU	European Union
EWSR	European Waste Shipment Regulation
GDP	Gross domestic product
GHG	Greenhouse gas
IenM	Dutch Ministry for Infrastructure and the Environment
KWR	Watercycle Research Institute
MCA	Multi-criteria analysis
MCI	Material Circularity Indicator
MSP	Municipal Sewage Plan 2016-2021
MSW	Municipal solid waste
NL	The Netherlands
OECD	Organization for Economic Cooperation and Development
PLR	Policies, laws and regulations
RE	Renewable energy
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SMEs	Small and medium-sized enterprises
TNO	Netherlands Organisation for Applied Scientific Research
UN	United Nations
UNDP	United Nations Development Programme
UvW	Association of Dutch Water Authorities
VROM	Dutch Ministry of Housing, Spatial Planning and the Environment
WEEE	Waste electronic and electric equipment
WFD	Water Framework Directive
WWTP	Waste water treatment plant

CHAPTER 1: INTRODUCTION

Over the past decades, human's use of natural resources and generation of waste has increased at an unprecedented and unsustainable rate and scale (Hoekstra & Wiedmann, 2014). This is caused by the predominant linear economy that is based on taking resources from nature, consuming and, finally, disposing them. This 'take-make-dispose' system has led to a variety of interrelated environmental challenges, of which climate change, food insecurity, water scarcity and water pollution are only a few of the many examples (Sauvé et al., 2016). Population and consumption levels are expected to continue to increase, challenging the Earth's capacity even further and making our current linear system unsustainable (Dasgupta & Ehrlich, 2013; Ghisellini et al., 2016; United Nations, 2015).

Due to urbanization, the largest part of the environmental degradation takes place in cities. While the world's cities occupy just 3% of the Earth's land surface, they produce 50% of the global waste, account for 60-80% of the global energy consumption and 75% of the greenhouse gas (GHG) emissions and consume 75% of the natural resources (UNEP, 2012; United Nations, 2016). Rapid urbanization will put additional pressure on urban services like water supply, sanitation, sewage, solid waste collection and overall public health and well-being. However, many of cities' characteristics offer opportunities for progress. The high density of people could give rise to social and technological innovation, leading to a reduction of resource and energy consumption (United Nations, 2016).

In recent years, the concept of "circular economy" has been introduced as a sustainable alternative for the linear economy (Sauvé et al., 2016). A circular economy can be defined as an economy "…that is restorative and regenerative by design, and which aims to keep products, components and materials at their highest utility and value at all times, distinguishing between technical and biological cycles" (EMF, 2016b). Goods that have been produced according to the principles of the circular economy can be repaired, refurbished and reused easily. By reaching their end-of-life stage, the goods can be recycled into raw materials that become raw resources again (Preston, 2012; Sauvé et al., 2016).

A transition from a linear to a circular economy does not come about easily. It requires policies and legislations to overcome barriers (Hanemaaijer & Rood, 2016). Several targets have been set by different levels of governments worldwide to speed up the transition (PBL, 2016). The municipality of Amsterdam is one of the most prominent governmental actors actively involved in this matter. The municipality aims to be the first to show the world that the circular economy is possible and profitable. The city government has fully committed themselves to a transition towards a circular economy; this a central element in their sustainability policy (CE et al., 2015a).

Central to Amsterdam's sustainability policy is a circular innovation program that comprises joint efforts of research institutions, businesses and the municipality to strengthen, accelerate and connect innovation, research and circular activities. The executive board of the municipality has identified 23 pilot projects that concern circularity. The focus of these projects is on the value chains of construction waste, organic waste, circular energy, stimulating industrial symbiosis and new business and revenue models (Gemeente Amsterdam, 2015, 2017a). The high ambition of the local government, a well-functioning logistics network and the benefits of a compact city, provide major opportunities to succeed in establishing a circular economy (The Netherlands Circular Hotspot, 2016).

1.1 PROBLEM DESCRIPTION

The transition towards a circular economy does not necessarily require an entire new system, merely, it demands the current system to at least adjust and bend along (PBL, 2016). The municipality of Amsterdam faces a variety of opportunities and challenges regarding the transition from linear to circular. In general, written and unwritten regulations, customs and perceptions pose a bigger challenge for a sustainability transition than the technological solutions and innovations (Potting et al., 2016).

This also applies for the transition towards a circular economy. While new policies are being formulated to support the transition towards a circular economy, the great majority of the existing policies, laws and regulations (PLR) have been formulated corresponding the linear economy, i.e. in accordance with opposing ("old") principles. Research shows that those existing PLR can be a barrier for the transition towards a circular economy (see for example the studies EMF (2016c), Rli (2015), SER (2016) and WING (2016)). Despite the large number of researches, only a few focus on how to effectively measure its impact. Besides, every research has its own concept, list of criteria, and definitions, leading to a lack of a general and practical approach to assess the impact of the existing PLR on the transition towards a circular economy. In addition, due to the researches incomparable concepts, criteria and definitions, generalizations cannot be made. Moreover, the researches present relatively general findings that do not allow for straightforward and ready to implement recommendations for the local level. Altogether, the municipality of Amsterdam is aware of existence of barriers caused by existing PLR, but is unable to overcome them. It is the gap between knowing of the existence of problems and the lack of a practical impact assessment that constitutes the starting point for this thesis.

From drinking water via the sewer system to waste water, meanwhile affecting both nature and people - water is a connecting factor in the circular city. The challenge of achieving vital and future-proof cities is, to an important degree, related to how well we handle our water. Accordingly, water governance has emerged as one of the most critical areas to improve the sustainable use of natural resources (Boere, 2016a; UNDP, 2013). Research has shown that the barriers for the circular transition posed by existing PLR, also prevail for the water governance sector in Amsterdam (see: KWR et al., 2016a; KWR et al., 2016b).

1.2 RESEARCH OBJECTIVE

This thesis aims to engage with this research gap by developing an analytical framework that can be used to assess the impact of existing PLR on the transition towards a circular economy. This can be summarized as follows:

The objective of this thesis research is to develop an analytical framework to assess the impact of existing policies, laws and regulations on the transition towards a circular economy.

The research will firstly contribute to the transition towards a circular economy in Amsterdam as the analytical framework will provide a way to measure the impact of existing PLR on circularity. This will make the transition easier and faster. Furthermore, the water governance sector in Amsterdam functions as a case study to validate the framework. Therefore this thesis comprises an analysis of the water governance sector in Amsterdam. See Chapter 1.4 for a further elaboration of the case study.

1.3 RESEARCH QUESTIONS

The aim of this research is to both create and validate an analytical framework to assess the impact of the existing PLR. This has been operationalized in the main research question as follows:

What analytical framework can be used to assess existing policies, laws and regulations regarding their impact on the transition towards a circular economy and how can this framework be applied?

The research is built upon five sub questions, that together answer the main research question. The five sub questions are:

I. **What criteria can be used to assess the impact of existing policies, laws and regulations on circular economy and other sustainability transitions?**

II. **How can the criteria be combined to develop an analytical framework for the assessment of existing policies, laws and regulations?**

III. **What actors and politics constitute the water governance sector in Amsterdam?**

IV. **How can the developed analytical framework be applied to the water governance sector?**

V. **How can the analytical framework be improved according to the water governance validation process?**

1.4 RESEARCH SCOPE

The scope of this research is limited in three main areas, namely "existing policies, laws and regulations", "municipality of Amsterdam", and "water sector". Each of these areas will be elaborated upon briefly.

When analysing policy, a first distinction can be drawn between *ex ante* and *ex post* policy analysis. *Ex ante* policy analysis is a method for the development and design of policy, as it aims to evaluate policy prior to its implementation. *Ex post* policy evaluation, on the other hand, is a retrospective analysis that focusses on policy that has already been implemented, i.e. "existing" policy. An assessment of existing policy can contribute to improve their quality (Crabb & Leroy, 2012; EC, 2015a). This research will solely focus on the analysis of existing (*ex-post*) policy, however also including existing laws and regulations.

In this thesis the municipality of Amsterdam applies as a living lab for the development of the analytical framework for three reasons. First, the municipal level seems crucial for the transition towards a circular economy. While not all activities of a circular economy have to take place within city or regional boundaries, an emphasis lies on factors like urban and industrial symbiosis, closing loops and the definition of waste (EMF, 2016c). As for the latter, cities are important for the transition towards a circular economy since waste policies have been decentralised for decades (Rood & Hanemaaijer, 2014). A second reason results from the fact that the municipality of Amsterdam wants to be a frontrunner in establishing a circular economy. Accordingly, the city has a circular innovation program, a department (partly) focussing on circularity and targets set for the transition (Gemeente Amsterdam, 2017a). This makes Amsterdam not only an interesting and vibrant case, it also means there is compared to other cities a lot of expertise on (a transition towards) the circular economy that can be employed for this case. Last but not least, this thesis has been conducted in collaboration with the AMS Institute in Amsterdam. Accordingly, the project focuses on a case from the Amsterdam metropolitan context. As with most research conducted by the AMS Institute, Amsterdam is the focus area to gather data.

Existing PLR of the regional, national and European governmental levels do have an impact on the Amsterdam case. While these higher levels of governance levels are not the focus of this research, they will be elaborated upon briefly when the impact is significant.

The water governance sector in Amsterdam is quite unique in the Netherlands. The municipal duties for waste water collection and sewerage and the Regional Water Authority's functions for water treatment are combined in one organisation, the water cycle company Waternet. The water governance sector is one of the sectors in Amsterdam where circular initiatives have been prepared and set up. For instance, Waternet recovers nutrients and other resources from the municipal waste water streams (Cramer, 2014). A research commissioned by the Regional Water Authority ("Waterschap") Amstel, Gooi en Vecht (AGV) stated that existing regulations and policies may impede the introduction of innovations into practice (KWR et al., 2016b, pp. 27-28). The latter together with the connecting role water plays in a circular city, makes the Amsterdam water governance sector a perfect case study to test and validate the analytical framework upon. Concepts related to the water governance case will be elaborated upon in the in the next chapter, while a general introduction of the case will be given in Chapter 5.

1.5 READING GUIDE

Before the analytical framework will be explicated, the theoretical framework of the thesis will be outlined in the next chapter. The concepts circular economy, governance, the transition theories, and the urban water cycle will be discussed. In the final sub-chapter an overview of the concepts will be provided and linked to the topic and design of this research.

The third chapter concerns the operationalization of the theoretical framework. It regards the question how the concepts and analytical framework can be applied. The methods that will be discussed are: systematic literature review, single case study, semi-structured interviews, cluster analysis and the abductive research process.

As of the fourth chapter, the analysis of the research starts. This analysis consists of two parts. First, the development of the generic analytical framework through which the impact of existing policies, laws and regulations (PLR) on the transition towards a circular economy can be measured. Based on an extensive literature review, interviews with experts and subsequent criteria clustering, sub-chapter 4.1, 4.2 and 4.3 build up towards the creation of the framework by providing an answer to the first sub-question: *"What categories can be used to assess the impact of existing policies, laws and regulations on circular economy and other sustainability transitions?"* In sub-chapter 4.4 the criteria will subsequently be combined by developing the analytical framework. The corresponding sub-question reads: "*How can the criteria be combined to develop an analytical framework for the assessment of existing policies, laws and regulations?"*

This brings us to the second part of the analysis; the application of the analytical framework. As the framework will be applied to an existing PLR of the water governance sector in Amsterdam, Chapter 5 starts with an introduction of this case by answering the third sub-question: "*What actors and policies constitute the water governance sector in Amsterdam?"* Chapter 6 continues with an analysis of the Amsterdam water governance sector by means of the analytical framework. On the one hand, this offfers an insight of the status quo as well as of the opportunities and challenges for the transition towards a circular economy in the Amsterdam water sector. On the other hand, the assessment allows for the translation of the generic framework into a specific water related framework. This implicitly provides an answer for the fourth sub-question: *How can the developed analytical framework be applied to the water governance sector?* The translation from generic to specific will make an application to a particular policy, law or regulation in this sector possible.

It follows a quick scan of the existing Municipal Sewerage Plan 2016-2021 of the municipality of Amsterdam. Besides providing some insights into the impact of the MSP on the transition towards a circular economy in Amsterdam, the quick scan will primarily function as a test and validation of the analytical framework. This has been formulated in the fifth sub-question: *How can the analytical framework be improved according to the water governance validation process?* Accordingly, feedback for the clusters, criteria and method is provided.

The final two chapters of this thesis concern the discussion and conclusion of the research. The discussion chapter serves to further examine the research findings before arriving at the conclusions. This examination aims to position the findings in context, and to elaborate on further research and measures to be taken. In the final chapter, the main empirical and theoretical findings of the research will be summarized by answering the sub-questions and main research question.

CHAPTER 2: THEORETICAL FRAMEWORK

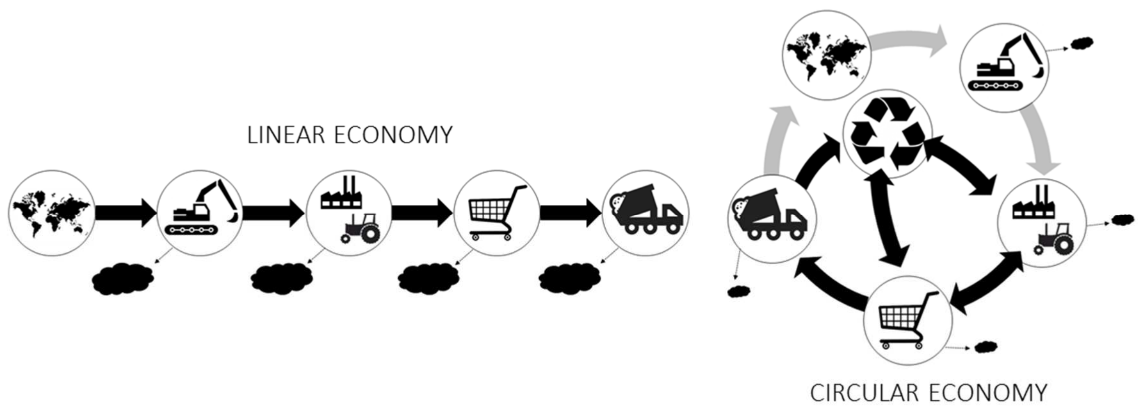
In this chapter, the main concepts and theoretical considerations will be discussed. The concept of the "circular economy" will firstly be elaborated upon further. Secondly, the general notion of "governance" will be explained, where after the relating forms of governance that are specifically relevant for the thesis will be discussed; "reflexive governance", "urban governance" and "water governance" . The third concept to be introduced is that of the "transition theories", whereby the circular economy will be explained as a sustainability transition. The final concept concerns the "urban water cycle" that is specifically relevant for the case study of this research. Finally, all concepts will be linked to each other to illustrate their position in this thesis.

2.1 THE CIRCULAR ECONOMY

The main concept of this thesis is "circular economy", which refers to an economic model that is radically different from our current economy. The present model is based on taking resources from nature, consuming those resources and, finally, disposing them. This economic mode can be described as linear, as it has a beginning and an end - from extraction to disposal. The primary focus of this "take-make-dispose" system is economic gain. Ecological and social concerns receive little attention, as the external costs linked to virgin resource extraction and the generation of waste and pollution are not internalized. Due to population growth, urbanization and consumption growth per capita, the linear system goes beyond the Earth's finite capacity (EMF, 2013, 2016b; Sauvé et al., 2016).

A circular model has been proposed as a sustainable alternative for the linear economy. The circular principle starts with the "Cradle to Cradle" (C2C) design approach, developed by Michael Braungart and William McDonough in 2002. They formulated the biomimetic strategy to the design of products and systems according to three principles. The first principle concerns "waste equals food" which entails the elimination of waste from the design and, accordingly, the rest of the system. This requires a strict separation of biological (materials that biodegrade) and technological (technical materials) cycle, as mixing up the two can degrade the value of the materials. The second principle involves the "use of solar power", by which the use of renewable energy is meant. Finally, the principle "celebrate diversity" considers diversity in how a product is manufactured, and how and by whom it is used (McDonough & Braungart, 2002).

Figure 2.1: The Linear versus the Circular Economy

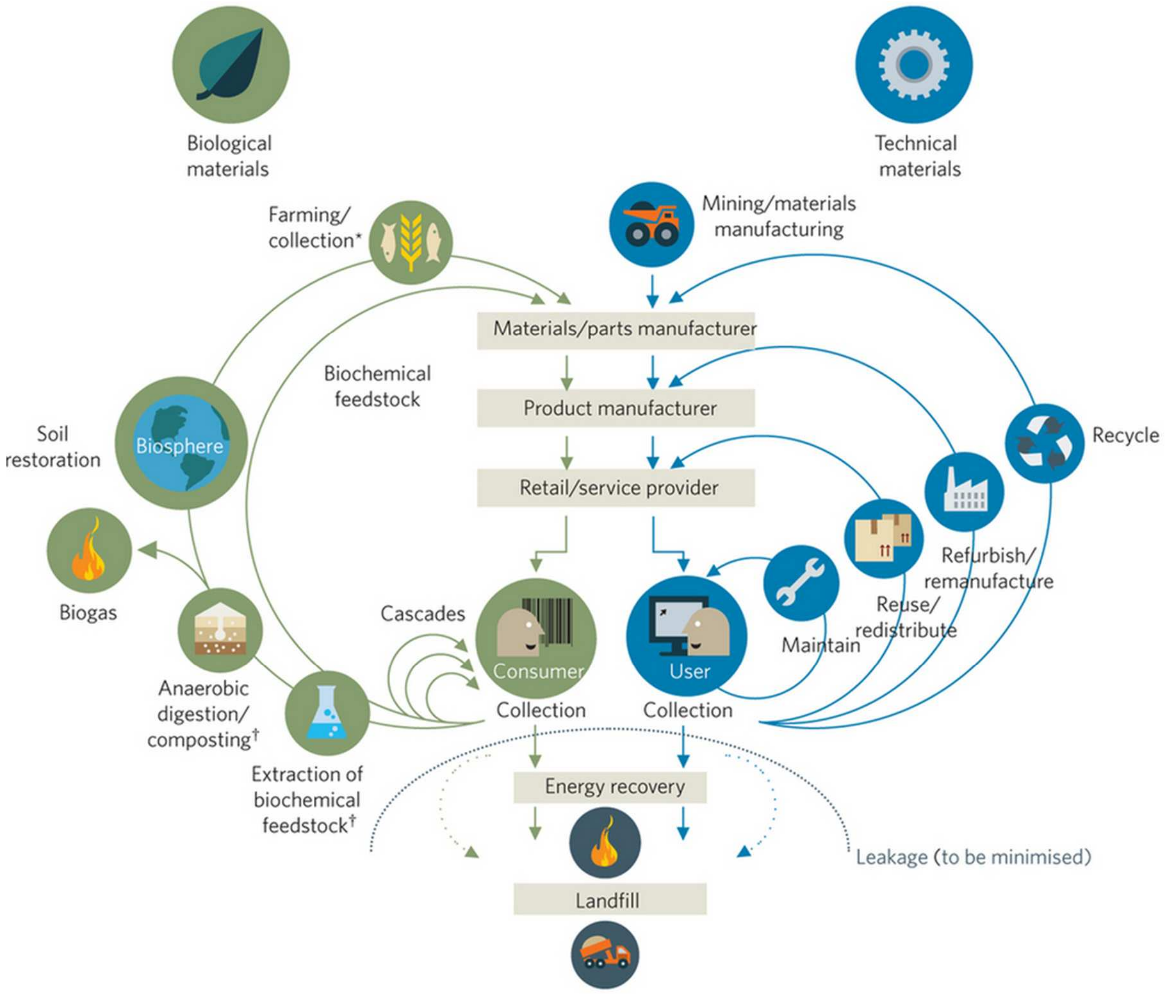


Source: created by author.

Moving beyond product design, the broader notion of a "circular economy" was introduced in the following years (EMF, 2013). The leading global organization on circular economy, the Ellen MacArthur Foundation (EMF) has defined the circular economy as "an industrial system that is restorative and regenerative by design, and which aims to keep products, components and materials at their highest utility and value at all times, distinguishing between technical and biological cycles" (EMF, 2016b). The ultimate aim of the circular economy is to close material loops on all levels across all stakeholders, industries and geographies to replace the current "cradle to grave" system by one of "cradle to cradle" (EMF, 2014; World Economic Forum, 2014). Closing the loops includes taking into account the impact of the consumption of the resource and the waste it generates, hence optimizing the use of (virgin) resources and reducing waste and pollution at each step (Sauvé et al., 2016). The core steps of both the linear and circular economy are drawn in figure 2.1. It shows that a transition from the first to the latter requires a shift within all segments of our system. This encompasses a paradigm shift in the entire production and consumption chain, with tremendous implications for today's society.

The industrial system of the circular economy is further described by the EMF by defining three closed-looped cycles of resources in this system: biological nutrients, technical nutrients and energy. When a resource loop is closed, large volumes of finite resources (e.g. metals and minerals) are captured and reused, while other plant-based products biodegrade (Preston, 2012). Figure 2.2 shows how both technical and biological nutrients cycle through the economic system separately, each with their own characteristics.

Figure 2.2: The Circular Economy – Restorative by Design



Source: EMF (2013).

Many concepts that promote sustainability in one way or the other have been introduced before. A significant difference with the circular economy concept, is the momentum this concept is gaining amongst stakeholders, such as policy advocates, business practitioners and teachers (CE & Ecofys, 2016; Geng et al., 2012; Owen & Liddell, 2016; Preston, 2012; Webster & Johnson, 2010). Moreover, governmental bodies have adopted circular principles in (parts of their) policies, both in- and outside Europe. One of the most invested governmental actors is the municipality of Amsterdam. This city wants to be a frontrunner in circularity. It has committed itself to a transition towards a circular economy: the transition is a pillar of the city's sustainability policy (CE et al., 2015a).

The municipality of Amsterdam has outlined seven core of a circular transition. These principles show the broad and systemic notion of a circular economy (CE et al., 2015a):

- **I.** All materials enter into an infinite technical or biological cycle.
- **II.** All energy comes from renewable sources.
- **III.** Resources are used to generate (financial or other) value.
- **IV.** Modular and flexible design of products and production chains increase adaptability of systems.
- **V.** New business models for production, distribution and consumption enable the shift from possession of goods to (use of) services.
- **VI.** Logistics systems shift to a more region- oriented service with reverse-logistics capabilities.
- **VII.** Human activities positively contribute to ecosystems, ecosystem services and the reconstruction of "natural capital".

2.2 GOVERNANCE

The use of the concept "governance" fits nowadays somewhere between politics and government. It refers to both the formal institutions for resolving political issues (e.g. laws, official policies, organizational structures), and the relating informal institutions (e.g. power relations, practices that have developed, rules that are followed in practice) (Huitema et al., 2009). The concept thus moves the attention away from the traditional "command-and-control" function of the government, towards a broader notion of public regulation including a wide range of non-governmental actors (Hague & Harrop, 2010). It is used in so many areas in political science (e.g. governance international relations or comparative politics, public administration and public policy, governance in the European Union (EU) and good governance) that one could argue a common understanding of the concept is not feasible anymore (Kjaer, 2004).

In this thesis, a commonly used definition of governance will be employed; one that captures the broadness of the term, though setting clear boundaries. This definition reads: "governance as any process of ordering, ruling, steering, controlling – whether state or non-state – in a society and its results and impact on society" (Nuijten, 2004). As elaborated upon before, the concept governance is used in many more consistencies. Three of those are especially relevant for this thesis, namely "reflexive governance", "urban governance" and "water governance". Each of these three perspectives on governance will be introduced briefly.

2.2.1 REFLEXIVE GOVERNANCE

As the general definition of governance implies, governance is in most cases a disorganised, ambiguous and controversial process of "multi-level institutional transformation" (Voß et al., 2009, p. 280). The concept of reflexive governance has been developed to put special emphasis on this feature of governance. It sees governing processes as "shaping, interlinked with and open to feedback from broader social, technological and ecological changes, both in terms of innovative action and structural change" (Voß et al., 2009, p. 280). This inherently recognizes multiple phenomena effecting day to day politics, such as the inherent ambivalence of policy goals, uncertainty about long-term effects, and the distributed agency and power that shapes the implementation process (Meadowcroft, 2009).
Combined with sustainability transitions or sustainable development (see Chapter 2.3), the practice of reflexive governance can also be conceptualized as a "state-led co-ordination to promote system innovation", or as "a mode network co-ordination to promote system innovation" (Hendriks & Grin, 2007, p. 333). This reflects the attention that is required for new ambitious coalitions that can enable public, private and societal actors to develop new (business) systems, forms of knowledge and governance, that help to navigate towards a circular economy. In addition, this form of governance might not only be necessary for the transition pathway, but also for the sound execution of a circular economy (EC, 2015b; Loorbach, 2014).

2.2.2 URBAN GOVERNANCE

This thesis focuses at the local governance of the urban area of Amsterdam. Governance in this regards is put as "urban governance", which is widely understood as "a process through which local authorities, in concert with private business and civil society, seek to enhance collective goals in an urban context" (Monstadt, 2009, p. 1931). This reflects urban governance as a "two-way-street", that offers a frame for pressures as well as objectives both ways across the public-private border (Pierre, 1999, p. 375).

Considering the high amount of environmental degradation originating from cities, environmental scientists are frequently focussing on the urban area and urban governance. Particularly interesting in this regard is the urban governance of infrastructure. The infrastructure in cities interact with and shape the urban ecology, and thus impact the future of the environment in cities and beyond. To put it in other words, how we "develop, govern, and renew our urban infrastructures are key matters in the regulation of a sustainable relationship between nature and societies" (Monstadt, 2009, p. 1927).

2.2.3 WATER GOVERNANCE

Yet another form of governance can be distinguished in the light of the case study of this research: wWater governance. This concerns who gets water, when and how (Allan, 2002), and the continuously (re-)produced rules, practices and processes determining those (Jiménez et al., 2016). A comprehensive definition has been drawn up in a report by the Organization for Economic Cooperation and Development (OECD), after reviewing the existing literature on this matter. They defined water governance as "the range of political, institutional and administrative rules, practices and processes (formal and informal) through which decisions are taken and implemented, stakeholders can articulate their interests and have their concerns considered, and decision-makers are held accountable for water management" (OECD, 2015, p. 5). Water governance has always been very important in the Netherlands given its geographical conditions. (Toonen et al., 2006).

In practical terms, water governance can also be described as the governance of water management. The latter includes tasks like treating waste water, producing and supplying drinking water, maintaining water levels, storm water management, water conservation, keeping surface water clean (Daigger, 2009; Waternet, 2016c), and the management of the water infrastructure. Today most cities in developed countries (including Amsterdam) have urban water infrastructure systems that pursue "total water cycle management". This involves all activities to optimize the urban water cycle to satisfy human and environmental objectives within a specific (urban) area, as well as their socio-economic effects (Sitzenfrei et al., 2014). However, the technical possibilities for citizens to produce their own drinking water and thus disconnect themselves from the water distribution network, are increasing rapidly. Although currently not happening on a large scale in the Netherlands or Amsterdam in particular, a transition to decentralized drinking water production would change the urban water landscape dramatically (van Alphen, 2016).

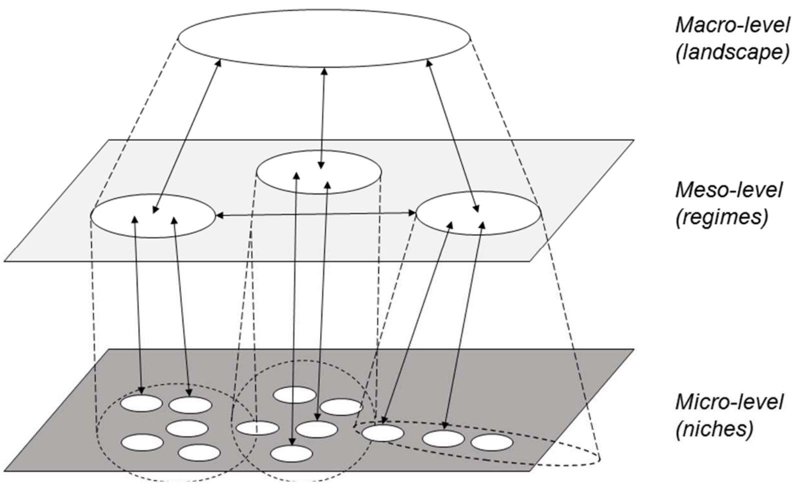
Many components of the urban water cycle (see sub-chapter 2.4 for an explanation of this concept) are inherently complex and uncertain, resulting from changing water demands, land uses and hydrological variability. In addition, the water sector experiences many socio-economic changes, such as stronger roles for the private sector through public-private partnerships, integrated and coordinated decision-making, stakeholders' participation, and decentralization (UNDP, 2013). A broad consensus exists that this requires the socio-administrative as well as the biophysical aspects of the water system to be adaptive. The concept "adaptive governance", a form of governance which provides space to adapt to the arising changes, should therefore be linked to modern water governance (Huitema et al., 2009; KWR et al., 2016b; Pahl-Wostl et al., 2013).

2.3 THE TRANSITION THEORIES

Achieving a circular economy is a continuous process (Ghisellini et al., 2016; Lozano, 2008). In this thesis, this process is understood as a "transition". Transitions can be explained as "transformation processes in which existing structures, institutions, culture and practices are broken down and new ones are established" (Loorbach, 2007, p. 17). It takes up to one to two generations before these processes materialise at the level of a societal system, which is constituted by culture, structure and practices. Interacting changes in all societal domains, e.g. technology, economy, ecology, institutions and welfare, can finally result in a societal transition of structural and long-term change (Avelino et al., 2016; Loorbach, 2007; Rotmans et al., 2001).

The transition from a linear towards a circular economy by the local government Amsterdam can be described as a sustainability transition, as it is a process of fundamental social change in response to persistent environmental problems. Like many other sustainability transitions, the transition towards a circular economy encounters multiple barriers that can be attributed to the path dependency of dominant practices and structures (including policy) (Avelino et al., 2016; Grin et al., 2010).

Figure 2.3: Interaction Between Different Scale-levels



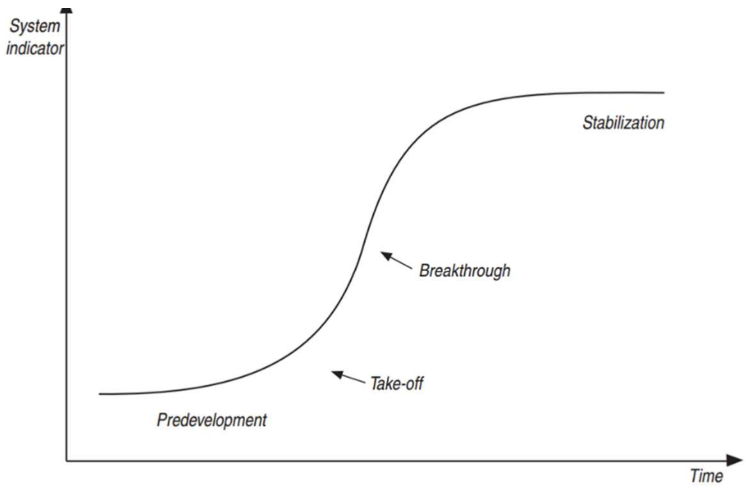
Source: created by author, based on Geels and Kemp (2000) and Loorbach (2007).

There is a substantive body of literature on transitions. Loorbach (2007) listed three commonalities of transitions that exist through all studies. First of all, the systems are open and embedded in a co-evolving outside environment. Second, an outside changing environment influences the system. And third, the system itself behaves non-linear to adapt to its environment. Additionally, the transition theory divides three levels in our system. The previously mentioned dominant cultures, structures and practices together constitute the central level called the "regime" (see figure 2.3 for the different scale levels and their interaction). Examples of physical and immaterial infrastructures that embody this meso-level are roads, power grids, routines, actor-networks, power relationships and regulations. Subsequently, innovations take place within the micro-level of the system. They are created, tested and diffused in so-called "niches". A niche can be defined as a domain where actors are prepared to work with specific functionalities and accept teething problems such as higher initial costs. They have to be willing to invest in the improvement of new technology and in the development of new markets. If successful, the new technology might start to eat into markets covered by the existing regime. Potential pathways for this transition are the adoption of specific elements from the niches by the regime or the possibility for the new niche technology to compete with the existing regime technology head-on. Examples of niches are new organizations, new technologies, new rules and legislation and new projects, concepts or ideas. Finally, the macro-level or "landscape" consists of the social values, built environment, political cultures, and economic development and trends. Although developing autonomously, it directly influences the regime as well as the niche-level by defining the room and direction for change (Geels & Kemp, 2000; Loorbach, 2007).

Based on multiple historical analyses of societal transitions, the transition theory suggests that transition processes go through different stages (Rotmans et al., 2000). All in all, four phases are distinguished that can be represented by an S-shaped curve (see figure 2.4). The transition process starts in its predevelopment phase. Although there is little visible change on the regime level, lots of experimentation takes place. This might eventually trigger the transition to take off. In this phase, the process of change starts and firstly influences the meso-level. Next, the transition reaches a breakthrough. This includes an accumulation of socio-cultural, economic, ecological and institutional changes that react to each other, are structural and visible. In the final phase, the speed of societal change decreases and stabilizes, where after a new dynamic equilibrium is reached (Loorbach, 2007; Rotmans et al., 2000). The transition towards a circular economy in Amsterdam is currently in its predevelopment phase.

Transitions do not come about easily. Research about challenges faced by sustainability transitions has often taken the well-known transition from fossil to renewable energy (RE) as an example. One of the challenges faced by the RE transition as well as the transition towards a circular economy regards the existing policies, laws and regulations (PLR) as elaborated upon in the introduction chapter. A sound transition requires existing PLR to overcome barriers and enforce a different view (Hanemaaijer & Rood, 2016).

Figure 2.4: Four Phases of Transition



Source: Loorbach (2007).

2.4 THE URBAN WATER CYCLE

The two concepts directly related to the case study on the Amsterdam water sector are "water governance" (as discussed in chapter 2.2) and "the urban water cycle". The latter starts with the notion that the water we use cycles through the environment infinitely. The never ending process in which water molecules evaporate from moist surfaces to the atmosphere, where after it falls down as rain or snow and passes through living organisms before it returns to the ocean and evaporates again, is known as the hydrological cycle (Cunningham & Cunningham, 2013; Huang et al., 2013; NASA, 2016). This natural water cycle gets altered in engineered environments like cities through alteration in infiltration and runoff. Modifications include rain that hits concrete and pavement and is collected as storm water, the lack of infiltration and ground water recharge, and water brought to communities via aqueducts leaving through sewage or storm water systems (see figure 2.5). Such an altered hydrological cycle is called the urban water cycle (Shuster et al., 2005; The National Oceanic and Atmospheric Administration, 2015).

Water is in essence a renewable source as the natural water cycle has systems in place to cleanse and replenish the water. However, renewal takes time, and current water use by humans exceeds this speed by far (Cunningham & Cunningham, 2013; Pimentel & Pimentel, 2008). The large scale interference of humans and the urban environment in the hydrological cycle results in two major interrelated problems: decreasing quantity and quality of water. First of all, the volume of the water that percolates into the ground in cities decreases, resulting in an increase in volume of surface water of less quality. Besides the increasing risk of flooding, it has a significant impact on the quantity of fresh water that is available for all living species as well (Centre for Watershed Protection, 2003; Huang et al., 2013). Current trends like population growth and urbanization are expected to make this more problematic. With only 0.02% of the Earth's water that is fresh and accessible, any decline of fresh water quantity is problematic (Cunningham & Cunningham, 2013). The alteration of the hydrological cycle goes beyond the specific path the water takes, it also concerns the quality of the water after human usage. This second problem relating to the urban water cycle is twofold. At the one hand, pollutants present in urban areas end up in the surface water. Moreover, waste water causes environmental pollution. As water is used for many purposes, countless different components can be an origin of contamination. Examples of components that influence water quality negatively are pathogens (e.g. bacteria), organic compounds (e.g. pesticides, oil, pharmaceuticals), inorganic chemicals (e.g. heavy metals), synthetic chemicals, and nutrients (e.g. nitrogen and phosphorus) (Corcoran et al., 2010; Pimentel & Pimentel, 2008). The European Water Framework Directive, for instance, lists 33 priority substances plus eight other pollutants for which environmental quality standards have been set (EC, 2008). Declining water quality and the change of the hydraulic system lead to the destruction of the ecosystem, thereby also impacting human health and food production (Fletcher et al., 2013; WWAP, 2009).

Waste water is, as the name implies, seen as a polluted flow. This leads to the other side of the problem: water is most of the times ending up as waste water after consumption, neglecting the huge opportunities of reuse, recycling and recovery of energy, a variety of substances and critical materials from the water (WssTP, 2015). Waste water can thus be viewed as a potential resource as well, though in most cases resource recovery from waste water is simply ignored (Corcoran et al., 2010). Besides the potential of water recovery and reuse, resource recovery would also engage with problems like the world wide depletion of certain resources (e.g. phosphorus) and resource dependency (Galvis et al., 2014).

In this research the concept of the circular economy is applied to the urban water cycle. The transition towards "circular water" moves away from the use and disposal of water by trying to close the cycle. In other words; to move away from consumption towards (temporary) usage of water[1] (Boere, 2016b). "Closing" the water cycle could reduce the amount of waste water and its costs, directly affecting the liveability and attractiveness of cities, while valuable resources are recovered from the waste water (Boere, 2016a; WssTP, 2015). Examples of circular activities in the water sector are the recovery of phosphor from waste water, reusing water inside a home and producing drinking water from rainwater.

Figure 2.5: The Urban Water Cycle

Source: PacificWater SOPAC (2016).

[1] "Van VERbruik naar GEbruik van water", Boere (2016b).

2.5 CONCEPTUAL FRAMEWORK

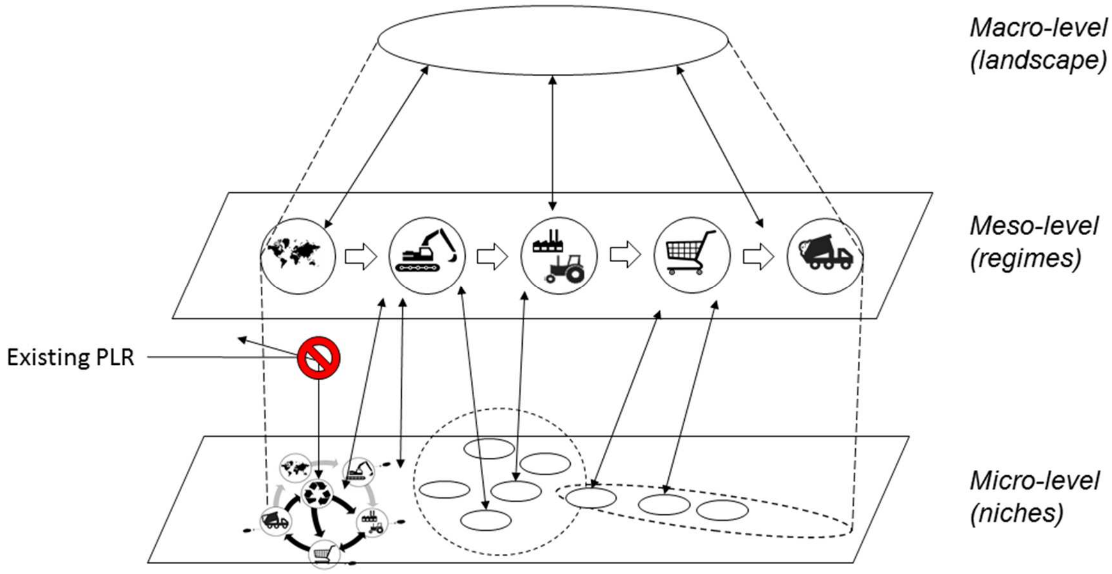
By summarizing and connecting the main concepts of this thesis as discussed in the previous sub-chapters, a conceptual framework can be formulated that constitutes the lens through which **water governance** and the **urban water cycle** will be assessed. (see figure 2.6). To start with, the current system is based on taking resources from nature, consuming those resources and, finally, disposing them. This economic mode can be described as linear, as it has a beginning and an end - from extraction to disposal. The **linear economy** is part of our dominant culture, structures and practices. Accordingly, the linear economy is part of the **meso-level** or regime.

The **circular economy** that is restorative and regenerative by design, is in the predevelopment phase of a transition. New technologies, products and business models have to be developed and improved for the transition to come about. As such, the circular economy currently finds itself at the **micro-level** of our system. Within the micro-level of the system innovations take place. They are created, tested and diffused in **niches**. A niche is a domain where actors are prepared to work with specific functionalities, accept teething problems such as higher initial costs. They have to be willing to invest in the improvement of new technology and in the development of new markets. If successful, the new technology might start to eat into markets covered by the existing regime. A **transition** towards a circular economy requires the current niches to become part of the regime, as is shown by the upwards pointing arrows in figure 2.6.

However, a transition from a linear to a circular economy faces a variety of barriers hence does not come about easily. One of these barriers is constituted by the **existing PLR** (depicted as a stop sign in figure 2.6). While new policies are being formulated to support the transition towards a circular economy, the great majority of the existing PLR have been formulated corresponding the linear economy, i.e. in accordance with opposing ("old") principles. These existing PLR are steered by the **governance** practices in our society, as this is a process of ordering, ruling, steering and controlling that impacts society.

The conceptual framework provides an overview of the theoretical considerations on which this research will be based. The next chapter will continue with laying the groundwork for this research, by providing an operationalization of the conceptual framework.

Figure 2.6: The Conceptual Framework



Source: created by author.

CHAPTER 3: METHODOLOGY

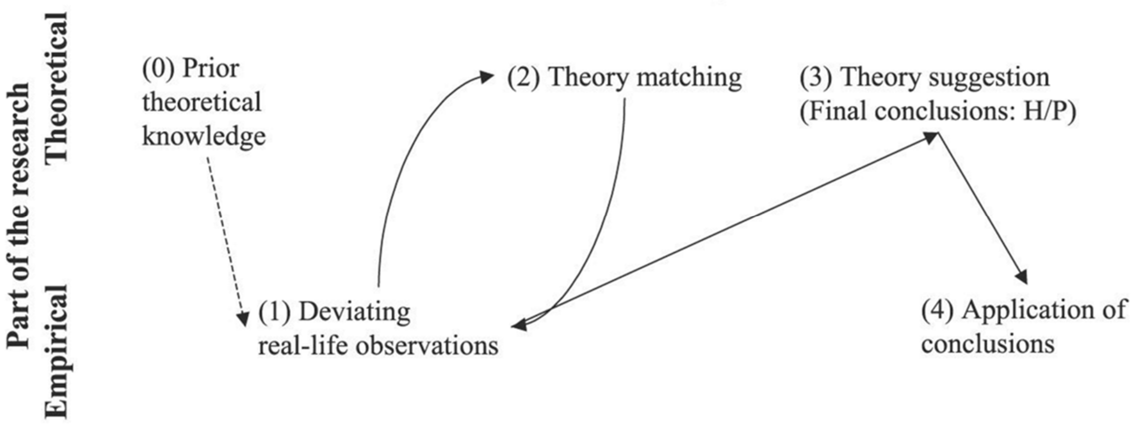
This research is of an exploratory nature. The main research question *"What analytical framework can be used to assess existing policies, laws and regulations regarding their impact on the transition towards a circular economy and how can this framework be applied?"* is broad and indefinite, as there are no specific parameters available to base the analytical framework upon. In this chapter, the necessary operational steps to answer the main and sub-research questions will be outlined. It is important to note that this is a qualitative research, hence the research questions will be addressed on a qualitative manner. Each method, procedure and technique of the research methodology will be chosen and discussed accordingly.

Starting point for this research design is the concept of "abductive research process", which implies an interactive research process in which the data collection and theory building happen simultaneously. This notion will be discussed further in the first sub-chapter. Subsequently, the research methods will be introduced in a chronological order. Sub-chapter 3.2 regards the methods discussed in the first part of this thesis: systematic literature review, semi-structured interviews and cluster analysis. These methods will be used to develop the general analytical framework. The relevant methods for second part of the thesis will be introduced in sub-chapter 3.3. This again concerns the literature review and interviews, yet also the case study method. Finally, the research design will be introduced in the fourth sub-chapter. This comprises a step by step description of the research.

3.1 THE ABDUCTIVE RESEARCH APPROACH

The objective of this research is to develop an analytical framework for the assessment of the impact of existing policies, laws and regulations (PLR) on the transition towards a circular economy. As such, the development of the analytical framework requires research methods, while the analytical framework itself will function as a method as well. The collection of data thus contributes to the design of the research. As such, the design and data collection are likely to overlap. This can be explained further by means of the so-called "abductive research process". This approach is based upon the insight that many scientific research processes do not follow the pattern of pure deduction or induction (Kovács & Spens, 2005; Taylor et al., 2002). Rather, the data collection and theory building happen simultaneously. Advances in science are often achieved through an "intuitive leap that comes forth as a whole" (Kovács & Spens, 2005, p. 136). As depicted in figure 3.1, this implies a learning loop between theory and empirical study. By going back and forth between these two research activities, the understanding of both theory and empirical phenomena can be expanded (Dubois & Gadde, 2002). In this thesis, an abductive research approach will be taken, as it allows for the further development of the research according to the discoveries during the fieldwork. Simultaneously, theory can contribute to a better understanding and direction of the real-life observations.

Figure 3.1: The Abductive Research Process



Source: Kovács and Spens (2005).

3.2 RESEARCH PART I: GENERIC

The first part of the research in this thesis concerns the development of a generic analytical framework to assess the impact of existing policies, laws and regulations (PLR) on the transition towards a circular economy. This objective concerns the first two sub-questions. The first sub-question reads: *"What criteria can be used to assess the impact of existing policies, laws and regulations on circular economy and other sustainability transitions?"* As there is no accepted way to measure circularity, and certainly not to measure the impact of existing PLR on circularity (see Chapter 2.1), this question will be answered by deriving criteria from a combination of a systematic literature review and interviews with experts. The second sub-question, *"How can the criteria be combined to develop an analytical framework for the assessment of existing policies, laws and regulations?"*, is answered by using the method "cluster analysis". Each of the just mentioned methods will be discussed in this sub-chapter.

3.2.1 SYSTEMATIC LITERATURE REVIEW

The first method to distinguish criteria for the analytical framework is the literature review. This method of secondary data collection makes use of a diverse set of literature (e.g. scientific articles, policy documents, reports and measurement tools) to consolidate and integrate a solid knowledge base. In this thesis the so-called "systematic literature review" will be conducted. This is an approach of reviewing literature according to specific procedures. By adopting explicit procedures, the chances of bias and lack of thoroughness are diminished (Bryman, 2008). Millar (2004) has described the procedure of the systematic literature review in five steps. Below, the steps will be introduced one after another, whereby each of them will be translated to this research design.

As the first step, the purpose of the literature review has to be defined. For the first part of this research, the purpose of the literature review is to formulate criteria that can assess the impact of existing PLR on the transition towards a circular economy or on other sustainability transitions. This purpose has been outlined in the first research question.

The second step comprises the establishment of criteria to guide the selection of literature. This regards, for example, restrictions set by a particular time period, region, or keywords. These must be relevant to the purpose of the research as defined in step one.
To guide the review and the selection of literature, the concept of the Transition Theories (see Chapter 2.3) will be integrated in the method of the literature review. Accordingly, the literature review will be divided

in three parts: circularity at the micro-, meso- and governance level, each of them having different criteria for the literature search (see table 3.2 for a summary). In the first part, the literature has to focus on the so-called niches in which circular innovations are created, tested and diffused. Solely studies that have identified criteria to measure circularity on this level are included in the literature review. The second part of the literature review regards circularity within dominant cultures, structures and practices that together constitute the meso-level, or regime. For this level, researches comprising opportunities, barriers or principles for a circular economy at the meso-level will be included. The final part of the literature review regards the governance level of the transition towards a circular economy. As the transition towards a circular economy has started only recently, there is not sufficient literature on the governance process of this transition. Therefore, the organization, management and governance of other sustainability transitions has been explored as well.

Three requirements have been formulated to further filter the selection of literature. First, the literature should comply to at least one out of two benchmarks that ensure the quality of the literature: published in a credible, peer-reviewed scientific journal or published by an existing and recognized university or organization. Second, following the objective of the literature review, the literature should include criteria that could be used for an assessment. Lastly, for the review of the micro- and meso-level, there was only made use of literature published as from 2010, as this was the year in which the current notion of the circular economy was introduced. This does not count for the governance level, as this part of the literature review not only focusses on the transition towards a circular economy, but also on other sustainability transitions that have been going on longer.

According to the third step as described by Millar (2004), the criteria as spelled out in the previous step should be incorporated in the search for literature. Literature has been investigated on the basis of the criteria for the selection of literature as presented in table 3.2. A complete list of literature used for review can be found in Appendix A.

Table 3.2: Criteria for the Selection of Literature

PART OF THE LITERATURE REVIEW	KEYWORDS	REQUIREMENTS
Micro-level	Circularity Circular economy Micro-level Niches	High-quality research Must contain criteria >2010
Meso-level	Circularity Circular economy Meso-level Regime Opportunities Barriers	High-quality research Must contain criteria >2010
Governance level	Circular economy transition Sustainability transition Governance Policy Transition management	High-quality research Must contain criteria

The fourth step of the literature review regards the identification and presentation of the key features of each research. Examples of the features that could be recorded are the date, location, data collection methods and main findings. This has been combined with the fifth and final step of the systematic literature review: the inclusion of a synthesis of the results. Appendix A presents the synthesis of the micro-, meso- and governance level, including the presentation of the key features of each body of literature.

3.2.2 SEMI-STRUCTURED INTERVIEWS

Simultaneous to the systematic literature review, pimary data were collected through the conduction of semi-structured interviews. In contrast to a structured or standardized interview, a semi-structured interview does not follow a set script. Rather, the focus lies on the interviewee's own perspectives; i.e. what they consider to be relevant and important. As the conversation follows the direction in which the interviewees take it, a semi-structured interviewing tends to be flexible. Additionally, the emphasis of the research might be adjusted as a result of the data collected during the interviews (Bryman, 2008, p. 196 & 437). With the aim of increasing the reliability of the data, the notes taken during the interviews were sent to the interviewees for an audit.

In this first part of the research, 8 interviews are held with experts working closely with the topics circular economy and (municipal) PLR. This includes actors working for the municipality of Amsterdam, the Amsterdam Economic Board and several research institutes. On the one hand, the abductive research process allows the data derived from the interviews to confirm the importance of particular criteria that are extracted from the literature review. On the other hand, the interviewees can provide information that has not come up during the literature review. The list of interviewees can be found in Appendix C. A general topic list for this round of interviews is presented in Appendix D.

3.2.3 CLUSTER ANALYSIS

The criteria derived from both the literature review and the interviews have to be combined to be able to develop an analytical framework for the assessment of the existing PLR on the transition towards a circular economy. This will be pursued by conducting a "cluster analysis". This method classifies data "into groups that are meaningful, useful, or both" (Tan et al., 2006, p. 487). This results in groups of objects in which the objects are similar (or related) to one another. Moreover, they should be different compared to (or unrelated to) the objects in other groups (Tan et al., 2004, p. 2). Groups consisting of objects with related properties are then referred to as clusters (Aldenderfer & Blashfield, 1984).

The cluster analysis for this thesis has been carried out by means of a creative brainstorm session with fellow Master students affiliated with the AMS Institute. Conducting this analysis together with other researchers increases the interrater reliability while diminishing the chance of bias. The criteria extracted from the literature as well as from the interviews[2] were printed on small cards, for them to be clustered by the students manually. The two main questions asked to the students were: *"Wat belongs together?"* and: *"What can be grouped together?"* The brainstorm took place on the 18th of January 2017, and the results of the cluster analysis are shown in Appendix B. The input provided during this brainstorm session has been reviewed and confirmed by the author, where after the generic analytical framework could be formulated.

[2] Not all interviews were carried out before the brainstorm session took place. As a result, not all data could be included in this session. The criteria derived from the remaining interviews were therefore added afterwards.

3.3 RESEARCH PART II: SPECIFIC

The second part of the research focuses on the water governance sector in Amsterdam. Answering the third sub-question *"What actors and politics constitute the water governance sector in Amsterdam?"* will provide an overview of the case. Subsequently, the Amsterdam water governance sector will be assessed by means of the generic analytical framework, again using an abductive research approach. This enables the translation from a generic to a specific framework focussing on water governance, which implicitly provides an answer for the fourth sub-question: *How can the developed analytical framework be applied to the water governance sector?* The translation from generic to specific will enable an application to a particular policy, law or regulation in this sector. Subsequently, the specified analytical framework will be applied to an existing policy plan, which functions as both a test and validation of the analytical framework. This has been formulated in the fifth sub-question: *How can the analytical framework be improved according to the water governance validation process?* The data collection for the case study will again be an abductive process by reviewing literature and conducting interviews simultaneously. Each of the methods will be introduced briefly.

3.3.1 CASE STUDY

A single case study is defined as the "detailed and intensive analysis of a single case" (Bryman, 2008, p. 52). The term "case" is often associated with a particular location, such as an organisation or community. In this thesis, the case is determined by both geographical and sectoral boundaries. The geographical boundaries are shaped by the borders of the municipality of Amsterdam. The sectoral boundaries are not as clear cut, as they are based on the indefinite concept of water governance. This case study follows the definition of water governance as stated in Chapter 2.2.3: "the range of political, institutional and administrative rules, practices and processes (formal and informal) through which decisions are taken and implemented, stakeholders can articulate their interests and have their concerns considered, and decision-makers are held accountable for water management" (OECD, 2015, p. 5). A description of the case study will be presented in Chapter 5.

3.3.2 LITERATURE REVIEW

The use of literature in this part of the research is twofold. First, literature will be reviewed to answer the sub-question *"What actors and politics constitute the water governance sector in Amsterdam?"* A variety of sources will be made use of, such as policy documents, organizational websites, scientific articles and reports. Second, to answer the sub-question *"How can the developed analytical framework be applied to the water governance sector?"*, only one body of literature is utilized. This regards the study "Water Governance" (2016), commissioned by the Water Authority AGV and Waternet, and conducted by KWR, Kennisland and AWS. For this study, 23 interviews were conducted with a diverse group of actors from the water governance sector about present and future trends of water governance.

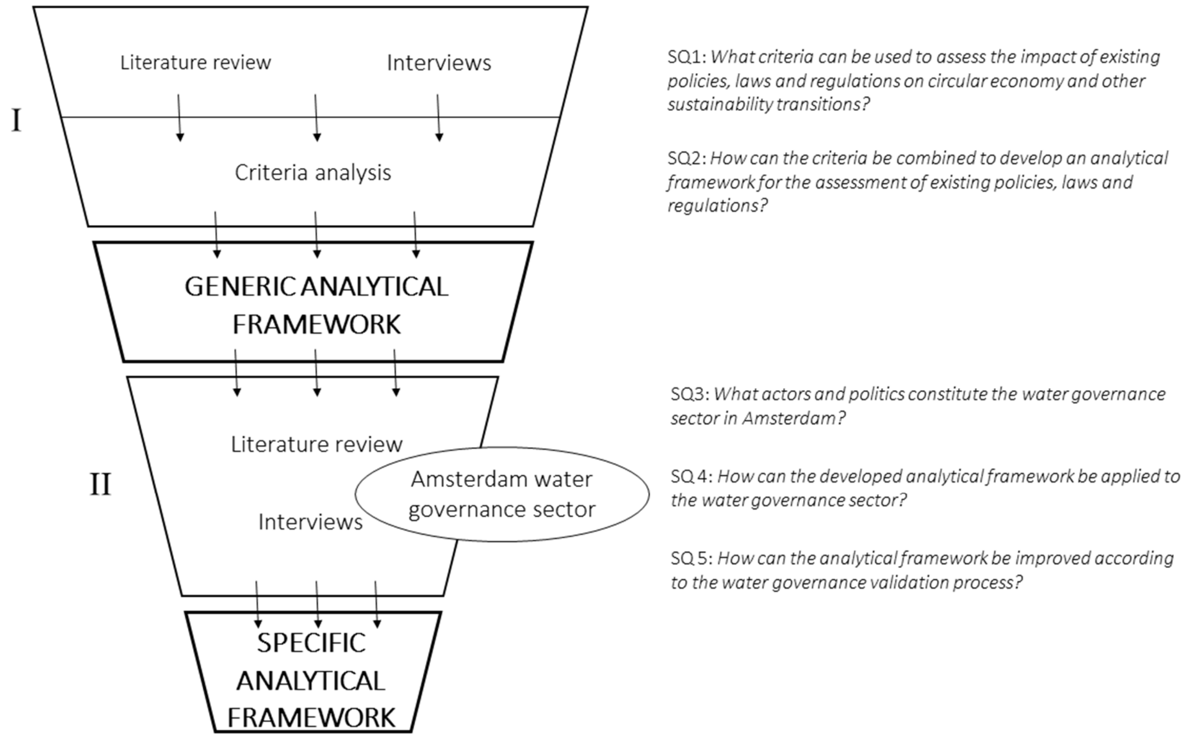
3.3.3 SEMI-STRUCTURED INTERVIEWS

Similar to the first part of the research, empirical data are collected simultaneous to the literature review by conducting semi-structured interviews. 7 interviews are held with a wide spectrum of actors within the water governance sector. These actors either belong to the scientific community, public sector, or are "practitioners" (people working on bringing innovation to practice) (KWR et al., 2016b). A list of interviewees can be found in Appendix C. The aim of the interviews is threefold. First, additional information about the Amsterdam water governance sector is required to describe the case study, as well as to apply the generic framework to the case. Second, the translation from the generic to the specific requires further information about the transition towards a circular economy within the water governance sector. Finally, the interviews can validate the criteria of the framework specified for the water governance sector. These three reasons were the main topics during the second round of interviews (see Appendix E).

3.4 RESEARCH DESIGN

The framework for the collection and analysis of data as discussed in the previous sub-chapters is summarized in figure 3.3. The research design is funnel shaped; i.e. the research starts generic, and becomes more and more specific later on. The first part of the study consists of an abductive combination of a literature review and interviews, which, via a cluster analysis, leads to the generic analytical framework. This framework allows for an assessment of the impact of existing PLR on the transition towards a circular economy. In the second part of the thesis, the generic analytical framework is applied to the Amsterdam water governance case. Literature review and interviews are again used on an abductive manner as the methods of data collection. In the end, this results in an analytical framework specified for the assessment of the impact of existing PLR on the transition towards a circular economy in the water governance sector.

Figure 3.3: Research Design



Source: created by author.

CHAPTER 4: TOWARDS A GENERIC FRAMEWORK

In this chapter the analytical framework is explicated through which the impact of existing policies, laws and regulations (PLR) on the transition towards a circular economy can be measured. Based on an extensive literature review, interviews with experts and subsequent cluster analysis[3], the first three sub-chapters of the chapter build up towards the creation of the framework by introducing the suitable clusters. The Appendices A and B present an overview of the literature review and cluster analysis that shaped the analytical framework.

The research focussing on the corresponding sub-question *"What criteria can be used to assess the impact of existing policies, laws and regulations on circular economy and other sustainability transitions?"* is divided in three parts, each focussing on another level of impact measuring. Because of insufficient recognized ways to measure circularity, the first two sub-chapters focus on this matter. Accordingly, the first sub-chapter regards the clusters that have to be included to measure the impact of existing PLR on the level of circularity at the micro-level, following the level of circularity at the meso-level in the second sub-chapter. The division between these two levels is by no means absolute nor strict. There might be cases or specific clusters that belong to both levels, or somewhere in between. The clusters are classified according to their general focus.

Sub-chapter 4.3 takes a broader perspective and concerns the mutual effect of existing PLR and sustainability transitions. The impact of existing PLR on sustainability transitions has been researched frequently. An overview of the clusters assessing the existing PLR on the governance of sustainability transitions will be provided. Besides data derived from interviews with experts, literature on sustainability transitions, transition management and strategic niche management are analysed to give an overview of possible clusters.

The final step is based on the second sub question of this research, which reads: "*How can the criteria be combined to develop an analytical framework for the assessment of existing policies, laws and regulations?"* Accordingly, the fourth sub-chapter introduces the analytical framework that assembles the criteria that will be applied to the Amsterdam water governance case in Chapter 6.

4.1 CIRCULARITY AT THE MICRO-LEVEL

As a first step, measuring the impact of PLR on circularity will be explored by focussing on the so-called niches in which circular innovations are created, tested and diffused. Examples of these novelties are new organizations, new technologies, new rules and legislation and new projects, concepts or ideas. Criteria have been derived from an extensive literature review (see Appendix A for a synthesis) and interviews with experts (see Appendix C for the list of interviewees). The criteria have been grouped in seven clusters during a brainstorm session with fellow students at the AMS Institute and will be introduced accordingly (see Appendix B). Besides a general description of the clusters and their relation to PLR, corresponding criteria will be introduced. These criteria provide an entry for the measurement of that particular cluster, i.e. that what you have to assess to measure a certain cluster.

[3] See Chapter 3.2.1-3.2.3 for more information about these methods, and Appendix A-C for a synthesis of the analyses.

Cluster: Product Design

A redesign of products is often required to make them circular. A modular and flexible design of products, including the separation of the technical and biological nutrients, increases the adaptability of systems. In addition, the design has to include the value of resources. As this leads to the reduced use and the increased use and recycling of materials, waste will in the end be "designed out" (CE et al., 2015b; EMF, 2016a; Evans & Bocken, 2013). Current (eco-)design regulations do not sufficiently address both resource efficiency and circular economy aspirations (EMF, 2016c).

Criteria: the impact of existing PLR on the amount of materials wasted in the production process; biodegradability of the materials and product; material characteristics (scarcity, eco-efficiency, toxicity); waste in the production process; repair costs vs. production costs; availability of maintenance or repair service; access to internal workings; complexity of workings; and standardization of components of the product.

Cluster: Input in the Production Process

A circular production process requires different inputs than a traditional production process. Each of these distinct inputs can be impacted by existing PLR. The most obvious alternative input is energy from renewable sources. The entire system should be able to run on renewable energy, and the use and waste of energy should be kept as low as possible (CE et al., 2015b; EMF, 2016a; Metabolic, 2016b). The material input in the production process is crucial as well. This includes the material intensity of a product and the amount of input originating from virgin and recycled materials as well as reused components (EMF, 2013, 2015a). Using non-virgin materials is currently often problematic, as the existing PLR have set very strict requirements for the recycling and reuse of materials (Soede, personal communication, 12-01-2017). Lastly, the labour inputs required to make a new product versus the labour required to make a circular loop should be compared and included (EMF, 2013; Geng et al., 2012).

Criteria: the impact of existing PLR on the percentage of renewable energy use; material intensity of products; origin of materials; and the ratio labour inputs of a new product vs in a circular loop.

Cluster: Output of the Production Process

The production process can be reviewed by looking at the output as well. Existing PLR might have impact on the emissions emitted in the production process. This concerns both greenhouse gas (GHG) and pollutant emissions. Criteria are the carbon footprint of the process of manufacturing, the GHG emissions per gross domestic product (GDP) output and the emissions of key pollutants (EMF, 2013, 2015a; Geng et al., 2012). Furthermore, the amount of GDP produced from the resource used in the production process can be measured. A higher score means higher material efficiency (Geng et al., 2012).

Criteria: the impact of existing PLR on the carbon footprint of the process of manufacturing; GHG emissions per GDP output; emissions of key pollutants; and the GDP produced from the resource used in the production process.

Cluster: Use Phase

Existing PLR can impact the circularity during the use phase. Usage concerns criteria such as the number of product failures, life-time of the product, required amount of energy and resources for usage (Evans & Bocken, 2013). In addition, the utility during the use phase has to be factored in. This includes the intensity of use, repair and maintenance and shared consumption (EMF, 2015a). A final criterion that allows another perspective to the use phase, is resource productivity. This can be measured by weighting the GDP per kilo of domestic material consumption (EMF, 2015b).

Criteria: the impact of existing PLR on the number of product failures; life-time of the product; required amount of energy; resources for usage; intensity of use; required repair and maintenance; shared consumption; and resource productivity.

Cluster: Destination After Use

When the loops are entirely closed, there is, obviously, no waste. This cluster describes to what extent the ideals of the circular economy have been reached, by taking into account the current destination of products, materials or nutrients after use. This covers the overall waste generation, but also the efficiency of the recycling processes concerning the production of recycled input and to recycle materials after use (EMF, 2015a, 2015b; Evans & Bocken, 2013). Existing PLR can impact that destination largely.
Criteria: the impact of existing PLR on the waste generated per GDP output; municipal waste generated per capita; and the ratio recycled materials/waste.

Cluster: Closed Loops

In a circular economy all cycles have to be close-looped, e.g. all materials enter into an infinite technical or biological cycle (CE et al., 2015a). Consequently the different allocations and utilizations of the technical and biological nutrients have to be considered (EMF, 2016a). Priority is given to the preservation of material complexity, meaning it is aimed to use high-quality products, components and parts as long as possible, before they are recycled as raw materials (Metabolic, 2016b). The cycles to close the loops have to be created on several levels, such as between business, within a business and between business and customers. New markets have to be created for the second-hand sales of, amongst others, products, material and nutrients (EMF, 2016c; Evans & Bocken, 2013). Challenges in this regard firstly concern the complexity of business and business models. Strict regulations require the production process to be traceable and controllable. This is a complicated process, which will become even more complex when extra loops are created. A second challenge results from the lack of infrastructure for a circular economy. An example is an overarching system that functions as a market place where products, materials and nutrients could be tracked and traded (Jonkhoff, personal communication, 24-01-2017; Oskam, personal communication, 19-01-2017; Soede, personal communication, 12-01-2017).
Criteria: the impact of existing PLR on a market for second hand sales of products, materials & nutrients; costs of remanufacturing/refurbishment; costs to collect and return; amount of products returned; ease to disassemble; possibility to upgrade parts; amount of mechanical connections; and amount of tools required to disassemble.

Cluster: New Business Models

The transition towards a circular economy accompanies the emergence of new business models for production, distribution and consumption that have incorporated circular principles. This includes innovations regarding the variety of business models. An example is a business model in which products are sold as a service, e.g. the purchase of a certain amount of hours of "light" rather than a light bulb (Evans & Bocken, 2013; Oskam, personal communication, 19-01-2017). The focus thus moves away from ownership towards use and access (CE et al., 2015a). Even further goes the idea of a "sharing economy"; a socio-economic trend concerning the sharing of human, physical and intellectual resources (IenM, 2015a). Existing PLR oppose a variety of barriers for this circular innovation. Important factors are the prevailing financial frameworks that are not compatible with a circular economy, as the current concept of leasing has legal ambiguities regarding ownership (Rli, 2015). Furthermore, the current fiscal framework does not provide sufficient circular incentives as subsidy schemes mostly focus on the purchase of sustainable products, while circular behaviour (e.g. sharing products) is ignored (Jonkhoff, personal communication, 24-01-2017; TNO, 2013). The problems regarding the financial frameworks closely related to the prevailing legal frameworks. There exists no legal framework focussing on "circular" ownership, and collaborations within a supply chain (a must for a circular economy) are in most cases not allowed (Heybroek, personal communication, 22-12-2016; Rli, 2015).
Criteria: the impact of existing PLR on the amount of products sold as a service; legal frameworks for CE business models; financial frameworks for CE business models.

Table 4.2 depicts a summary of the clusters as described in this sub-chapter. The first column lists the clusters and the second the corresponding criteria. The column on the right states the key references the clusters and criteria are based upon.

Table 4.1: Clusters – Circularity at the Micro-level

CLUSTER	CRITERIA: THE IMPACT OF EXISTING PLR ON THE…	KEY REFERENCES[4]
Product design	Amount of materials wasted in the production process Biodegradability of the materials and product Material characteristics (scarcity, eco-efficiency, toxicity) Waste in the production process Repair costs vs. production costs Availability of maintenance or repair service Access to internal workings Complexity of workings Standardization of components of the product	1, 5, 6, 11
Input in the production process	Percentage of renewable energy use Material intensity of products Origin of materials Ratio labour inputs of a new product vs in a circular loop	1, 2, 3, 5, 12, 13, D
Output of the production process	Carbon footprint of the process of manufacturing GHG emissions per GDP output Emissions of key pollutants GDP produced from the resource used in the prod. process	2, 4, 12
Use phase	Number of product failures Life-time of the product Required amount of energy Resources for usage Intensity of use Required repair and maintenance Shared consumption Resource productivity	3, 4, 6
Destination after use	Waste generated per GDP output Municipal waste generated per capita Ratio recycled materials/ waste	3, 4, 6
Closed loops	Market for second hand sales of products, materials & nutrients Costs of remanufacturing/refurbishment Costs to collect and return Amount of products returned Ease to disassemble Possibility to upgrade parts Amount of mechanical connections Amount of tools required to disassemble	1, 5, 6, 11, 13, D, E, F
New business models	Amount of products sold as a service Legal frameworks for CE business models Financial frameworks for CE business models	5, 6, 7, 8, 9, C, E, F

[4] Each number corresponds with one specific piece of literature, and each letter matches one specific interview. See Appendix A for the list of literature including the relating numbers, and Appendix C for an overview of the interviews and the corresponding letters.

4.2 CIRCULARITY AT THE MESO-LEVEL

This second sub-chapter explores measuring the impact of existing PLR on circularity within dominant cultures, structures and practices that together constitute the meso-level. Examples of physical and immaterial infrastructures that embody this meso-level are infrastructures, actor-networks, power relationships and regulations. Again based on a literature review, interviews with experts and a cluster analysis brainstorm session, this section follows the same structure as the previous one. Starting with the more specific flows (practices and structures) and ending with principles, each of the five clusters will be introduced and reflected upon, after which the corresponding criteria will be introduced.

Cluster: Waste = Food

As elaborated upon in Chapter 2.1, the first principle of circularity is "waste equals food" which entails the elimination of waste from the design and entire system. Unfortunately, the current paradigm of waste corresponds more with 'we must get rid of waste', rather than 'waste is food', even within the rather progressive governmental body the municipality of Amsterdam (Soede, personal communication, 12-01-2017; TNO, 2013). According to the law, waste is not a product nor a resource. The law aims to protect the environment and public health, which, however, impedes the organization of important aspects of the circular economy. Identical products can be subject to different regulations when one is made from virgin materials and the other is made from recycled materials, as the process of using waste as a resource is classified as waste handling (EMF, 2016c; Rli, 2015). Most of the laws and regulations are based on the European Waste Framework Directive, that consists of rules that determine when a material or product is seen as waste. The Directive is often considered to be a barrier for the circular businesses, as it unintentionally obstructs reuse and recycling. Examples are the strict regulations concerning food safety and the use of materials, often hindering the potential use of resources and energy from biotic residue flows (Steen, personal communication, 10-02-2017; TNO, 2013). Furthermore, the import and export of secondary raw materials is hindered by existing regulations (e.g. the European Waste Shipment Regulation directive) or differing interpretations of those regulations (EMF, 2016c; IenM, 2015a). Importing products after their first stage of life for the purpose of recycling is currently not allowed due to an ambiguity about the rules regarding processing. It is unclear whether this is caused by unclear regulations, lack of knowledge or incorrect execution of regulations. Regulations regarding the import and export of residue flows are very complex as they differ a lot per product group (TNO, 2013).
Criteria: the impact of existing PLR on using waste as a product; using waste as a resource; transporting secondary materials; importing secondary materials; and exporting secondary materials.

Cluster: Standardization

Standardization in respect to the circular transition is connected to two subtopics. The first subtopic regards the lacking knowledge about circularity and a circular economy. This is partly due to novelty of the concept of "circularity", yet also because of the "immeasurability" of certain aspects of a circular economy. In contrast to, for example, renewable energy, the circular economy is much more complex and comprehensive (Soede, personal communication, 12-01-2017). Together, this causes a lack of widely recognized circular standards (Metabolic, 2016a). This is one of the reasons why, for instance, the municipality of Amsterdam is unable to oblige companies to incorporate a certain level of circularity when putting up a tender (Jonkhoff, personal communication, 24-01-2017).
The second subtopic has to do with the negative effects of certification in the few cases this exists. While certification and the corresponding standardization can stimulate innovation by facilitating business-to-business transactions and by providing products extra visibility in the market, circular entrepreneurs (especially from SMEs) often experience drawbacks caused by these standards (IenM, 2016a). The high costs of getting certified and the corresponding requirements for the production and management hamper innovation. In addition, not all companies experience an economic surplus due to the certification (SIRA,

2013). All in all, circular methods are currently the exception, instead of being ordinary or even the preference. This must be reversed: the circular exception must become normalized for a circular transition to prevail (Soede, personal communication, 12-01-2017).

Criteria: the impact of existing PLR on setting up circular standards; applying circular standards; and drawback resulting from certification.

Cluster: Urban and Industrial Symbiosis

Industrial symbiosis stands for the collective approach of separate industries aiming to incorporate the physical exchange of materials, energy, water and by-products ("waste") into their business processes. Urban symbiosis is then an extension of industrial symbiosis and can be defined as "the use of by-products from cities (or urban areas) as alternative raw materials or energy sources for industrial operations" (Geng et al., 2012, p. 221). Both urban and industrial symbiosis are key activities to reach a successful circular economy. It can aid firms to use inputs that are not specific to any particular industry, e.g. reuse and recycling of municipal solid waste (MSW), accounting services, shared public infrastructure and labour market (Geng et al., 2012; Jonkhoff, personal communication, January 24, 2017; Rli, 2015). Urban and industrial symbiosis promotes thinking in systems (i.e. the understanding of the mutual influence of different parts of the system) and thinking in cascades (i.e. the different allocations and utilizations of the biological and technical nutrients) which are both crucial for a well-functioning circular economy (EMF, 2016a). This requires a shift to a more region-oriented logistics system with reverse-logistics capabilities (CE et al., 2015a). While being determined for a circular economy, the required intensive cooperation (e.g. within product chains) is often not permitted. Dutch and European legislation aims to prohibit cartel forming and the abuse of dominant positions to protect consumer interests, which unintendedly affects the circular urban and industrial symbiosis (Heybroek, personal communication, 22-12-2017; Rli, 2015).

Criteria: the impact of existing PLR on the total number of scavenger and decomposer business; connectivity among different industries; and diversity of industrial sectors involved in the urban/industrial symbioses activities.

Cluster: Level Playing Field

Many barriers intersect with issues relating to a level playing field. These barriers can be divided into four broader themes: small and medium-sized enterprises (SMEs) vs. big businesses; activities higher or lower in the cycle; fossil vs. biotic raw materials; and Dutch vs. foreign companies (IenM, 2016a; Oskam, personal communication, 19-01-2017; TNO, 2013). Many of the barriers causing an un-level playing field are related to financing. As described in the previous sub-chapter, it is difficult to get funding for circular business cases. Partly because of a general tendency towards increasingly strict rules, yet also due to particular reasons such as a high degree of uncertainty and unpredictability (IenM, 2016a). This particularly affects SMEs, as they have relatively small amounts of money, materials and working space available (Steen, personal communication, 10-02-2017). A further monetary barrier is the relatively high tax on labour, especially compared to natural resources and materials. This tax system supports the linear principles, as this makes new products and materials in a lot of cases the most inexpensive option (Rli, 2015; Soede, personal communication, 12-01-2017). An example are the current subsidy schemes, which are mostly focus on the purchase of sustainable products, while circular behaviour (e.g. sharing products) is ignored (SIRA, 2013; TNO, 2013). These taxes are causing an uneven playing field for businesses higher or lower in the cycle. A final monetary trade-off concerns the price mechanisms. In many circular business cases, the investment costs are higher, while the financial, yet also societal benefits are often higher in the long run. As for the established system, companies are not sure if they will collect enough return (Borgman, personal communication, 24-11-2016; Oskam, personal communication, 19-01-2017). Additionally, there is currently no level playing field for fossil and biotic raw materials and their applications. Biotic materials and their applications are unevenly taxed (e.g. import levies and excise duties) compared to fossil fuels and products based on fossil fuels (TNO, 2013; VROM, 2001). To overcome barriers like these, room has to be made

for new actors (Kemp & Rotmans, 2005). One of the bigger barriers for new actors and business models in the level playing field is the existing infrastructure, such as roads, pipes and buildings. Our system is largely determined by this infrastructure, which cannot changed overnight due to its great size and corresponding costs (Soede, personal communication, 12-01-2017).
Criteria: the impact of existing PLR on room for new actors; and correct price mechanisms (regarding Dutch vs foreign companies, activities higher or lower in the cycle, SMEs vs big business and fossil vs biotic raw materials).

Cluster: Focus Beyond Economic Gain

In a well-functioning circular economy, raw materials are used to create value beyond pure economic gain. The contribution of a circular economy exceeds the economy: there can be social and environmental costs and benefits as well (Geng et al., 2012; Metabolic, 2016b). The social benefits can be divided in two. The first concerns the cultural and social values, which should be supported and maintained through activities in the circular economy (Metabolic, 2016b). Examples are the employment rate through circular activities and the degree of public awareness (Geng et al., 2012). Furthermore, the economic activities should support human health and wellbeing. This aspect focuses for example on healthy work environments, fair wages and the avoidance of toxic and hazardous substances (Metabolic, 2016b). Obviously, the latter overlaps with the potential environmental benefits, which includes the desired strengthening of ecosystems and natural capital (i.e. the natural systems we make use of) by means of circular economic activities (Metabolic, 2016b). These not merely financial aspects of the circular economy have to be included in any form of analytical framework, as these have a value as well. According to many interviewees, the focus lies currently almost only on monetary criteria, neglecting the other aspects (Borgman, personal communication, 24-11-2016; Heybroek, personal communication, 22-12-2016; Oskam, personal communication, 19-01-2017).
Criteria: the impact of existing PLR on the cultural & social values; health & wellbeing; environmental justice; employment rate; degree of public awareness; social networks; and natural capital.

The table below depicts a summary of the clusters as described in sub-chapter 4.2. The first column lists the clusters and the second the corresponding criteria. The column on the right states the key references on which the clusters and criteria are based.

Table 4.2: Clusters – Circularity at the Meso-level

CLUSTERS	CRITERIA: THE IMPACT OF EXISTING PLR ON…	KEY REFERENCES[5]
Waste = food	Using waste as a product Using waste as a resource Transporting secondary materials Importing secondary materials Exporting secondary materials	7, 8, 9, 11, D, M
Standardization	Setting up circular standards Applying circular standards Drawbacks resulting from certification	8, 10, 13, D, F
Urban & industrial symbiosis	The total number of scavenger and decomposer business The connectivity among different industries The diversity of sectors in the urban/industrial symbioses	1, 5, 7, 12, C, F
Level playing field	Room for new actors Correct price mechanisms	7, 8, 9, 10, 15, 16, A, D, E, M
Focus beyond economic gain	Cultural & social values Health & wellbeing Environmental justice Employment rate Public awareness Social networks Natural capital	12, 13, A, C, E

[5] Appendix A lists the literature corresponding to the numbers, Appendix C the interviews and relating letters.

4.3 CIRCULARITY AND GOVERNANCE

In this third sub-chapter the organization, management and governance of circular and other sustainability transitions will be explored. Besides literature on the transition towards a circular economy, literature on sustainability transitions, transition management and strategic niche management has been analysed. Together, this provides us with possible clusters focussing on the policy and governance of the transition process itself. Again, the clusters will be introduced briefly, linked to PLR and specified.

Cluster: Long-term Design

The linear (economic) system is mostly focussed on short-term thinking, both in politics as well as in business (VROM, 2001). Inherent to a circular economy, however, is thinking about the long-term to make sure loops can be closed, waste is designed out, a symbiosis can exist, and so forth. By incorporating long-term thinking, the short-term steps can be developed underway. An example is the initial (investment) costs of a product or project that could be higher in the short-term, while the cost are lower on the longer term (Borgman, personal communication, 24-11-2016; Oskam, personal communication, 19-01-2017). Currently, this long-term vision is in a lot of cases not incorporated (Heybroek, personal communication, 22-12-2016). In addition, a long-term vision gives an impulse to system innovation as it functions as a frame for formulating short-term and long-term objectives (Kemp & Rotmans, 2005). Just like any sustainability transition, a transition towards a circular economy requires the system to innovate and change. Solutions involving system innovation are in most cases surrounded with great uncertainty (VROM, 2001). On the one hand, there is uncertainty about long-term effects. This relates to the limited knowledge of ecological cause-and-effect relations. It is both unclear what will happen because of ecological changes and what the effect of interventions and socio-technical transformations will be (Kemp et al., 2007). This often results in hesitant attitudes, inertia and procrastination manoeuvres from decision makers (VROM, 2001). On the other hand, when taking decisions, there is the danger to get linked into particular solutions that are suboptimal from a longer term perspective. This can, for example, be avoided by creating a portfolio in the context of a transition agenda and having a shared consensus about the need for change and the overall direction of that change (Kemp & Rotmans, 2005; Kemp et al., 2007).
Criteria: the impact of existing PLR on incorporating the long-term in decision making; developing long-term visions, uncertainty; danger of a lock-in; and the determination of short-term steps.

Cluster: Capacity Development

Actors working according to or supporting circular principles have to deal with a lot of uncertainty. It is not clear what a circular economy looks like exactly, and what is needed to reach that state (Jonkhoff, personal communication, 24-01-2017; Steen, personal communication, 10-02-2017). Additionally, there is often a missing link between theory and practice (Soede, personal communication, 12-01-2017). To overcome this barrier and to prevent decision-making with insufficient precaution, a variety of capacities has to be developed (VROM, 2001). Capacity development addresses multiple levels of agency in the public, private and civil society sectors. One way to develop capacity is through experimentation. Ideally this includes diverse community-based experimentation with disruptive solutions, place-based and/or issue-driven by empowered and autonomous communities of practice (Wolfram, 2016). The resulting innovations should, however, be embedded and coupled. This requires governmental bodies to give access to resources for capacity development, planning and mainstreaming transformative action, reflexive and supportive regulatory frameworks (Wolfram, 2016).
Criteria: the impact of existing PLR on innovation embedding and coupling; sufficient precaution; diverse & community-based experimentation; communities of practice; and access to resources for capacity development.

Cluster: Level of Integration

The transition towards a circular economy is impacted negatively by two differing kinds of lacking integration. First, as with many sustainability challenges, there is a lack of problem ownership. The actors who are causing the problems do not own the problem, i.e. are not responsible for the solutions of those problems (VROM, 2001). Accordingly, we see a distribution of the costs and benefits between the public and the private (Oskam, personal communication, 19-01-2017). Collaboration in this regard often requires people with different backgrounds to work together (e.g. public vs. private or natural vs. social sciences). This forms a challenges as they are likely to speak a different language resulting in miscommunications and failing cooperation (Jonkhoff, personal communication, 24-01-2017; Steen, personal communication, 10-02-2017). Second, as in any democratic state, control power is not centralized. Rather, it is distributed amongst various actors with different beliefs, interests and resources, within the government and beyond. The transition is affected by this fragmentation across political-administrative levels as well as geographical scales, as every level and location has different agendas and ambitions. This results in a lack of clarity concerning the division of roles, tasks and responsibilities (Jonkhoff, personal communication, 24-01-2017; Steen, personal communication, 10-02-2017; Wolfram, 2016). Finally, knowledge and responsibilities are often issued to a person, hence not integrated in an organisation or system. This leads to uncertainty when that person leaves the office. As such, knowledge has to be embedded (Steen, personal communication, 10-02-2017).

Criteria: the impact of existing PLR on problem-ownership; fragmentation across administrative levels; and fragmentation across geographical scales.

The table below again depicts a summary of the clusters as described in this sub-chapter. The first column lists the clusters and the second the corresponding criteria. The column on the right states the key references on which the clusters and criteria have been based.

Table 4.3: Clusters – Circularity and Governance

CLUSTERS	CRITERIA: THE IMPACT OF EXISTING PLR ON…	KEY REFERENCES[6]
Long-term design	Incorporating the long-term in decision making Developing long-term visions Uncertainty about long-term effects Danger of a lock-in Determination of short-term steps	15, 16, 18, A, C, E
Capacity development	Innovation embedding and coupling Sufficient precaution Diverse & community-based experimentation Communities of practice Access to resources for capacity development	15, 17, D, F, M
Level of integration	Problem-ownership Fragmentation across administrative levels Fragmentation across geographical scales	15, 17, 18, E, F, M

[6] See Appendix A for the literature corresponding to the numbers, and Appendix C for an list of the interviews and the corresponding letters.

4.4 THE ANALYTICAL FRAMEWORK

Building on the previous three sub-chapters, the second sub-question can be answered. This question reads: *"How can the criteria be combined to develop an analytical framework for the assessment of existing policies, laws and regulations?"* The requirements of the framework will be listed firstly, where after the analytical framework will be introduced and explained.

There are general and content requirements for the development of the analytical framework. The general requirements are twofold. First, the framework has to be understandable for experts of the circular economy, yet also for non-experts. The people who are likely to apply the framework to assess the impact of existing PLR on the transition towards a circular economy are working for a governmental body, hence having a variety of backgrounds. Often these do not include knowledge about the circular economy. The concepts that are used in the framework should therefore be explained thoroughly. Furthermore, the framework itself should be consistent and straightforward to apply. This increases the willingness to apply, applicability and assures the reliability of the assessment method.

The content requirements of the analytical framework concern the level of focus of the clusters and their criteria. The framework developed in this chapter will be rather generic as it does not regard a specific policy area yet. As soon as the framework is applied to a specific case, for example the water governance sector in Amsterdam in the second part of this thesis, specific criteria have to be developed. Since the analytical framework is relatively generic, not all clusters will be applicable to each case. Hence the operationalization process concerning the relevant clusters and criteria are case specific. The operationalization process of the water policy will be pursued in the next chapters.

The analytical framework has been compiled in table 4.4 (see the next page) according to the previous sub-chapters and the above described requirements. The first column lists the afore described clusters, and the second the corresponding criteria. The third and final column states the desired value of each criterion, i.e. the value the existing PLR should direct the criterion towards (low-high) to create room for circularity. This would pave the way for a fast and sound transition towards a circular economy.

Table 4.4: Analytical Framework – Measuring the Impact of PLR on the Transition Towards a CE

CLUSTERS	CRITERIA: THE IMPACT OF EXISTING PLR ON…	DESIRED VALUE
Product design	Amount of materials wasted in the production process	Low
	Biodegradability of the materials and product	High
	Material characteristics (scarcity, eco-efficiency, toxicity)	Low
	Waste in the production process	Low
	Repair costs vs. production costs	Low
	Availability of maintenance or repair service	High
	Access to internal workings	High
	Complexity of workings	Low
	Standardization of components of the product	High
Input in the production process	Percentage of renewable energy use	High
	Material intensity of products	Low
	Origin of materials	Low
	Ratio labour inputs of a new product vs in a circular loop	High
Output of the production process	Carbon footprint of the process of manufacturing	Low
	GHG emissions per GDP output	Low
	Emissions of key pollutants	Low
	GDP produced from the resource used in the production process	High
Use phase	Number of product failures	Low
	Life-time of the product	High
	Required amount of energy	Low
	Resources for usage	Low
	Intensity of use	Low
	Required repair and maintenance	Low
	Shared consumption	High
	Resource productivity	High
Destination after use	Waste generated per GDP output	Low
	Municipal waste generated per capita	Low
	Ratio recycled materials/waste	High
Closed loops	Market for second hand sales of products, materials & nutrients	High
	Costs of remanufacturing/refurbishment	Low
	Costs to collect and return	Low
	Percentage of products returned	High
	Ease to disassemble	High
	Possibility to upgrade parts	High
	Amount of mechanical connections	Low
	Amount of tools required to disassemble	Low
New business models	Amount of products sold as a service	High
	Legal frameworks for CE business models	High
	Financial frameworks for CE business models	High
Waste = food	Using waste as a product	High
	Using waste as a resource	High
	Transporting secondary materials	High
	Importing secondary materials	High

	Exporting secondary materials	High
Standardization	Setting up circular standards	High
	Applying circular standards	High
	Drawbacks resulting from certification	Low
Urban & industrial symbiosis	The total number of scavenger and decomposer business	High
	The connectivity among different industries	High
	The diversity of sectors in the urban/industrial symbioses	High
Level playing field	Room for new actors	High
	Fair price mechanisms	High
Focus beyond economic gain	Cultural & social values	High
	Health & wellbeing	High
	Environmental justice	High
	Employment rate	High
	Public awareness	High
	Social networks	High
	Natural capital	High
Long-term design	Incorporating the long-term in decision making	High
	Developing long-term visions	High
	Uncertainty about long-term effects	Low
	Danger of a lock-in	Low
	Determination of short-term steps	High
Capacity development	Innovation embedding and coupling	High
	Sufficient precaution	High
	Diverse & community-based experimentation	High
	Communities of practice	High
	Access to resources for capacity development	High
Level of integration	Problem-ownership	High
	Fragmentation across administrative levels	Low
	Fragmentation across geographical scales	Low

4.5 CONCLUSION

The analytical framework is developed from a broad notion of the circular economy and is therefore a generic framework. Before applying it to a particular policy, law or regulation, the generic criteria have to be specified to that policy area. This will be done in the second part of this thesis, by applying the analytical framework to the Municipal Sewage Plan 2016-2021 of the municipality of Amsterdam. This application will function as a test and validation of the framework itself, while providing an insight in the opportunities and barriers for the circular economy in the water governance sector in Amsterdam.

CHAPTER 5: INTRODUCTION TO THE CASE: THE WATER GOVERNANCE SECTOR IN AMSTERDAM

For centuries water management has been an essential task in the Netherlands to protect the northern and western parts from the sea and inland waterways, and to reclaim land (the "polders"). Accordingly, the Dutch water management has been highly organized for many years, creating a static water governance sector (Toonen et al., 2006). Since the water governance sector of Amsterdam will be used as a case study for this thesis, this chapter will give a first comprehensive overview of the current state and trends of this sector to enable the application of the analytical framework in the next chapter.

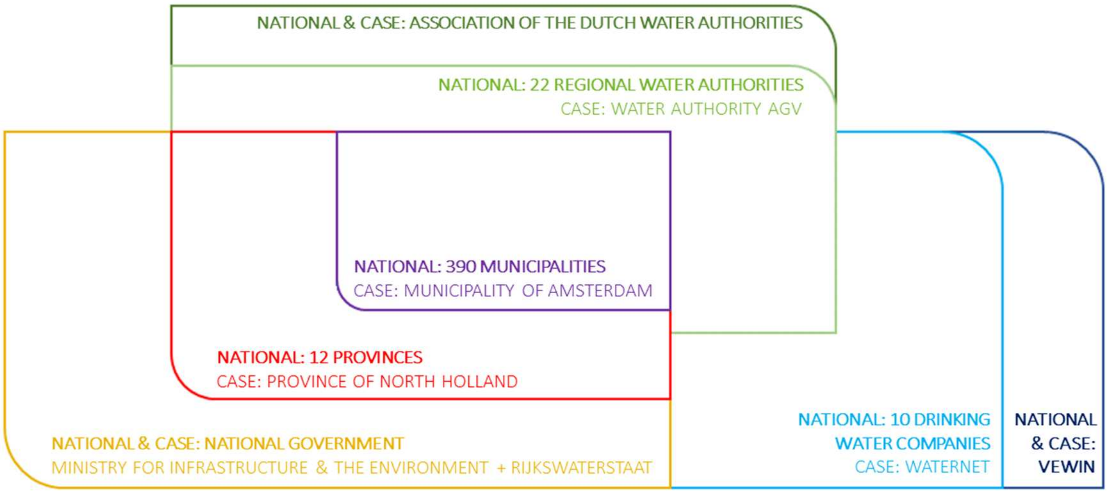
As explained in the second chapter, water governance concerns who gets water when and how. It regards "the range of political, institutional and administrative rules, practices and processes (formal and informal) through which decisions are taken and implemented, stakeholders can articulate their interests and have their concerns considered, and decision-makers are held accountable for water management" (OECD, 2015, p. 5). In the first sub-chapter, the main actors and policies of the water governance sector in Amsterdam will be introduced accordingly. The sub-question related to this chapter reads: *What actors and policies constitute the water governance sector in Amsterdam?* Thereafter, the position of water and the related actors in a (transition towards a) circular economy in Amsterdam will be outlined. The third and final sub-chapter presents a summary of the Municipal Sewage Plan 2016-2021 ("Gemeentelijk Rioleringsplan Amsterdam 2016-2021"). This policy plan serves as a test to validate the analytical framework in the next chapter.

5.1 ACTORS & POLICIES IN THE AMSTERDAM WATER GOVERNANCE SECTOR

In the Netherlands, water management is undertaken at all levels of government (see figure 5.1). Even though we nowadays have a more flexible and participatory style of water governance, the structures within the water governance sector are still hierarchical (van der Brugge et al., 2005; van der Brugge & van Raak, 2007). This first sub-chapter will provide a brief explanation of the power structures within the Dutch water governance sector, where after the most important actors of the water sector in Amsterdam specifically will be introduced. Who does what in this sector?

First of all, the European laws and regulations are leading to the water management at national level. Most important is the EU Water Framework Directive (WFD), which established a legal framework aiming to protect, restore and maintain clean water across Europe to ensure its long-term and sustainable use (Waterschap AGV, 2016; WGC, 2016). At the national governmental level, the Ministry of Infrastructure and the Environment ("Ministerie voor Infrastructuur en Milieu", or IenM) is responsible for setting standards, the national water policy, central planning and supervision (Loijenga, 2009; WGC, 2016), while the National Water Authority ("Rijkswaterstaat", or RWS) functions as the executing agency of this ministry. RWS is responsible for the operation and maintenance of the national water infrastructure (OECD, 2014). The provinces are subsequently responsible for the regional water policy, including the integrated spatial and environmental planning within administrative boundaries and developing groundwater plans and regulations. In addition, they oversee the Regional Public Water Authorities ("Waterschappen") (OECD, 2014; WGC, 2016).

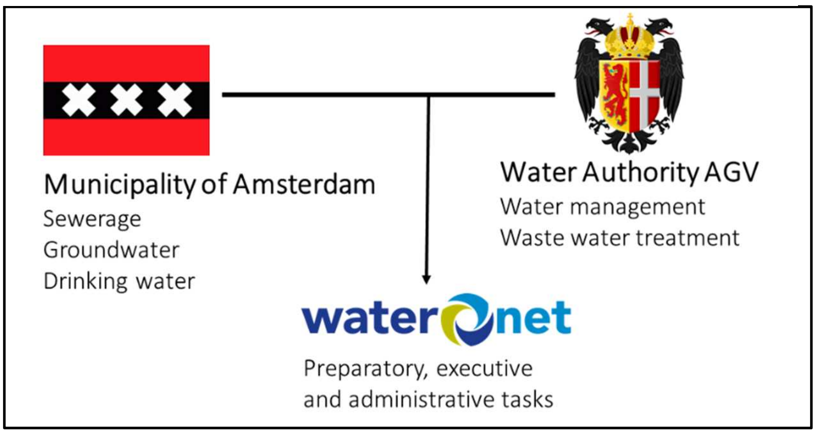
Figure 5.1: Mapping of the Stakeholders in the National & Amsterdam Water Sector



Source: created by author.

Following the hierarchical ladder, the Regional Public Water Authorities and municipalities form the most local governmental level. The Water Authorities are decentralized government institutions. They are the eldest (more or less) democratic governmental body of the Netherlands, having water management tasks only (Prak & van Zanden, 2013). These tasks include policy development for the fields of flood protection, water quantity and quality, groundwater and urban waste water treatment (Havekes et al., 2008; Loijenga, 2009; WGC, 2016). The geographical borders of the Regional Public Water Authorities are not just random lines on the map; they are primarily determined by hydraulic factors like dike rings, sub-catchment basins and puming and storage areas. As such they usually do not correspond with municipal or provincial borders (Havekes et al., 2008; OECD, 2014). In the Amsterdam region, the Water Authority Amstel, Gooi, Vecht ("Waterschap AGV") has the governmental responsibility for the water management. The 700 square kilometres managed by this Water Authority goes beyond the Amsterdam borders, and covers parts of the provinces North-Holland, Utrecht and South-Holland as well. The Dutch constitution prescribes a special law for the Water Authorities, the so-called Water Authority Act ("Waterschapswet"). This law states, amongst others, that the Water Authority is allowed to collect taxes for both (waste) water treatment and water management tasks. The collected levies must be used for the performance of those tasks exclusively. The Water Authority Act furthermore requires the Water Authority to draw up bye-laws (the "Keur"), a regulation aiming to safeguard the correct protection and maintenance of the water related infrastructure and control works. The infrastructures this Keur applies to are outlined on corresponding maps and tables called "leggers". These outline the district of the Water Authority, and show the division of tasks and responsibilities for upkeep and maintenance per area (Loijenga, 2009; UVW, 2017; Waterschap AGV, 2016, 2017).

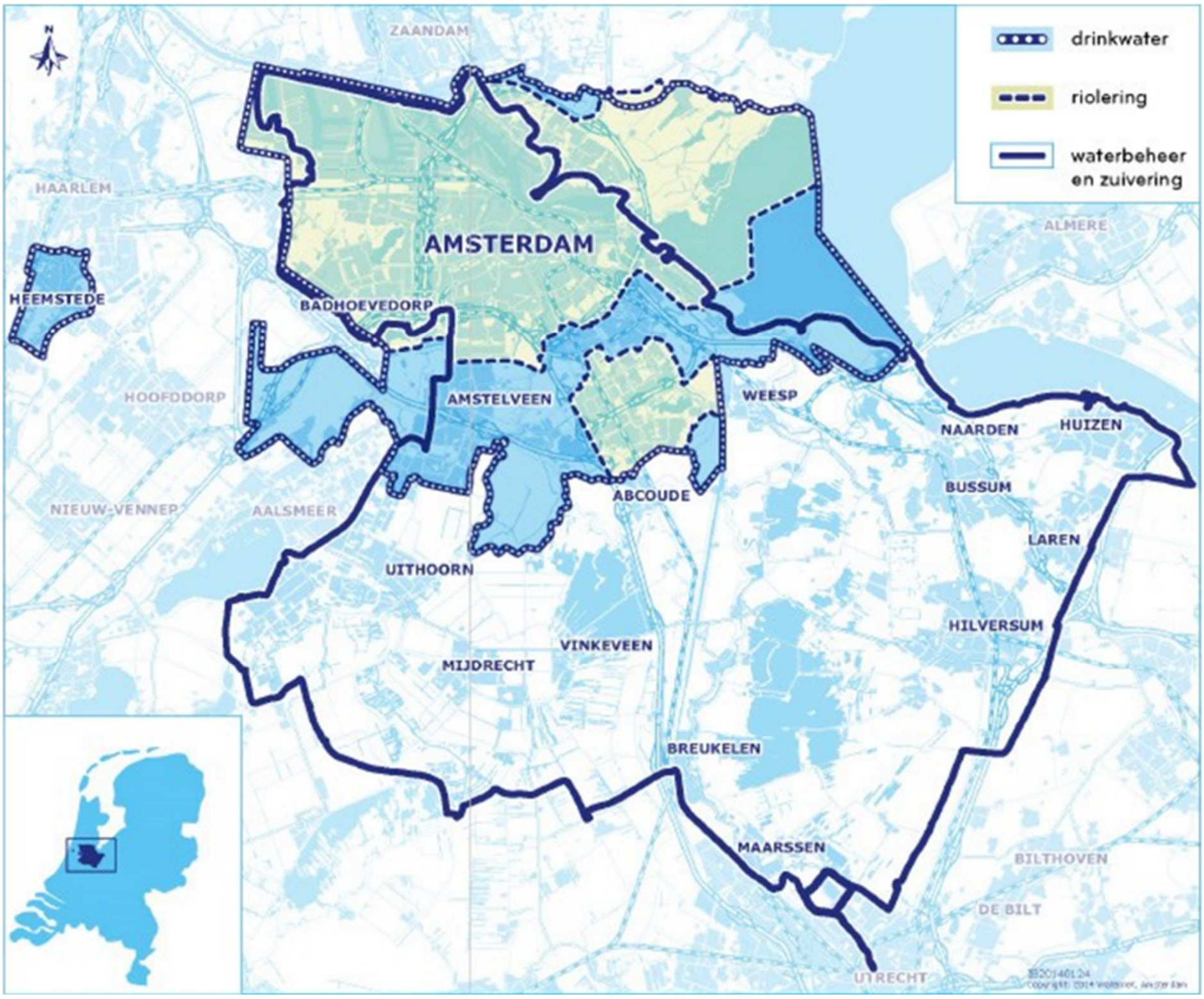
Figure 5.2: Distribution of Tasks in the Amsterdam Water Governance Sector



Source: created by author.

The municipality of Amsterdam has the legal responsibility ("duty of care") for a number of water related tasks. The three most important ones are the collection and transport of waste water, the collection and handling of rainwater, and taking groundwater measures in public areas (Loijenga, 2009; OECD, 2014; Waternet, 2016a). However, both the municipality and the Water Authority AGV have delegated the policy preparation, executive and administrative tasks to Waternet (see figure 5.2). Waternet has been founded in 2006 to bring the various urban water-related services under one roof, culminating in the Netherland's first water cycle company. All other Dutch water management organisations focus either on drinking water supply or on waste water management (Van Leeuwen & Sjerps, 2015). As co-contractors of Waternet, the municipality of Amsterdam and the Water Authority AGV have commissioned Waternet to manage the production and distribution of the drinking water and the cleaning of the waste water. Besides, Waternet is responsible for cleaning the surface water (i.e. rivers, canals, ditches and lakes) and maintaining the water levels (Gemeente Amsterdam, 2017b; Waterschap AGV, 2016). They are thus responsible for all water management related tasks within the municipality of Amsterdam. See figure 5.3 for the division of the specific tasks of Waternet in the Amsterdam area.

Figure 5.3: Specific Tasks of Waternet per Area



Source: Waternet (2017d).

5.2 WATER IN THE CIRCULAR ECONOMY IN AMSTERDAM

From drinking water via the sewer system to waste water, meanwhile affecting both nature and people - water is a connecting factor in the circular city. As elaborated upon in the second chapter, the urban water cycle is not necessarily compatible with the notion of a circular economy. This requires a transition from the consumption towards the temporary usage of water (Boere, 2016b). The water resource loop can be closed by capturing and reusing large volumes of finite resources (e.g. metals and minerals) from the water flow, while other plant-based products biodegrade (Preston, 2012). This second sub-chapter will describe the current and future position of water in the circular economy in Amsterdam.

In the water governance sector in Amsterdam and beyond, the concept of the "circular economy" is currently rarely used in existing measures and plans. Nevertheless, a lot of these could easily be positioned under this frame (Claassen, personal communication, 19-01-2017; van Alphen, personal communication, 13-02-2017). Without going into detail of the underlying reasons, the circular economy appears to be an unpopular issue in this governance sector. This requires for an additional interpretation in assessing the activities in the water governance sector in Amsterdam with regards to the circular economy.

The primary focus of the actors in the Amsterdam water governance sector currently lies on two broader aspects of water governance in a circular city: natural water management and resource recovery from waste water. The former concerns the improved management of the urban water cycle. This includes challenges around water infrastructure such as separate pipes for storm and waste water, the optimized use of underground infrastructure and improved above ground rainwater management (Metabolic et al., 2015). The main question related to these challenges is: how to "close" the urban water cycle? The second aspect regards the focus on the recovery of energy, nutrients, resources and water itself from waste water (Boere, 2016b). Waste water contains a lot of scarce and valuable components that can be reused. Examples are small particles of silver, gold and rare metals in our faeces, and phosphate in our urine (IenM, 2015b). This results in questions around the water infrastructure for the recovery of those resources from waste water. One could think of different sewer lines for different water types (e.g. separate collection of urine) and the implementation of (local) bio-refineries. In addition, the heat from waste water could be recovered (Metabolic et al., 2015).

According to actors in the water governance sector, the transition towards circular water activities is still in its infancy, (KWR et al., 2016a, 2016b). Most activities relating to the circular economy in the water sector currently regard experiments in new techniques, collaborations and forms of governance (e.g. in the areas of De Ceuvel and Buiksloterham) and research programs (e.g. Water Governance by KWR et al.). Whereas in most cases the necessary technology is available, questions about the economic, social and governance aspects remain largely unanswered (Claassen, personal communication, 19-01-2017; van Alphen, personal communication, 13-02-2017). This concerns questions such as: how can we apply the technologies to close the cycles and to recover more from the waste water? And: how will this take shape in our society?

Waternet has high circularity ambitions. Their innovation and research program is to a large extent driven by this ambition. They are partner of the Circular Innovation Program of the municipality of Amsterdam, won the Circular Challenge of 2015, and have multiple research and innovation programs focussing circular activities (Waternet, 2016b, 2017e). A transition towards a circular economy, but also other societal and technological developments, will most likely ask for a different water governance structure. Waternet is actively considering its role in the water governance sector in the future. Besides being part of the internal research program, this topic is also addressed in a new research commissioned by the Water Authority AGV and Waternet, and carried out by the KWR water cycle research institute (Claassen, personal communication, 19-01-2017). The pre-research for the program design of this research (cited as: KWR et al., 2016a; or: KWR et al., 2016b) will be used in the next chapter.

5.3 THE MUNICIPAL SEWAGE PLAN AMSTERDAM 2016-2021

The analytical framework as developed in the first part of this thesis will be tested and validated by applying it to a specific policy plan: the Municipal Sewerage Plan Amsterdam 2016-2021 (MSP) (Waternet, 2016a). In this sub-chapter, the MSP will be described briefly. What does the plan entail?

In short, the MSP contains the policy and corresponding measures and financing for the water related tasks (the collection and transport of waste water, the collection and handling of rainwater, and taking groundwater measures in public areas) of the municipality of Amsterdam. The waste water policy and implementation of municipal water tasks are decisive for the impact of the urban waste water on the surface water and purification. Hence, the municipality of Amsterdam has involved the Water Authority AGV in the development of the MSP. The MSP has been drawn up by a project team of Waternet (Waterschap AGV, 2016).

The MSP has outlined general policy principles per water task. Regarding the collection and transport of waste water, the MSP states the separation of the components of urban waste water should be undertaken at the source wherever possible. Furthermore, decentralized treatment should be preferred over the current central treatment, as long as it has proven to be beneficial. Five general policy principles are set for the collection and handling of rainwater. First, in principle the property-owner is responsible for the processing of rainwater on site. Second, the processing of rainwater is not a performance obligation, but rather an obligation of effect. Next, the premise of rainwater handling is to keep contaminated rainwater separate from the remaining rainwater. The municipality furthermore prefers the use of rainwater above the direct discharge, and finally, the municipality will take the temporary capture of extreme rainfall into account when designing a public space. The general policy principles for groundwater are twofold. First, the municipality aims for a sustainable functioning groundwater system. This includes the avoidence of new nuisance and the elimination of existing nuisance. In addition, the property owner is in principle responsible for the processing of the groundwater on site.

5.4 CONCLUSION

The most important actors of water governance sector in Amsterdam are the municipality of Amsterdam, the Water Authority AGV and Waternet. The municipality has three duties of care: the collection and transport of waste water, the collection and handling of rainwater, and taking groundwater measures in public areas. The Water Authority is responsible for the water management and waste water treatment. Together, they have delegated the policy preparation, executive and administrative tasks to Waternet, the water cycle company of Amsterdam. Each of these stakeholders in the Amsterdam water governance sector have high circularity ambitions. The primary focus of these actors currently lies on two broader aspects of water governance in a circular city: natural water management and resource recovery from waste water. Yet, the transition towards a circular economy in this sector appears to be in its infancy.

CHAPTER 6: CIRCULARITY IN THE AMSTERDAM WATER GOVERNANCE SECTOR

Drinking water, ground water, waste water; while the status of water may change, the basic characteristics of water stay the same. All water flows are part of the urban water cycle. As connecting factor in a circular city, water is an important component of the transition towards a circular economy in Amsterdam. This chapter focuses on circularity in the Amsterdam water governance sector, by firstly discussing the case by means of the previously developed analytical framework, and secondly applying the framework to the Municipal Sewage Plan 2016-2021 (MSP).

The assessment of the Amsterdam water governance sector according to the analytical framework will on the one hand offer an insight of the status quo, opportunities and challenges for the transition towards a circular economy in the Amsterdam water sector. On the other hand, the assessment allows for the translation of the generic criteria[7] of the analytical framework into specific water related criteria. This implicitly provides an answer to the fourth sub-question: *How can the developed analytical framework be applied to the water governance sector?* The translation from generic to specific will enable an application to a particular policy, law or regulation in this sector. This specified analytical framework will be presented in the second sub-chapter, where after the specified analytical framework will be applied to the existing policy plan MSP in the third sub-chapter. This will be carried out as a "quick scan"; a global evaluation covering the most important aspects. The scan will provide some insights into the impact of the MSP on the transition towards a circular economy in Amsterdam. More importantly however, the quick scan will primarily function as a test and validation of the analytical framework. This has been formulated in the fifth sub-question: *How can the analytical framework be improved according to the water governance validation process?* Accordingly, feedback for the clusters, criteria and method of application is provided.

The focus of this analysis lies on water as a product, i.e. the management of water production, use and loops in Amsterdam. It puts water in the centre, while features like nutrients, energy and infrastructure are seen as components that are either part of or serving the water flow.

[7] See Chapter 4 for a description of the criteria and corresponding cluster. Table 4.4 shows the complete generic analytical framework.

6.1 CIRCULAR WATER GOVERNANCE

This first sub-chapter concerns the circularity of the Amsterdam water governance sector. The case will be assessed by means of the analytical framework, resulting in the translation from a generic to a specific analytical framework. Based on interviews with experts within the water sector and a pre-research conducted by KWR, Kennisland and AWS, the three levels (micro, meso and governance) of circularity will be discussed. Each respective cluster will be introduced in the context of the water governance sector in Amsterdam. Besides a specified explanation of each cluster, the status quo, opportunities and challenges of each cluster in this case will be elaborated upon. At the end of each sub-chapter the results will be summarized in a table (6.1-6.3).

6.1.1 CIRCULAR WATER GOVERNANCE AT THE MICRO-LEVEL

Products often require a redesign to become circular. This is covered by the first cluster to measure the impact of existing policies, laws and regulations (PLR) on a transition towards a circular economy: **product design**. Water in itself is a constant product consisting of the molecular bond H2O. However, water is basically being "redesigned" as substances are being extracted from and added to the water with the help of water treatment systems (van der Woude, personal communication, 17-02-2017). The national law has, for example, set requirements for the maximum quantity of those substances to ensure the quality of our drinking water (Waternet, 2017c). Water for industrial purposes, however, serves another purpose hence has to comply to different standards.
One could also "redesign" the concept of water in our society. In a true circular economy, water is made use of temporarily instead of being consumed. There are different requirements for the product of water for each kind of water usage. In other words, it is all about the function of water. Examples of these different functions are recreation, transport, heating, drinking water or sports. Every function requires other conditions, e.g. more or less resources, more or less warmth, more or less energy, and more or less purified (van Alphen, personal communication, 13-02-2017; van der Woude, personal communication, 17-02-2017). When including this plurality of functions to water design, legal requirements for the quality of water should be diversified as well.

The second cluster at the micro-level is the **input in the production process**. Firstly, the entire production process should be able to run on renewable energy, while the use and waste of energy is kept as low as possible. Renewable energy use is an important topic in the current sustainability agenda of Waternet and the Water Authority AGV; the organizations aim to be climate neutral by 2020. Besides the application of renewable energy sources, it includes the sustainable use of raw and auxiliary materials, and the minimization of direct emissions and waste streams (Waternet, 2017b; Waterschap AGV, 2016). Furthermore, the criterion "origin of the materials" mainly concerns the origin of the water. In this case there are three possibilities: surface water, ground water and rain water. Waternet uses surface water for the production of drinking water (Waternet, 2017a). It would also be possible for individuals to produce their own drinking water by purifying rainwater (Jansen, personal communication, 19-01-2017).

The **output of the production process** is closely related to the input in that same production process. The shift towards climate neutral drinking water production implicitly minimizes the greenhouse gas emissions (Waterschap AGV, 2016). To minimize the emissions of key pollutants, the residual substances and chemicals used for the production process should be filtered out. Preferred would be a redesign of the production process to prevent the emergence of waste (van Alphen, personal communication, 13-02-2017).

In the water governance sector the clusters **use phase, destination after use** and **circular loops** overlap to a great extent. The former focuses on the circular use of water, i.e. closing the loops in the use phase. A first example is the use of rain water flows in buildings. The Amsterdam water policy program Rainproof, for instance, advises to reuse water on all fronts. Rain water could be stored and used for the toilet or washing machine, instead of directly being discharged to the sewer (Rainproof, 2017). Waste water streams inside the house could be reused as well. Water used in the shower could, for example, be redirected to flush the toilet. All in all, various actors in the water governance sector deem water flows should be taken into account from a broader perspective. A possibility would be to include water aspects in the design and construction of buildings. This could result in "water neutral" buildings, just like energy neutral buildings exist (KWR et al., 2016a). However, such zero-water-buildings are presumably difficult to implement in the existing buildings in the Netherlands, as the efficiency of the established water infrastructure takes away the financial incentive (van der Woude, personal communication, 17-02-2017). The Water Authority AGV and Waternet take care of the transport and treatment of the urban waste water after use. The first destination after use is the waste water treatment plant (WWTP). The water is treated to comply with the national effluent standards, to finally be discharged to the surface waters. An important point of focus of AGV and Waternet is the minimization of the levels of micro pollutant such as micro plastics and medicine residues (Waterschap AGV, 2016). In addition, there is attention for the recovery of energy, nutrients and resources from the waste water, i.e. to close the loops at the destination after use. It is all about the question: how can we recover more resources from the waste water? The law does not prescribe the recovery of resources, hence a regulatory incentive for these kind of activities is lacking (Steenwinkel, personal communication, 31-01-2017). Yet its importance appears to be clear to most of the actors in the water sector as it is part of the current policy agenda (see for example: KWR et al., 2016a; Waterschap AGV, 2016). Apart from the recovery of resources, the waste water could be upcycled as well. A first option is to give the waste water such treatment the water quality becomes sufficient to stay in the system as surface water of a higher quality (e.g. for recreational use) (van der Woude, personal communication, 17-02-2017). A further option is to intensify the treatment even further, to produce drinking water from waste water (van Alphen, personal communication, 13-02-2017). The loop from waste water to drinking water is, to a certain extent, already closed. Waste water gets discharged in natural waters after treatment, where after another drinking water company makes use of that same portion of natural water to produce drinking water (van der Woude, personal communication, 17-02-2017). Finally, waste water could be employed for other purposes instead of solely being discharged after treatment. Examples are the use of waste water to cool the data centres, and the utilization of fertile waste water to grow crops. The creation of these kind of loops correspond with the basic idea of the clusters "urban and industrial symbiosis", that will be described in the next sub-chapter.

The closing of the water loops in a circular economy just described involves the emergence of **new business models** for the production, distribution and consumption of water that have incorporated circular principles. A crucial starting point is the access to safe water facilities for all Dutch citizens. Accordingly, a transition towards a circular economy includes new business models that facilitate a transition towards a plurality of solutions for water in a circular economy while the basic water provision is ensured (Claassen, personal communication, 19-01-2017; KWR et al., 2016a; van Alphen, personal communication, 13-02-2017). For a new business model to succeed, the financial business case has to be sound. In practice many business cases focussing on the recovery of energy, nutrients and resources seem to be conclusive. It depends, however, a lot on the specifics of the business case. The main question is: what is valuable? This continuous to be a quest for all stakeholders (Claassen, personal communication, 19-01-2017; Steenwinkel, personal communication, 31-01-2017). Business cases for the implementation of innovative water interventions seem to be more problematic. The most important reason is the long payback time of the established infrastructure, as will be elaborated upon further as part of the cluster "level playing field" in the next sub-chapter (KWR et al., 2016a). While many business cases in the water sector are proven to be financially sound, the financial and legal frameworks are lacking or even non-existing. It is not clear how one should deal with the investment costs as well as with the continuous financing of circular business models in the water sector (Jansen, personal communication, 19-01-2017; KWR et al., 2016a). The static and strict quality and safety standards of water but also of the water production process hinders the development of new business models in this sector. Firstly, the standards for all privately used water flows are the same, while only a small percentage of that water is used as drinking water. Second, according to the law, waste water treatment is an industrial process. This makes it very difficult for local initiatives to comply to the corresponding rules (van Alphen, personal communication, 13-02-2017). A final difficulty results from the different legal status for public and private organizations. An example is the recovery of energy from water. A Water Authority is not allowed to do so on its own, since the energy market is privatized and the Water Authority is a public body. These private-public tensions could become a challenge for the recovery of nutrients and substances from waste water as well. "Are you still able to be a public organization, while also operating as a kind of entrepreneur?" (KWR et al., 2016a; van Alphen, personal communication, 13-02-2017).

Table 6.1 depicts the translation from generic to specific per cluster at the micro-level. The first column lists the clusters, the second the corresponding general criteria and the third the desired value as formulated in the analytical framework in Chapter 4. Based on the analysis of this sub-chapter, the column on the right lists the specific water criteria that are applicable to existing PLR in the water governance sector. In those cases where the general criterion cannot be translated, an "X" will be noted in this column.

Table 6.1: Measuring the Impact of PLR on Circular Water at the Micro-Level

CLUSTERS	GENERAL CRITERIA	DESIRED VALUE	SPECIFIC CRITERIA
Product design	Amount of materials wasted in the production process	Low	Amount of resources wasted in the production process
	Biodegradability of the materials and product	High	X
	Material characteristics	Low	X
	Waste in the production process	Low	The use of raw and auxiliary materials in the production process
	Repair costs vs. production costs	Low	X
	Availability of maint. or repair service	High	X
	Access to internal workings	High	X
	Complexity of workings	Low	X
	Standardization of components of the product	High	Strict water quality standards
Input in the production process	Percentage of renewable energy use	High	Percentage of renewable energy use in the production process
	Material intensity of products	Low	X
	Origin of materials	Low	Renewable origin of the water for production
			Renewable origin of the raw and auxiliary materials for production
	Ratio labour inputs of a new product vs in a circular loop	High	Ratio labour inputs of a "fresh" water vs in a circular loop
Output of the production process	Carbon footprint of the process of manufacturing	Low	Carbon footprint of the water production process
	GHG emissions per GDP output	Low	GHG emissions of the production process per GDP output
	Emissions of key pollutants	Low	Emissions of key pollutants in the production process

	GDP produced from the resource used in the production process	High	GDP produced from the resource used in the production process
Use phase	Number of product failures	Low	X
	Life-time of the product	High	X
	Required amount of energy	Low	Required amount of energy for usage
	Resources for usage	Low	Required resources for usage
	Intensity of use	Low	X
	Required repair and maintenance	Low	X
	Shared consumption	High	X
	Resource productivity	High	X
Destination after use	Waste generated per GDP output	Low	Waste water generated per GDP output
	Municipal waste generated per capita	Low	Municipal waste water generated per capita
	Ratio recycled materials/waste	High	X
Closed loops	Market for second hand sales of products, materials & nutrients	High	Market for second hand sales of waste water
			Market for second hand sales of recovered resources
	Costs of remanufacturing/refurbishment	Low	Costs of cleaning water
			Costs to recover resources
	Costs to collect and return	Low	Costs to collect water
	Percentage of products returned	High	Percentage of waste water collected
	Ease to disassemble	High	X
	Possibility to upgrade parts	High	X
	Amount of mechanical connections	Low	X
	Amount of tools required to disassemble	Low	Amount of tools required to recover resources from water
New business models	Amount of products sold as a service	High	X
	Legal frameworks for CE business models	High	Legal frameworks for CE water business models
	Financial frameworks for CE business models	High	Financial frameworks for CE water business models

6.1.2 CIRCULAR WATER GOVERNANCE AT THE MESO-LEVEL

The first of the five clusters to measure the impact of PLR on a transition to a circular economy at the meso-level beholds "**waste equals food**". According to the national law, both waste water and resources recovered from waste water are considered as waste. This creates obstacles for the recovery of those resources in the Amsterdam water sector. Firstly because the transport of (recovered) waste is not allowed. An exception status must be approved officially, yet this must be lobbied for and takes a long time. Secondly, conducting resource recovery makes Waternet act like a "waste processor". However, the law does not consider them as such, making their performance unlawful. This requires the obtaining of an exception status as well. Finally, the resources having a "waste" status makes the marketing more difficult (Claassen, personal communication, 19-01-2017; Steenwinkel, personal communication, 31-01-2017; van Alphen, personal communication, 13-02-2017).

The cluster **standardization** has twofold implications for the Amsterdam water governance sector. First, circularity is not at all standardized in the water context. It is currently more or less an umbrella term. Everybody has a notion of the concept, but there is no agreement about what it means exactly (Claassen, personal communication, 19-01-2017; van der Woude, personal communication, 17-02-2017). When more concrete standards are formulated, they can be included in legal frameworks. This results in the second implication: the inclusion of circular standards in laws and regulations would provide an incentive for actors in the water governance sector to innovate (Giezen, personal communication, 31-01-2017). In the end, the standardization must contribute to a well-functioning water governance sector in which actors and processes complement each other (Claassen, personal communication, 19-01-2017).

Water is an important resource to include in the **urban and industrial symbiosis**. The collaboration to exchange both water itself and resources recovered from waste water can take place with actors from the water sector and beyond (Claassen, personal communication, 19-01-2017). Collaboration between the established actors within the water governance sector is relatively uncomplicated. The Water Authorities, for instance, have the same organizational structures and goals, while facing the same challenges (Steenwinkel, personal communication, 31-01-2017). An example of this symbiosis is the Association of Dutch Water Authorities ("Unie van Waterschappen", or: UVW). Extending the collaboration to more unconventional actors part of the water sector (e.g. local initiatives) seems, however, to be rather troublesome (KWR et al., 2016a). The current system is regarded as not flexible enough, while the stakeholders often lack openness and respect for fruitful cooperation. This issue will be elaborated upon further in the next paragraph on the cluster "level playing field". Expanding the collaboration beyond the water governance sector requires actors to get out of their own domain and mix into the playing field. Opportunities arise for the exchange of several sorts of flows, together constituting a system for symbiosis (KWR et al., 2016a). Examples of symbiosis are using the waste water from a beer brewery as a fertilizer for the grain that is grown to produce that same beer, and turning on a water pumping station only when the nearby wind mills are producing renewable energy (Steenwinkel, personal communication, 31-01-2017; van der Woude, personal communication, 17-02-2017). Challenging for the physical exchange of water and its by-products is the proximity of the collaborating parties. Longer distances require more expensive and demanding arrangements, such as pipes (i.e. physical infrastructure) or big trucks (Giezen, personal communication, 31-01-2017). Spatial planning is an important element to improve the integration of water (innovation). To date, there seems to be limited attention for the spatial aspects of a circular economy and the interaction between the environmental and spatial policy and a circular economy (KWR et al., 2016a; PBL, 2016).

Collaboration for and in urban and industrial symbiosis is closely linked to the characteristics of the water sector with regards to the next cluster, the **level playing field**. The water governance sector has been described as relatively old-fashioned, hierarchical, and conservative (de Geus, personal communication, 01-02-2017; Jansen, personal communication, 19-01-2017; van der Woude, personal communication, 17-02-2017). AGV and Waternet have hold centralized control over the water system in the Amsterdam area for many years. A transition towards a circular economy would greatly change the current governance system as it involves a transition to a more hybrid system. This involves (partial) decentralization, decoupling and changing tasks and responsibilities for the AGV and Waternet as well as for civilians (Claassen, personal communication, 19-01-2017; de Geus, personal communication, 01-02-2017). A hybrid system also has a practical aspect: the existing infrastructure. First of all, as our established infrastructure functions very well, there is no incentive to change this overnight. In addition, the well-functioning established infrastructure is the starting point when planning for the future. Infrastructure has a long payback period, which can hinder innovation as it is often opposite to local and decentral solutions (Giezen, personal communication, 31-01-2017; Jansen, personal communication, 19-01-2017; van Alphen, personal communication, 13-02-2017). The existing financing and tax schemes corresponding with these infrastructures result in rather strange price mechanisms in the water governance sector. First, drinking water costs about €1,50 per 1000 litres. The production costs of drinking water are more or less the same at all volumes, as the fixed expenses make up for most of the costs. This results in lacking incentives for water saving. A further interesting mechanism results from the versatility of responsible parties. Although the water management in Amsterdam is relatively straightforward with Waternet as sole water cycle company, both the residents and the owners of a building have a large impact on the quality and quantity of water. Yet, they are often neglected in the water governance process (van Alphen, personal communication, 13-02-2017). Investment costs of innovative circular projects are impacted as well. It is in many cases not clear who should invest, and how the tasks and responsibilities are divided. The lack of clarity regarding the financial structure results in circular projects getting stuck on the financial aspects (Claassen, personal communication, 19-01-2017; Giezen, personal communication, 31-01-2017; KWR et al., 2016a).

The financial aspects of the transition are related to notion that the creation of value beyond economic gain is essential to a well-functioning circular economy. In the water governance sector, the final cluster to measure the impact of existing PLR on a transition towards a circular economy at the meso-level, **focus beyond economic gain,** particularly concerns the topics redundancy, awareness building and justice. The degree of redundancy is a soft policy barrier. In most cases the focus lies on performing as efficient as possible. When we would focus less on efficiency and more of redundancy, we would be more flexible in the future. The downside are the often increasing costs of current performances (Giezen, personal communication, 31-01-2017). Furthermore, the prevention of damage and hence not spent money is often not (yet) included in the cost-benefit calculations (de Geus, personal communication, 01-02-2017). The inclusion of the above mentioned aspects leads to transparency of the real social costs of the water systems, which is considered as an essential mean for a transition towards a circular future (KWR et al., 2016a). The second criterion, awareness building, regards the creation of a consciousness, storytelling, organizing example projects, and much more. According to many interviewees, increasing the awareness and acceptance of water issues is an important step in including the citizens of Amsterdam in the transition (KWR et al., 2016a). Especially because of the huge impact of the attitude and behaviour of citizens (Claassen, personal communication, 19-01-2017; Steenwinkel, personal communication, 31-01-2017). Such an inclusion is furthermore desired to ensure social and environmental justice amongst the citizens of Amsterdam. These forms of justice are being challenged by local initiatives and the corresponding decentralization. Because of a variety of reasons (e.g. availability of financial means, time or knowledge) not everybody has the opportunity to participate. Besides the extent of representativeness of the local initiatives, equal access to basic water infrastructure must be guaranteed (Giezen, personal communication, 31-01-2017; KWR et al., 2016a).

Table 6.2 depicts the translation from generic to specific per cluster at the meso-level. The first three columns list the clusters, the corresponding general criteria and the desired value as formulated in the analytical framework in Chapter 4. The column on the right shows the specific water criteria that are applicable to existing PLR in the water governance sector.

Table 6.2: Measuring the Impact of PLR on Circular Water at the Meso-Level

CLUSTERS	GENERAL CRITERIA	DESIRED VALUE	SPECIFIC CRITERIA
Waste = food	Using waste as a product	High	Using waste water as a product
	Using waste as a resource	High	Using waste water as a resource
			Using resources from waste water as a resource
	Transporting secondary materials	High	Transporting waste water
			Transporting recovered resources from waste water
	Importing secondary materials	High	Importing waste water
			Importing recovered resources from waste water
	Exporting secondary materials	High	Exporting waste water
			Exporting recovered resources from waste water
Standardization	Setting up circular standards	High	Setting up circular water standards
	Applying circular standards	High	Applying circular water standards
	Drawbacks resulting from certification	Low	Drawbacks resulting from certification
Urban & industrial symbiosis	The total number of scavenger and decomposer businesses	High	The number of resource recovery businesses
	The connectivity among industries	High	The connectivity within the water sector
			The connectivity among water and other industries
	The diversity of sectors in the urban/industrial symbioses	High	The diversity of sectors in the urban/industrial symbioses
Level playing field	Room for new actors	High	Room for new actors
	Fair price mechanisms	High	Fair price mechanisms
			Transparency of the real social costs
Focus beyond economic gain	Cultural & social values	High	Room for redundancy
	Health & wellbeing	High	Access to basic water infrastructure
	Environmental justice	High	Inclusion of citizens in the transition
	Employment rate	High	Employment rate in the water sector
	Public awareness	High	Public awareness of water issues
			Public acceptance of water measures
	Social networks	High	Local water initiatives
	Natural capital	High	Natural water capital

6.1.3 CIRCULAR WATER AT THE GOVERNANCE LEVEL

The first cluster at the governance level regards the **long-term design**, representing the incorporation of long-term thinking in which the short-term steps are developed underway. In general, actors in the water governance sector witness too little of this long-term thinking in the existing PLR. While voluntary covenants and collaborations are a welcome first step, written legislation concerning pricing, sewage charges and contracting should be modified as well (KWR et al., 2016a). Interviewees had differing opinions regarding to what extent the governmental bodies in the water governance sector currently have a long-term vision. One view regards the strategy of Waternet as adaptive; they have set a dot on the horizon yet did not set out which steps they will take to get there (Claassen, personal communication, 19-01-2017). One of the interviewees (practitioner Albert Jansen) has, however, experienced behaviour of governmental bodies that seemingly shows they are not solely focused on the long-term (Jansen, personal communication, 19-01-2017). Additionally, actors in the water governance sector experience uncertainty about the long-term effects in general. This is mostly recognized in the field of tenders. Whereas the procurement is a mean to enforce innovation, it seems to be a rather difficult activity for the time being. Dutch governmental purchasers wish to see proof and assurances. Accordingly the latest technologies are most often not purchased, hence indirectly delaying innovation (de Geus, personal communication, 01-02-2017; Steenwinkel, personal communication, 31-01-2017). Uncertainty in the water governance sector also regards questions about the different scale levels. Each governance initiative asks for a different scale level of implementation, as the optimal level differs per aspect of the water cycle. Research is necessary to determine the most suitable level of scale for each initiative (KWR et al., 2016a). Proper research also prevents us from getting locked into solutions that are not optimal from a longer term perspective. The danger of lock-in in the water sector is relatively high, as the aforementioned water related infrastructure has a long depreciation time (van Alphen, personal communication, 13-02-2017).

To ensure the right long-term design and short-term steps are taken, the water governance sector has to arrange for **capacity development**. This firstly regards diverse and community based experimentation, which appears to be difficult to execute. A continuously changing and vibrant urban area like the municipality of Amsterdam offers little serenity and tranquillity for such experiments (Claassen, personal communication, 19-01-2017). In addition, the structured water governance sector does not offer space for experimentation to all innovators (Jansen, personal communication, 19-01-2017). Experimentation is required to develop a proven concept of what the water governance of the future could look like (Claassen, personal communication, 19-01-2017). This is, however, most and for all a social and policy matter. The technologies are available, yet it is unclear how to systematically implement the circular principles by means of these technologies (van Alphen, personal communication, 13-02-2017). Innovation in the governance of water will not happen if the research does not include the social implementation and application of the circular technologies. We therefore need to translate science to practice (de Geus, personal communication, 01-02-2017; KWR et al., 2016a). Relevant questions are the impact of the new technologies over time regarding maintenance, management and replacement, yet also about the changing activities underground, on what basis one should choose a certain type of infrastructure, and so forth. The necessary research and relating experiments require more transparency regarding the activities, focus, intentions, financial flows and social responsibility of actors such as the Water Authority AGV and Waternet. Just as important, though, is the embedding and linking experiments and innovations. On the one hand because knowledge exchange accelerates new research and innovations. On the other hand because this allows PLR to keep up with the newest innovations more adequately (KWR et al., 2016a).

The final cluster at the governance level is the **level of integration**. This cluster can be divided in two differing topics: the lack of evident problem-ownership and distributed power of control. The former concerns the many responsible parties involved in the water sector. There is often a lack of clarity regarding the division of tasks and responsibilities amongst these parties. This raises questions such as: what do we want exactly? How can we organize this? Who is prepared to invest? And to collaborate? Who carries the risks? And who is responsible? Many questions, though in many cases it is even not clear who should take the lead in answering these questions. This eventually impacts the planning, financing and supervision of water related tasks (Claassen, personal communication, 19-01-2017; KWR et al., 2016a; van Alphen, personal communication, 13-02-2017). Additionally, a transition towards a circular economy probably alters the playing field. Established structures might change accordingly, clouding the responsibility questions even further. These challenges can be faced by setting up collaborations and partnerships. Such collaborations overlap with the second topic of this cluster: the distributed power. Power in the Amsterdam water sector is fragmented across geographic scale levels and administrative scale levels. A pilot like Buiksloterham required both levels to show commitment; multiple external parties had to organize and collaborate together, where after each of them had to make sure their own organizations where on board (Claassen, personal communication, 19-01-2017). The latter also concerns the creation of a support base for decisions and policies within an organization. A specific challenge is the internal structure of bodies such as a municipality and Water Authority AGV. It has been suggested both are, at least to a certain extent, compartmentalized. Sectors or departments focus on their own subjects, frequently neglecting the overall scope. This results in contradictory PLR as well (KWR et al., 2016a; van Alphen, personal communication, 13-02-2017).

Table 6.3 shows the translation from generic to specific per cluster at the governance level. The first three columns list the clusters, general criteria and desired values as formulated in the analytical framework. The column on the right depicts the specific water criteria that are applicable to existing PLR in the water governance sector.

Table 6.3: Measuring the impact of PLR on Circular Water at the Governance Level

CLUSTERS	GENERAL CRITERIA	DESIRED VALUE	SPECIFIC CRITERIA
Long-term design	Incorporating the long-term in decision making	High	Incorporating the long-term in decision making
	Developing long-term visions	High	Developing long-term visions
	Uncertainty about long-term effects	Low	Uncertainty about long-term effects
	Danger of a lock-in	Low	Danger of a lock-in
	Determination of short-term steps	High	Determination of short-term steps
Capacity development	Innovation embedding and coupling	High	Innovation embedding and coupling
	Sufficient precaution	High	Sufficient precaution
	Diverse & community-based experimentation	High	Diverse & community-based experimentation
	Communities of practice	High	Translation from science to practice
	Access to resources for capacity dev.	High	Access to resources for capacity dev.
Level of integration	Problem-ownership	High	Problem-ownership in the water sector
	Fragmentation across administrative levels	Low	Fragmentation across administrative levels
	Fragmentation across geographical scales	Low	Fragmentation across geographical scales

6.2 A SPECIFIC FRAMEWORK FOR THE WATER GOVERNANCE SECTOR

A specific analytical framework focussed on the water governance sector can be developed by example of the generic analytical framework as developed in the first part of this thesis. Based on the analysis of the circularity of the Amsterdam water governance sector, the framework could be specified for this sector (see table 6.4). The first column again outlines the broader clusters of the framework. The second column, however, lists the case specific instead of generic criteria based upon the analysis carried out in the previous sub-chapter. The criteria that could not be translated have been eliminated from the table. Again, the desired value of the criteria is noted. A fourth column stating the "real value" has been added to the framework. This comprises the actual impact the existing policy, law or regulation has on a criterion, i.e. the direction this policy, law or regulation steers the criterion towards. This column does not have any content yet, as it has to be filled in during the assessment. Potential values would be low, high or unknown.

A remarkable aspect of the translation from generic to specific criteria regards the high number of criteria that have been eliminated at the micro-level. This can be explained by the particular characteristics of "water as a product", which inherently impacts its design and use. Water is, for example, biodegradable in itself, and cannot be "repaired" nor "maintained" (in the narrow sense of the words). In addition, as described in the analysis of the case, the emphasis of circular water use particularly lies on closing loops during and after use. This leads to a reduced number of criteria at the micro-level for the water governance case.

Table 6.4: A Specified Analytical Framework for the Water Governance Sector

CLUSTERS	SPECIFIC CRITERIA: IMPACT OF EXISTING PLR ON...	DESIRED VALUE	REAL VALUE
Product design	Amount of resources wasted in the production process	Low	
	The use of raw and auxiliary materials in the production process	Low	
	Strict water quality standards	Low	
Input in the production process	Percentage of renewable energy use in the production process	High	
	Renewable origin of the water for production	Low	
	Renewable origin of the raw and auxiliary materials for production	Low	
	Ratio labour inputs of a "fresh" water vs in a circular loop	High	
Output of the production process	Carbon footprint of the water production process	Low	
	GHG emissions of the production process per GDP output	Low	
	Emissions of key pollutants in the production process	Low	
	GDP produced from the resource used in the production process	High	
Use phase	Required amount of energy for usage	Low	
	Required amount of resources for usage	Low	
Destination after use	Waste water generated per GDP output	Low	
	Municipal waste water generated per capita	Low	
Closed loops	Market for second hand sales of waste water	High	
	Market for second hand sales of recovered resources	High	
	Costs of cleaning water	Low	
	Costs to recover resources from water	Low	
	Costs to collect water	Low	
	Percentage of waste water collected	High	

	Amount of tools required to recover resources from water	Low	
New business models	Legal frameworks for CE water business models	High	
	Financial frameworks for CE water business models	High	
Waste = food	Using waste water as a product	High	
	Using waste water as a resource	High	
	Using resources from waste water as a resource	High	
	Transporting waste water	High	
	Transporting recovered resources from waste water	High	
	Importing waste water	High	
	Importing recovered resources from waste water	High	
	Exporting waste water	High	
	Exporting recovered resources from waste water	High	
Standardization	Setting up circular water standards	High	
	Applying circular water standards	High	
	Drawbacks resulting from certification	Low	
Urban & industrial symbiosis	The number of resource recovery businesses	High	
	The connectivity within the water sector	High	
	The connectivity among water and other industries	High	
	The diversity of sectors in the urban/industrial symbioses	High	
Level playing field	Room for new actors	High	
	Fair price mechanisms	High	
	Transparency of the real social costs	High	
Focus beyond economic gain	Room for redundancy	High	
	Access to basic water infrastructure	High	
	Inclusion of citizens in the transition	High	
	Employment rate in the water sector	High	
	Public awareness of water issues	High	
	Public acceptance of water measures	High	
	Local water initiatives	High	
	Natural water capital	High	
Long-term design	Incorporating the long-term in decision making	High	
	Developing long-term visions	High	
	Uncertainty about long-term effects	Low	
	Danger of a lock-in	Low	
	Determination of short-term steps	High	
Capacity development	Innovation embedding and coupling	High	
	Sufficient precaution	High	
	Diverse & community-based experimentation	High	
	Translation from science to practice	High	
	Access to resources for capacity development	High	
Level of integration	Problem-ownership	High	
	Fragmentation across administrative levels	Low	
	Fragmentation across geographical scales	Low	

6.3 QUICK SCAN OF THE MUNICIPAL SEWAGE PLAN 2016-2021

In this third sub-chapter the specified analytical framework (see table 6.4) will be applied to the Municipal Sewage Plan Amsterdam 2016-2021 (MSP; see Chapter 5.3 for an introduction of this plan). The application will be carried out as a "quick scan"; a global evaluation covering the most important aspects. The scan will provide some insights into the impact of the MSP on the transition towards a circular economy in Amsterdam. However, the application primarily functions as a test and validation of the analytical framework itself: it will show whether the analytical framework is feasible, and what problems arise during its application. This reflection will be carried out in the next sub-chapter.

The application of the specified analytical framework takes three steps. The first concerns the question whether the MSP impacts each cluster. As the plan focuses on waste water, groundwater and rainwater management of Amsterdam, the clusters relating to the drinking water production process are not impacted by the policy. Accordingly, the clusters product design, input in the production process, output of the production process and use phase will be left out of this impact assessment and thus removed from the table.

Next, the real value of the remaining criteria can be examined. For these criteria it follows the question: to what value does the MSP steer the criterion? The answer is provided based on a qualitative document analysis (see Appendix F for this background research). Accordingly, the values low, high or unknown are added to the fourth column. Unknown is added in those cases where the MSP did not deal with that criterion specifically. The results of this analysis are summarized in the table below.

Table 6.5: The Impact of the MSP on the Transition Towards a Circular Economy in Amsterdam

CLUSTERS	SPECIFIC CRITERIA: IMPACT OF EXISTING PLR ON…	DESIRED VALUE	REAL VALUE
Destination after use	Waste water generated per GDP output + Municipal waste water generated per capita	Low	Low
Closed loops	Market for second hand sales of waste water	High	Unknown
	Market for second hand sales of recovered resources	High	Unknown
	Costs of cleaning water	Low	Low
	Costs to recover resources from water	Low	Unknown
	Costs to collect water	Low	Low
	Percentage of waste water collected	High	High
	Amount of tools required to recover resources from water	Low	Unknown
New business models	Legal frameworks for CE water business models	High	Unknown
	Financial frameworks for CE water business models	High	Unknown
Waste = food	Using waste water as a product	High	Unknown
	Using waste water as a resource	High	Unknown
	Using resources from waste water as a resource	High	High
	Transporting waste water	High	Unknown
	Transporting recovered resources from waste water	High	Unknown
	Importing waste water	High	Unknown
	Importing recovered resources from waste water	High	Unknown
	Exporting waste water	High	Unknown
	Exporting recovered resources from waste water	High	Unknown

Standardization	Setting up circular water standards	High	Unknown
	Applying circular water standards	High	Unknown
	Drawbacks resulting from certification	Low	Unknown
Urban & industrial symbiosis	The number of resource recovery businesses	High	Unknown
	The connectivity within the water sector	High	Unknown
	The connectivity among water and other industries	High	Unknown
	The diversity of sectors in the urban/industrial symbioses	High	Unknown
Level playing field	Room for new actors	High	Unknown
	Fair price mechanisms	High	Low
	Transparency of the real social costs	High	Low
Focus beyond economic gain	Room for redundancy	High	High
	Access to basic water infrastructure	High	Unknown
	Inclusion of citizens in the transition	High	Unknown
	Employment rate in the water sector	High	Unknown
	Public awareness of water issues	High	Unknown
	Public acceptance of water measures	High	Unknown
	Local water initiatives	High	Unknown
	Natural water capital	High	Unknown
Long-term design	Incorporating the long-term in decision making	High	High
	Developing long-term visions	High	High
	Uncertainty about long-term effects	Low	Unknown
	Danger of a lock-in	Low	Unknown
	Determination of short-term steps	High	High
Capacity development	Innovation embedding and coupling	High	High
	Diverse & community-based experimentation (+ sufficient precaution + translation from science to practice)	High	Low-High
	Access to resources for capacity development	High	Unknown
Level of integration	Problem-ownership	High	High
	Fragmentation across administrative levels	Low	Low
	Fragmentation across geographical scales	Low	Low

The final step regards the interpretation of the completed table. Comparing the desired and real value of table 6.5 will provide an insight of the specific origin of the negative or positive impact of the MSP on the transition towards a circular economy in Amsterdam. In those instances where desired value differences significantly, the desired and real value is marked red. Whenever the real value matched the desired value, the cells are marked green.

The quick scan has demonstrated that the MSP steers three criteria in the wrong direction. Both “fair price mechanisms” and “transparency of the real costs” of the cluster “level playing field” regard the distribution of the costs for sewage activities in Amsterdam. Although the sewage levies are based on the total cost of the sewage activities, they bear no relation to the degree of causation of these costs. The MSP recognizes this is not ideal, yet no concrete measures are proposed. The third red marked criterion is the “diverse & community based experimentation” of the “capacity development” cluster. This real value has been put as "low-high". The plan elaborates on many experiments beneficial for the transition towards a circular economy, yet one part of the plan has a negative impact on this transition. The MSP states experiments about alternative sanitation methods will only take place in newly built environments and in case of large scale restructuring. No pilots will be carried out in existing built environments. Consequently, the plan neglects most of the urban areas of Amsterdam, as the majority of the city consists of existing built environments.

Noticeable is the large number of "unknowns" listed in the "real value" column. As shown in the background analysis in Appendix F, these criteria were not mentioned in the MSP. However, this does not mean the impact of the MSP on these criteria is neutral. Not mentioning certain criteria could also be a barrier for the transition as there is no policy to steer these criteria in the right direction. Further research is necessary to be able to draw conclusions on this matter.

6.4 REFLECTION ON THE APPLICATION

The application of the specified analytical framework enables the reflection on the application process. The final sub-question "*How can the analytical framework be improved according to the water governance validation process?"* can be answered by reviewing the feasibility of the process. This reflection regards two aspects: the clusters and criteria of the framework and the method of application.

During the application, several criteria of the analytical framework were merged. First of all, the criteria "waste water generated per GDP output" and "municipal waste water generated per capita" were combined. As the general aim of the policy plan is to minimize waste water, no specific distinction between the two criteria could be made. Furthermore, the three criteria "sufficient precaution", "diverse and community-based experimentation" and "translation from science to practice" were merged. This aggregation was of a more fundamental nature. It turned out "sufficient precaution" is the logical consequence of experimentation. Simultaneously, "translation from science to practice" happens automatically when an experiment is undertaken. Consequently, the criteria are inherently connected, hence cannot be examined individually. As such, they should be combined in a next version of the analytical framework.

The clusters that were eliminated beforehand and the criteria that have been marked as "unknown" are a lot harder to reflect upon. The elimination and "unknown"-markings were case specific, hence cannot be generalized directly. When applying the analytical framework to another existing policy, law or regulation, the criteria that are left out should be compared to this application to be able to draw further conclusions. The criteria might be useful for the assessment of other existing PLR, however, it could also turn out to be not relevant in general. More testing is required, by both applying the framework on more water related PLR and by translating the generic analytical framework to another policy area.

The method of application in the form of a quick scan has been conducted with the available resources (see Appendix F for the background analysis). This enabled an extra validation of the analytical framework in this thesis as it could be conducted in little time. This main advantage of the quick scan is, however, also its weakness. The speed of the application as well as the single perspective could have had an impact on the trustworthiness of the results. A method such as a Multi-Criteria Analysis (MCA) is recommended to ensure the quality of the results. This will be discussed further in the next chapter.

6.5 CONCLUSION

The application to the case of the Amsterdam water governance sector was the first step towards a well-functioning analytical framework. The analysis has offered insights concerning the opportunities and challenges for the transition towards a circular economy in this sector. Furthermore, the assessment enabled a translation from a generic to a specific analytical framework. This specific analytical framework (as depicted in table 6.4) facilitates an assessment of the impact of an existing water policy, law or regulation to the transition towards a circular economy. The existing policy plan MSP could be reviewed accordingly. This review revealed three criteria of the MSP that have a negative impact on the transition: "fair price mechanisms" and "transparency of the real costs" of the cluster "level playing field" and "diverse & community based experimentation" of the "capacity development" cluster. The specified framework and its application to the MSP together provided an answer to the fourth sub-question of this research: *How can the developed analytical framework be applied to the water governance sector?*

Besides providing an insight of the impact of the MSP on the transition towards a circular economy in Amsterdam, the application primarily functioned as a test and validation of the analytical framework. This was formulated in the fifth sub-question: *How can the analytical framework be improved according to the water governance validation process?* Content wise, several criteria[8] were merged during the research as the application process revealed they could not be reviewed individually. The reflection on the criteria that were eliminated beforehand and the criteria that have been marked as "unknown" was more difficult. As these eliminations and "unknown"-markings were case specific, they cannot be generalized directly. A final version of the analytical framework specified for the impact assessment of existing water PLR can be found in Appendix H.

Even though the application to the MSP provided valuable feedback, more testing is required to refine the framework. Two options are the application of the framework on more water related PLR and the translation of the generic analytical framework to another policy area. In addition, the method of application should be developed further. All in all, this first evaluation step appeared to be valuable, yet there are many steps to be taken. These steps will be examined in the next chapter of this thesis.

[8] This concerned the merger of the criteria "waste water generated per GDP output" and "municipal waste water generated per capita", and of "sufficient precaution", "diverse and community-based experimentation" and "translation from science to practice".

CHAPTER 7: DISCUSSION

This discussion chapter serves to further examine the research findings before arriving at the conclusions. The examination aims to position the findings in political and social context, and to elaborate on further research and measures to be taken. First, the generic and specific analytical framework[9] will be discussed. In sub-chapter 7.2, there will be reflected upon the analysis of the water governance sector. The chapter will be concluded with some broader remarks.

7.1 THE ANALYTICAL FRAMEWORK

The development and application of the analytical framework gave rise to three topics for discussion: the research's timing, scope, and stage. The first topic, the timing, came up during the interviews, and concerns what moment would be optimal to develop a framework to measure the impact of existing policies, laws and regulations (PLR) on a circular transition. It was argued it could be too early for such a research or assessment, as the circular economy is a relatively new concept and therefore lacks clear characteristics to base the framework upon. On the other hand, without assessing the impact of existing PLR on the transition, the establishment of a circular economy might be hindered and slowed down. All in all, this discussion can be described as a "chicken or the egg?-question": it is not clear which of the two should be considered as the cause and which should be considered as the effect. The analytical framework developed in this thesis has nevertheless proved it was feasible.

The second discussion item concerns the scope of the research. The analytical framework has been developed to be applied at the municipal governance level. The city of Amsterdam functioned as a clear and tangible case. Yet, the national and European level are excluded completely, although its governance, laws and regulations have a large impact on the local level. It would therefore be wise to include these higher governance levels in further research. A first step would be to review to what extent the current analytical framework is applicable to those conditions.

The third topic covers the stage of the research. In this thesis, fundamental theoretical and empirical research has been conducted to enable the development of the generic analytical framework. This comprises the first step towards a reliable and well-functioning analytical framework. A second step was taken by focussing on the Amsterdam water governance case study as a first undertaking to validate and improve the framework. The case study has provided valuable feedback, however, the research is not in its final stage. More testing and improvements are necessary to refine the analytical framework. To start with, the method of applying the framework could be enhanced. Ideally, the framework would be applied according to the multi-criteria analysis (MCA) method. An MCA offers a framework to deal with large amounts of complex data in a consistent way. It can, amongst others, be used to rank options, to identify a single most preferred option, to distinguish possibilities according to their acceptability, or to short-list a number of options. An MCA makes all options and their impacts explicit by making use of an evaluation-matrix. The most reliable result would be achieved when a group of experts conduct the analysis (Dodgson et al., 2009; Hermann et al., 2007; Khalili & Duecker, 2013). Another effective way to further test and validate the analytical framework, is to translate the framework from generic to specific again, this time to another policy area. This would increase the validity of the framework as the case studies can be compared.

[9] Generic framework: see Appendix G. Specific framework: see Appendix H.

7.2 THE WATER GOVERNANCE SECTOR IN AMSTERDAM

The main objective of the case study was to test and validate the analytical framework. In doing so, the analysis provided some valuable insights of the status quo, opportunities and challenges for the transition towards a circular economy in the water governance sector in Amsterdam. Although, a lot of the existing measures and plans could easily be positioned under the frame of circular economy, in general, the concept of the circular economy is rarely used by water governance actors to describe measures and plans for the future of water management. Besides being an unpopular term in the water sector, its specific meaning is not clear as well. Whenever the circular economy (or related concepts) is mentioned, it is more or less used as an umbrella-term for sustainability. It remains the question, however, what "circular water" denotes. Does the water itself become circular? Or do the nutrients and materials that are part of the water become circular? These clarifications are required to pave the way for a long-term vision of circular water governance.

High standards for the quality of drinking water are considered of particular importance in the water governance case. While these standards are essential to ensure the trust in, and the access to safe drinking water, they are also the Achilles heel of circular innovations in the water system. Such high and fixed standards are an obstacle for a diversification of the water system in which access is provided to water flows of differing qualities. Water of a lesser quality - typically referred to as "grey" water - could in such a case be used for purposes other than drinking water, e.g. to flush the toilet or to do the laundry.

A further remarkable aspect in the analysis of the water governance sector was the actors' predominant focus on the "second part" of the cycle (e.g. on the "destination after use" and the "waste = food). In contrast, less attention was paid to the circular adaptation of the first part of the cycle (e.g. on the "product design" and the "production process"). There seem to be two main reasons for this particular area of focus. First, the established, centralized and well-functioning water infrastructure is the starting point when planning for the future. Consequently, as often is the case, the water governance sector is locked into solutions that are in line with the current proceedings, which primarily allow for an adjustment of the second part of the cycle. Second and complementary, the current circular water activities usually focus on the recovery of nutrients, materials or energy from waste water. These are the circular activities that have the best business case, i.e. are the most lucrative. While these activities directly neglect the circular principle "focus beyond economic gain", it is understandable since the performance of actors like Waternet is (still) measured by existing (linear) standards, thus discouraging truly circular measures.

Concluding, the Amsterdam water governance case itself is quite unique in the Netherlands. In contrary to other regions, Waternet is solely responsible for the activities throughout the complete water cycle. Consequently, the Amsterdam water sector provides the ideal conditions for the circular economy. The comprehensive approach is to a certain extent inviting Waternet to pursue circular practices. Be that as it may, if Waternet is already facing difficulties to transition towards a circular economy, it is expected to be even more challenging for companies focussing either on drinking water production or waste water management.

7.3 CONCLUSION

The empirical and theoretical data collection revealed many conditions for PLR to promote the establishment of a well-functioning circular economy. Without wishing to prejudice the conclusions summarized in the next and final chapter, the conditions will be not be easy to implement. There are many factors influencing the political arena, hence influencing the impact assessment of existing PLR, as well as influencing the establishment of new PLR. Examples of these factors that arose during the interviews and in literature are the laborious collaboration between people with different (disciplinary) backgrounds, the slow pace of drafting laws and regulations and the risk-averse attitude of local authorities regarding innovations. In addition, one of the most prominent barriers is posed by the exceptional position of circular methods. As long as circularity does not become normalized, the transition will continue on the current slow pace.

CHAPTER 8: CONCLUSION

To create room for circularity, the objective of this thesis' research was to develop an analytical framework to assess the impact of existing policies, laws and regulations (PLR) on the transition towards a circular economy. In this final chapter, the main empirical and theoretical findings of the research will be summarized by answering the sub-questions (see box 8.1). Together, they will provide an answer to the main research question, which reads:

What analytical framework can be used to assess existing policies, laws and regulations regarding their impact on the transition towards a circular economy and how can this framework be applied?

The first part of this research was guided by the first and second sub-question. Based on an abductive combination of a systematic literature review and semi-structured interviews 71 criteria grouped in 17 clusters were defined, each focussing on another aspect of the CE across the micro-, meso- and governance levels of our system. The clusters are: product design; input in the production process; output of the production process; use phase; destination after use; closed loops; new business models; waste = food; standardization; urban & industrial symbiosis; level playing field; focus beyond economic gain; long-term design; capacity development; and level of integration. The analytical framework has been compiled in a table, in which the clusters and corresponding criteria were listed (see Appendix G). The desired value of each criterion was indicated, i.e. the value the existing PLR should direct towards (low-high) to create room for circularity. This analytical framework was developed from a broad notion of the circular economy and is therefore a generic framework.

Box 8.1: Sub-questions

I. **What criteria can be used to assess the impact of existing policies, laws and regulations on circular economy and other sustainability transitions?**

II. **How can the criteria be combined to develop an analytical framework for the assessment of existing policies, laws and regulations?**

III. **What actors and politics constitute the water governance sector in Amsterdam?**

IV. **How can the developed analytical framework be applied to the water governance sector?**

V. **How can the analytical framework be improved according to the water governance validation process?**

Based on an analysis of the circularity of the Amsterdam water governance sector, the generic framework could be tested and validated. The most important actors of the case are the municipality of Amsterdam, the Regional Water Authority AGV and the public company Waternet (sub-question three). The municipality has the duty of care for the collection and transport of waste water, the collection and handling of rainwater, and taking groundwater measures in public areas. AGV is responsible for the fields of flood protection, water quantity and quality, groundwater and urban waste water treatment. However, both the municipality and AGV have delegated their policy preparation, executive and administrative tasks to the public water cycle company Waternet. The urban water cycle is not necessarily compatible with the notion of a circular economy; this requires a transition from the consumption towards the temporary usage of water. In the water governance sector in Amsterdam and beyond, the concept of the "circular economy" is currently rarely used in measures and plans. Nevertheless, many of these could easily be positioned under this frame. The primary focus of the actors in the Amsterdam water governance sector currently lies on two broader aspects of water governance in a circular city: natural water management and resource recovery from waste water.

Before the analytical framework is applicable to a particular policy, law or regulation, the generic criteria have to be specified to that policy area (sub-question four). In this thesis, the analytical framework was specified to the water sector based on the analysis of the circularity of the water governance sector in Amsterdam (see Appendix H). The 17 clusters remained the same, though several criteria were adjusted. Most changes were made to the criteria belonging to the micro-level of the circular economy. This can be explained by the particular characteristics of "water as a product", which inherently impacts its design and use. Water is, for example - in contrast to many other products - biodegradable in itself. Again, the analytical framework was compiled in a table, indicating the broader clusters. Case specific instead of generic criteria were listed. The criteria that could not be translated were eliminated from the table. Besides the desired value, the "real value" of the criteria was added to the framework. This comprises the actual impact the existing policy, law or regulation has on a criterion, i.e. the direction this policy, law or regulation directs the criterion towards. Potential values would be low, high or unknown. This column has to be completed during an assessment of existing PLR.

The case study also provided some valuable insights regarding the status quo, opportunities and challenges of circularity in the Amsterdam water governance sector. First, the concept of CE appeared to be an unpopular and ambiguous term in the water sector. While circularity is currently more or less used as an umbrella-term for sustainability, a clarification is required to pave the way for a long-term vision of circular water governance. Next, while the high quality standards are essential to ensure the trust in and access to safe drinking water, these standards also pose an obstacle for a diversification of the water system in which access is provided to water flows of differing qualities. Water of a lesser quality - typically referred to as "grey" water - could in such a case be used for purposes other than drinking water, e.g. to flush the toilet or to do the laundry. Finally, the municipality of Amsterdam, AGV and Waternet predominantly focus on waste water management (the "second part" of the cycle). In contrast, less attention is paid to the circular adaptation of the first part of the cycle, e.g. the drinking water production process. The two main reasons for this particular area of focus are the lock-in to solutions that are in line with the current (non-circular) proceedings, and the lucrative nature of resource recovery.

The specified analytical framework has been applied to the Municipal Sewage Plan Amsterdam 2016-2021 (MSP) to provide an answer to the final sub-question. The analytical framework was improved according to the water governance validation process. The quick scan of the MSP showed that several criteria of the framework had to be merged to be able to conduct an optimal assessment. These criteria appeared to be connected inherently, hence cannot be examined individually. As such, they should be combined in a subsequent version of the analytical framework. The results of the reflection on the generic and specific analytical framework have been incorporated into the final versions of both frameworks (see Appendix G and H).

In sum, this thesis has provided fundamental theoretical and empirical research that enabled the development of a well-functioning and reliable framework to conduct an impact assessment of existing PLR on the transition towards a CE. It is recommended to conduct further research to refine the framework. A first option would be to enhance the application method of the framework. Ideally, the framework would be applied as multi-criteria analysis (MCA). An MCA offers a method to deal with large amounts of complex data in a consistent way. It makes all options and their impacts explicit by making use of an evaluation-matrix. The most reliable result would be achieved when a group of experts conducts the analysis. Another effective way to further test and validate the analytical framework is to translate the framework from generic to specific again, this time to another policy area. This would increase the validity of the framework as the case studies can be compared. Ultimately, this results in a framework that allows governmental actors to conduct an impact assessment of all existing PLR to, along the way, create room for circularity.

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APPENDIX A: SYSTEMATIC LITERATURE REVIEW

This systematic literature review has been conducted according to the description in sub-chapter 3.2.1. The literature presented in the table below will be reviewed. In the review, the key characteristics of the literature as well as the main findings will be presented.

Table A.1: List of Literature for the Systematic Literature Review

NR	AUTHOR	YEAR	TITLE
1	EMF	2016	Characteristics
2	EMF	2013	Towards the Circular Economy: Economic and business rationale for an accelerated transition. Volume 1
3	EMF	2015	Circularity Indicators: An Approach to Measuring Circularity: Project Overview
4	EMF	2015	Delivering the Circular Economy: A Toolkit For Policymakers
5	CE et al.	2015	Amsterdam Circular: Vision & Agenda
6	Evans & Bocken	2013	The Circular Economy Toolkit
7	Rli	2015	Circular Economy: From Wish to Practice
8	IenM	2016	Smart Regulation for Green Growth
9	TNO	2013	Opportunities for the Circular Economy in the Netherlands
10	SIRA	2013	Removing Barriers in the Biobased Economy
11	EMF	2016	Denmark: Taskforce for Resource Efficiency
12	Geng et al.	2012	The National Circular Indicator System in China
13	Metabolic	2016	Spaarndammertunnel Circulair
14	Loorbach & Rotmans	2006	Managing Transitions for Sustainable Development
15	VROM	2000	National Environmental Policy Plan 4
16	Kemp & Rotmans	2005	The management of the co-evolution of technical, environmental and social systems
17	Wolfram	2016	Conceptualizing urban transformative capacity: A framework for research and policy
18	Kemp et al.	2007	Assessing the Dutch energy transition policy

LITERATURE REVIEW OF CIRCULARITY AT THE MICRO-LEVEL

Measuring circularity at the mico-level will be explored by discussing relevant literature and covering this topic. The literature discussed in this sub-chapter focusses on the so-called niches in which circular innovations are created, tested and diffused. Examples of these novelties are new organizations, new technologies, new rules and legislation and new projects, concepts or ideas. Studies that have identified criteria to measure circularity on this level will be introduced briefly, where after those criteria will be introduced.

1: CHARACTERISTICS – EMF

Number	**1**
Author	Ellen MacArthur Foundation
Title	Characteristics
Year	2016
Benchmark	Published by an existing and recognized organization

The Ellen MacArthur Foundation has developed five fundamental characteristics that describe a pure circular economy (EMF, 2016a). These characteristics are:

- ❖ Design out waste: By redesigning products, technical and biological nutrients can be reduced, reused and recycled.
- ❖ Build resilience through diversity: Modularity, versatility and adaptivity needs to be included in the design of products and product chains. This enhances the resilience of the systems within the circular economy.
- ❖ Work towards energy from renewable sources: The entire system should be able to run on renewable energy.
- ❖ Think in systems: Crucial for a well-functioning circular economy is the understanding of the mutual influence of different parts of the system. The different elements have to be considered in relation to their environmental and social contexts.
- ❖ Think in cascades: Value is created by closing loops. The different allocations and utilizations of the biological and technical nutrients have to be considered.

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2: TOWARDS THE CIRCULAR ECONOMY - EMF

Number	2
Author	Ellen MacArthur Foundation
Title	Towards the Circular Economy: Economic and business rationale for an accelerated transition. Volume 1
Year	2013
Benchmark	Published by an existing and recognized organization

A first attempt to measure circularity has been done by the Ellen MacArthur Foundation in 2013. The "Circular Calculator" analysis they developed compares the inputs needed to make a new "linear" product with those needed to make the same product according to circular economy principles (EMF, 2013). The Circular Calculator focuses on five key areas of economic and environmental impact, namely:

- ❖ Material inputs: Comparison of the material intensity of a 'linear' version (discarded by its first owner), with the material intensity of a 'circular' version (calculated and factored in the various forms of circular options reuse, refurbishing, remanufacturing, recycling).
- ❖ Labour inputs: Comparison of the labour required to make a new product versus the labour required to make a circular loop (i.e., to refurbish, remanufacture, recycle, or reuse).
- ❖ Energy inputs: The difference in energy required to make a linear product versus a circular product.
- ❖ Carbon emissions: **T**he carbon footprint of the process of manufacturing a linear product versus the emissions generated to make a circular loop.
- ❖ Balance of trade: The inputs that are imported into the European Union, for the production process of both linear and circular versions.

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3: CIRCULARITY INDICATORS – EMF

Number	3
Author	Ellen MacArthur Foundation
Title	Circularity Indicators: An Approach to Measuring Circularity: Project Overview
Year	2015
Benchmark	Published by an existing and recognized organization

Due to lacking recognized ways to measure circularity, the Ellen MacArthur Foundation set up a project to develop indicators that be used to estimate the circularity of products and businesses (EMF, 2015a). The

Foundation developed these indicators specifically to be used for internal reporting or for procurement and investment decisions. However, they state that variants or extensions of the indicators could also be used in research, education, rating or policy making. The primary focus of the project was the quantification of the restoration of material flows and the development of a Material Circularity Indicator (MCI). Complementary indicators were included to cover other considerations, such as toxicity, scarcity and energy.

The project concluded that the inputs that have to be used to calculate the MCI are:

- ❖ Input in the production process: The relative amount of input originating from virgin and recycled materials as well as reused components.
- ❖ Utility during use phase: The amount of time the product is used compared to an industry average product of similar type. This includes the intensity of use, durability of products, repair and maintenance and shared consumption.
- ❖ Destination after use: The amount of material that goes into landfill or energy recovery, is collected for recycling and the amount of components collected for reuse.
- ❖ Efficiency of recycling: The efficiency of the recycling processes concerning the production of recycled input and to recycle material after use.

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4: DELIVERING THE CIRCULAR ECONOMY – EMF

Number	4
Author	Ellen MacArthur Foundation
Title	Delivering the Circular Economy: A Toolkit For Policymakers
Year	2015
Benchmark	Published by an existing and recognized organization

Aiming to provide policy makers with a toolkit to help accelerate the transition towards the circular economy, the Ellen Macarthur Foundation produced a report about the circular economy from a country and policy makers perspective. In this report, they proposed a simplified[10] method to baseline a country's level of circularity. The four key circularity areas and their indicators are (EMF, 2015b, pp. 42-44):

- ❖ Resource productivity: This circularity area covers the resource efficiency by measuring the indicator GDP (Euro) per kg of domestic material consumption. A potential drawback of this metric the influence of the industrial structure of a country on the domestic material consumption. As such, that weight does not necessarily reflect environmental costs.
- ❖ Circularity activities: Ideally, this area is measured by a full set of indicators including sharing and the adoption of remanufacturing. Since this data is not readily available, two proxy indicators were selected. The first one is the recycling rate, of which the major mineral waste is excluded and is adjusted for trade. Measured as tonnes recycled per tonnes treated (percent). The second proxy indicator is the eco-innovation index, which is measured according to the Eco-Innovation Scoreboard (Eco-IS). This scoreboard applies a variety of in total 16 indicators to capture the different aspects of innovation (see Giljum and Lieber (2016) for more information).
- ❖ Waste generation: The overall waste generation is measured with two metrics, that together reflect waste generation from both industries and consumers. As for the resource productivity, the same caveats account. The first indicator is the waste generated per GDP output, excluding major mineral waste, measured in tonnes recycled / ton treated (percent). Second, the municipal waste generated per capita is measured in kWh/kWh (percent).

[10] The authors acknowledge this method is neither comprehensive nor a firm recommendation. They however want to propose a baselining method that can be executed within reasonable time and effort (EMF, 2015b).

- ❖ Energy and greenhouse gas emissions: The indicators corresponding with this relatively straightforward circularity area are the share of renewable energy (percent of gross final energy consumption) and the GHG emissions per GDP output (tonnes CO2e/EUR million).

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5: AMSTERDAM CIRCULAR: VISION & AGENDA – CE, TNO & FABRIC

Number	5
Author	CE, TNO & FABRIC
Title	Amsterdam Circular: Vision & Agenda
Year	2015
Benchmark	Published by existing and recognized organizations

The municipality of Amsterdam has outlined seven principles according to which they work towards a transition. In other words, these principles represent the political cultures and trends at the municipality of Amsterdam level, which directly influences the regime and niches by defining the room and direction for change. These formulated principles are (CE et al., 2015a):

- ❖ Close-looped cycles: All materials enter into an infinite technical or biological cycle.
- ❖ Renewable energy: All energy comes from renewable sources.
- ❖ The value of resources: Resources are used to generate (financial or other) value.
- ❖ Product design: Modular and flexible design of products and production chains increase adaptability of systems.
- ❖ New business models: New business models for production, distribution and consumption enable the shift from possession of goods to (use of) services.
- ❖ Logistics: Logistics systems shift to a more region- oriented service with reverse-logistics capabilities.
- ❖ Positive contributions of human activities: Human activities positively contribute to ecosystems, ecosystem services and the reconstruction of "natural capital".

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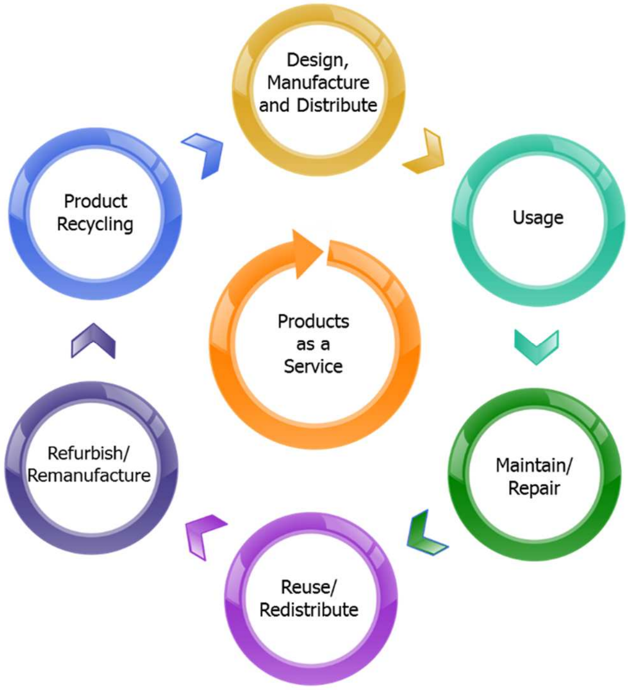
6: THE CIRCULAR ECONOMY TOOLKIT – EVANS & BROCKEN

Number	6
Author	Evans & Bocken
Title	The Circular Economy Toolkit
Year	2013
Benchmark	Published by an existing and recognized university

In a lot of cases businesses have a hard time to visualise how their company would function within a circular economy. Researchers from the Institute for Manufacturing of the University of Cambridge have developed an assessment tool to help businesses to identify new circular opportunities. The toolkit is broken down in seven key areas, each consisting of a wide range of indicators (Evans & Bocken, 2013):

- Design, manufacture and distribute: Amount of materials wasted in the production process, biodegradability of the materials and product, material characteristics (scarcity, eco-efficiency, toxicity), percentage of waste in the production process.
- Usage by the customer: Number of product failures, life-time of the product, required amount of energy and resources for usage.
- Repair and maintenance of the product: Repair costs vs. production costs, availability of maintenance or repair service, access to internal workings, complexity of workings, standardization of components of the product, ease to find the fault.
- Reuse and redistribution of the product: Market for second hand sales, life-time of the product.
- Remanufacturing and refurbishment of product or part: costs of remanufacturing/refurbishment, costs to collect and return, percentage of products returned, ease to disassemble, damage during disassembly, ease to identify parts, modularity of parts, possibility to upgrade parts, amount of mechanical connections, amount to tools required to disassemble.
- Products as a service: Market to sell products as a service, amount of products sold as a service.
- Product recycling at end of life: Number of material combinations, encased materials.

Figure A.2: 7 Key Areas for Circular Opportunities



Source: Evans and Bocken (2013).

LITERATURE REVIEW OF CIRCULARITY AT THE MESO-LEVEL

This paragraph explores literature about circularity within dominant cultures, structures and practices that together constitute the meso-level, or regime. Examples of physical and immaterial infrastructures that embody this meso-level are roads, power grids, routines, actor-networks, power relationships and regulations. Each study will be introduced briefly where after the proposed criteria will be outlined.

7: CIRCULAR ECONOMY: FROM WISH TO PRACTICE – RLI

Number	7
Author	Dutch Council for the Environment and Infrastructure (Rli)
Title	Circular Economy: From Wish to Practice
Year	2015
Benchmark	Published by an existing and recognized organization

In 2015, the Dutch Council for the Environment and Infrastructure (*Raad voor de leefomgeving en infrastructuur;* Rli*)* distinguished six major barriers specifically for the Dutch transition towards a circular economy that have to do with current Dutch legislation and regulation. While not all of them can be applied directly to the case study in this thesis, they are certainly relevant as contextual information. The barriers legislative barriers this council listed are (Rli, 2015):

- ❖ European and national competition policy: While being determining for a circular economy, intensive cooperation within product chains is often not permitted. Dutch and European legislation aims to prohibit cartel forming and the abuse of dominant positions to protect consumer interests.
- ❖ According to the law, waste is not a product nor a resource: These laws aim to protect the environment and public health. However, this impedes the organization of important aspects of the circular economy, such as waste collection and cross-border transport.
- ❖ Relatively high taxes on labour: Labour is currently taxed heavily, especially compared to natural resources and materials. This tax system supports the linear principles, as this makes new products and materials in a lot of cases the cheapest option.
- ❖ Property-based legal frameworks: The concept of leasing, elemental for the circular economy, still has legal ambiguities regarding ownership. There exists no legal framework focussing on "circular" ownership.
- ❖ Financial frameworks: The prevailing financial frameworks are not compatible with the circular economy. The most important example concerns the current purchasing or rental rules, that are inadequate for the performance based contracting of products (viz. everything is amortised to a residual value of zero, without taking into account the value of the remaining materials in the product).
- ❖ European Waste Shipment Regulation (EWSR): This directive is a barrier for the cross-border transport of valuable secondary raw materials. It results in a high administrative burden and an un-level playing field due to differences in interpretation and enforcement in the various European countries.

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8: SMART REGULATION FOR GREEN GROWTH – IENM

Number	8
Author	Dutch Ministry of Infrastructure and the Environment (IenM)
Title	Smart Regulation for Green Growth
Year	2016
Benchmark	Published by an existing and recognized organization

The Dutch Ministry of Infrastructure and the Environment (*Ministerie van Infrastructuur en Milieu*, or IenM) has launched a program called "Smart Regulation for Green Growth" (*Ruimte in Regels voor Groene Groei*) that aims to remove regulatory obstacles in favour of green innovation and investments necessary for a bio-based and circular economy. Within the program, a multidisciplinary and interdepartmental team collects the barriers and initiates pathways to realize solutions. While sometimes an operational or solution might be sufficient, sometimes fundamental and structural barriers ask for the adjustment of policies and regulations (IenM, 2015a, 2016a).

The program searches for barriers resulting from policies and regulations according to multiple topics. These are (IenM, 2016b):

- ❖ Sharing economy: A socio-economic trend concerning the sharing of human, physical and intellectual resources. The focus moves away from ownership towards use and access.
- ❖ Implementation: Although policy is adjusted to remove potential barriers, proper implementation of the new policy might be lacking. This can be caused by lack of knowledge, risk-averse behaviour and the execution and control of regulations.
- ❖ Waste transport: The aforementioned EWSR directive is a barrier for the cross-border transport of valuable secondary raw materials.

- REACH: is the abbreviation for the European Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals. It aims to minimize the environmental and health risks posed by chemicals (EC, 2017). This regulation sometimes clashes with the aim of the circular economy to reuse and recycle as many components and materials as possible.
- Financing: It is difficult to get funding for circular business cases. Partly because of a general tendency towards increasingly strict rules, yet also due to particular reasons such as a high degree of uncertainty and unpredictability.
- Duties & taxes: Business entrepreneurs often experience the costs for these taxes as barrier for their business case. Most duties and taxes are determined by international organisations, like the WTO or the EU.
- Certification: While certifications and the corresponding standardization can stimulate innovations, entrepreneurs (especially from the SMEs) often experience drawbacks caused by these standards.
- Level playing field: About a quarter of the barriers encountered by the Smart Regulation for Green Growth intersects with the issues relating to a level playing field. These barriers can be divided in four broader themes: Dutch vs. foreign companies; SMEs vs. big business; activities higher or lower in the cycle; and fossil vs. non-fossil raw materials.
- Food: Entrepreneurs are working with new and efficient sources for food. Simultaneously, the food packaging industry is innovating as well. While lots is possible technically, the (waste) laws and regulations are often unclear or too strict.
- Green construction: In many cases, construction laws and regulations are not stimulating for green construction. Examples are the rather expensive but required life cycle assessments and lack of knowledge.
- Wood: Wood can be seen as an important renewable resource in a green economy. It can be used as construction material, to fabricate products, and to generate energy at the end of the life cycle. However, sustainable wood is increasingly scarce, hence the material should be cascaded as often as possible. Current laws and regulations oppose drawbacks to cascading wood.
- Manure & fermentation: Strict European regulations form barriers towards The European Commission forbids the use of fertilizer substitutes as a high-quality application for mineral concentrate and digestate.
- Waste or no waste: The European Waste Framework Directive consists of rules that determine when a material or product is seen as waste. This Directive is often a barrier for the circular businesses, as it unintentionally obstructs reuse and recycling.
- North Sea Resources Roundabout: This comprises a partnership between the Netherlands, the UK, Germany, France and Belgium aiming to align the interpretation of and control on regulations concerning (raw) resources. This is supposed to encounter barriers caused by transnational waste legislation.
- Nature & biodiversity: Green entrepreneurs experience barriers when playing their parts in the protection of nature and biodiversity.

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9: OPPORTUNITIES FOR THE CIRCULAR ECONOMY IN THE NETHERLANDS – TNO

Number	9
Author	Netherlands Organisation for Applied Scientific Research (TNO)
Title	Opportunities for the Circular Economy in the Netherlands
Year	2013
Benchmark	Published by an existing and recognized organization

The non-profit knowledge organisation Netherlands Organisation for Applied Scientific Research (*Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek*, or TNO) published an extensive report about the opportunities for the circular economy in the Netherlands in 2013. In the context of this research, TNO consulted and interviewed experts in the field where after they found three series of barriers concerning policy. Firstly, they found four barriers within current policy for the upcycling of biotic residue flows (TNO, 2013, pp. 64-65):

- Level playing field fossil versus biotics: There is currently no level playing field for fossil and biotic raw materials and their applications. Biotic materials and their applications are unevenly taxed (e.g. import levies and excise duties) compared to fossil fuels and products based on fossil fuels.
- Overcapacity of waste incinerators: This overcapacity is a barrier for the potential upcycling of waste flows.
- Regulations concerning food safety: These often strict regulations hinder the potential use of resources and energy from biotic residue flows.
- Regulations concerning minerals: These regulation currently impede the use of digestate from bio-digester as fertilizer replacement.

The second series of barriers of the study by TNO also consisted of four policy related barriers, this time opposing an increase of the abiotic economy (2013, p. 65):

- Complexity of the regulations regarding export and import of residue flows: Regulations differ a lot per product group, which complicates the recycling from e.g. plastic from electronic devices.
- The waste electronic and electric equipment (WEEE) directive: This directive focuses on a certain target weight of collected waste, rather than on the value of the materials. Consequently, recycling of scarce materials is not stimulated sufficiently, as there are little amount per product.
- Subsidy schemes: Current subsidy schemes mostly focus on the purchase of sustainable products, while circular behaviour (e.g. sharing products) is ignored.
- Import of used products for the purpose of recycling: Importing shiploads of products after their first stage of life is currently not allowed due to an ambiguity about the rules regarding processing. It is unclear whether this is caused by unclear regulations, lack of knowledge or incorrect execution of regulations.

Finally, the report states four general barriers opposed by laws and regulations in the Netherlands (TNO, 2013, pp. 63-64):

- Risk-averse attitude of local authorities regarding innovation: Companies and civilians experience a risk-averse attitude from local authorities regarding granting permits for unknown and new technologies.
- Lack of consistency of the government regarding possible incentives: These incentives are relatively instable and dependent on the political climate.
- Slow completion time of drafting of legislation and regulations: The pace of the (launching of products on the) market is much faster than the development of new laws and regulations.
- Paradigm of waste legislation: The current paradigm is 'we must get rid of waste', rather than 'waste is food'.

10: REMOVING BARRIERS IN THE BIOBASED ECONOMY – SIRA

Number	10
Author	SIRA
Title	Removing Barriers in the Biobased Economy
Year	2013
Benchmark	Published by an existing and recognized organization

Prior to transitioning towards a circular economy, the Dutch government had stated to support a transition towards a biobased economy (BBE). Since "biobased" can be seen as an important part of the circular economy, the regulatory barriers that have been identified concerning a transition towards a BBE are extremely relevant for the topic of this thesis. Three fundamental barriers for this transition are (SIRA, 2013, pp. 16-17):

- Certification and sustainability: The high costs of getting certified and the corresponding requirements for the production and management hamper innovation. In addition, not all companies experience an economic surplus due to the certification.
- Level playing field: As BBE is a new sector, companies focussing on the BBE experience an un-level playing field caused by existing laws and regulations. This concerns the topics: BBE companies versus companies using fossil resources, BBE companies investing in the Netherlands versus investing in foreign countries, BBE companies who want to upscale the use of biomass versus companies using biomass for energy production, and small and medium-sized enterprises (SMEs) versus large enterprises within the BBE.
- Excise duties and taxes: These policy instruments steer economic activities and generate income for the governmental. Entrepreneurs call especially the excise duty on bioethanol as a barrier for its use as a raw material in the BBE.

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11: DENMARK: TASKFORCE FOR RESOURCE EFFICIENCY – EMF

Number	11
Author	Ellen MacArthur Foundation
Title	Denmark: Taskforce for Resource Efficiency
Year	2016
Benchmark	Published by an existing and recognized organization

The afore described research Toolkit for Policymakers is currently being applied in a pilot study in Denmark. A Taskforce on Resource Efficiency has been set up to identify barriers in existing regulations to resource productivity and circular economy practices, and to propose options how to overcome them (EMF, 2015b). Although the research program is not finished yet, the preliminary findings show four areas the focus might lie (EMF, 2016c):

- Import/export of waste: There are significant barriers to start trading secondary raw materials because of existing regulations or differing interpretations.
- Take-back of products and/or packaging: Regulation governing the collection of more than one product is onerous.
- Definition of waste: Identical products can be subject to different regulations when one is made from virgin materials and the other is made from recycled materials: the process of using waste as a resource is classified as waste handling.
- Product design: Current eco-design regulations do not sufficiently address resource efficiency and circular economy aspirations.

12: THE NATIONAL CIRCULAR ECONOMY INDICATOR SYSTEM IN CHINA – GENG ET AL.

Number	12
Author	Geng, Fu, Sarkis & Xue
Title	The National Circular Indicator System in China
Year	2012
Benchmark	Published in a credible, peer-reviewed scientific journal

China is the one and only country in the world that has developed and implemented an indicator system for the circular economy on a national level. Geng et al. first describe the four criteria that together constitute the current CE Indicator System in China (2012, p. 219):

- Resource output: This indicator group refers to the amount of GDP produced from resource consumption. A higher score means higher material efficiency.
- Resource consumption: These indicators refer to the amount of resourced consumed per unit product or per unit GDP. A higher score corresponds with relatively higher consumption of water, material and energy.
- Integrated resource utilization: This group refers to the level of material recycling. A higher score reflects increased material recycling, i.e. more closed loops.
- Waste disposal and pollutant emissions: This indicator group represents the total amount of waste disposal plus the emissions of key pollutants. A higher score stands for a more efficient circular performance.

The authors continue by arguing several indicators are lacking. They make a case to add the following indicators to the national CE indicator system (Geng et al., 2012, pp. 221-222):

- Social indicators: As the practical implementation of the circular economy has a direct effect on and involves environmental, economic and social dimensions, these aspects should be addressed as well. Potential indicators could be environmental justice issues, employment rate through circular economy efforts, and the degree of public awareness.
- Urban/industrial symbiosis indicators: Both urban and industrial symbiosis are key activities to reach a successful transition towards a circular economy. Industrial symbiosis can aid firms to use inputs that are not specific to any particular industry, e.g. reuse and recycling of municipal solid waste (MSW), accounting services, shared public infrastructure and labour market. Urban symbiosis constitutes an extension towards industrial symbiosis, as it includes the use of byproducts ("waste") from urban areas as an alternative source for materials or energy in industrial operations. Exemplary indicators would be the total number of scavenger and decomposer business, connectivity among different industries, diversity of industrial sectors involved in the urban/industrial symbioses activities, etc.
- Business indicators: Promotion, production and design by businesses play a key role in the transition towards a circular economy. Indicators that evaluate the performances of businesses could function as an incentive and driver to make (more) internal changes.
- Absolute material/energy reduction indicators: Most current indicators measure in relative numbers. However, these may only tell part of the story. Absolute indicators would complement the measurements by offering another perspective to the story.
- Prevention-oriented indicators: The existing indicators focus on reuse and recycle dimensions. This has, however, ignored the prevention perspective to a large extent.

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13: SPAARNDAMMERTUNNEL CIRCULAIR – METABOLIC

Number	13
Author	Metabolic
Title	Spaarndammertunnel Circulair
Year	2016
Benchmark	Published by an existing and recognized organization

Based on a systems perspective, the Amsterdam based consulting firm Metabolic has formulated an integral framework to assist cities NGOs and companies to understand how they can exploit strategic opportunities for accelerating sustainability goals and transition toward a circular economy. These seven performance characteristics of a circular economy are (Metabolic, 2016b):

- Materials & water: Ideally, materials are kept in closed cycles infinitely and re-used in the highest quality as possible. Priority is given to the preservation of material complexity, meaning it is aimed to use high-quality products, components and parts as long as possible, before they are recycled as raw materials. Scarce materials are reused in shorter cycles so that they continue to be available for different functions.
- Energy: Energy comes from renewable sources. Use and waste of energy is kept as low as possible.
- Biodiversity: Economic activities should strengthen ecosystems and natural capital (i.e. the natural systems we make use of), instead of affecting the biodiversity negatively through these activities.
- Civil society & culture: Activities of the economy support and maintain social and cultural values.
- Health & wellbeing: Economic activities support human health and wellbeing. Toxic or hazardous substances that could harm human health and well-being are avoided and employees have a healthy work environment and fair wages.
- Promotion of various types of values: Raw materials are not only used for the purpose of creating financial value, but also for other kinds of value. For example to enhance social networks or natural capital.
- Resilience & adaptivity: Economic structures are set up to be resilient and adaptive. Any disruptions or impacts on the system are ideally absorbed by the resiliency, resulting in the minimization of the risk of the system to collapse.

LITERATURE OVERVIEW OF CIRCULARITY AND GOVERNANCE

Finally, the organization, management and governance of circular and other sustainability transitions will be explored. Literature on sustainability transitions, transition management and strategic niche management will be analysed to give an overview of possible criteria measuring the impact of existing policy on a sustainability transition. Again, the studies will be introduced briefly before describing the criteria.

14: MANAGING TRANSITIONS FOR SUSTAINABLE DEVELOPMENT – LOORBACH & ROTMANS

Number	14
Author	Loorbach & Rotmans
Title	Managing Transitions for Sustainable Development
Year	2006
Benchmark	Published in a credible, peer-reviewed scientific journal

Transition management is oriented towards long-term sustainability goals, as elaborated upon in Chapter 2.3. Loorbach & Rotmans (2006) wrote a book chapter on the challenge of sustainable development, and the management of transitions towards sustainability. They introduced two criteria according to which existing and possible policy (actions) should be evaluated against:

- ❖ Content goal: The immediate contribution of the policy to policy goals. This could for example be measured in terms of kilotons of CO2 reduction or reduced vulnerability through climate change adaptation measures.
- ❖ Process goal: The contribution of the policy to the overall transition process. While regular policy processes are flow oriented and gradual, transition management requires policy to be oriented towards both system improvement (improvement of an existing trajectory) and system innovation (representing a new trajectory of development or transformation).

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15: NATIONAL ENVIRONMENTAL POLICY PLAN 4 – VROM

Number	15
Author	VROM
Title	National Environmental Policy Plan 4
Year	2000
Benchmark	Published by an existing and recognized organization

The Dutch Ministry of Housing, Spatial Planning and the Environment (*Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer* or VROM; currently: IenM) identified seven barriers to sustainability in their fourth national environmental policy plan (NPM4) in 2001. The NMP4 was distinct compared to previous Dutch environmental policy plans; for the first time it took a long-term scope. Rather than looking four years into the future, it covered a time frame of the upcoming 30 years, while assessing the achievements of the past 30 years. The barriers to sustainability as identified in the NMP4 are (VROM, 2001):

- ❖ Unequal distribution: Poverty causing irresponsible environmental management.
- ❖ Short-term thinking: Both in politics as well as in business.
- ❖ Fragmentation: In policies, causing institutional deficits.
- ❖ False price mechanisms: Prices do not reflect external costs of environmental degradation.
- ❖ Lacking problem-ownership: Actors causing problems do not own the problem; they are not responsible for the solution of those problems.
- ❖ Uncertainty of system change: Solutions involving system changes are surrounded with great uncertainty
- ❖ Insufficient precaution: Corresponding with the criteria "short-term thinking" and "false price mechanisms", are decisions made with insufficient precaution. Especially in case of unclearity about the future effects of a decision.

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16: THE MANAGEMENT OF THE CO-EVOLUTION OF TECHNICAL, ENVIRONMENTAL AND SOCIAL SYSTEMS – KEMP & ROTMANS

Number	16
Author	Kemp & Rotmans
Title	The management of the co-evolution of technical, environmental and social systems
Year	2005
Benchmark	Published in a credible, peer-reviewed scientific journal

Transition management offers an approach for policy making that enables a sustainability transition. Kemp and Rotmans (2005) listed three conditions (existing) policy needs to comply to in order to make room for this transition. Policy needs to contain:

- ❖ Long-term vision: functions as a framework and a frame for formulating short-term and long-term objectives and evaluating existing policy.
- ❖ Framework for the alignment of short-term goals and policies to long-term visions: long-term visions that function as a framework and a frame for formulating short-term and long-term objectives and evaluating existing policy.
- ❖ Room for new actors: Via a process of so-called niche participation, new players who are as yet insignificant but who may become important in the future should become involved in the process.

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17: CONCEPTUALIZING URBAN TRANSFORMATIVE CAPACITY – WOLFRAM

Number	17
Author	Wolfram
Title	Conceptualizing urban transformative capacity: A framework for research and policy
Year	2016
Benchmark	Published in a credible, peer-reviewed scientific journal

In a recent paper, Wolfram (2016) combined the transition theories with the recognition that cities are crucial for sustainability transitions to come about. Accordingly, he developed a framework to analyse the so-called urban transformative capacity: the ability to adapt to external shocks and pressures by generating means of governing the process of industrial change. The purpose of transformative capacity development is widely recognized as to enable and drive systemic change towards sustainability. The 10 key components and development factors of Wolfram's framework are:

- ❖ Inclusive and multiform urban governance: Consisting of participation & inclusiveness, diverse governance modes & network forms and sustained intermediaries & hybridization.
- ❖ Transformative leadership: In the public, private and civil society sectors.
- ❖ Empowered and autonomous communities of practice: place-based and/or issue-driven, addressing social needs and motives.
- ❖ System(s) awareness and memory: active development of new knowledge, system is subject to dedicated analysis, knowledge is openly shared, path dependencies are recognized.
- ❖ Urban sustainability foresight: Diversity and transdisciplinary co-production of knowledge, collective vision for radical sustainability changes, collective vision for radical sustainability changes.
- ❖ Diverse community-based experimentation with disruptive solutions: place-based and/or issue-driven by communities of practice.
- ❖ Innovation embedding and coupling: Access to resources for capacity development, planning and mainstreaming transformative action, reflexive and supportive regulatory frameworks.
- ❖ Reflexivity and social learning: On all dimensions of urban transformative capacity development.
- ❖ Working across human agency levels: Capacity development addresses multiple levels of agency in the public, private and civil society sectors.
- ❖ Working across political-administrative levels and geographical scales: Capacity development reflects interactions between political-administrative levels and between geographical scales.

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18: ASSESSING THE DUTCH ENERGY TRANSITION POLICY – KEMP, ROTMANS & LOORBACH

Number	18
Author	Kemp, Rotmans & Loorbach
Title	Assessing the Dutch Energy Transition Policy
Year	2007
Benchmark	Published in a credible, peer-reviewed scientific journal

The limitations of capacities of political steering and governance with regards to sustainable development have been discussed by Kemp et al. (2007). Applying transition management to the case of the Dutch energy transition, they distinguished six interrelated potential problems that could limit the capacities for steering:

- Ambivalence about goals: Almost every complex societal problem has to deal with dissent on goals, values and means. It is hard to solve this problem, but reducing or clarifying it, is certainly possible.
- Uncertainty about long-term effects: This relates to the limited knowledge of ecological cause-and-effect relations. It is both unclear what will happen because of ecological changes and what the effect of interventions and socio-technical transformations will be.
- Distributed power of control: As in any democratic state, control power is not centralized. Rather, it is distributed amongst various actors with different beliefs, interests and resources, within the government and beyond. The logical question is how this diversity can be utilized for long-term societal change.
- Political Myopia: This criterion deals with the duration of a transition, which in most cases takes at least one generation (25 years) to come about.
- Determination of short-term steps for long-term change: It is often unclear which short-terms steps are necessary for particular long-term change.
- Danger of a lock-in: When taking decisions, there is the danger to get linked into particular solutions that are non-optimal from a longer term perspective. This can, for example, be avoided by creating a portfolio in the context of a transition agenda and having a shared consensus about the need for change and the overall direction of that change.

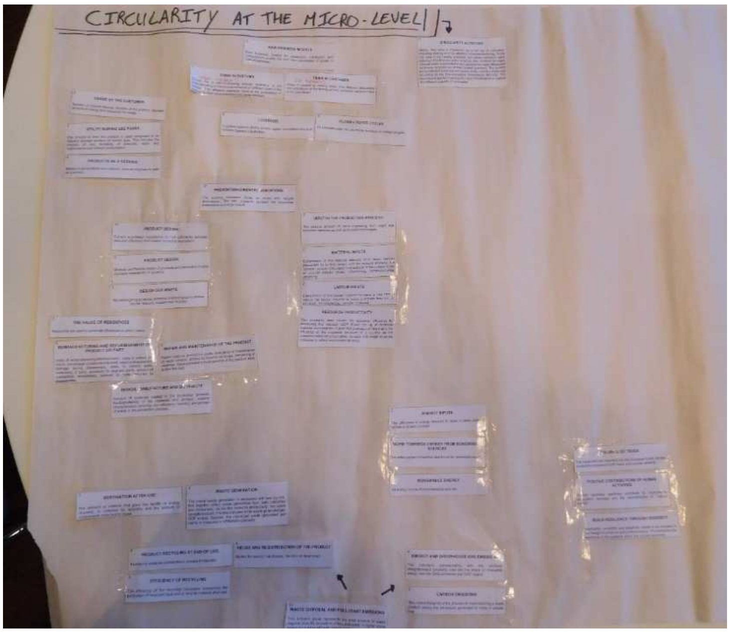
APPENDIX B: CLUSTER ANALYSIS

This cluster analysis has been carried out based on the systematic literature review (see Appendix A) and the interviews. The cluster analysis started with a brainstorm session with fellow Master students at the AMS Institute in Amsterdam. See Chapter 3.2.3 for a further explanation of this research method.

CLUSTER ANALYSIS AT THE MICRO-LEVEL

CLUSTER: PRODUCT DESIGN

Figure B.1: Results Brainstorm Session Criteria Clustering Micro-level



- 1: Design out waste: By redesigning products, technical and biological nutrients can be reduced, reused and recycled.
- 1: Product design: Modular and flexible design of products and production chains increase adaptability of systems.
- 5: Product design: Modular and flexible design of products and production chains increase adaptability of systems.
- 5: The value of resources: Resources are used to generate (financial or other) value.
- 6: Design, manufacture and distribute: Amount of materials wasted in the production process, biodegradability of the materials and product, material characteristics (scarcity, eco-efficiency, toxicity), percentage of waste in the production process.
- 11: Product design: Current eco-design regulations do not sufficiently address resource efficiency and circular economy aspirations.

++

CLUSTER: INPUT IN THE PRODUCTION PROCESS

- 1: Work towards energy from renewable sources: The entire system should be able to run on renewable energy.
- 2: Material inputs: Comparison of the material intensity of a 'linear' version (discarded by its first owner), with the material intensity of a 'circular' version (calculated and factored in the various forms of circular options reuse, refurbishing, remanufacturing, recycling).
- 2: Labour inputs: Comparison of the labour required to make a new product versus the labour required to make a circular loop (i.e., to refurbish, remanufacture, recycle, or reuse).

- 2: Energy inputs: The difference in energy required to make a linear product versus a circular product.
- 3: Input in the production process: The relative amount of input originating from virgin and recycled materials as well as reused components.
- 4: Resource productivity: This circularity area covers the resource efficiency by measuring the indicator GDP (Euro) per kg of domestic material consumption. A potential drawback of this metric the influence of the industrial structure of a country on the domestic material consumption. As such, that weight does not necessarily reflect environmental costs.
- 5: Renewable energy: All energy comes from renewable sources.
- 5: The value of resources: Resources are used to generate (financial or other) value.
- 12: Absolute material/energy reduction indicators: Most current indicators measure in relative numbers. However, these may only tell part of the story. Absolute indicators would complement the measurements by offering another perspective to the story.
- 13: Energy: Energy comes from renewable sources. Use and waste of energy is kept as low as possible.
- D: Waste legislation: This is very important. It was implemented with the best intentions, but is not compatible with a fully developed circular economy. When following the law to the letter, it forbids the recycling of waste.

++

CLUSTER: OUTPUT OF THE PRODUCTION PROCESS

- 2: Carbon emissions: **T**he carbon footprint of the process of manufacturing a linear product versus the emissions generated to make a circular loop.
- 4: Energy and greenhouse gas emissions: The indicators corresponding with this relatively straightforward circularity area are the share of renewable energy (percent of gross final energy consumption) and the GHG emissions per GDP output (tonnes CO2e/EUR million).
- 12: Waste disposal and pollutant emissions: This indicator group represents the total amount of waste disposal plus the emissions of key pollutants. A higher score stands for a more efficient circular performance.
- 12: Resource output: This indicator group refers to the amount of GDP produced from resource consumption. A higher score means higher material efficiency.

++

CLUSTER: USE PHASE

- 3: Utility during use phase: The amount of time the product is used compared to an industry average product of similar type. This includes the intensity of use, durability of products, repair and maintenance and shared consumption.
- 4: Resource productivity: This circularity area covers the resource efficiency by measuring the indicator GDP (Euro) per kg of domestic material consumption. A potential drawback of this metric the influence of the industrial structure of a country on the domestic material consumption. As such, that weight does not necessarily reflect environmental costs.
- 6: Usage by the customer: Number of product failures, life-time of the product, required amount of energy and resources for usage

++

CLUSTER: DESTINATION AFTER USE

- 3: Destination after use: The amount of material that goes into landfill or energy recovery, is collected for recycling and the amount of components collected for reuse.
- 3: Efficiency of recycling: The efficiency of the recycling processes concerning the production of recycled input and to recycle material after use.
- 4: Waste generation: The overall waste generation is measured with two metrics, that together reflect waste generation from both industries and consumers.
- 6: Reuse and redistribution of the product: Market for second hand sales, life-time of the product.

++

CLUSTER: CLOSED LOOPS

- 1: Think in cascades: Value is created by closing loops. The different allocations and utilizations of the biological and technical nutrients have to be considered.
- 5: Close-looped cycles: All materials enter into an infinite technical or biological cycle.
- 6: Repair and maintenance of the product: Repair costs vs. production costs, availability of maintenance or repair service, access to internal workings, complexity of workings, standardization of components of the product, ease to find the fault.
- 6: Reuse and redistribution of the product: Market for 2nd hand sales, life-time of the product.
- 6: Remanufacturing and refurbishment of product or part: costs of remanufacturing and refurbishment, costs to collect and return, percentage of products returned, ease to disassemble, damage during disassembly, ease to identify parts, modularity of parts, possibility to upgrade parts, amount of mechanical connections, amount to tools required to disassemble.
- 11: Take-back of products and/or packaging: Regulation governing the collection of more than one product is onerous.
- 13: Materials & water: Ideally, materials are kept in closed cycles infinitely and re-used in the highest quality as possible. Priority is given to the preservation of material complexity, meaning it is aimed to use high-quality products, components and parts as long as possible, before they are recycled as raw materials. Scarce materials are reused in shorter cycles so that they continue to be available for different functions.
- D: Complexity of processes within businesses and business models: Quality systems of companies are focussed on producing a good product. This requires the whole production process to be traceable and controllable. This is very complicated. A transition towards a CE creates an extra dimension for the production process, as extra loops need to be created. Even more complicated. Too complicated?
- D: There is not (yet) an overarching system for the CE: The municipality could play a part in the creation of such a system. For example: A market place where materials can be tracked and traced. This does not have to impede competition.
- E: Infrastructure for new business models: There is no infrastructure available for a circular economy. E.g. materials need to be tracked and traced. By whom and how?
- F: Closing loops within one company: strict regulations

++

CLUSTER: CLUSTER: NEW BUSINESS MODELS

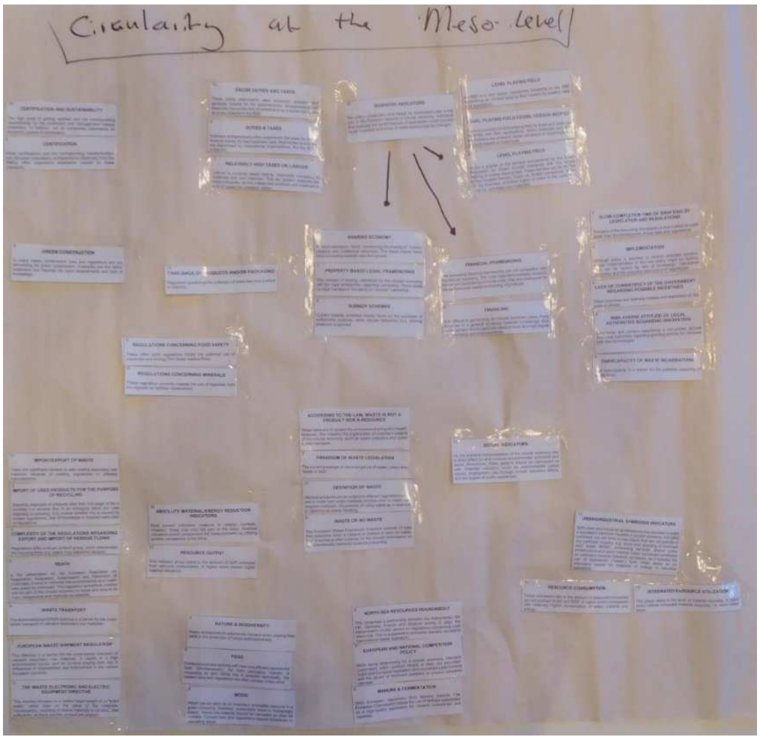
- 5: New business models: New business models for production, distribution and consumption enable the shift from possession of goods to (use of) services.
- 6: Products as a service: Market to sell products as a service, amount of products sold as a service.
- 7: Property-based legal frameworks: The concept of leasing, elemental for the circular economy, still has legal ambiguities regarding ownership. There exists no legal framework focussing on "circular" ownership.
- 7: Financial frameworks: The prevailing financial frameworks are not compatible with the circular economy. The most important example concerns the current purchasing or rental rules, that are inadequate for the performance based contracting of products (viz. everything is amortised to a residual value of zero, without taking into account the value of the remaining materials in the product).
- 8: Sharing economy: A socio-economic trend concerning the sharing of human, physical and intellectual resources. The focus moves away from ownership towards use and access.
- 9: Subsidy schemes: Current subsidy schemes mostly focus on the purchase of sustainable products, while circular behaviour (e.g. sharing products) is ignored.
- C: Collaboration (within a supply chain). For example for leasing. If one company goes bankrupt, others will take over their responsibilities. A must for a CE.
- E: Thinking of services rather than products: For example: a government could buy (the service) light on the streets, rather than streetlights. Requires another way of thinking.
- F: Fiscal framework: the current fiscal framework does not provide (sufficient) circular incentives

CLUSTER ANALYSIS AT THE MESO-LEVEL

CLUSTER: WASTE = FOOD

- 7: According to the law, waste is not a product nor a resource: These laws aim to protect the environment and public health. However, this impedes the organization of important aspects of the circular economy, such as waste collection and cross-border transport.
- 8: Waste transport: The aforementioned EWSR directive is a barrier for the cross-border transport of valuable secondary raw materials.
- 8: Waste or no waste: The European Waste Framework Directive consists of rules that determine when a material or product is seen as

Figure B.2: Results Brainstorm Session Criteria Clustering Meso-level



waste. This Directive is often a barrier for the circular businesses, as it unintentionally obstructs reuse and recycling.

- ❖ 9: Complexity of the regulations regarding export and import of residue flows: Regulations differ a lot per product group, which complicates the recycling from, for example, plastic from electronic devices.
- ❖ 9: Import of used products for the purpose of recycling: Importing shiploads of products after their first stage of life is currently not allowed due to an ambiguity about the rules regarding processing. It is unclear whether this is caused by unclear regulations, lack of knowledge or incorrect execution of regulations.
- ❖ 9: Paradigm of waste legislation: The current paradigm is 'we must get rid of waste', rather than 'waste is food'.
- ❖ 11: Import/export of waste: There are significant barriers to start trading secondary raw materials because of existing regulations or differing interpretations.
- ❖ 11: Definition of waste: Identical products can be subject to different regulations when one is made from virgin materials and the other is made from recycled materials: the process of using waste as a resource is classified as waste handling.
- ❖ D: Waste legislation: This is very important. It was implemented with the best intentions, but is not compatible with a fully developed circular economy. When following the law to the letter, it forbids the recycling of waste.
- ❖ M: Strict regulations: concerning food safety and the use of materials.

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CLUSTER: STANDARDIZATION

- ❖ 8: Certification: While certifications and the corresponding standardization can stimulate innovations, entrepreneurs (especially from the SMEs) often experience drawbacks caused by these standards.
- ❖ 10: Certification and sustainability: The high costs of getting certified and the corresponding requirements for the production and management hamper innovation. In addition, not all companies experience an economic surplus of certification.
- ❖ D: Circular methods are currently the exception: instead of being ordinary or the standard. This must be reversed: the circular exception must become normalized.
- ❖ D: Non-measurability of the CE: progress usually happens faster when it can be measured. For example m2 solar panels.
- ❖ F: Requirements tender: current regulations do not allow circular requirements

++

CLUSTER: URBAN AND INDUSTRIAL SYMBIOSIS

- ❖ 1: Think in systems: Crucial for a well-functioning circular economy is the understanding of the mutual influence of different parts of the system. The different elements have to be considered in relation to their environmental and social contexts.
- ❖ 1: Think in cascades: Value is created by closing loops. The different allocations and utilizations of the biological and technical nutrients have to be considered.
- ❖ 5: Close-looped cycles: All materials enter into an infinite technical or biological cycle.
- ❖ 5: Logistics: Logistics systems shift to a more region- oriented service with reverse-logistics capabilities.

- 5: New business models: New business models for production, distribution and consumption enable the shift from possession of goods to (use of) services.
- 7: European and national competition policy: While being determining for a circular economy, intensive cooperation within product chains is often not permitted. Dutch and European legislation aims to prohibit cartel forming and the abuse of dominant positions to protect consumer interests.
- 12: Urban/industrial symbiosis indicators: Both urban and industrial symbiosis are key activities to reach a successful transition towards a circular economy. Industrial symbiosis can aid firms to use inputs that are not specific to any particular industry, e.g. reuse and recycling of municipal solid waste (MSW), accounting services, shared public infrastructure and labour market. Urban symbiosis constitutes an extension towards industrial symbiosis, as it includes the use of byproducts ("waste") from urban areas as an alternative source for materials or energy in industrial operations. Exemplary indicators would be the total number of scavenger and decomposer business, connectivity among different industries, diversity of industrial sectors involved in the urban/industrial symbioses activities, etc.
- C: Collaboration (within a supply chain). For example for leasing. If one company goes bankrupt, others will take over their responsibilities. A must for a CE.
- F: Industrial symbiosis

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CLUSTER: LEVEL PLAYING FIELD

- 7: Relatively high taxes on labour: Labour is currently taxed heavily, especially compared to materials and raw materials. This tax system supports the linear principles, as this makes new products and materials in a lot of cases the cheapest option.
- 8: Level playing field: About a quarter of the barriers encountered by the Smart Regulation for Green Growth intersects with the issues relating to a level playing field. These barriers can be divided in four broader themes: Dutch vs. foreign companies; SMEs vs. big business; activities higher or lower in the cycle; and fossil vs. non-fossil raw materials.
- 8: Financing: It is difficult to get funding for circular business cases. Partly because of a general tendency towards increasingly strict rules, yet also due to particular reasons such as a high degree of uncertainty and unpredictability.
- 9: Level playing field fossil versus biotics: There is currently no level playing field for fossil and biotic raw materials and their applications. Biotic materials and their applications are unevenly taxed (e.g. import levies and excise duties) compared to fossil fuels and products based on fossil fuels.
- 9: Regulations concerning food safety: These often strict regulations hinder the potential use of resources and energy from biotic residue flows.
- 9: Regulations concerning minerals: These regulation currently impede the use of digestate from bio-digester as fertilizer replacement.
- 9: Subsidy schemes: Current subsidy schemes mostly focus on the purchase of sustainable products, while circular behaviour (e.g. sharing products) is ignored.
- 10: Subsidy schemes: Current subsidy schemes mostly focus on the purchase of sustainable products, while circular behaviour (e.g. sharing products) is ignored.
- 16: Room for new actors: Via a process of so-called niche participation, new players who are as yet insignificant but who may become important in the future should become involved in the process.
- A: Price mechanisms: higher initial costs could reduce costs in the long run.
- D: Existing basic legislation and/or infrastructure.

- E: Level playing field: For example: the difference between countries regarding the internalization of the external costs.
- M: Start-ups have less resources: innovations require start-ps. These have, however, less money, materials and space compared to the established companies.
- M: Lack of expertise: within initiatives and of innovators.

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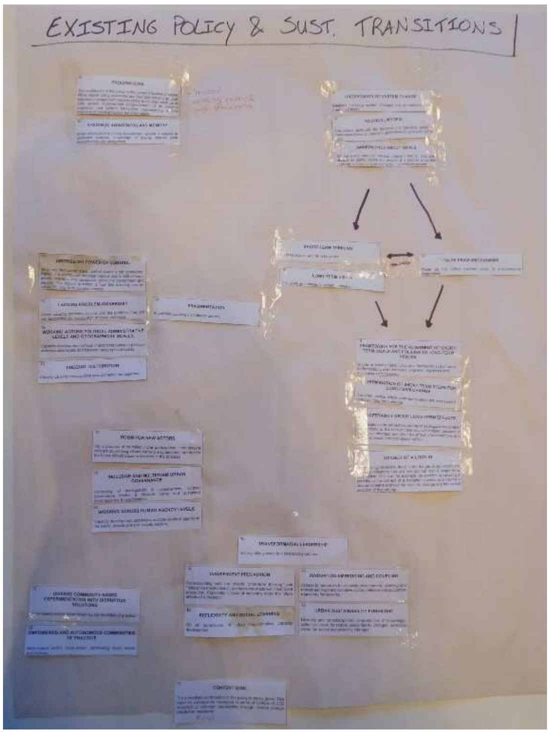
CLUSTER: FOCUS BEYOND ECONOMIC GAIN

- 12: Social indicators: As the practical implementation of the circular economy has a direct effect on and involves environmental, economic and social dimensions, these aspects should be addressed as well. Potential indicators could be environmental justice issues, employment rate through circular economy efforts, and the degree of public awareness.
- 13: Civil society & culture: Activities of the economy support and maintain social and cultural values.
- 13: Health & wellbeing: Economic activities support human health and wellbeing. Toxic or hazardous substances that could harm human health and well-being are avoided and employees have a healthy work environment and fair wages.
- 13: Promotion of various types of values: Raw materials are not only used for the purpose of creating financial value, but also for other kinds of values, for example to enhance social networks or natural capital.
- 13: Biodiversity: Economic activities should strengthen ecosystems and natural capital (i.e. the natural systems we make use of), instead of affecting the biodiversity negatively through these activities.
- 13: Resilience & adaptivity: Economic structures are set up to be resilient and adaptive. Any disruptions or impacts on the system are ideally absorbed by the resiliency, resulting in the minimization of the risk of the system to collapse.
- A: societal costs and benefits are important. The contribution transcends the pure economic benefits.
- C: Non-financial indicators: the focus lies currently almost only on monetary criteria. Extra criteria should be added.
- E: Investment costs: A transition towards a CE requires high investments. Companies are not sure if they will also have the benefits.
- E: Distribution of the costs and the benefits: public vs private
- E: Ambiguity of the government: costs vs social responsibility
- E. Ambiguity of citizens: costs vs social responsibility

CLUSTER ANALYSIS AT THE GOVERNANCE LEVEL

CLUSTER: SHORT-TERM VS. LONG-TERM

Figure B.3: Results Brainstorm Session Criteria Clustering Governance



- 15: Short-term thinking: Both in politics as well as in business.
- 15: Uncertainty of system change: Solutions involving system changes are surrounded with great uncertainty
- 16: Long-term vision: This gives an impulse to system innovation.
- 16: Framework for the alignment of short-term goals and policies to long-term visions: long-term visions that function as a framework and a frame for formulating short-term and long-term objectives and evaluating existing policy.
- 18: Uncertainty about long-term effects: This relates to the limited knowledge of ecological cause-and-effect relations. It is both unclear what will happen because of ecological changes and what the effect of interventions and socio-technical transformations will be.
- 18: Danger of a lock-in: When taking decisions, there is the danger to get linked into particular solutions that are non-optimal from a longer term perspective. This can, for example, be avoided by creating a portfolio in the context of a transition agenda and having a shared consensus about the need for change and the overall direction of that change.
- A: Price mechanisms: higher initial costs could reduce costs in the long run.
- C: Long term vision: is this long term vision incorporated? One could scale to what extent a business has incorporated the longer term in their plans.
- E: Short-term vs. long-term thinking: Investment costs can, for example be high, while the return on the longer term might be worth it.
- 16: Inclusive and multiform urban governance: Consisting of participation & inclusiveness, diverse governance modes & network forms and sustained intermediaries & hybridization.
- 16: Transformative leadership: In the public, private and civil society sectors.
- 16: Empowered and autonomous communities of practice: place-based and/or issue-driven, addressing social needs and motives.
- 16: Working across human agency levels: Capacity development addresses multiple levels of agency in the public, private and civil society sectors.

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CLUSTER: CAPACITY DEVELOPMENT

- 15: Insufficient precaution: Corresponding with the criteria "short-term thinking" and "false price mechanisms", are decisions made with insufficient precaution. Especially in case of unclearity about the future effects of a decision.
- 17: Diverse community-based experimentation with disruptive solutions: place-based and/or issue-driven by communities of practice.
- 17: Empowered and autonomous communities of practice: place-based and/or issue-driven, addressing social needs and motives.
- 17: Innovation embedding and coupling: Access to resources for capacity development, planning and mainstreaming transformative action, reflexive and supportive regulatory frameworks.
- 17: Reflexivity and social learning: On all dimensions of urban transformative capacity development.
- 17: Working across human agency levels: Capacity development addresses multiple levels of agency in the public, private and civil society sectors.
- D: Implementing theoretically thought of solutions: Missing link between theory and practice.
- F: Lacking knowledge: we do not know everything yet.
- M: Lack of knowledge of the municipality: they do not know how to deal with the new situation; how they could or should facilitate.
- M: Lack of clarity: concerning the division of roles, tasks and responsibilities.

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CLUSTER: LEVEL OF INTEGRATION

- 15: Lacking problem-ownership: Actors causing problems do not own the problem; they are not responsible for the solution of those problems.
- 17: Working across political-administrative levels and geographical scales: Capacity development reflects interactions between political-administrative levels and between geographical scales.
- 18: Distributed power of control: As in any democratic state, control power is not centralized. Rather, it is distributed amongst various actors with different beliefs, interests and resources, within the government and beyond. The logical question is how this diversity can be utilized for long-term societal change.
- E: Ambiguity of the government: costs vs social responsibility
- F: Working together with multiple disciplines: different languages across disciplines – people planet profit.
- F: Differing ambitions: Every area / location has different ambitions.
- M: Every department of the municipality says, does and thinks differently than the other.
- M: Public and private parties speak a "different language", resulting in miscommunications.
- M: knowledge and responsibilities are often issued to a person, hence not integrated in an organisation or system.

APPENDIX C: LIST OF INTERVIEWEES

Table C.1: Interview Round 1 - Generic

#	NAME	POSITION	ORGANIZATION	CATEGORY	DATE
A	Karin Borgman	Senior Advisor	INFRAM	Practitioner	24-11-2017
B	Sladjana Mijatovic	Program Manager City Innovation	Municipality of Amsterdam	Public sector / governance	19-12-2016 & 23-01-2017
C	Virpi Heybroek	Programme Developer Circular City	AMS Institute / TU Delft	Science	22-12-2016
D	Annelies Soede	Project Manager Economy	Municipality of Amsterdam	Public sector / governance	12-01-2017
E	Edwin Oskam	Strategic Advisor	Amsterdam Economic Board	Public sector / governance	19-01-2017
F	Eveline Jonkhoff	Strategic Advisor	Municipality of Amsterdam	Public sector / governance	24-01-2017
G	Gerard Roemers	Sustainability Consultant	Metabolic	Practitioner	02-02-2017
M	Kris Steen	Researcher	AMS Institute	Science	10-02-2017

Table C.2: Interview Round 2 - Specific

#	NAME	POSITION	ORGANIZATION	CATEGORY	DATE
H	Albert Jansen	Owner	Hemelswater	Practitioner	19-01-2017
I	Maarten Claassen	Strategic Advisor & Process Manager	Waternet	Practitioner	19-01-2017
J	Mendel Giezen	Researcher	University of Amsterdam / Amsterdam Water Science	Science	31-01-2017
K	Rolf Steenwinkel	Member of the Board	Waterschap AGV	Practitioner	31-01-2017
L	Tessa de Geus	Advisor Social and Urban Innovation	Kennisland	Practitioner	01-02-2017
N	Henk-Jan van Alphen	Senior Researcher	KWR Watercycle Research Institute	Science	13-02-2017
O	Jasper van der Woude	Advisor	INFRAM	Practitioner	17-02-2017

APPENDIX D: TOPIC LIST INTERVIEWS ROUND 1

For the first part of the research, semi-structured interviews were held with experts working closely with the circular economy topic and (municipal) PLR. This includes actors working at the municipality of Amsterdam, Amsterdam Economic Board and several research institutes. A list of interviewees can be found in Appendix C. This Appendix comprises the general topic list used for the interviews.

INTRODUCTION

- What is your pursuits concerning the circular economy?
- Wat are your pursuits concerning the circular economy and PLR?

MUNICIPALITY & THE TRANSITION TOWARDS A CIRCULAR ECONOMY

- What does the municipality undertake concerning (the transition towards) the circular economy?
- In what circular projects/researches/pilots is the municipality involved?
- How do you view the role of the municipality with regards to this transition?

EXISTING PLR & THE TRANSITION TOWARDS A CIRCULAR ECONOMY

- How do you perceive the current relation between existing policy and the transition towards a circular economy?
- What are barriers for the transition towards a circular economy?
- What is needed for a successful transition?

MEASURING CIRCULARITY

- How could circularity be measured?
- What criteria come to mind to measure circularity?

THE ANALYTICAL FRAMEWORK

- What criteria come to mind to measure the impact of existing PLR on the transition towards a circular economy.
- How could such a tool be used (by the municipality)?
- Are you aware of any similar frameworks?

APPENDIX E: TOPIC LIST INTERVIEWS ROUND 2

For the second part of the research, semi-structured interviews were held with a wide spectrum of actors within the water governance sector. These actors will either belong to the scientific community, the public sector, or are “practitioners”. Practitioners are people working on bringing innovation to practice.
A list of interviewees can be found in Appendix C. This Appendix comprises the general topic list used for the interviews.

INTRODUCTION

- What is your pursuits concerning the circular economy?
- Wat are your pursuits concerning the circular economy and PLR?

WATER & THE TRANSITION TOWARDS A CIRCULAR ECONOMY

- How do you see the future of water governance?
- Could you describe the position of water within the transition towards a circular economy?
- What is the current “level of circularity” of water governance?
- What are opportunities? And barriers?
- How do you view the role of your organization with regards to this transition?

EXISTING PLR & THE TRANSITION TOWARDS A CIRCULAR ECONOMY

- What do you think of the current water PLR?
- How do you perceive the current relation between existing policy and the transition towards a circular economy (in the water sector)?
- What are barriers for the transition towards a circular economy (in the water sector)?
- What is needed for a successful transition?

MEASURING CIRCULARITY

- How could circularity be measured in the water sector?
- What criteria come to mind to measure circularity in the water sector?

THE ANALYTICAL FRAMEWORK

- What criteria come to mind to measure the impact of existing PLR on the transition towards a circular economy.
- How could such a tool be used (by the municipality)?
- Are you aware of any similar frameworks?

APPENDIX F:
BACKGROUND ANALYSIS OF THE MSP QUICK SCAN

This Appendix comprises the background analysis of the Quick Scan of the Municipal Sewage Plane 2016-2021 (MSP). For this Quick Scan, the specified analytical framework has been applied to the MSP. This application takes three steps. The first step concerns the question whether the MSP impacts each particular criteria cluster. As the MSP focuses on the waste water, groundwater and rainwater management of Amsterdam, the clusters relating to the drinking water production process are not impacted by the policy. Accordingly, the clusters product design, input in the production process, output of the production process and use phase will be left out of this impact assessment and are not included in this background analysis. The second step regards the question that is answered by this background analysis: to what value does the MSP steer the criterion?

In this background analysis, the clusters are discussed one by one. The criteria of each cluster are listed in the first column. The second column gives room for the citations of the MSP that concerns each particular criterion. The page number of this citation will be noted in the next column. Finally, the resulting real value the citation of the MSP steers the criterion towards will be inserted in the fourth column. This real value will be adopted by table 6.5 of Chapter 6.

CLUSTER: DESTINATION AFTER USE

CRITERIA	CITATIONS	PAGE	REAL VALUE
Waste water generated per GDP output + Municipal waste water generated per capita	Uitgangspunt bij de invulling van de gemeentelijke watertaken is de voorkeursvolgorde uit de Wet milieubeheer (artikel 10.29a): 1. voorkom of beperk het ontstaan van afvalwater.	16	Low
	Polderriolen[7] worden gepland aangepakt waarbij de mogelijkheid tot opheffing van het polderriool wordt onderzocht. In de nieuwe of aangepaste situatie worden de waterstromen zoveel mogelijk gescheiden	25	Low

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CLUSTER: CLOSED LOOPS

CRITERIA	CITATIONS	PAGE	REAL VALUE
Market for 2nd hand sales of waste water	X		Unknown
Market for 2nd hand sales of recovered resources	X		Unknown
Costs of cleaning water	Amsterdam heeft in 2013 deelgenomen aan de benchmarking rioleringszorg van Stichting RIONED. Hieruit bleek dat Amsterdam positief scoort op functioneren van de riolering, beheerkennis, kostenbesparing en een lage rioolheffing heeft.	20	Low
Costs to recover resources from water	X		Unknown
Costs to collect water	Amsterdam heeft in 2013 deelgenomen aan de benchmarking rioleringszorg van Stichting RIONED. Hieruit bleek dat Amsterdam positief scoort op functioneren van de riolering, beheerkennis, kostenbesparing en een lage rioolheffing heeft. De activiteiten in Rainproof worden positief beschouwd.	20	Low
Percentage of waste	In Amsterdam ligt een uitgebreid rioolstelsel. Vrijwel alle woningen,	17	High

water collected	bedrijven en gebouwen zijn aangesloten op de riolering en kunnen daarmee hun afvalwater kwijt.		
Amount of tools required to recover resources from water	X		Unknown

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CLUSTER: NEW BUSINESS MODELS

CRITERIA	CITATIONS	PAGE	REAL VALUE
Legal frameworks for CE water business models	X		Unknown
Financial frameworks for CE water business models	X		Unknown

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CLUSTER: WASTE = FOOD

CRITERIA	CITATIONS	PAGE	REAL VALUE
Using waste water as a product	X		Unknown
Using waste water as a resource	X		Unknown
Using resources from waste water as a resource	Daarnaast worden nuttige stoffen uit afvalwater hergebruikt en wordt energie teruggewonnen	16	High
	Voor stedelijk afvalwater is het algemene uitgangspunt voor de langere termijn zoveel mogelijk scheiding aan de bron om hergebruik van grondstoffen te vereenvoudigen en de energie-inhoud beter te kunnen benutten en fosfaat zoveel mogelijk terug te winnen	23	High
	verder verbeteren van de duurzame bedrijfsvoering door efficiënt energiegebruik en terugwinnen en hergebruik van grondstoffen.	27	High
	gescheiden inzameling van afvalwater (bij de bron) om zuivering te vergemakkelijken en meer bruikbare grondstoffen terug te winnen;	37	High
	terugwinnen van thermische energie (koude en warmte) uit afvalwater;	37	High
	inzameling van GF-afval via het riool (pilot shredders) in plaats van met het vast afval. Idee is dat hierdoor meer duurzaam biogas kan worden gewonnen	37	High
	meten van de hoeveelheid methaan en lachgas dat ontstaat in het afvalwaterriool en eventueel aanpakken van deze emissies.	37	High
Transporting waste water	X		Unknown
Transporting recovered sources from waste water	X		Unknown
Importing waste water	X		Unknown
Importing recovered sources from waste water	X		Unknown
Exporting waste water	X		Unknown
Exporting recovered resources from waste water	X		Unknown

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CLUSTER: STANDARDIZATION

CRITERIA	CITATIONS	PAGE	REAL VALUE
Setting up circular water standards	X		Unknown
Applying circular water standards	X		Unknown
Drawbacks resulting from certification	X		Unknown

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CLUSTER: URBAN & INDUSTRIAL SYMBIOSIS

CRITERIA	CITATIONS	PAGE	REAL VALUE
The number of resource recovery businesses	X		Unknown
The connectivity within the water sector	X		Unknown
The connectivity among water and other industries	X		Unknown
The diversity of sectors in the urban/industrial symbioses	X		Unknown

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CLUSTER: LEVEL PLAYING FIELD

CRITERIA	CITATIONS	PAGE	REAL VALUE
Room for new actors	X		Unknown
Fair price mechanisms	Om ervoor te zorgen dat de voorziening rioolrecht een positief saldo houdt aan het einde van de planperiode, dient de rioolheffing verhoogd te worden.	41	High
	De huidige heffingsmaatstaf in Amsterdam – een vast bedrag van eigenaren van percelen – houdt geen enkel verband met de mate van veroorzaking van deze kosten. Een rechtvaardiger kostenverdeling van gemeentelijke rioleringskosten betekent voor de rioolheffing aansluiting bij kostenveroorzaking en/of bij het beginsel 'de vervuiler betaalt'.	43	Low
Transparency of the real social costs	De huidige heffingsmaatstaf in Amsterdam – een vast bedrag van eigenaren van percelen – houdt geen enkel verband met de mate van veroorzaking van deze kosten.	43	Low

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CLUSTER: FOCUS BEYOND ECONOMIC GAIN

CRITERIA	CITATIONS	PAGE	REAL VALUE
Room for redundancy	Hoogstens eenmaal per jaar treedt er een grote storing op die niet binnen 2 uur opgelost kan worden. Het risico is echter laag, omdat de meeste rioolgemalen redundant uitgevoerd zijn.	19	High
Access to basic water infrastructure	X		Unknown
Inclusion of citizens in the transition	X		Unknown
Employment rate in the water sector	X		Unknown
Public awareness of water issues	X		Unknown

Public acceptance of water measures	X		Unknown
Local water initiatives	X		Unknown
Natural capital	X		Unknown

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CLUSTER: LONG-TERM DESIGN

CRITERIA	CITATIONS	PAGE	REAL VALUE
Incorporating the long-term in decision making	Door het beoordelen van alle rioolstelsels is inzicht in het totale werkpakket voor de korte termijn. Door in dezelfde beoordeling voorspellingen te doen, ontstaat inzicht in de benodigde maatregelen op de lange termijn. Omdat dit een continue activiteit is, is er altijd een actueel meerjarenprogramma beschikbaar. Dit bevordert een soepele afstemming met andere diensten en bedrijven bij het werken in de openbare ruimte. Deze wijze van werken zal in de komende planperiode verder geoptimaliseerd worden.	37	High
Developing long-term visions	De visie op de Amsterdamse zorgplichten 2040 is daarbij richtinggevend	15	High
Uncertainty about long-term effects	X		Unknown
Danger of a lock-in	X		Unknown
Determination of short-term steps	Door het beoordelen van alle rioolstelsels is inzicht in het totale werkpakket voor de korte termijn. Door in dezelfde beoordeling voorspellingen te doen, ontstaat inzicht in de benodigde maatregelen op de lange termijn. Omdat dit een continue activiteit is, is er altijd een actueel meerjarenprogramma beschikbaar. Dit bevordert een soepele afstemming met andere diensten en bedrijven bij het werken in de openbare ruimte.	37	High

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CLUSTER: CAPACITY DEVELOPMENT

CRITERIA	CITATIONS	PAGE	REAL VALUE
Innovation embedding and coupling	verder professionaliseren van de (project)registratie.	27	High
Sufficient precaution + Diverse & community-based experimentation + Translation from science to practice	Voor grootschalige uitbreidingen (vanaf duizend woningen) wordt onderzocht of een 'decentrale' zuivering op wijkniveau voordelen biedt op basis van onder andere de beschikbaarheid van (fysieke) ruimte, geschikte lozingspunten, milieueffect, duurzaamheid en kosten.	23	High
	Zodra dat technisch mogelijk is, zullen er kleinschalige pilots worden uitgevoerd naar alternatieve sanitatie. In deze pilots wordt onderzocht of individuele behandeling in de toekomst als volwaardig alternatief kan gelden.	23	High
	in bestaand gebied worden in principe geen pilots uitgevoerd voor alternatieve sanitatie.	23	Low
	onderzoek hoe afvalwater optimaal kan worden benut voor terugwinning van energie en grondstoffen (fosfaat alsmede andere nutriënten), onder andere door de verwerking van GF-afval en alternatieve sanitatie	31	High
	onderzoek in hoeverre alternatieve sanitatie en 'decentrale' zuivering (zuivering op wijkniveau) voordelen biedt en of innovatieve pilots kunnen worden opgezet (nieuwe wijk met 2.000 woningen)	31	High
	onderzoek naar het functioneren van de gemengde stelsels aan de hand van metingen in een klein bemalingsgebied (Prinseneiland). Hiervoor is het gebied in 2014/2015 voorzien van meetapparatuur. Er wordt ook gekeken naar het effect op oppervlaktewater, uitstoot broeikasgassen en wat de beste meetmethode is	31	High
	onderzoek naar de mogelijkheden om een variabele heffing voor stedelijk	31	High

	afvalwater door bijvoorbeeld een mogelijke koppeling van de rioolheffing aan het drinkwaterverbruik		
Access to resources for capacity development	X		Unknown

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CLUSTER: LEVEL OF INTEGRATION

CRITERIA	CITATIONS	PAGE	REAL VALUE
Problem-ownership	Het realiseren van deze ambitie is daarmee een gezamenlijke verantwoordelijkheid van alle Amsterdammers. De gemeente neemt het voortouw in het activeren van zo veel mogelijk Amsterdammers om bij te dragen aan de verwerking van hemelwater	24	High
	de perceelseigenaar is in principe zelf verantwoordelijk voor de verwerking van hemelwater op eigen terrein	24	High
	De aanpak van grondwaterproblemen in tuinen en gebouwen is in principe de taak van de particuliere eigenaar zelf. Verblijfsruimtes behoren vocht- en waterdicht te zijn en de overlast zal moeten worden weggenomen door bouwkundige maatregelen.	35	High
Fragmentation across administrative levels	Daarnaast is het plan op hoofdlijnen afgestemd met de Eigenarentafel, het overlegorgaan waar Amsterdamse diensten die verantwoordelijk zijn voor de boven- en ondergrondse infrastructuur afspraken maken over een efficiënte aanpak.	13	Low
	Er wordt nauw samengewerkt met de waterschappen en jaarlijks wordt gerapporteerd over het functioneren van de riolering. Het vergunningsstelsel dat tot voor kort van toepassing was, is overgegaan in samenwerking (Waterwet artikel 3.8).	20	Low
	Aan de Eigenarentafel worden afspraken gemaakt over een efficiënte aanpak van wijzigingen in de infrastructuur. Op deze manier hoeft de straat minder vaak open, wat zowel goedkoper is als minder overlast oplevert ('1 Stad 1 Opgave', gebiedsgericht werken).	20	Low
	Met het programma Amsterdam Rainproof kiest de stad (de gemeentelijke diensten, stadsdelen, corporaties, bedrijven, ondernemers en bewoners) voor één gezamenlijke aanpak.	21	Low
	versnellen Programma Amsterdam Rainproof (t/m 2017) zodat hemelwaterbestendig werken geborgd wordt in de reguliere stedelijke ontwikkeling- en beheerprocessen	27	Low
	Proactieve advisering en toetsing van ruimtelijke plannen wordt voortgezet. Waternet zoekt strategische contacten bij de andere Amsterdamse diensten omdat er vroeg in de ruimtelijke planontwikkelingen meer mogelijkheden zijn om de inrichting van de ruimte beter te laten aansluiten op het grondwatersysteem. Aandachtspunt is de juridische verankering van grondwateradviezen	34	Low
	Waternet wil deze planperiode de samenwerking met de stadsdelen verbeteren door: 1) Intensivering van het overleg en de samenwerking met de stadsdelen over de aanpak van de hemel- en grondwaterproblematiek. 2) Samen op te trekken om een optimale inrichting van het maaiveld te realiseren en hiermee hoge kosten voor aanpassing van het rioolstelsel (als gevolg van klimaatverandering) te voorkomen.	36	Low
Fragmentation across geographical scales	Het Gemeentelijk Rioleringsplan is namens de gemeente Amsterdam opgesteld door een projectteam van Waternet. Conform de Wet Milieubeheer (art 4.23) zijn de volgende instanties bij het opstellen van het plan betrokken via overleg, afstemming en een formele commentaarronde: Hoogheemraadschap Amstel, Gooi en Vecht; Hoogheemraadschap van Rijnland; Hoogheemraadschap Hollands Noorderkwartier; Rijkswaterstaat.	13	Low
	Met het programma Amsterdam Rainproof kiest de stad (de gemeentelijke diensten, stadsdelen, corporaties, bedrijven, ondernemers en bewoners) voor één gezamenlijke aanpak.	21	Low

APPENDIX G: THE ANALYTICAL FRAMEWORK - GENERIC

CLUSTERS	CRITERIA: THE IMPACT OF EXISTING PLR ON…	DESIRED VALUE
Product design	Amount of materials wasted in the production process	Low
	Biodegradability of the materials and product	High
	Material characteristics (scarcity, eco-efficiency, toxicity)	Low
	Waste in the production process	Low
	Repair costs vs. production costs	Low
	Availability of maintenance or repair service	High
	Access to internal workings	High
	Complexity of workings	Low
	Standardization of components of the product	High
Input in the production process	Percentage of renewable energy use	High
	Material intensity of products	Low
	Origin of materials	Low
	Ratio labour inputs of a new product vs in a circular loop	High
Output of the production process	Carbon footprint of the process of manufacturing	Low
	GHG emissions per GDP output	Low
	Emissions of key pollutants	Low
	GDP produced from the resource used in the production process	High
Use phase	Number of product failures	Low
	Life-time of the product	High
	Required amount of energy	Low
	Resources for usage	Low
	Intensity of use	Low
	Required repair and maintenance	Low
	Shared consumption	High
	Resource productivity	High
Destination after use	Waste generated per GDP output	Low
	Municipal waste generated per capita	Low
	Ratio recycled materials/waste	High
Closed loops	Market for second hand sales of products, materials & nutrients	High
	Costs of remanufacturing/refurbishment	Low
	Costs to collect and return	Low
	Percentage of products returned	High
	Ease to disassemble	High
	Possibility to upgrade parts	High
	Amount of mechanical connections	Low
	Amount of tools required to disassemble	Low
New business models	Amount of products sold as a service	High
	Legal frameworks for CE business models	High

	Financial frameworks for CE business models	High
Waste = food	Using waste as a product	High
	Using waste as a resource	High
	Transporting secondary materials	High
	Importing secondary materials	High
	Exporting secondary materials	High
Standardization	Setting up circular standards	High
	Applying circular standards	High
	Drawbacks resulting from certification	Low
Urban & industrial symbiosis	The total number of scavenger and decomposer business	High
	The connectivity within one industries	High
	The connectivity among different industries	High
	The diversity of sectors in the urban/industrial symbioses	High
Level playing field	Room for new actors	High
	Fair price mechanisms	High
Focus beyond economic gain	Room for redundancy	High
	Cultural & social values	High
	Health & wellbeing	High
	Environmental justice	High
	Employment rate	High
	Public awareness & acceptance	High
	Social networks	High
	Natural capital	High
Long-term design	Incorporating the long-term in decision making	High
	Developing long-term visions	High
	Uncertainty about long-term effects	Low
	Danger of a lock-in	Low
	Determination of short-term steps	High
Capacity development	Innovation embedding and coupling	High
	Diverse & community-based experimentation	High
	Access to resources for capacity development	High
Level of integration	Problem-ownership	High
	Fragmentation across administrative levels	Low
	Fragmentation across geographical scales	Low

APPENDIX H: THE ANALYTICAL FRAMEWORK – WATER

CLUSTERS	SPECIFIC CRITERIA: IMPACT OF EXISTING PLR ON…	DESIRED VALUE	REAL VALUE
Product design	Amount of resources wasted in the production process	Low	
	The use of raw and auxiliary materials in the production process	Low	
	Strict water quality standards	Low	
Input in the production process	Percentage of renewable energy use in the production process	High	
	Renewable origin of the water for production	Low	
	Renewable origin of the raw and auxiliary materials for production	Low	
	Ratio labour inputs of a "fresh" water vs in a circular loop	High	
Output of the production process	Carbon footprint of the water production process	Low	
	GHG emissions of the production process per GDP output	Low	
	Emissions of key pollutants in the production process	Low	
	GDP produced from the resource used in the production process	High	
Use phase	Required amount of energy for usage	Low	
	Required amount of resources for usage	Low	
Destination after use	Waste water generated per GDP output	Low	
	Municipal waste water generated per capita	Low	
Closed loops	Market for second hand sales of waste water	High	
	Market for second hand sales of recovered resources	High	
	Costs of cleaning water	Low	
	Costs to recover resources from water	Low	
	Costs to collect water	Low	
	Percentage of waste water collected	High	
	Amount of tools required to recover resources from water	Low	
New business models	Legal frameworks for CE water business models	High	
	Financial frameworks for CE water business models	High	
Waste = food	Using waste water as a product	High	
	Using waste water as a resource	High	
	Using resources from waste water as a resource	High	
	Transporting waste water	High	
	Transporting recovered resources from waste water	High	
	Importing waste water	High	
	Importing recovered resources from waste water	High	
	Exporting waste water	High	

	Exporting recovered resources from waste water	High	
Standardization	Setting up circular water standards	High	
	Applying circular water standards	High	
	Drawbacks resulting from certification	Low	
Urban & industrial symbiosis	The number of resource recovery businesses	High	
	The connectivity within the water sector	High	
	The connectivity among water and other industries	High	
	The diversity of sectors in the urban/industrial symbioses	High	
Level playing field	Room for new actors	High	
	Fair price mechanisms	High	
	Transparency of the real social costs	High	
Focus beyond economic gain	Room for redundancy	High	
	Access to basic water infrastructure	High	
	Inclusion of citizens in the transition	High	
	Employment rate in the water sector	High	
	Public awareness of water issues	High	
	Public acceptance of water measures	High	
	Local water initiatives	High	
	Natural capital	High	
Long-term design	Incorporating the long-term in decision making	High	
	Developing long-term visions	High	
	Uncertainty about long-term effects	Low	
	Danger of a lock-in	Low	
	Determination of short-term steps	High	
Capacity development	Innovation embedding and coupling	High	
	Diverse & community-based experimentation	High	
	Access to resources for capacity development	High	
Level of integration	Problem-ownership	High	
	Fragmentation across administrative levels	Low	
	Fragmentation across geographical scales	Low	