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Developing Circular Business in Urban Ecosystems

Master's Thesis

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ABSTRACT

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Circular economy has recently become a widely discussed topic in urban ecosystems. Cities have chosen the enhancement of circular economy and resource wisdom as their strategic focus areas. One focus area is to develop cities' energy systems to be more sustainable. Because cities have just started the redirection towards implementing circular economy, this study aims to analyze current drivers and barriers of circular business in urban ecosystems. The research also analyzes effects of municipal decision-making and conceptualizes partnerships as well as networks when executing circular business.

The main research method in this study is an explorative case study including nine semi-structured interviews in eight cities in Finland. These results have been enriched by conducting a Webropol-survey resulting in 116 replies from 85 municipalities. The respondents have different roles such as city managers, municipal officials, decision-makers and representatives of energy and waste companies. The results have been analyzed by using qualitative content analysis.

According to the results of the study, Finnish municipalities are interested in enhancing circular economy principles and have begun to set ambitious carbon neutrality and zero waste targets to be reached by 2050. The main drivers behind this development have been economic benefits and political enablers such as EU and national level targets to reduce emissions. The circular economy related objectives are accepted in municipal councils and special targets are collected to resource wisdom roadmaps and different municipal strategies. The development of cities' energy systems focuses on the transition to renewable energy sources, energy efficiency projects as well as sustainable transportation and mobility. Cities enhance circular economy in tight cooperation with local companies and knowledge institutions. The development of circular business will in the future focus on enhancement of technologies and especially digitalization opportunities.

TIIVISTELMÄ

Tekijä: Sini Piiparinen

Työn nimi: Kiertotalousliiketoiminnan kehittäminen kunta- ja kaupunkiekosysteemeissä

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Kiertotalous ja sen arvioidut liiketoimintamahdollisuudet ovat nousseet viime vuosina esille urbaaninen alueiden kehityksessä. Muutamat kaupungit ovat jopa ottaneet kiertotalouden ja resurssiviisauden ratkaisujen edistämisen strategiseksi kärjekseen kaupunkiympäristön kehittämisessä. Kiertotalouden lisäksi keskustelu energiamurroksen vaikutuksista ja erityisesti energiajärjestelmien kehitystarpeista kiihtyy alati yritysten, kaupunkien ja valtioiden tavoitellessa maapallon kantokyvyn kestävää tulevaisuutta. Tämän tutkimuksen tavoitteena on tarjota tietoa kiertotalousliiketoiminnan esteistä ja mahdollisuuksista kaupunkiekosysteemeissä sekä analysoida kuntapäätöksenteon, kumppanuusmallien ja verkostojen vaikutuksia kiertotalouden edistämiseen. Erityisenä kiinnostuksen kohteena ovat tulevaisuuden energiajärjestelmien kehitystarpeet ja niiden linkittyminen kiertotalouden tavoitteisiin.

Päämenetelmänään tutkimus hyödyntää eksploratiivista tapaustutkimusta, joka on toteutettu tekemällä yhdeksän puolistrukturoitua haastattelua kahdeksassa Suomen kaupungissa. Lisäksi tuloksia on laajennettu keräämällä aineistoa Webropol-nettikyselyllä, johon on saatu 116 vastausta yhteensä 85 kunnasta Suomessa. Tulokset on analysoitu käyttämällä laadullista sisällön analyysin menetelmää.

Tutkimuksen tulosten mukaan Suomen kunnat ja kaupungit ovat kiinnostuneet kiertotalouden tuomista mahdollisuuksista ja lähteneet asettamaan itselleen kunnianhimoisia tavoitteita jätteettömyydestä sekä hiilineutraaliudesta vuoteen 2050 mennessä. Tavoitteiden asettamista ovat ohjanneet taloudellisuus sekä Euroopan Unionin että Suomen valtion itselleen asettamat tavoitteet. Kaupunkitasolla kiertotalouden tavoitteet on usein hyväksytetty kunnanvaltuustoissa ja kirjattu erilaisiin resurssiviisauden tiekarttoihin tai kaupunkistrategioihin. Energiajärjestelmien kehityksessä paikalliset energiayhtiöt ovat avainasemassa kehityksen painottuessa uusiutuviin energialähteisiin siirtymiseen, energiatehokkuushankkeisiin ja kestäviin liikenneratkaisuihin. Kaupungit edistävät kiertotaloutta tiiviissä yhteistyössä alueen yritysten ja tutkimusorganisaatioiden kanssa. Kiertotalouden liiketoiminnan haluttaisiin lisääntyvän jatkossa, samalla edistäen kuntien elinvoimaisuutta ja kuntalaisten hyvinvointia. Tulevaisuudessa kiertotalousliiketoiminnan kehittäminen tulee painottumaan yhä enemmän teknologian ja digitalisaation tuomien uusien ratkaisujen hyödyntämiseen.

ACKNOWLEDGMENTS

This Master's Thesis was part of a broader research project *D2W: From data to wisdom – Approaches enabling circular economy* and was conducted in cooperation with LUT School of Business and Management researchers and the case company Fortum. Therefore, this thesis has provided me a great possibility to familiarize myself with the world of academic research as well as new business development processes. Writing this master's thesis has been a very interesting but also challenging process and I have been lucky to learn something new every day.

Firstly, I would like to thank my supervisors Ville Ojanen and Nina Tura for their guidance and valuable feedback during the research process. Especially I would like to thank Nina for the rigorous comments and the inspiring discussions that have helped me to understand this topic from new perspectives. I would also like to thank the Fortum's experts who have provided me many practical viewpoints and asked critical questions. Additionally, I wish to thank all cities and informants as well as survey respondents who have provided me valuable discussions and opinions about this challenging topic.

Last but not least, I wish to thank my parents and family who have supported and encouraged my education from the beginning. Special thanks belong to all my lovely friends who have not only supported me with this thesis project but also made my study time unforgettable. Finally, I wish to thank you Santeri – without your sincere encouragement during the journey, I would have forgotten many times that one purpose of this project was to develop myself personally and thus to be a bit readier for the next challenges.

"The key to wisdom is knowing all the right questions" – John A. Simone

Espoo, 31st of July 2017

Sini Piiparinen

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1 INTRODUCTION

Over the last decade, sustainability has become widely discussed topic and gained attention worldwide. Geissdoerfer, Savaget, Bocken, and Hultink (2017) define sustainability as the balanced integration of economic performance, social inclusiveness, and environmental resilience, to the benefit of current and future generations. The transition towards a more sustainable future has a clear driver: the current linear economic system is reaching its physical limits. The dominant economic development model 'take-make-dispose' is unsustainable, because it is based on the use of enormous quantities of cheap and easily available materials and energy (Ellen MacArthur Foundation, 2012). This current model consists in linear steps where material flows run through resource, extraction, production, consumption and waste phases without further re-utilization (Ness, 2008). Inside the umbrella of sustainability, the concept of the circular economy (CE) is seen as one of the proposals to enhance sustainability goals (Murray et al., 2015). In this study, c*ircular economy* is understood as a system that aims value creation by minimizing waste, energy and the use of natural resource through slowing, closing and narrowing loops of material and energy (Geissdoerfer et al., 2017). In addition, *circular business* is defined to cover all solutions (such as products and services) that aim to enhance circular economy; to respond the resource scarcity, to minimize adverse environmental impacts and to produce economic benefits both in short-term and long-term.

1.1 Background

The aim of CE is to change the practicalities of society to more circular and sustainable ones, and to overcome the global problems of overproduction and overconsumption that are based on the increasing use of resources and the need for continuous growth (Ghisellini, et al., 2016). CE focuses on the optimization of value circulation, not only the prevention of waste generation (Ellen McArthur Foundation, 2012). In the pursuit of sustaining life, Cohen and Munoz (2016) mention that need for transition to more sustainable consumption and production

will be essential worldwide. The transition into CE demands adopting both more efficient ways of exploiting recycled materials as well as creating new innovative business models.

It has been recognized that one of the most discussed issues related to the sustainability and CE targets is the usage of energy. The need for preventing climate change, pollution and resource waste has pushed our planet on the edge of energy revolution worldwide: energy systems are in a process of a thorough transformation. In recent years, the *energy trilemma* including energy security, rising cost of energy and climate change caused by humans have received increasing attention and brought out the challenge of controlling extensive energy systems change (Bradshaw, 2010; Smith, 2009; Verbong & Loorbach, 2012). Centralized energy production based on mostly on pollutant fossil fuels is not seen as an exclusive solution anymore, which has made the need for more efficient and more sustainable ways of energy production grow constantly. Thus, the quick transition into renewable energy, like wind and solar power sources, already affects and increases volatility and changes in energy systems.

However, it should not be disregarded that CE not only requires new, efficient and innovative course of actions but also innovative actors. Many major players have woken up to the large-scale problems related to resource scarcity, carbon neutrality in energy production and the need for new ways of enhancing sustainability. CE is an attractive and realizable alternative that businesses have already begun exploring. For example, both China and Europe have adopted CE as a part of their future strategies (Su et al., 2013 & European Commission, 2017). According to the European Commission (2017), the strategies towards moving to a more circular economy, reducing greenhouse emissions and decreasing environmental impacts are for example boosting recycling and preventing loss of valuable materials, creating new business models and enhancing eco-design and industrial symbiosis. The Finnish Government has highlighted the importance of CE also in Finland. CE, bioeconomy and clean technology are the themes in the current government

platform. These sustainable solutions have increased self-sufficiency, created new workplaces and tried to achieve climate targets (Valtioneuvoston kanslia, 2015).

In addition to national level, green image has become a significant target for local councils (Geng et al, 2012). Smith (2007) highlights that even if the energy governance has a major role in many countries, there is a wide range of other actors. According to number of scholars, the actors on a local level, such as companies, various community groups and local authorities, play a key role when moving towards a sustainable energy system (Bolton & Foxon, 2013; Hawkey et al., 2013; Hodson & Marvin, 2010). On the other hand, CE helps urban areas to contribute to higher regional competitiveness and an equal distribution of economic growth and wealth (Geng et al., 2009). CE is a topical issue from the viewpoint of current challenges by cities. For the first time in history, more people were living in cities than in the countryside in 2008 (UNFPA, 2011). The population of Finland is also centralized in urban areas; almost 85 % of the Finnish inhabitants were living in the population centers in the end of the year 2015 (Tilastokeskus, 2017). Urbanization is expected to accelerate both in Finland and worldwide in the future. According to forecasts, 72,2 % of inhabitants of Finland are living in urban areas and only 26,8 % in the countryside in 2030 (Tilastokeskus, 2017). According to worldwide forecasts, 60 % of inhabitants are living in cities 2030. This will increase both environmental, economic and social challenges of cities (UNFPA, 2011).

Transition into circular business attracts countries and cities due to broad economic potential in the future. According to Sitra, the Finnish Innovation Fund report (2014), the CE can increase the value of our national economy by a minimum of 3 billion euros by 2030. The circular business effects on the employment situation are also significant; according to the Club of Rome (2015), the number of additional jobs would exceed even 75,000 in Finland. The Club of Rome calculations are based on the potential of the three decoupling strategies: The renewable scenario, the energy efficiency scenario and the material efficiency scenario. Therefore, CE related to energy systems development provide great possibilities to enhance circular business and sustainability in Finnish urban environments. This study is

conducted in order to clarify Finnish cities current interest and ongoing projects related to CE and energy transition, especially related to energy systems development in urban ecosystems. Hence, the study will help companies, cities and other actors develop urban ecosystems even further towards circularity.

1.2 Objectives and scope

The aim of this study is to explore what kind of factors enhance circular business in Finnish cities and municipalities, and to identify barriers that hinder the development of urban ecosystems towards circularity. The circular business tries to respond the resource scarcity, to minimize adverse environmental impacts and to produce economic benefits both in short-term and long-term. According to Geissdoerfer et al. (2017), this can be achieved within long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling. Especially, the study focuses on observing circular business opportunities related to energy systems of municipalities and cities. An energy system essentially consists of the entire energy supply chain from energy generation to use. In this study, concept of *circular energy system* means all actions that enhance the replacement of non-renewable energy resources as well as minimization of energy leakages by developing and optimizing energy systems in cities and thus supporting adoption of truly circular business in urban areas.

The opportunities to develop cities and regions towards CE can be better understood by identifying what kind of circular business initiatives and needs there already exist, what kind of drivers and barriers have influenced the projects, and by analyzing the special characteristics of decision-making processes related to CE projects. Furthermore, the study aims to examine what kind of partnership models and cooperation could support the regional development of circular business. Finally, this study aims to analyze and create new practices and models supporting circular business and especially energy systems projects in urban environment. To reach the set goals, one main research question within two supplementary research questions were formed and are presented in **Table 1** with their respective targets.

Table 1 The research questions of the study with the objectives

Research question	Objective
RQ1: How to enhance circular business in urban ecosystems?	→ To understand cities' current interest, drivers and capabilities of enhancing circular business → To understand current difficulties, problems and barriers hindering circular business in urban environment →To create conclusion of future development opportunities and goals for circular business in urban ecosystems
RQ1.1: *How (municipal) decision-making processes affect circular business?*	→ To identify decision-making processes related to circular business in urban ecosystems, e.g. which issues are required from political decision-making
RQ1.2: *What kind of partnership models support circular business in urban ecosystems?*	→ To understand the roles and responsibilities of different actors in circular business and energy systems development → To construct circular business network in cities and analyze partnership models supporting the development of circular business and energy systems projects

The aim of the *main research question (RQ1)* is to create understanding of the current state of circular business in Finnish cities and municipalities. By collecting information about what kind of CE related projects and actions cities have already been participating, the drivers and motivation for enhancing circular business can be better understood. The specific aim is to clarify opportunities to enhance CE targets by developing energy systems in urban ecosystems. Furthermore, the first research questions aim to analyze current capabilities and future needs and goals for development of circular business in urban ecosystems. Additionally, the aim is to define the present problems, difficulties and barriers that have been faced in with CE projects. The study aims especially to understand specific barriers hindering circular business development in the context of energy systems. The final aim is to list and analyze future challenges and opportunities in cities and to help in avoiding and solving problems.

Because the study focuses on the circular business in urban ecosystems, the aim of the *first supplementary research question (RQ1.1)* is to clarify decision-making aspects related to CE projects in cities of Finland. By analyzing decision-making processes of cities, the goal is to form understanding of what the possibilities are to enhance public sector solutions to be more effective and support circular business in the future. In addition, the second question aims to clarify the background and motivation of cities and municipalities to be committed to CE projects. The final target is to identify which issues are under political decision-making. The aim of the *second supplementary research question (RQ1.2)* is to evaluate the key actors, networks and partnership models in circular business in urban ecosystems. By identifying different roles, responsibilities, and needs for circular business and especially energy systems development, it is possible to construct the best possible cooperation models for enhancing common targets towards circularity.

Due to the large area of this study, limitations are next presented. Urban areas have been chosen as a target group because urbanization is expected to accelerate in cities and municipalizes and they are facing major challenges while aiming sustainable solutions during the next decades. Due tothe country-specific legislation defining responsibilities and tasks for cities and municipalizes, the review is limited to the urban areas in Finland. This ensures reaching clear results from homogenous area under similar legislation and political climate. Cities and municipalities are interesting actors because they can act as the engine of circular business development and show the way for companies and other stakeholders. The multidimensional characteristic of CE requires analyzing networks around city ecosystems. Even if cities have large potential to enhance CE themselves, the impacts are not only limited to their own actions. Moving towards circularity happens in close cooperation with local companies and organizations, other cities nearby and even residents. However, many cities have newly woken up and participated incentives and CE development work, which provides a fruitful research area for analyzing current situation with drivers, barriers, challenges and opportunities with circular business in Finnish urban ecosystems.

Due to a broad scope of CE concept itself, this study focuses mostly on circular business in the energy sector. This study focuses especially on opportunities to enhance circular business realizing opportunities related to energy from renewable sources and by analyzing opportunities to enhance the CE targets in the context of energy systems. Energy systems have a significant, supportive role for other circular business and this is why it is an interesting area for research and development. In addition, the energy sector in Finland is facing many challenges in the near future which provides an opportunity to make a cross-section about the current situation and the predicted future challenges.

This thesis is part of a broader research project ***"D2W: From data to wisdom – Approaches enabling circular economy".*** The project is funded by Smart & Green Growth programme of Tekes (the Finnish Funding Agency for Technology and Innovation) and its aim is identifying and mapping the key enablers and barriers for circular business models. This knowledge will be exploited when developing approaches for a) new circular business through shift from data to wisdom, b) revolutionizing circular value formation by disruptive business models and innovations, and c) leveraging relationships and networks for circular business. The research partners of the project are VTT Technical Research Centre of Finland Ltd, Lappeenranta University of Technology – LUT, and Tampere University of Technology – TUT. Industrial partners are BMH Technology Oy, Fortum Power and Heat Oy, Solita Oy, and UPM Kymmene Oyj. In addition to enhance common targets of the research, the aim of this thesis is to enhance CE projects development together with Fortum Power and Heat Oy. The topic and goals of this thesis is developed and set together with Fortum Power and Heat experts.

1.3 Execution of the study

The execution of the study consists of three main research phases. **Figure 1** summarizes the research process, timetable and the purposes of the different phases. The research has been conducted between February and July 2017. The first phase of the study is a theoretical part focusing on literature review aiming to get common

understanding about the circular business and CE business models in urban ecosystems. In addition, the literature review aims at collecting theoretical background about drivers and barriers for circular business and collecting studies about energy systems in the context of CE. First phase also gives theoretical background for partnership models and networks supporting circular business.

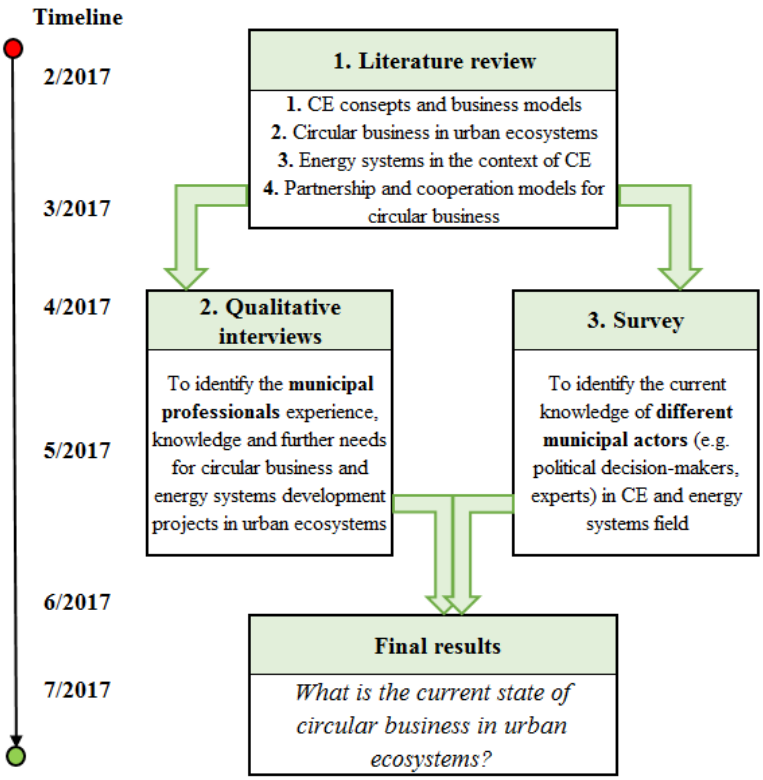

Figure 1 Execution of the study

The empirical part of the study consists of two phases. The first empirical phase contains nine qualitative interviews including semi-structured questions for the 13 professionals in the municipal organizations. The phase aims to collect informants' experience, knowledge and perception about CE projects in urban ecosystems from the viewpoint of municipal organization. The second empirical phase is the Webropol-survey including 116 responses that aims to enrich the sample of interviews and to collect opinions of different municipal actors like political decision-makers, municipal managers, municipal officials and experts and representatives of municipal development companies. Finally, based on both theoretical and empirical implications, the results can be conducted. Methodology and the execution of the study are introduced in detail in chapter four.

1.4 Structure of the report

The thesis' structure is next briefly described. **Figure 2** summarizes the input and output of every chapter. The purpose of the first chapter *Introduction* is to provide background for the thesis and clarify the main target, give limitations and describe the structure for the thesis. Chapter two *Circular business* collects information about CE in general and describes circular business and energy systems in the context of CE. The final outcome of this chapter is the identification of CE business models and theoretical categorization of drivers and barriers for circular business with PESTE analysis. After this identification, chapter three C*ircular economy in urban ecosystems* can be concentrated on especially circular business from the cities' and municipalities point of view. The aim of this chapter is to provide understanding of the role of urban ecosystems executing CE business and describes cooperation and partnership needs and possibilities in the CE initiatives.

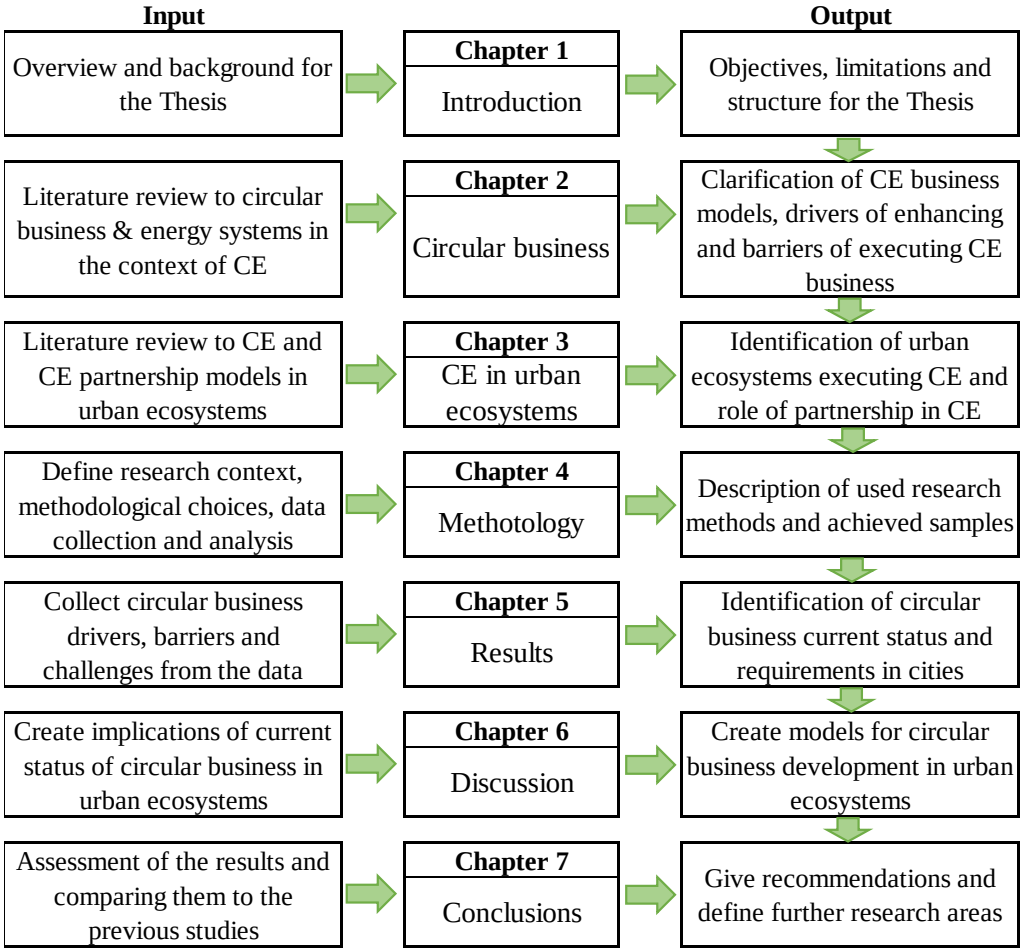

Figure 2 The structure of the Thesis

In chapter four *Methodology*, the research context is introduced briefly and methodological choices (case study and qualitative method) and data collection and analysis (content analysis) are justified. The outcome of this chapter is to describe the conducted research process and achieved samples. The aim of chapter five *Results* is to collect main observations from the research data. This provides identification for the current state of circular business in urban ecosystems and base for the final analysis that are conducted in the chapter six *Discussion.* The chapters five and six answer to the set research questions and provide additional information how to enhance circular business in urban ecosystems. Furthermore, these chapters' summarize municipal decision-making processes related to CE initiatives and describe the value network and possible partnership models for CE projects. Chapter seven *Conclusions* summarizes both theoretical and managerial implications and gives recommendations for further research areas.

2 CIRCULAR BUSINESS

This chapter provides a literature review of circular economy (CE). The first part of the chapter introduces circular business generally and defines different concepts related to the topic. The second a part of the chapter describes CE business models and focuses on definition and opportunities of CE in the context of energy systems. Finally, part four reveals and gathers drivers and barriers for circular business based on current research and literature.

2.1 Principles of circular economy

Although CE has gained incremental attention in literature and discussion within the last years, the definitions of the concept are still very varied. CE related concepts have gained attention since the 1970s (Kraaijenhagen, van Oppen & Bocken, 2016). Actually, already Kenneth Boulding (1966) debated in his essay that Earth can be perceived as a closed spaceship where humans must find their place in a cyclical ecological system. The Club of Rome made also an early report in the 1972. They predicted that if the decision makers are not able to find a consensus between the pollution and the overconsumption of resources, the world economy will crash after hundreds of years (Lacy & Rutqvist, 2015). In 1984, Stahel brought out the resource efficiency aspect as a part of CE. According to him, all lifecycle impacts of products must be taken into account while enhancing resource efficiency. Stahel defines CE also as a spiral-loop system where environmental decoration, energy-flow and matter are minimized whilst economic growth is not threatened. In 1998 von Weizsäcker introduced his notice of society development without destroying natural resources by using the current resources efficiently (Lacy & Rutqvist 2015).

One of the most significant driver for CE discussion has been the book *Cradle to Cradle: Remaking the Way We Make Things* written by McDonough and Braungart in 2002. The vital message of the book is the need for systematic change in our wasteful society. Shifting towards CE is a multidimensional process aiming to eliminate the waste of products, systems, materials and even business models

during the whole lifecycle. There are two types of management of material flows described by Braungart & McDonough (2002): technical nutrients, which must circulate at a high quality without ending up in the biosphere, and biological nutrients, which have to return to the biosphere securely and create again natural capital. During the past years, Ellen MacArthur Foundation has developed and maintained this classification and provided a visual tool for understanding the model. This model is shown in **Figure 3**.

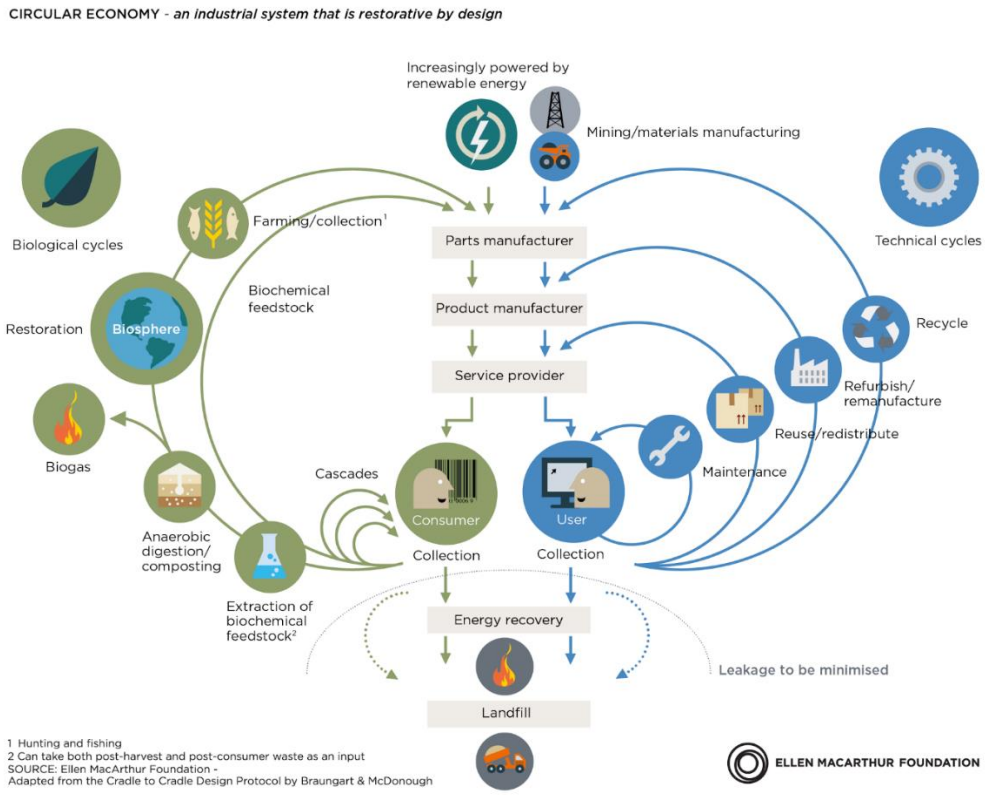

Figure 3 Model of Circular Economy (Adapted from Ellen MacArthur Foundation, 2012)

Model of CE provides simplified view of the CE system and describes biological and technical nutrient-based materials and products circulating through the economic system. The need for energy increases outwards and wastage of nutrients is in the lowest level when the material flows are near consumers and users. Thus, importance and effectiveness of cycles are getting smaller from the inner cycles towards the outer edge from both biological and technical point of view. Because the ways to deal with technical and biological nutrients differ, these cycles have been separated in the model. If we look at the left-hand side of the model, the first way to reuse biological materials is to cascade them and for example to create

purpose to reuse the biological material in a way that that differs from the original use. When biological material has to be discarded, instead of burning, the more sustainable way is to gather and reuse all nutrients and for example reclaim materials in the production of biogas. The core idea of CE is to minimize leakage of materials and this is the reason for avoiding landfilling or burning technical materials as well. Returning materials back to the material flows saves energy and decreases carbon dioxide emissions compared to burning and using the virginal raw materials. If we take a look at the right-hand side of the model, the best way to reuse technical materials is to maintain the value for example by fixing. The final recycling of materials or components should be done only when all the other ways have been tried to utilize. (Ellen MacArthur Foundation, 2012)

Also Lacy and Rutqvist (2015) point out the fact that CE means keeping resources in productive use as long as possible. They define waste as four forms shown in **Figure 4.** The idea of this classification is to describe that waste does not mean only physical waste such as rubbish in the case of CE; the concept is wider and that is one of the reasons why CE provides a huge business opportunity.

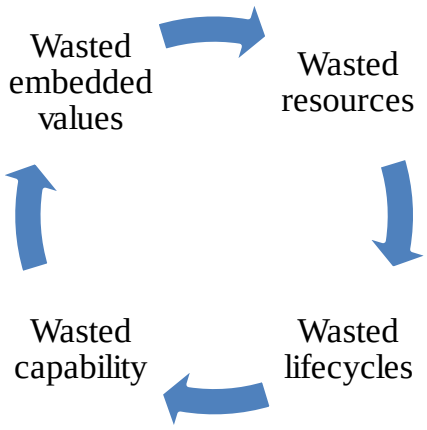

Figure 4 Four types of waste in circular economy (Lacy & Rutqvist, 2015)

Wasted resources mean the energy and materials that are not possible to reconstruct continually. Resources are used up permanently after their first function. Some of the products have wasted lifecycles: even if there might be a possibility to reuse them by another user, products are disposed. A similar problem exists within wasted capacity of products. There is for example products that are unnecessarily not in use most of their lives. Some materials, components, and energy has embedded

value that is not reclaimed and put back into use. (Lacy & Rutqvist, 2015) Sustainable value creation and maintaining of value are one of the core issues related to CE. By keeping the created value through all stages of the value chain within wise use of the energy and materials, the resource efficiency can be achieved (Yuan et al., 2006). There is a significant difference between the linear and circular approach and value creation. The differences between supply chains are visualized with value hill model by Achterberg et al., (2016) in **Figure 5**.

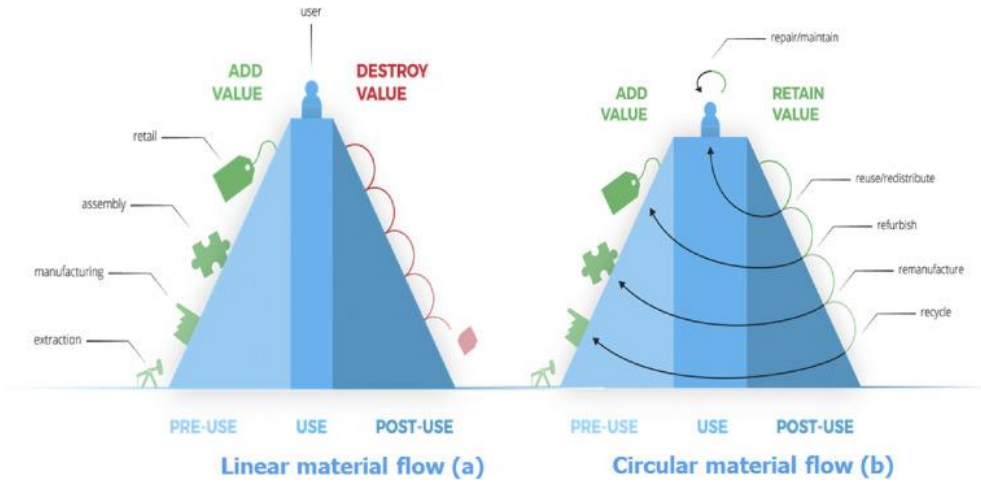

Figure 5 Visualization of linear vs. circular supply chain (adapted from Achterberg et al., 2016)

The current system (Figure 5a) is based on linear flow: taking materials, making products, using, consuming and finally disposing of the goods. The lifecycle of the linear system ends after the use-phase and therefore the value of the product is destroyed. In CE approach (Figure 5b) the supply chain is longer and after use-phase the value of the product is retained by reusing, refurbishing, remanufacturing or recycling. Therefore, the lifecycle of a product is extended and value can be added with less energy and resources compared to the linear supply chain. Thus, the key difference in these two business models is that the linear system is sales oriented and aims at gaining revenue from selling as many products as possible (Achterberg et al., 2016) whereas the linear system relies on long lasting products that are suitable for repair and slowing resource loops (Bocken et al., 2016a). Furthermore, one of the core concepts in CE is “3Rs” principle including three actions shown in **Figure 6**: Reduce, Reuse and Recycle (Ghisellini et al., 2016; Jawahir & Bradley, 2016; Wu et al. 2013). The 3Rs summarize CE principles introduced by other definitions and as many other concepts, the principles must be implemented both in production and consumption. The first target is to reduce the

waste generation completely, the second phase requires looking for reuse opportunities, and the third phase aims to recycle the materials, but only if the first and second phases are impossible.

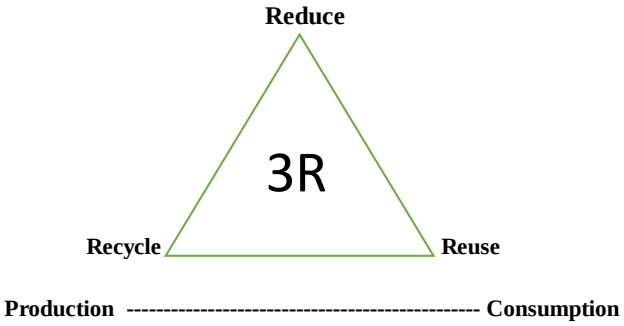

Figure 6 3R principles (adapted from; Jawahir & Bradley, 2016; Wu et al. 2013)

As the examples before show, the current literature does not provide an unambiguous interpretation for CE and the definitions made by different scholars differ slightly both nowadays and in the past. Ellen MacArthur Foundation (EMF) (2013) provides one of the most used interpretations for CE and replaces the old end-of-life-concept. The interpretation made by EMF defines CE as an economic model, which enables keeping value of materials within efficient recirculating as long as possible, while waste of materials and resources are minimized during the whole lifecycle of the product. It aims to decrease the environmental impact of material usage by enhancing their life cycle by circulating higher value added products and services. According to Mitchell (2015) CE replaces the traditional linear economy model (make, use, dispose) by extracting the maximum value from the resources in use, recovery and reuse of materials and products. Some definitions highlight the role of closed loops in CE concept. For example, CE can be defined as a model that aims at the production and consumption in closed loops material flows. In this kind of system, the objective is to internalize external environmental effects such a virgin resource extraction and the generation of waste (e.g. Sauvé et al., 2016; Yong, 2007; Yuan et al., 2006).

A definition made by Green Alliance (2017) describes CE as a development strategy that keeps materials in use with their highest value as long as possible. CE

requires companies to minimize waste production at the same time with maximization of resource efficiency within the perspective of sustainable social and economic development. Improvements for entire living and economic model have gained attention in the definition made by Ghisellini et al. (2016). Also Su et al. (2013) highlight the CE role in enhancing all three viewpoints of sustainability including environmental, economic and social aspects. The targets of the economic aspect are pursuing improvements in the productivity, resource allocation, and resource consumption and thus increasing competitive advantages. The social approach enhances both an equal economic distribution, creates an employment opportunities and improves overall well-beings in societies. The environmental approach believes in eco-friendly redesign of the industrial structure within the target of decreasing the negative issues. However, the gradual extension of CE direct the discussion from material management issues towards other aspects such as land management, soil protection, water and especially energy efficiency. (Su et al., 2013) In conclusion, both economic, environmental and social dimensions must be involved in part of practical implementation of CE (Feng & Yan, 2007).

By understanding the wider potential of CE, companies and organizations are able to enhance new practices and business models to catch the comprehensive value of CE. Rizos, Tuokko and Behrens (2017) have observed the dearth of definition and have published the report *The Circular Economy - A review of definitions, processes and impacts* that aims to collect the most used definitions for CE and to clarify different dimensions of the CE concept. According to their review, there is two main categories of interpretations for CE: “resource-oriented definitions/interpretations, emphasizing the need to create closed loops of material flows and reduce the consumption of virgin resources” and “interpretations that attempt to move beyond the notion of management of material resources and incorporate additional dimensions” (Rizos et al., 2017, p. i). They provide classification of eight different CE processes under three different categories shown in **Table 2**.

Table 2 Circular economy processes by Rizos et al. (2017)

USE LESS PRIMARY RESOURCES
•Recycling •Efficient use of resources •Utilisation of renewable energy sources
MAINTAIN THE HIGHEST VALUE OF MATERIALS AND PRODUCTS
•Remanufacturing, refurbishment and re-use of products and components •Product life extension
CHANGE UTILISATION PATTERNS
•Product as service •Sharing models •Shift in consumption patterns

This conclusion describes CE as a broad concept without a strict definition. The same themes related to sustainable value creation, reducing resource use and change utilization habits are found. Many scholars make definitions for CE in the context of their own study, e.g. Kraaijenhagen et al. (2016, p.14) define the CE as *"an economy in which stakeholders collaborate in order to maximize the value of products and materials, and as such contribute to minimizing the depletion of natural resources and create positive societal and environmental impact".* If compared this interpretation to definitions introduced before, this definition highlights the role of collaboration in CE activities.

Another problem is met with CE concept with relation to the concept of sustainability. Geissdoerfer et al. (2017) defines in their article the relationship between the concepts to avoid blurring between terms and the targets. According to them, the sustainability is defined as *"the balanced and systemic integration of intra and intergenerational economic, social, and environmental performance"* (Geissdoerfer et al., 2017, 759). Instead of that, the newest definition for CE says: "*as a regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling"* (Geissdoerfer et al., 2017, 759). This study follows this definition and focuses on research circular business opportunities and business development potential in urban ecosystems.

2.2 Circular business models

To reach circular business objectives, the CE framework for industry has been published for introducing these three perspectives and their specific boundaries for circular business (Lieder & Rashid, 2016). The framework is shown in **Figure 7**.

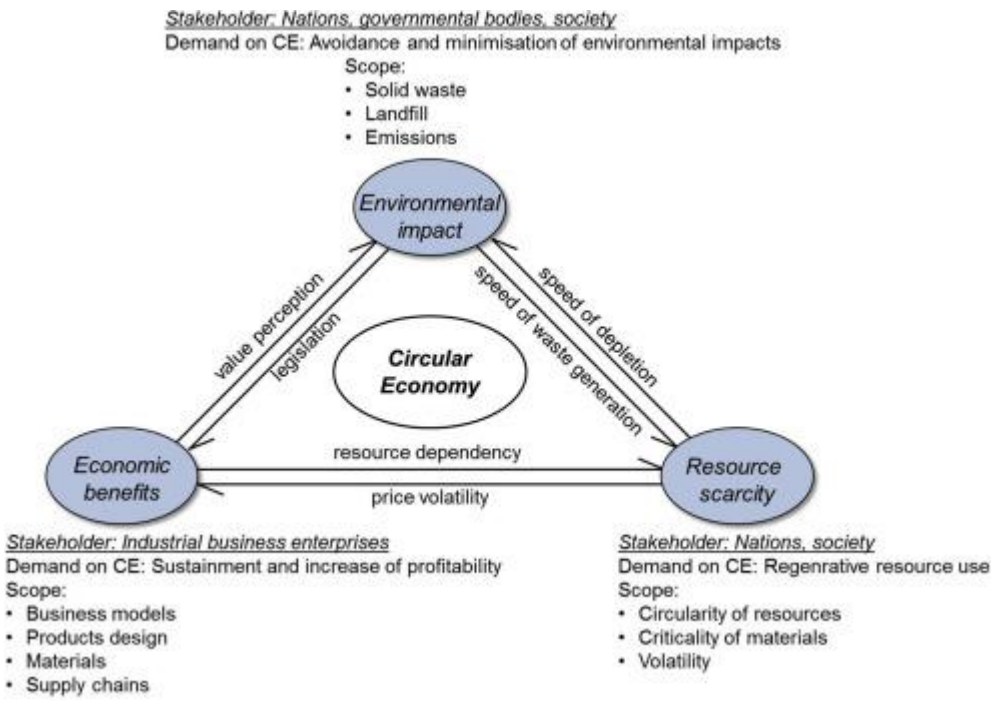

Figure 7 Framework of circular economy (adopted from Lieder & Rashid, 2016)

First, every company pursues to reach economic benefits and strives a competitive edge and profitability. The scope must be focused on both business models, choice of materials, product design as well as supply chain design. The economic benefits strongly depend on resources and e.g. resource price volatility and supply risks have direct influence on the competitive edge of firms and the capability of performing their industrial activity in profitable as well as sustainable manner. Both in environmental impacts and resource scarcity issues, nations, governments and the whole society have a significant effect for circular business as stakeholders. Circular business aims at reducing solid waste, landfill and emissions through activities such as reuse, remanufacturing and/or recycling. The one key issue is to understand e.g. the end-of-life products as resource rather than waste in the future. Different legislation e.g. directives are set to controlling industrial activity and to preventing waste generation and negative influences on the natural environment.

These actions put constrains and affect competitiveness naturally. The underlying factors in resource scarcity concern circularity of resources, material criticality and volatility of resources in the light of the globally increasing number of industrial activities. Re-thinking of business models for CE has a strong effect to product design and forward and reverse supply chains in order to reach operational efficiency and generate valuable circular business. (Lieder & Rashid, 2016)

The aim of the business model is to describe how a company does its business completely. Essentially, a 'business model describes the rationale of how an organization creates, delivers and captures value' (Osterwalder and Pigneur, 2010, 14) by meeting the demand of its customers. By modelling the data, the logic, and the structure of costs and revenues companies are able to understand how value is created and delivered for the customer (Teece, 2010). In fact, a business model is a kind of picture of the company's strategy (Casadesus-Masanell & Ricart, 2010). Recent discussion of business models as a facilitator for sustainability has been a popular theme in research (Bocken et al., 2013; Porter and Kramer 2011 & Schaltegger et al., 2012) and even CE related business models have been created.

Adopting CE affects an extensive systemic change for business. For example, people and industry are going to share products and services instead of owning them. The most innovative CE business models have a disruptive nature and change current markets behavior radically. Due to that, shift towards CE require major changes in thinking how companies are generating returns. In the context of linear economy, revenues are generated satisfying customer demand by selling more and fast (Kraaijenhagen et al, 2016). When CE will be adopted even better in the future, companies must rethink their business models and value creation for customers. For example, Beattie and Smith (2013) indicate companies' business areas such as finance, marketing, R&D, product design, procurement and manufacturing are going to merge in the CE model and value is created collaboratively.

Due to radical changes in current habits, Kraaijenhagen et al. (2016) highlight the importance of understanding the business model innovation as result of the CE approach. The aim of business model innovation is to change the way business is

done (Magretta, 2002). Bocken et al. (2014) has highlighted the concept of business model innovation for sustainability that aims at making changes for value creation process. It clarifies the ways of value delivery and capture of the organization and network. This will create positive benefits for both the environment and the society, reduce negative impacts (Bocken et al., 2014) and at the same time circular business models are economically competitive (Kraaijenhaagen et al, 2016). For gaining a better understanding about sustainable and circular value creation, the Conceptual Sustainable Business Model framework (Kraaijenhaagen et al, 2016) adopted from Bocken & Short (2016b) and originally from Richardson (2008), Osterwalder & Pigneur (2005), Bocken et al. (2014) and Short et al. (2014), is shown in **Figure 8.**

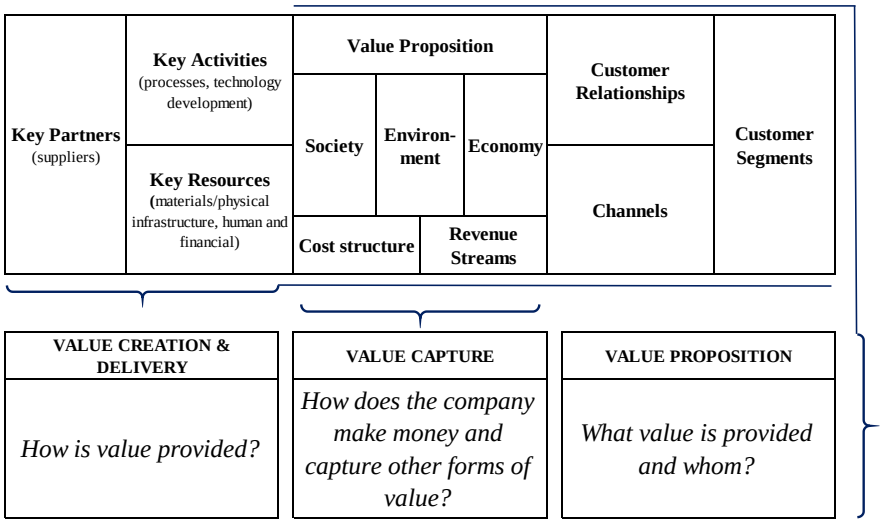

Figure 8 Conceptual sustainable business model framework (adopted from Kraaijenhagen et al., 2016)

The sustainable business model is based on the conventional business model canvas, but instead of satisfying one corporation pursuit of benefits, it focuses on the concept of creating shared value. This model takes collaborative value creation as a part of *value proposition*; a value is maybe created for a network instead of just the consumer. In addition, the solution takes into account both value for the environment and the society. Value proposition describes also those products and services through which the value is really provided and defines customer segments and relationships. *Value creation and delivery* describes the key partners and suppliers, key activities, key resources and distribution channels as well as the technology and product features that helps to understand how value is provided.

The *value capture* phase concentrates describing both growth strategies, cost structure and revenues streams as well as value capturing for the environment and the society. (Kraaijenhagen et al., 2016)

In addition to this sustainable business model canvas, there are other accurate models for describing the implementation of CE as a part of business. In recent years, for example Bocken et al. (2016a) and Lacy & Rutqvist (2015) have collected and introduced CE business models and strategies for better understanding of special characteristics of the circular business. Bocken et al. (2016a) have divided circular business models strategies into three groups shown in **Figure 9**: slowing resource loops, closing resource loops or narrowing resource flows.

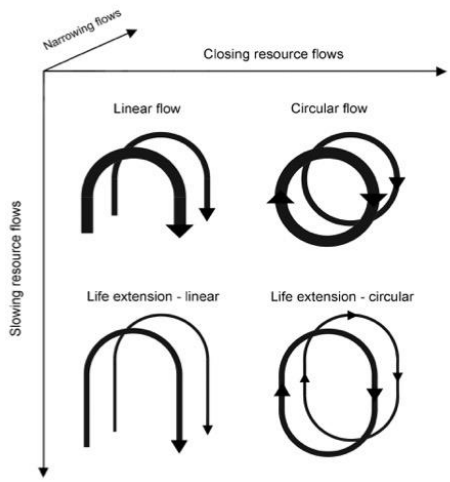

Figure 9 Strategies of closing, slowing and narrowing loops (adopted from Bocken et al. 2016a)

As a result of slowing resource loops, the utilization period of products is extended and flow of resources is slowed down. This is achieved e.g. by designing long-life products and by extending the life of goods. Strategies to slow resource loops e.g. prefer functionality instead of ownership, extending product value, preferring classic long-life model and encouraging sufficiency. Functionality instead of ownership is achieved by e.g. providing services that satisfy consumer needs without owning physical products such as in car sharing. Extending product value means looking for residual value of products e.g. by refurbishing goods and providing them again back to market. As the classic long-life name suggests, the idea of this business model is to deliver goods relying on quality and durability as

e.g. long-lasting furniture. Sufficiency encouraging as a business model is based on solutions that reduce consumption. This can be produced by preferring features such durability, upgradability, warrantees as well as non-consumerism. A good example of this business model is energy service company (ESCO) that aims to reduce energy consumption with consumers. In summary, slowing resource loops means actions enabling prolonged use and reuse of goods during the whole lifecycle. (Bocken et al. 2016a & Kraaijenhagen et al., 2016).

Closing resource loops -business model focuses on the reuse of materials and enabling a circular, closed flow of resources. This strategy is mostly based on recycling. Sub-strategies for efficient recycling and closed resource flows are both industrial symbiosis creation and extension of resource value. Industrial symbiosis itself is a process-oriented solution where residual output is feedstock for other processes and thus resources circulating and are used as efficiently as possible. A typical example about industrial symbiosis is an eco-industrial park in which firms and other stakeholders cooperate tightly and the whole community shares resources such as infrastructure, materials, information, energy and other natural resources efficiently and thus tries to achieve resource wisdom together (Gibbs & Deutz, 2007). Exploiting the residual value of resources means collecting and creating new forms of value from materials and resources otherwise wasted. This can be achieved e.g. by collecting waste from the ocean and using this as a raw material for new products. (Bocken et al. 2016a & Kraaijenhagen et al., 2016).

The third CE business model category made by Bocken et al. (2016a) is resource efficiency or narrowing resource flows with the aim of doing more with using fewer resources per product. This business model strategy concentrates on maximizing material and resource efficiency completely, both associated with the product and the production process. These benefits can lead to continuous improvements and help firms find ways to become more efficient and cost-effective. The lean thinking can be seen as one example of this ways of doing business effectively. (Bocken et al. 2016a & Kraaijenhagen et al., 2016). In addition, CE models made by Bocken et al. (2016a) and Lacy & Rutqvist (2015) provide five examples about circular

business models: (1) Circular Supply-chain, (2) Recovery and Recycling. (3) Product Life-extension, (4) Sharing Platform, and (5) Product as a Service. As we can see already on the grounds of the names of these classes, these models have same characteristics as those introduced before. The circular supply-chain business model aims to provide substitutes for the virgin, often nonrecyclable and toxic raw materials. Firms can apply the circular supply-chain model producing either nontoxic, fully renewable or recyclable materials for others or for their own operations. The core idea of the business model is to offer and increase more predictable, cost-effective and long-term sources of energy and materials and thus enable to choose more sustainable alternatives. The easiest example of replacing materials in products vale chain is to change nonrenewable energy with renewable one. (Lacy & Rutqvist, 2015)

The recovery and recycling business model aims to eliminate resource leakage as well as maximize the economic value of return flows. The benefits of this business model are not difficult to understand: companies can increase revenues by selling useless outputs, achieve cost-savings with waste management and lower demand for virgin materials and energy. The two variations for recapturing value within this business model are recovering either end-of-life products or waste and by-products. Recovery in the case of end-of-life products can be implemented in closed loops while using company´s own products, or in open loops when utilizing any company´s products. Recovery of waste and by-products can be implemented from a company´s own production processes and operations. This business model requires deep understanding of each step of the production cycle and aims to zero waste future. (Lacy & Rutqvist, 2015)

Under the product life-extension business model, the goal is clear. Instead of volume production and cheap, never-ending resources, companies must be focused on maximizing useful life and making products sustainable over the lifecycle. This business model focuses on lengthening products' lifecycle and generating revenues through longevity. This can be achieved by designing high quality, durable and functional products. Business model requires firms to change their own thinking

and e.g. build take-back, buy-back and refurbish mechanisms. The fourth business model for CE, sharing platforms, has become more common recently. The model relies on e.g. the renting, sharing, lending and bartering the resources. Money is made e.g. within service fees and revenue streams created from accelerating utilization of idle resources. Digitalization and e.g. mobile applications has been boosting the development of sharing opportunities. The fifth business model, the product as a service, focuses on consumer as a service user instead of consumer as a product buyer. A typical example is car renting instead of owning a car. The model can take forms such as customers buying usage-based, such as based on hours used or data transferred, or customers pay for the leasing, rental or according to performance agreement. (Lacy & Rutqvist, 2015)

2.3 Circular energy systems

The energy use has an enormous significance when shifting from linear to circular economy. In the linear system, a lot of energy is lost because of disposal of products in landfill without recycling. In addition, the linear consumption and production models are relying on endless energy resources. The circular system saves energy especially when products are organized for reuse. (Ellen McArthur, 2013) Despite of dominant linear thinking, the energy resources are not endless. One of the global challenges met in recent years is the energy transition. The current energy usage still relies on nonrenewable fossil fuels, which are not only limited and scarce but also polluting. According to e.g. Heck (2006) the utilization of sustainable energy has a significant role when adopting CE: the transition into renewable energy enhances circularity itself. Also according to Ellen MacArthur Foundation (2013), the CE is based on five simple principles: *Design out waste, Build resilience through diversity, Rely on energy from renewable sources, Think in 'systems' and Waste is food* - this definition highlights renewable energy as one significant sector when aiming CE as well as truly circular business.

This role of energy will be highlighted even more in the future because energy consumption is assumed to increase. Key issues in CE development are resource

wisdom concentrated both on resource input as well as on waste, and on emission and energy leakage minimizing. This study focuses especially on researching opportunities, which enables more efficient energy use by developing energy systems and thus supporting the adoption of truly circular business in urban areas. The role of energy sector in the context of CE is thus supporting e.g. industrial sustainability by enhancing energy efficiency and resource wisdom of production processes. An energy system encompasses the entire energy supply through energy services to end-users of energy (e.g. Groscurth et al, 1995). Hence, energy systems can be defined to cover all factors related to energy generation, conversion, delivery, and use of energy. The urban energy system components adopted from Calvillo et al. (2016) are introduced in **Figure 10**.

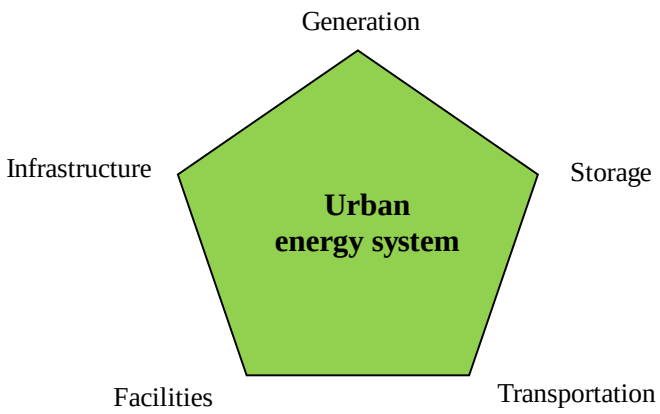

Figure 10 Key components of urban energy system (adopted from Calvillo et al., 2016)

The aim of circular energy systems is to do the same or even more with less. Sustainable energy system will be a combination of centralized and local generation in the future and it will include energy storages too. The role of customers will change and one key element is the flexibility and intelligence of the energy systems. The volatility is going to increase because of e.g. increasing use of solar and wind power. The digitalization and Internet of Things support the technology development and enables energy efficiency improvements both in the buildings, in infrastructure, in transportation as well as in the industry. This is one way to drive resource wisdom, decrease carbon-emissions and aim to society based on CE. Energy efficiency does not cover only efficiency of different equipment and components but also means using side streams and for example waste heat

efficiently (Tekes, 2017). It has been noticed e.g. in China that the energy utilization, residual heat recovery potential and energy savings can be better analyzed and evaluated if the methodology and the data availability will be developed (Zhang et al, 2013). These opportunities are increased and become more interesting from the viewpoint of cities and municipalities. Developing technology such as heat pumps will enhance the energy efficiency significantly in the future. However, this kind of changing and more intelligence energy systems requires new, innovative business models such as CE in generally. In addition, the service business is going to become more common in energy sector too and it requires new ways of working. (Tekes, 2017)

2.4 Drivers and barriers for circular business

Even though circular economy has gained increasing attention worldwide and the topic is more popular, the implementation of CE projects and circular business is still not easy in a society and business based strongly on linear processes. The global pressure aiming at a sustainable, environmental friendly future is recognized (e.g. Mathews & Tan, 2011) as well as potential for innovation (e.g. Kok et al., 2013) and workplace creation (e.g. European Commission, 2014a) but the implementation of CE principles demands deeper understanding of specific drivers and barriers for circular solutions and business. With a literature review, it has been noticed that many organizations as European Environment Agency (2016), IMSA Amsterdam (2013) and McKinsey & Company with Ellen MacArthur Foundation (2015) have published reports handling drivers and barriers, but a comprehensive list of drivers and barriers is needed. In this study, these factors have been categorized as political, economic, social, technological and environment factors within PESTE analysis method. PESTE analysis provides a framework to analyze the broad macro-environment and thus can be used to identify how these different factors in the current environment and future trends might influence (Johnson, Scholes & Whittington, 2008) for circular business. In addition to external macro drivers and barriers separated with PESTE analysis, there are some organizational, internal micro level drivers and barriers introduced based on literature as well.

2.4.1 Drivers

The PESTE categorization for circular business drivers based on literature is introduced in **Table 3.** The categorization aims to improve the understanding of the common enablers enhancing CE development. Lastly, also organizational drivers for circular business are collected.

Table 3 PESTE drivers of the circular business based on the literature

PESTE-factor	Examples with literature source
Political drivers	• **Laws and set targets** e.g. environmental laws e.g. toxic waste and control, set goals e.g. energy intensity, emissions (Mathews & Tan, 2011) • **Requirements for sustainable public procurement** (Witjes, & Lozano, 2016) • **Requirements through global standards** e.g. ISO 14001 standards (Bai et al., 2015) • **Government support** e.g. via recycling policies (Velis & Vrancken, 2015) and via subsidies, pricing policies (Dong et al., 2016)
Economic drivers	• **Financial capability** e.g. subsidies and funds enhance the collaboration and help the adopting technologies and infrastructures (Ilic & Nicolic, 2016; Yu et al., 2014) • **New economic potential** e.g. increased margin, profit and new revenue streams (Andersen, 2007; Linder & Williander, 2015; Schulte, 2013; World Economic Forum, 2014) • **Opportunities for cost savings and efficiency** e.g. by reducing material, energy or waste disposal costs (Andersen, 2007; Esposito, Tse, & Soufani, 2015; Ghisellini et al., 2015; Liu & Bai, 2014; Murray et al., 2015; Pitt & Heinemeyer, 2015; Rizos et al., 2015)
Social drivers	• **Environmental consciousness** e.g. via environmental stewardship programs (Kok et al., 2013), mainstream movement towards environmental concepts (Mathews & Tan, 2011) and increased market internationalization (Zhu et al. 2011) • **Potential to create jobs** (European Commission, 2014a) • **Changed consumer attitudes**, e.g. increasing demand for sustainable products (Andrews, 2015) • **Ideological values** e.g. opportunities to eliminate the negative effects of current technology and maintain the quality of life as a high level for future generations (Ghisellini et al., 2016)
Technological drivers	• **New technologies** e.g. for making industrial closed-loop connections technologically feasible (Lacy and Rutqvist, 2015; Mathews & Tan, 2011) • **Digital innovations** e.g. platforms for information sharing (Dong et al., 2016; Ellen McArthur Foundation, 2013; Lacy and Rutqvist, 2015)
Environment drivers	• **Resource constrains** (Kok et al., 2013; Lacy and Rutqvist, 2015; Moreno et al., 2014) • **Reducing environmental impact** e.g. cutting waste (Ellen MacArthur Foundation, 2013; European Commission, 2014a; Linder & Williander, 2015) and decreasing and preventing pollution (Andrews, 2015; Ghisellini et al., 2015)

Political drivers

Laws and set targets by governments (e.g. targets for carbon neutrality) direct the movement towards CE. Environmental laws for e.g. toxic waste and control enhance energy efficiency, motivate companies in pursuing lower emission and pollution as well as seek reutilization opportunities for waste (Mathews & Tan, 2011). In addition to direct laws and targets, different requirements encourage companies move from linear to circular business. The sustainable public procurement requirements (Witjes, & Lozano, 2016) and global standards such as ISO 14001 (Bai et al., 2015) are good examples of recommendations enhancing CE objectives. The support from the government is one of the most important drivers for CE. Both the direct support e.g. supportive recycling policies (Velis & Vrancken, 2015), the subsidies and pricing policies (Dong et al., 2016) and indirect support e.g. through taxation for non-renewable resources accelerate companies into transition towards CE (Dong et al., 2016; Stahel, 2013).

Economic drivers

According to Ilic & Nicolic (2016) and Yu et al. (2014) the financial capability supports CE implementation. They mention e.g. subsidies and funds as enablers of the adoption of new technologies and infrastructures. Financial support can also enhance the collaboration in CE projects. (Ilic & Nicolic, 2016; Yu et al., 2014) Furthermore, circular business itself provides a wide range of benefits that can motivate companies from the economic point of view. The potential of increased margin, profit, value creation as well as opportunities to generate new revenue streams motivates as well (Andersen, 2007; Linder & Williander, 2015; Schulte, 2013 & World Economic Forum, 2014). CE provides also many opportunities to improve the cost efficiency. CE aims to reduce material and resource use e.g. by connecting waste streams and by seeking new beneficiaries for side streams and thus providing fruitful opportunities to reduce energy, waste disposal and material costs at all (Andersen, 2007; Esposito, Tse, & Soufani, 2015; Ghisellini et al., 2016; Liu & Bai, 2014; Murray et al., 2015; Pitt & Heinemeyer, 2015 & Rizos et al., 2015).

Social drivers

The increased environmental consciousness is one of the biggest social factors enhancing CE. The mainstream movement towards sustainability and environmental friendly concepts themselves drive circular business (Mathews & Tan, 2011). In addition, environmental policies in different countries have become stricter and caused e.g. manufacturers to extend their environmental management requirements to cover e.g. their suppliers' actions and thus CE impacts can be applied wider (Zhu et al. 2011). The ideological values, such as opportunities to eliminate the negative effects of current technology and maintain the quality of life as a high level for future generations, guides following circular principles as well (Ghisellini et al., 2016). The changing consumer attitudes have already affected the increasing demand for the circular business and according to Andrews (2015) the demand for sustainable products will be increased in the future. One important social driver is the potential to increase future job opportunities within development of circular business in the future (European Commission, 2014a). This will produce many direct and indirect benefits for the companies and the whole society.

Technological drivers

Lacy and Rutqvist (2015) argue that new technologies and especially digital innovations enable making CE more and more concretely valuable for business. For example, Mathews and Tan (2011) highlight technology as a key possibility for making industrial closed-loops connection technologically feasible. Additionally, the digitalization boosts the development of CE. Digital platforms for information sharing enable transparency of information (Ellen McArthur Foundation, 2013) and can boost e.g. the supply chain management of CE project to the next level (Ying & Li-jun, 2012). The CE adoption is getting more efficient because of increased information sharing and internationalization. Platforms for information sharing can promote stakeholders to identify synergy opportunities (Dong et al., 2016).

Environmental drivers

The resource scarcity and constrains are clear drivers for circular business (Kok et al., 2013; Lacy and Rutqvist, 2015; Moreno et al., 2014). CE solutions provide

possibilities cut the loss of resources and for example save dwindling natural resources. Another significant driver is the possibility to reduce the adverse environmental impacts on nature by implementing circular business principles. The possibilities for cutting waste (Ellen MacArthur Foundation, 2013; European Commission, 2014a; Linder & Williander, 2015) and possibilities to decrease and prevent pollution (Andrews, 2015; Ghisellini et al., 2015) provide a fruitful base for circular business development. The CE adoption has an interesting nature also related to supply chain challenges. Several virgin materials and natural resources are going to became rare and critical already in the near future. The resource wisdom and especially opportunities to reduce supply dependence of these critical virgin resources, and on the other hand the improved supply of recycled materials, motivate companies invest in CE (Kok et al., 2013; Ghisellini et al., 2015; Andrews, 2015; Esposito et al., 2015; Moreno et al., 2014; Pitt & Heinemeyer, 2015; Schenkel et al. 2015 & Winkler, 2011).

Organizational drivers

According to Bocken et al. (2016b) and Kok et al. (2013), a goal or a vision that concentrates on circularity at least slightly can be seen as an internal driver for circular business. Geng et al. (2012) highlight the meaningfulness of eco-design and cleaner production internal promotion and see investments on CE research and development as a key driver for the success of circular business implementation. This will encourage companies' innovators to capture the business potential of CE completely (Lovins et al., 2014). Both Golinska et al. (2015) and Küçüksayraç et al. (2015) notice that due to complexity of the sustainable development vision (such as CE), innovation designers can help to adopt the radical and often necessary changes while updating practices, policies and even decision making tools to respond to CE needs. CE is also a great opportunity for brand protection and provides differentiation potential e.g. with green image for local governments (Geng et al. 2012 & Linder & Williander, 2015). Furthermore, the fear of a rapid increase of prices as well as high volatility boost also firms to seek possibilities to recycle and reuse critical resources (Ellen MacArthur Foundation, 2013; Kok et al., 2013; Linder & Williander, 2015; Moreno et al., 2014; Schulte, 2013).

2.4.2 Barriers

Although benefits and value of implementing circular economy solutions are identified quite well, there are several barriers hampering CE business. The PESTE categorization for barriers met in circular business is introduced in **Table 4**. In addition, the internal, organizational barriers for circular business are collected in the end of chapter.

Table 4 PESTE barriers of the circular business based on the literature

PESTE-factor	Examples with literature source
Political barriers	• **Unclear CE policies** e.g. limitations on cross-border transportation of waste (Bechtel et al., 2013; Raedemaekers et al., 2011) • **Lack of governmental support** e.g. taxation policy, laws, regulations, royalty regimes, (Parker et al., 2009 & Calogirou et al., 2010) and financial support (Xue et al., 2010; Gumley, 2014) • **Strong focus on linear models** e.g. Industry policies is strongly favoring industry policies that favor a linear life cycle (Gumley, 2014)
Economic barriers	• **High cost of technology** e.g. for re-processing of metals (Gumley, 2014) • **Lack of financial capability** (Ilic & Nicolic, 2016; Rizos et al., 2016) • **Uncertainty of economic forecasts** e.g. difficulties in valuing future benefits against current costs (Rizos et al., 2015) • **Difficulties in defining business case** e.g. challenges in defining economic benefits of CE business model which is consistent with current business (Bechtel et al., 2013) and uncertainty about market place and market pull-and-push factors (Liu & Bai, 2014; Rizos et al., 2015)
Social barriers	• **Weaknesses of public consciousness** (Xue et al., 2010) • **Decision-makers' weak awareness** e.g. circular economy implementation and development relies on municipal government officials 'awareness of the issue (Xue et al., 2010; Ilic & Nicolic, 2016) • **Lack of support from the supply and demand network** e.g. uncertainty of consumer responsiveness and demand (Bechtel et al., 2013; Raedemaekers et al., 2011; Rizos et al., 2016; Wooi & Zailani, 2010) • **Lack of expertise** e.g. to make contracts (Benton et al, 2014)
Technological barriers	• **Lack of technologies** e.g. to establish circular business models (Bechtel et al., 2013) • **Lack of support for recyclable materials** e.g. missing infrastructure (Benton et al, 2014; Raedemaeker et al. 2011) • **Lack of technical skills** e.g. challenges in identifying, assessing and implementing more advanced technical options (Rademaekers et al., 2011; Rizos et al., 2016; Trianni & Cango, 2012) • **Lack of databases** e.g. difficulties in indentifying recycling data and opportunities to access materials (Rademaekers et al., 2011) • **Lack of information and knowledge** e.g. related to life-cycle analysis, data and methodology to assess business efficiency (Lawton et al., 2013; Rademaekers et al., 2011;Rizos et al., 2016)
Environment barriers	N/A

Political barriers

According to many sources, CE policies are quite unclear too. Institutional barriers and especially strong focus on linear business models hamper CE adoption and e.g. industry policies favor still a linear lifecycle (Gumley, 2014). Even if many CE business models rely on waste utilization, there is still limitations on cross-border transportation of waste (Bechtel et al., 2013). Furthermore, the lack of governmental support for CE and for example complexity of laws and regulations, lack of royalty regimes and ineffective taxation policies hamper circular business (Parker et al., 2009 & Calogirou et al., 2010). In addition, lack of funding reflect the lack of governmental support for CE (Bechtel et al., 2013; Gumley, 2014) and delay CE implementation. There is for example lack of reward for firms incurring costs to contribute to public welfare outcomes (Xue et al., 2010; Gumley, 2014).

Economic barriers

Economic barriers are in a key role when companies list difficulties in the context of CE. An expensive technology e.g. for re-processing of metals and high cost of waste collection slow down the progress of CE (Gumley, 2014). Problems are faced with lack of financial capability and support even wider. Many companies do not have enough resources and financial capability themselves (Ilic & Nicolic, 2016; Rizos et al., 2016). Capital barriers arise because of the increasing amount of activities when shifting from a linear to a circular business model. This change requires redesigning inventory management, production and distribution planning, and management of a reverse logistic network (Kok et al., 2013). Realization of these improvements asks significant investments and amount of time. Furthermore, the difficulties in definition of value and especially economic benefits of CE actions can act as a barrier for adoption of CE business models (Bechtel et al., 2013). Rizos et al. (2015) list as barriers also various market pull-and-push factors and difficulties in valuing future benefits against current costs. Additionally, competing priorities inhibit commitment to circular economy and due to that, there is uncertainty about the market place (Liu & Bai, 2014). Lack of incentives can appear also indirectly because of high costs of recycled materials. This also hinders positive push effects from the consumer side and thus demand does not create a pull

effect. Incentives have not been built into budgetary systems to stimulate the CE innovations. (Liu & Bai, 2014 & Rademaekers et al., 2011)

Social barriers

Sometimes successful circular business implementation depends on municipal government officials' weak awareness of the CE, which is still a significant structural barrier hampering the development (Ilic & Nicolic, 2016 & Xue et al., 2010). Similarly, the weak knowhow of partners, e.g. environmental awareness of suppliers and customers in the CE network cause also barriers for CE development (Rizos et al., 2016 & Wooi & Zailani, 2010). These kinds of social barriers denote also wider lack of social awareness e.g. related to weaknesses of public consciousness (Xue et al., 2010). Lack of market demand and uncertainty of consumer responsiveness causing uncertainties to the marketability and profitability of CE business models (Bechtel et al., 2013 & Rademaekers et al., 2011). The lack of contract expertise to make new kind of deals can cause unwillingness and too high risks to develop new circular business cases (Benton et al, 2014).

Technological barriers

Technological barriers hinder development and adoption of CE as well. Lack of technologies and processes appear when firms are trying to establish new CE business models (Bechtel et al., 2013). Missing reprocessing infrastructure hamper CE enhancing and companies meet e.g. challenges to handle and operate with recyclable materials (Benton et al, 2014; Raedemaeker et al. 2011). Lack of technical skills are faced when companies are identifying, assessing and implementing more advanced technical solutions related to CE (Rizos et al. 2015 & Trianni & Cagno, 2012). Additionally, one typical barrier is also the lack of knowhow and information (Lawton et al., 2013; Rademaekers et al., 2011Rizos et al., 2016). Data and knowhow can be insufficient e.g. related to lifecycle analysis (Rademaekers et al., 2011). The role of databases and open information sharing is also critical for CE development. The lack of databases e.g. for waste and material

information hinder identifying and finding CE opportunities (Rademaekers et al., 2011).

Organizational barriers

The organizational barriers inside the firm harm CE development as well. The difficulties of switching from linear approach to circular models cause problems inside the organization (Bechtel et al., 2013; Benton et al., 2014). The internal company culture has a significant role in the change management and conflicts with existing organizational culture. For example, hierarchical systems harm both the flexibility and innovativeness in CE adoption. Lack of skills to change a mindset and e.g. switch from one-year goals towards long-term and system thinking are significant organizational problems (Liu & Bai, 2014 & Rizos et al., 2016). Companies can for example have difficulties to accept a long enough return of investment (Benton et al, 2014). The recent investment to old infrastructure naturally hinders investments to new technology (Benton et al, 2014). Lack of skills to create even wider cooperation and create common understanding inside the firm are identified barriers hindering implementation of CE business models. Silo thinking e.g. between planning and production and fear of risks implement these challenges. In addition, leadership, lack of management support and incompatibility with existing operations and development targets hinder the change towards CE business models. (Benton et al, 2014; Bechtel et al., 2013 & Liu & Bai, 2014). Lack of time to consider the new circular business opportunities harm internal development as well (Benton et al, 2014).

3 CIRCULAR ECONOMY IN URBAN ECOSYSTEMS

Inside the circular economy discussion, one hot topic is the role of enhancing circularity by developing urban ecosystems more sustainable. Even if urban areas cover only 3 % of the planet's land, cities produce approximately 75 % of the world's carbon dioxide emissions, consume 75% of the world's natural resources and 80% of global energy supplies (United Nations, 2016). Hence, it has been recognized that cities are facing major challenges during the next decades: urbanization is accelerating and cities are in a key role for example in realization of the targets of Paris Agreement 2015. Rapidly growing city areas have problems to solve related to heating, cooling, increasing traffic emissions, increasing amount of waste and energy efficiency in general. Especially the prevention of pollution becomes a more important issue at the city and regional level. The importance of material and energy circulation will be highlighted from the both sustainable social, economic and environmental point of views (Feng & Yan, 2007). The next chapters provide first brief introduction of what CE cover in the context of urban ecosystems. Then different ways to execute circular business in urban ecosystems are introduced. Finally, this chapter collects possible collaboration and partnership models to support circular business development in cities and municipalities.

3.1 Different circular economy approaches in cities

At the high level, the idea of CE in urban ecosystems can be understood with the context of *linear and circular metabolism of cities* illustrated in **Figure 11** and **Figure 12**. These sustainability city concepts describe two different situations of city metabolism. The idea of sustainability city is introduced first time by Girardret (1992). Also from the cities point of view in linear metabolism the inputs and outputs of urban ecosystem are unsustainable. The linear metabolism relies mostly on finite energy resources and other material inputs. These inputs produce organic and inorganic waste outputs that ends up in the landfill site and causes emissions. The circular metabolism is a more desirable system where inputs based on

renewable resources and the waste is reduced, reused, or recycled. (Doughty et al., 2004)

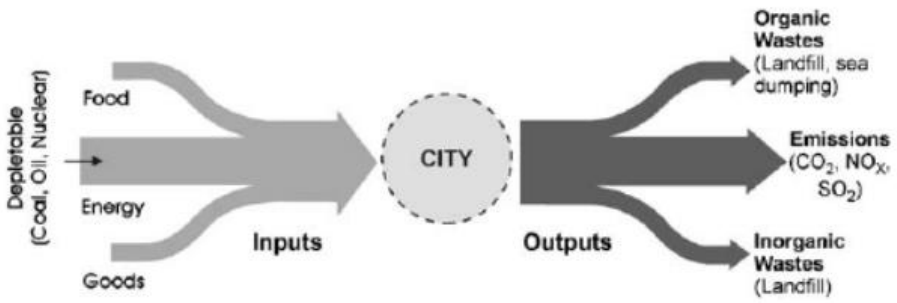

Figure 11 Linear metabolism of cities (adopted Doughty et al. 2004)

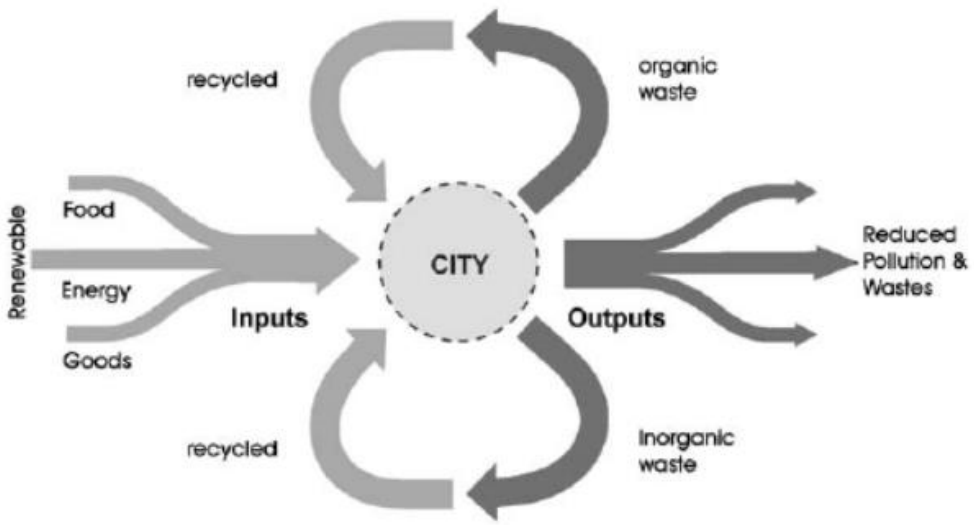

Figure 12 Circular metabolism of cities (adopted Doughty et al. 2004)

The ideal situation in urban ecosystems is that all resource streams and inputs are either renewable or else suitable for circularity and on the other hand, all the outputs can be exploited and the polluting emissions are thus minimized. This kind of city development will enhance CE targets both ecologically, socially and economically. (Doughty et al., 2004) To facilitate a pathway for eco-city transition, many cities have begun to measure different indicators. Dong et al. (2016b) have introduced six methods for following environment, economy and decision-making issues in eco-city context: input–output analysis (IOA), life-cycle analysis (LCA), ecological footprint (EF), carbon footprint (CF), emergy analysis (EA) and cost benefit analysis (CBA). These methods are introduced briefly in **Table 4.**

Table 4 Six methods for eco-city assessment (adopted from Dong et al, 2016b)

Method	Definition	Scale
Input-output analysis (IOA)	An economic technique that uses sectoral monetary transaction data to account for the complex interdependencies of various economic sectors.	Macro level, such as national and regional
Life-cycle analysis (LCA)	A method used to comprehensively assess environmental effects of product choices from the generation of raw materials to the ultimate disposal of wastes.	Micro level, such as product and process
Ecological footprint (EF)	The biologically productive land and water a population requires to produce the resources it consumes and to absorb part of the waste generated by fossil and nuclear fuel consumption.	Multi-levels, particularly regions and cities.
Carbon footprint (CF)	The amount of CO2-equivalent emissions caused directly and indirectly by an activity.	From micro to macro levels
Emergy analysis (EA)	The energy of one type required in transformations to generate a flow or storage.	Multi-levels
Cost benefit analysis (CBA)	A technique that is used to determine options that provide the best approach for the adoption and practice in terms of benefits in labor, time and cost savings.	More efficient in project or technology

These methods are a good way to reach the whole picture of the situation in the city or municipality. Evaluation also helps to create the precise picture of the issues can be developed and are in a key role while following the further development. However, the concrete actions are reached with cooperation with companies, citizens and other stakeholders operating in city area. The accurate development opportunities differ worldwide, are always city-based, and depend on e.g. the industrial structure of the urban ecosystem. Next, the current opportunities are described in China, in Europe and in Finland.

Globally the power of developing CE solutions in cities has been recognized and researched especially in China. The reason behind Chinas' CE activities is late developing: China is the world biggest country with unfinished industrialization.

However, the late development and late urbanization has enabled both digitalization and ecological development at the same time – China can consider environmental issues in an early development phase (Qi et al. 2016). Additionally, CE has been chosen as one of the topics of the European Union. In 2015, The European Commission adopted CE package that aims to support the transition towards a more CE in the EU. CE development from the regions and urban areas has been esteemed e.g. as a part of UIA (Urban Innovative Actions) that is an initiative promoting pilot projects in the field of sustainable urban development in EU and as a one of the key topics of the European week of regions and cities (European Commission, 2017).

The implementation of CE has many approaches in practical level. According Feng and Yan (2007), the adoption of CE in China can be divided in vertical and horizontal aspects. This implementation involves vertically e.g. cities, regions, companies, and industrial parks and horizontally urban infrastructures, the cultural environment, the social consumption system and industries. They assume that CE should be implemented first by the enterprises, then by eco-industrial parks and finally by cities and regions. That means movement from the micro level to meso level and eventually to macro level. Hence, each of the levels provide the basis for the next. Different levels are introduced in **Figure 13**. Altogether, CE can be seen as an outcome of the national political strategy and top-down approach in China (Feng & Yan, 2007). The EU transition towards CE relies mainly on a bottom up approach and e.g. occurs as initiatives of environmental organizations and nongovernmental organizations (Ghisellini et al., 2016).

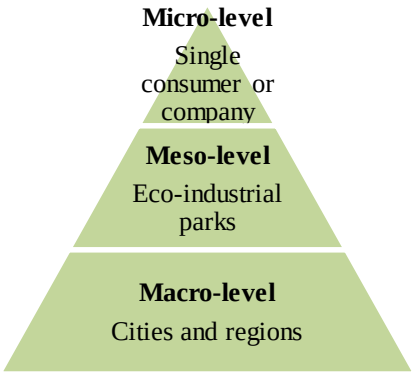

Figure 13 Implementation of CE in different levels (adopted from Feng and Yan, 2007)

Ghisellini et al. (2016) highlight this difference between approaches made by China and other countries. According to them, Chinese studies has brought out both horizontal and vertical approach within these micro, meso and macro levels. The other countries focus on mostly case studies at single level, mostly based on the meso level examples. The role of cities and urban ecosystems is highlighted in macro level in China approach (Feng & Yan, 2007 & Ghisellini et al., 2016). According to them, there are four key systems inside the circular-economy cities: *(1) Industrial system, (2) Infrastructure, (3) Cultural setting, and (4) Social consumption.* These four systems create together a larger complex system. A CE based *industrial system* means a need to construct industrial symbiosis and material circulation. This kind of system supports the regional development and help people and companies to use efficiently resources from the surrounding ecological system. In such a system, especially local manufacture, distribute, and delivery of products can become more effective. The *infrastructure* development has a significant role in urban areas development: a workable city infrastructure guarantees CE development. This covers all the actions related to clean energy systems, clean material transit system, and the building of water-recycling systems. In such CE oriented system supports efficient use of energy, circulation of materials as well as information sharing within the system. The *cultural setting* highlights the meaning of the human habitation environment. This requires an ecofriendly environment within e.g. a green landscape and an architecture in the ecosystems in cities. These actions boost the long-term health and quality of the life when the ecological pain barriers are kept within the limits allowed. The *social consumption* focuses on the harmony between humanity and nature: consumer behavior should be oriented toward environmental protection, ecological balance, and sustainable social development. Hence, consumers can enrich the content of CE adoption by changing the consumption mechanism towards circularity. The governments have a key role ensuring this movement with different policies. (Feng & Yan, 2007 & Ness, 2008)

In Europe, cities are the home for a broad part of economic growth and 70 % population is centralized in urban areas. According to UIA initiative (2017), city areas provide a fruitful context for the development of the CE because they are close

to both citizens, companies and service providers as well. Cities are also places where both consumption of goods and generating of waste is centralized. Urban authorities in city areas typically organize waste management and additionally, cities have a key role for energy generation and water availability and reuse. Urban areas include also a broad potential to support and drive the change towards more sustainable production and consumption. The CE adoption in city areas is useful for cities because of regional development, increasing amount of employment opportunities and social discussion. In fact, cities as CE drivers can stimulate the creation of totally new business models as well as the creation of new business and enhance cooperation between manufacturers and retailers. (European Union, 2017 & UIA-initiative, 2017) **Table 5** introduces some examples of themes of CE projects that cities are involved in to think about in EU (UIA-initiative, 2017)

Table 5 Examples of CE development themes in urban ecosystems (adopted from UIA, 2017)

CE development theme in city	Description
Increase local cooperation between various stakeholders	Cooperation with local manufacturers and retailers or citizen-led initiatives and third sector/social enterprises as a good way to promote more durable, reparable and recyclable products.
Industrial symbiosis	Supporting industrial symbiosis would allow cooperation between businesses and the utilisation of surplus resources generated by industry.
Collaborative economy	Promotion of a collaborative economy which shares products or infrastructure would see citizens and businesses consuming services rather than products.
Public procurement	Tools such as Green Public Procurement and Public Procurement of Innovation with criteria developed by public authorities can ensure that the sustainability, durability and reparability when setting out or revising criteria.
Prevention of food waste	Prevention of food waste along the value chain by taking different steps including changing behaviours through awareness raising campaigns. Further development of urban composting systems, linked to urban farming and hydroponics projects.
Water reuse	Promote water reuse (e.g. rainwater harvesting), as a measure to address water scarcity and droughts.
Enhance data tools and measurement for CE solutions	Contribute to measurable and replicable resource-efficiency solutions by documenting baseline use and progress observed, through standard indicators and appropriate data collection, formats and sharing and publishing rules.
Enhance data openness	Ensure that any solution adopted to handle data is interoperable and based on open standards.

Even the concept of “circular city” has become more common recent years (Prendeville, Cherim & Bocken, 2017). Lieder & Rashid (2016) have introduced

the top-down and bottom-up approaches and implementation strategies for CE. Both have an important role in creating a collective CE nexus and enhancing CE targets completely. According to them, the top-down effort can be condensed as a national effort based on efforts of society, legislation and policies. Instead, the bottom-up approach highlight the impacts made by an individual firm. They have introduced these company-specific issues especially from manufacturing industry point of view. The proposed CE implementation strategies applying top-down and bottom-up approaches are shown in **Figure 14**. In top-down approach, the key issues to focus on are legislation and policies, supportive infrastructure and increasing social awareness. The bottom-up approach highlights the importance of collaborative business models, product design, supply chain and workability of information and communication technology. (Lieder & Rashid, 2016)

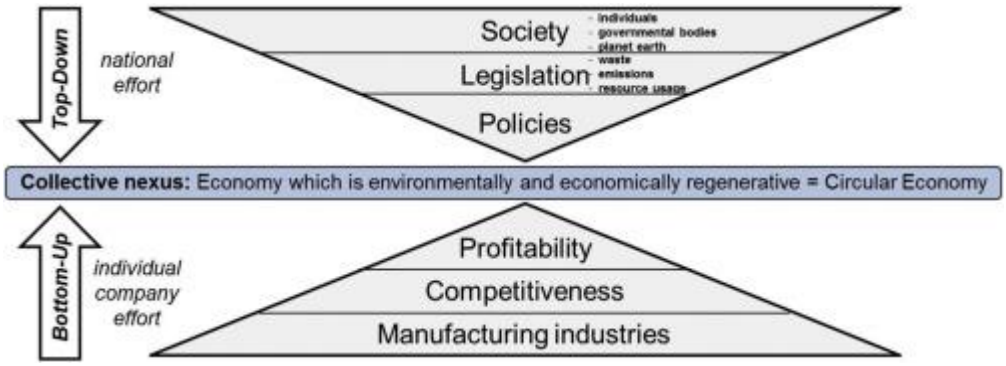

Figure 14 CE implementation strategies (adopted from Lieder & Rashid, 2016)

Furthermore, Ellen McArthur Foundation (2015) has listed six different policy types that enhance top-down approach of CE by political decision makers: *knowledge development, collaboration platforms, business support schemes, public procurement and infrastructure, regulatory frameworks and fiscal frameworks.* The knowledge development strategy includes CE projects related to both education, information and awareness. The aim of initiatives is to e.g. increase or develop understanding of CE and material flows and thus help the firms and policymakers in CE transition. This kind of projects are typical in pioneer cities often with tight collaboration with research institutes such as universities. As for the collaboration platforms, the aim is to utilize expertise and networks of broader stakeholder groups such as in collaboration with business and government. This kind of model develop

policymakers' and other partners' understanding and also needs of further development in CE field. (Ellen McArthur Foundation, 2015)

The business support schemes mean initiatives with the aim of supporting regional companies and business to develop innovative circular business. The city's policymakers develop these support systems in cooperation with local corporate partners in order to enhance regional vitality. In addition, policymakers can enhance CE by using regulatory frameworks to support CE business. This means the use of regulations to support CE development in order to help all collaborates such as companies, citizens and knowledge developers' actions inside the urban ecosystem. Within the procurement and infrastructure strategies, cities are able to promote CE development directly. They can set responsibility requirements for their own procurement, e.g. demand their executive cars to use renewable fuels. The sixth policy, the fiscal frameworks, means national strategies and actions that aim at fiscal incentives for a CE. Typical examples are increasing taxes of virgin materials or CO2 emissions. Naturally, policymakers of cities do not have that much political leverage in this category. (Ellen McArthur Foundation, 2015)

European Commission 16th European Forum on Eco-innovation (2014b) highlights the CE business possibilities in urban areas and the role of cities and public authorities leading the transition towards CE. According to the report made from the event, information technology will have a key role in product reuse, supporting leasing, collaborative consumption and take-back schemes. Applications combined to the Internet of Things expand the business possibilities e.g. in energy management systems, monitoring materials flows and efficient use of materials and machines. They also mention that business will change when asset sharing and collaborative consumption become more popular in urban ecosystems. Circular business might be increased especially in the service sector. (European Commission, 2014b)

The willingness of cities and municipalities towards resource wisdom, carbon neutrality and CE has increased rapidly these days also in Finland. The Finnish

Innovation Fund Sitra has begun an aggressive circular business development and e.g. has published the world´s first road map to a CE *"Leading the cycle – Finnish road map to a CE 2016-2025".* The targets of this work highlight the opportunities to enhance CE targets in the context of accelerating urbanization and finding pioneer solutions for sustainable well-being and a successful carbon neutral CE (Sitra, 2016). In addition, CE work in Finnish cities and municipalities is developed in cooperation with Sitra, SYKE (Finnish Environment Institute) and Motiva Group (Specialist in Energy and Material Efficiency) within the FISU-network (Finnish Sustainable Communities) and it focuses to be a network of trailblazers who aim to carbon neutrality, zero waste and global sustainable consumption by 2050 (FISU-network, 2015). As a consequence of this work, Sitra has created resource wisdom road maps for cities and municipalities. These maps focus on creating a base for sustainable urban areas development during next 10-30 years. The key areas in these roadmaps are introduced in **Figure 15**. All these operations related to CE and resource wisdom have a broad potential to strengthen regional economies and enhance employment, to create new business opportunities for local companies, and to enhance the well-being of local residents. The long-term target of resource wisdom in cities and municipalities is zero-waste, no overconsumption and no emissions. (Sitra, 2015b)

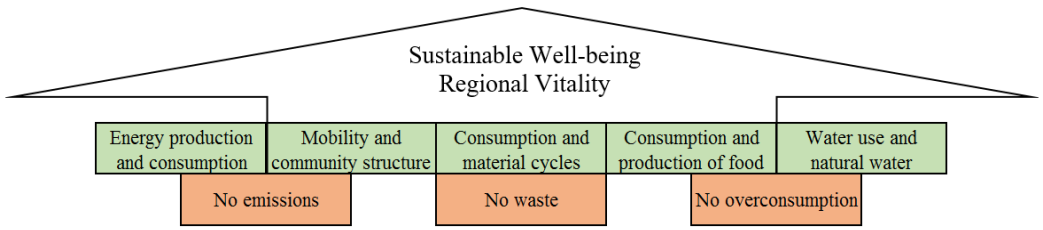

Figure 15 The regional road map towards resource wisdom (adopted from Sitra, 2015b)

The third example of already started development work is HINKU Forum (The Carbon Neutral Municipalities project) established in 2013. The aim of HINKU-network is to bring together municipalities, businesses, citizens and experts and to reduce greenhouse gas emissions at municipal level (HINKU Forum, 2017). All of these projects describe increasing attention towards CE in Finland and highlight the potential of increase actions in municipal level. In Finland, cities and municipalities have legal responsibilities e.g. to control their area's land use and construction,

taking care of water, energy and waste management, streets as well as environmental protection (Kuntaliitto, 2016). CE can be even a competitive advantage for Finnish cities and municipalities when they try to get more citizens and companies in their area. Hence, in Finnish urban ecosystems, cities can demand CE solution in many roles, e.g. when licensing authorities of land use. The municipal decision-making includes large amount of individual decisions that can either support or hamper circular business in urban ecosystem. In addition, the new procurement law in Finland support circular business adoption because one target of the new law is to enhance opportunities to take into account environmental and social aspects in public procurement (Finlex, 2016).

3.2 Collaboration and partnership models supporting circular business

One of the key features in circular business is the cooperation between different stakeholders. Especially cooperation and value-creation with external partners have a significant role in the CE: cooperation can develop e.g. knowledge transfer and help different actors to notice need for change. Complex relationships and networks between many stakeholders in CE projects demand active interaction and communication. Kraaijenhagen et al. (2016) note that according to many sustainability professionals, the collaboration is the key in transitioning towards CE and it is impossible to create an entire economy alone. From their point of view, lack of cooperation is one of the largest problems in CE initiatives. Porter and Kramer (2011) summarize that creating collaborative business or shared value enable creating value for a broad group of stakeholders at the same time. Successful collaboration is divided into three types: internal collaboration, collaboration with customers and collaboration with partners in the value chain (Kraaijenhagen et al., 2016). By investing in open and encouraging cooperation and by increasing knowledge transfer between stakeholders, the better outcomes can be reached in CE projects. The literature review has shown that there are no specified partnership models for CE initiatives. Due to that, this study focuses on researching partnership model opportunities for projects in urban ecosystems generally.

3.2.1 Networks and value networks

The term *networking* does not have a clear definition, but the key idea is to seek value e.g. over the organizational structures. According to Allee (2000), a network can be defined as an exchange that generates economic value between companies. The exchange can encompass both the traditional product and service exchange as well as the change of knowledge and other intangible assets between the network partners (Allee, 2000). Möller, Rajala and Svahn (2006) define networks and networking as a form of cooperation that aims the common targets set by stakeholders of the network. Network can be defined also as a *value network* where the members of network cooperate and create value together by exchanging information and services. In addition, the relationships between companies and responsibilities towards different members are often more flexible and weaker than in the traditional value chain, which makes the value network more agile. However, the participation of complex value networks demand agility and learning capabilities from companies. (Lusch et al., 2010) When companies operate in a value network, they should focus on a value co-creation with different partners, suppliers and customers (Peppard & Rylander, 2006). In addition, Moore (1993) has launched the business ecosystem concept already in the early 90s. According to his definition, companies should not be as a part of specific industry but as a part of a cooperation ecosystem. Firms cooperate, compete and co-create capabilities for innovations in the business ecosystems.

The CE networks and value co-creation has been recognized to be very complex, and the capabilities of value co-creation will be highlighted in CE projects as well. In municipal level, networks are often based on local partnership and regional development. This kind of networks can exist e.g. between industries such as in metal industry. There are also collaboration groups include various actors from several organizations. Urban networking can exist in also national or international level (Anttiroiko, 2010). The FISU-network is a good example of network-based development in CE field in Finnish cities and municipalities (FISU-network, 2016). These FISU cities meet regularly and change ideas of enhancing CE practicalities.

3.2.2 Strategic partnership

An alliance can be described as a diverse and an interactive co-operation between two or more organizations (Zeng & Chen, 2003). According to Shenkar and Reuer (2006, 26), *a strategic alliance* can be defined as a long-term agreement linking them to use their resources together. It does not mean an inclusive merger of the companies or neither comprise of a spot market transaction. However, the definition of strategic alliances is rather nebulous. That is why Shenkar et al. (2006) are presenting two distinctions for alliances: *activity-based alliances* and *project-based alliances*. An activity based alliance means operations that can be repeated indefinitely. Thus, the activity-based alliances have a starting point but not necessarily an ending. Instead, the project-based alliances are limited in time and are thus relatively short-lived in comparison to the activity-based alliances. Another categorization for alliances is a division for cooperative and contractual alliances. The cooperative alliance is a reciprocal commitment that enables resource and benefits sharing between partners. Duration of the cooperative alliance is often open-ended: it can continue as long as partners believe in mutual benefits. The contractual alliance is much more explicit: it is based on a legally binding agreement. This enables a measurable resource supply between partners within a defined timetable and a specified payment. (Shenkar et al., 2006, 26-27)

According to Rusko (2007), the strategic alliances formed are typically related to enabling product innovations or creating joint solution or service between different areas of expertise, industries, and platforms. Practically this can be realized by conducting joint venture between companies or by accomplishing e.g. project consortia between various organizations. In Finland, the strategic alliances have particularly been occurred e.g. in municipal joint ventures owned by several cities or municipalities. (Rusko, 2007) For example, several municipalities can own a waste management company together. However, the strategic alliances are quite rare in Finnish municipalities (Anttiroiko, 2010).

3.2.3 Public-private-partnership model

As a '*network*', neither does a *partnership* have a clear definition. In the public sector, one of the partnership models is *Public-private-partnership (PPPs)*. Many studies define PPP as a form of collaboration between the private and the public sector (e.g. Broadbent and Laughlin, 2003). The core idea in public-private partnerships e.g. for infrastructure and other public services are to make use of private capital for public services and at the same time increase the level, enhance innovations and quality of services and improve value for money (e.g. d'Alessandro et al., 2014). The PPPs are typically called as *Lifecycle models* in Finland. Many Lifecycle models are concentrated to the construction sector. The benefit of these models are low investment costs for the public sector when service fees pay the investment during the contract period. In an urban context, the partnership projects can be limited to e.g. cover contract-based partnership models between the public and the private sector (Anttiroiko, 2010).

There are also several forms of cooperation inside the PPPs. One of the first classifications for PPPs was made by Gidman et al. (1995). They have classified next forms: *Agreeing framework, Build, Operate and Transfer (BOT), Passive private investments, Passive public investments and Traditional public procurement*. In agreeing framework, the public sector influence local policy and actions through its own policy and strategies such as city strategy. These definitions of policies direct e.g. the local development. The private sector holds both strategic and operational risks. In the BOT model, the private sector both plan, operate and finance the public initiative during the contract period. After the end of the contract period, the responsibility for the item is transferred to the public sector. Passive private investments means the model where the public sector funds the infrastructure by selling government bonds to the private sector and hence has a financial risk. On the other hand, in the passive public investments the public sector provides funding e.g. via equity or grant to support to private sector providers of infrastructure and thus the private sector retains the strategic and operational risks. The traditional public procurement includes all contracts for short term, and the

public sector naturally has the responsibility of strategic and operational risks. (d'Alessandro et al., 2014 & Gidman et al., 1995).

3.2.4 ESCO-model

The idea of Energy Service Companies (ESCOs) is to provide energy usage optimization service e.g. to public buildings and companies (European Union, 2006). Achieved savings repay the investment and the customer is not obligated to pay the investment totally, if savings will not be fulfilled as the level guaranteed. The National Association of Energy Service Companies (2017) describes ESCOs an an effective delivery mechanism to provide the maximum amount of energy efficiency resources. The ESCO companies are project leaders and in addition to developing and analyzing energy efficiency actions, they can organize, operate and fund the whole ESCO-project. However, barriers for ESCO adoption such as hindering public procurement rules, lack and mismatch of financing, low client confidence and unclear contracts still exist (World Energy Council, 2008).

The Finish Government also supports ESCO-initiatives in Finland. The Ministry of Economic Affairs and Employment of Finland can grant investment projects that enhance renewable energy production or consumption, enhance energy efficiency or intensification of energy production or consumption or decrease the environmental hazards of energy production or consumption. The financial support may be granted for companies, municipalities or other organizations that are enhancing new energy technology implementation. The financial support aims enhancing the financial capability of new investment and reduce risks. In ESCO-model, one of the most critical issues is the creation of service contract. Service provider and customer have created the contract case-specific. The typical project is the renovation of energy system in building. In the public sector, competitive procurement makes cases complex. Due to that, there are created ESCO procurement instructions for the public organizations. (Motiva, 2017)

4 METHODOLOGY

The aim of this chapter is to provide additional information about the methods employed in this study. According to Saunders, Lewis and Thornhill (2009) the execution of a study includes both the research strategy and time perspective as well as the data collection and analysis strategies. Each stage of the methodology consists of a brief comment of methods recommended in the literature, followed by a discussion of the application of those methods in this study.

4.1 Research context

The aim of this study is to explore what kind of issues enhance circular business in Finnish cities and municipalities. The aim of the thesis has been determined in cooperation with the experts of the case company Fortum Power and Heat Oy and the supervisors during couple of workshops arranged in the beginning of the project. The main object is to research drivers and barriers for CE development in Finnish cities and municipalities. Furthermore, the study tries to clarify how the decision-making influences CE development in urban ecosystems and on the other hand, tries to collect and analyze possible partnership models to support further development of the circular business. Because of the case company, the energy systems development has been chosen as a special subject of the study as a part of CE and urban ecosystems development. However, the study aims to reach openly the whole picture of the current state of CE in urban ecosystems and then especially in the empirical part to answer and concentrate on this specific point of view.

4.2 Methodological choices

A case study and qualitative interviews have been chosen as the main research methods. The data collection of this study focuses on qualitative method which is implemented with qualitative interviews. According to Yin (2015), in a qualitative research there is a possibility to represent the views and perspectives of the participants in a research. Capturing these perspectives may provide an opportunity

to create new insights from the study. Since this study aims to capture the current state of CE in Finnish cities and municipalities, qualitative interviews with municipal experts have been implemented. The case study is an empirical research method that focuses on researching a subject in a defined environment. The aim of a case study is to examine in depth a couple of case examples and research the issue through these cases. Additionally, a case study method aims to describe the phenomenon and make new findings in the present study. (Syrjälä et al, 1994; Yin 2009) In this study, the defined research environment is Finnish urban ecosystems and the example cases are eight cities around the country. The study creates a common understanding about the current state of CE and circular business in Finland without analyzing cities one by one. However, the results are partly analyzed based on the size of the city (the number of residents in 2015). This detail provides additional information if the size of the city has any influence on the interest and actions of cities related to CE. Finally, the study describes generally the CE and circular business in Finland and provides general recommendations for the development of CE business.

According to Yin (2009), the diversity of the research data and data sources are utmost significant. In this study, the diversity of the data is ensured by using the survey as a secondary data source in addition to the qualitative interviews. The time perspective of the study is a cross-section. This kind of research has been executed in a quite short period of time. Thus, the aim is not to research phenomena from the dynamic point of view but to describe the issues at the particular moment. (Saunders et al. 2009) In this study, the interviews have been executed between March 31, 2017 and May 5, 2017. Hence, the time perspective is approximately one month. Furthermore, the survey has been open between April 21, 2017 and May 31, 2017 and the period being approximately one month as well.

4.3 Data collection

The chosen research area is Finland and the original set object was to arrange interviews at least in five cities and maximum in ten cities. The selection criteria

for cities were the variety of the size of cities (number of inhabitants), the geographical scattering and the current state of CE and energy systems based on the fact-finding from cities' webpages and district heating statistics (Energiateollisuus, 2016). These background materials for city selection process are introduced in **Appendices 1** and **2**. The reached sample of cities is eight and these cities are introduced below in **Figure 16.**

Figure 16 Interviewed cities

The chosen cities were contacted with interview-invitation first by email and after that by phone. The invitation was sent to both development manager and energy or environment manager of the city. After a telephone conversation, the contact person forwarded the invitation to a person having best knowledge about the CE related matters in the city. The conclusion of the interviews including job titles of the informants are presented in **Table 6.** The total number of informants is 13 including six individual and three group interviews. The total length of interviews is 735 minutes and the average duration of an interview is 82 minutes. The total number of pages (transcribed) is 129 A4-pages and the average number of pages from each interview is 14 A4-pages.

Table 6 Summary of the interview study

City	Date	Interview type Individual	Group	Specialty areas	Duration Min	Notes A4-papers
A	March 2017		x	Manager of Environmental Protection Manager of a CE project	124	21
B	April 2017		x	R&D Manager Environmental Manager	111	22
C	April 2017	x		City Architect, strategic planning	80	9
D1	April 2017	x		Environmental Manager	79	13
D2	April 2017	x		Strategy and Development Manager	50	7
E	April 2017		x	Manager of a CE project Environmental Specialist Environmental Manager	73	14
F	April 2017	x		Environmental Auditor	89	14
G	April 2017	x		Manager of Environmental Protection	63	14
H	May 2017	x		Development Manager	66	15
TOTAL		6	3	13 informants	735	129

A semi-structured interview was selected as a type of an interview which as a research method ensures that the information collected is comparable but also allows the interviewer to follow an interesting line of questioning (Kvale and Brinkmann, 2009). In semi-structured qualitative interviews, at least a part of approaches is set in advance (Wengraf, 2001). At least one employee from each city was interviewed providing insight into the way these cities approach CE as well as what kind of actions they have planned. In the beginning of an interview, the interviewees were introduced to the fact that they are able to present their impression as freely as they want. Furthermore, the interviewer was able to ask questions that were not a part of the interview framework in order to ensure better understanding. The interviews were mostly based on the same structure but some of the questions might have been asked in a different order in each unique discussion. The interviews were performed in Finnish and the structure of the interviews and all the questions are available in **Appendix 3** and in English on request. The structure of the questions has been developed in cooperation with experts of the case company and the supervisors of the study. The interviews were recorded and transcribed later.

To enrich these findings, the Webropol-survey was chosen as the secondary data source. This survey was created after half of the interviews were completed. It is available in **Appendix 4**. The survey supports and enriches the results of the interviews and the most interesting themes are asked. The survey was created in a way that it was easy to complete and that is why most of the questions were not mandatory. Most of the questions were in Likert scale where respondents are asked to answer in the following scale: 1. Strongly disagree, 2. Disagree, 3. Neither agree nor disagree, 4. Agree and 5. Strongly agree. Likert-type uses fixed choice response formats and it has been designed to measure attitudes or opinions (Bowling, 1997). The survey was asked to be send to municipal decision-makers, the relevant municipal officials and employees, such as environment managers, energy managers and municipal managers. Furthermore, cities were asked to send the poll to the representatives of their energy and/or waste companies, if possible. First interviews indicated that in many cities, municipal development companies are one of the key actors related to CE projects. Therefore, the survey were asked to be sent also to the relevant representatives of these kind of companies.

The survey was sent to all Finnish cities and municipalities by email. In 2017, there are 311 municipalities in Finland and 106 of these are called as cities. The list of Finnish municipalities had been downloaded from Statistics Finland webpages (Statistics Finland, 2017). The contact information had been collected from webpages of each municipality. The invitation of the survey with the instructions had been sent to the common email address of the city and they were asked to forward the invitation to target groups and also forward the contact information of the key persons back to the researcher. The researcher followed respondents from Webropol-pages weekly and sent reminders twice during the survey period to municipalities that have not been answered. The conclusion of the respondents with their roles are introduced in **Table 7.**

Table 7 Summary of the respondents in the survey study

Respondents of the survey	**N**	**Roles (N)**
Municipal decision-maker	69	Member of municipal council (38) Member of municipal executive board (18) Other/ No answer (13)
Municipal official and employee	41	Environmental manager (15) Technical manager (8) Municipal manager (6) Development manager (4) Other/ No answer (8)
Energy company's representative	5	
Waste company's representative	5	
Representative of municipal development company	3	
Other	2	
TOTAL	125 *	

*The total number of respondents is 116 persons but some of them have participated in the survey representing many roles (e.g. a person can be a municipal employee and a political decision maker at the same time)

The total number of respondents were 116 persons from 85 municipalities when the response rate achieved was 28 %. However, based on the data it was noticed that some of the respondents have participated in the survey representing two roles. This is possible because the person can be a municipal employee and a political decision maker at the same time. The main respondent group is municipal decision-makers with 69 replies. Inside the respondents group, there are 38 members of municipal the council, 18 members of the municipal executive board and 13 have not specified their roles. The second largest group is municipal officials and employees with 41 replies. This group includes 15 environmental managers, eight technical managers, six municipal managers and four development managers. Eight respondents have not specified their roles. The groups of both energy and waste companies have five replies. In addition, there are three respondents of the municipal development companies and two respondents without any clarification of role. The result has been decided to be analyzed among three different groups: Municipal decision-makers, municipal officials/employees, and energy and waste company's representatives. The replies of energy and waste companies have been merged because both groups represent firms owned by municipalities, thus being able to represent that kind of viewpoint. Both the informants of the interviews and the

respondents of the survey have been motivated by promising that the analyze of the key results will be delivered to them when the thesis is ready.

4.4 Data analysis

The target of the data analysis is to compress and structure the findings to ensure the understanding of the results. The main data analysis method used in this study is content analysis utilizing textual coding which aims to look for categories from the data. The content analysis can be utilized to analyze all textual data, e.g. transcript interviews. Content analysis aims to form a comprehensible description of the phenomenon to be investigated. After that, results can be merged with wider context and other research results made about the same phenomena. (Tuomi & Sarajärvi, 2009) The content analysis can be executed by specifying the content of the data. This kind of analysis is called as quantitative content analysis which aims to describe the content of the text quantitatively. Quantitative analysis can be executed e.g. by calculating the frequency of certain words in documents. The qualitative content analysis is based on a verbal description of the content. Both methods can be applied when analyzing the same data. The content analysis can be begun e.g. with qualitative content analysis and then continued by calculating quantitative results. (Tuomi & Sarajärvi, 2009) The content analysis can apply three distinct approaches: inductive, deductive and abductive approach. The inductive approach is based on a direct delivery of coding categories from the data. This method focuses mostly on the data, not the theoretical approach. Deductive approach analysis begins instead with a theory and theoretical findings guide the creation of codes. Abductive content analysis is a cross between inductive and deductive analysis. Abductive approach consists of counting and comparisons such as keywords and later the content is interpreted based on these findings. (Krippendorff, 2004 & Tuomi & Sarajärvi, 2009)

This study focuses on qualitative content analysis and exploratory research approach. The analysis is started by looking for interest themes appeared from the data. The whole research follows two main themes and aims first to explore what

kind of factors enhance CE in Finnish cities and municipalities and, on the other hand, to find out which issues hinder the development of urban ecosystems towards circularity. Secondly, the study focuses on observing circular business opportunities related to energy systems of municipalities and cities. These main themes have been used also as the starting point for content analysis. Thereafter, the findings from the data have been restructured and collected during several iterative rounds. The coding structures are introduced in **Figure 17** and **Figure 18**.

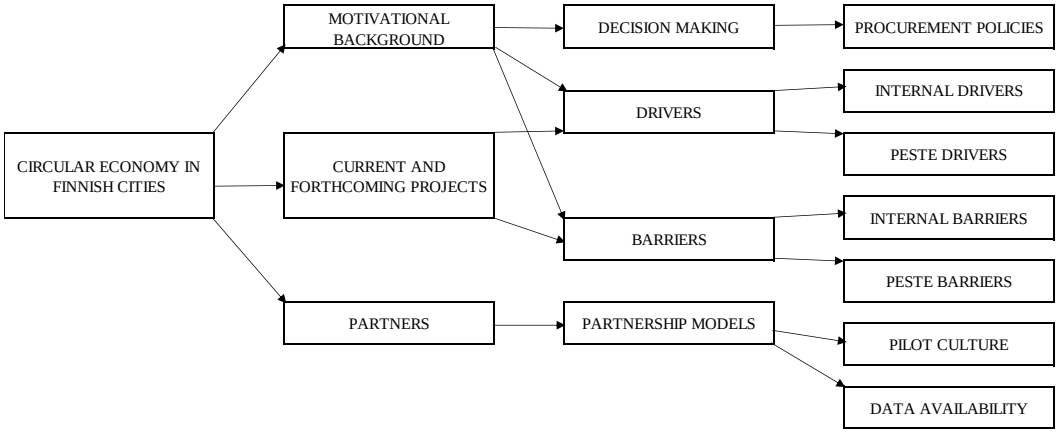

Figure 17 Content analysis – coding structure in CE approach

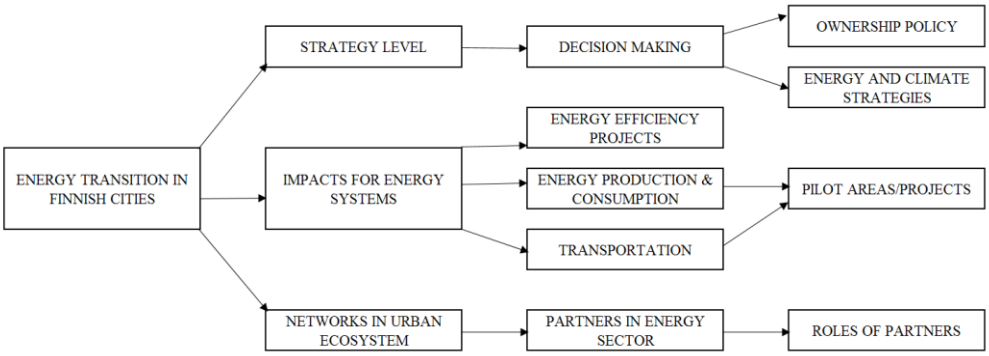

Figure 18 Content analysis – coding structure in energy transition approach

Furthermore, the survey results have been analyzed in order to enrich findings from the interviews. Because the survey has been executed by using the Likert scale, most of the results are shown as percentages in charts and tables. The survey analysis provides support for the findings from the interviews and, on the other hand, it provides additional information from different respondents because the survey has been analyzed by comprising the answers between three different

groups: municipal decision-makers, municipal officials/employees (same group such as in the interviews), and energy and waste companies' representatives.

4.5 Reliability of the results

The reliability of the results in qualitative research is ensured by describing the research process in detail. In this study, the research process is presented and validated in detail within this methodology chapter. Furthermore, the structure of both the interviews and the survey with precise questions are presented in the attachments. According to Yin (2009), the reliability of qualitative case study can be enhanced by using multiple sources of evidence in order to ensure construct validity. This has been ensured by using both interviews and survey as data sources. In addition, both the interviews and the survey deal with the same themes in order to reach results that are substantially similar. Yin (2009) also recommends creation of a database for material collected in the research as well as creation of a chain of evidence. The database creation has not been seen necessary in this study but the chain of evidences has been ensured by presenting the results of the interviews with a number of cities having the same opinion and, on the other hand, providing explicit figures and tables from the survey data.

However, it should be remembered that this study includes results only from eight cities from Finland and hence the results cannot be generalized without further research and the observations are only approximate. The interview situations were unique situations and both skills and personal characteristics of the informants and the interviewer can affect to the results. Additionally, it should be noticed that the informants represent only their own expertise and are not necessarily able to have all possible information of the represented city. The informants also told in the beginning of the interview if they are not familiar with e.g. with energy specific themes and gave the recommendations for further interviews within their city. Furthermore, there was difference between individual and group interviews. The group interviews were wider because informants had possibility to complete each other's answers.

The survey results of the groups “municipal decision-makers” including 69 replies and “municipal officials/employees” including 41 replies can be slightly generalized but not statistically analyzed. The results of the third group “energy or waste companies’ representatives” with only 10 replies cannot be generalized because a respondent’s opinion has 10 % influence on the results. Therefore, the results are partly analyzed based on the whole sample instead of a comparison between the groups. However, these results are used only as an approximation and as an opportunity to enrich results reached from the main data source. The survey questions were also quite hard to answer and couple of respondents mentioned that it was not easy to answer to the survey. This may also weaken a bit the reliability of the survey results.

5 CURRENT STATE OF CIRCULAR ECONOMY IN FINNISH CITIES AND MUNICIPALITIES

This chapter presents the results of both the semi-structured interviews and the survey. The results are presented in subchapters based on qualitative content analysis. First, the current state of CE and energy transition in Finnish urban ecosystems are introduced in Chapter 5.1. Chapter 5.2 gathers different drivers and barriers for circular business with PESTE analysis. Chapter 5.3 focuses on the decision-making related to CE in urban ecosystems and Chapter 5.4 describes the role of partners and networks in CE projects. The final analysis, answers to the research questions and further recommendations are introduced later in Chapter 6. The results are partly shown according to the size of the cities. The categorization divided cities into those having under and over 100,000 residents in 2015. The codes for the cities are introduced in **Table 8.** The number of residents in small cities category varies between 22,000 and 68,000 residents while variation in big cities category is between 112,000 and 186,000 residents.

Table 8 Categorization of the cities based on the number of residents 2015

The number of residents in 2015	City	Category
Under 100,000	A, C, D, F, G	Small cities
Over 100,000	B, E, H	Big cities

5.1 Circular economy projects in urban ecosystems

All informants described shortly the industrial background and values and the mission of the city. Three of cities named themselves as energy clusters meaning that energy industry and technologies are the main industrial area inside the city. One of the cities represents the paper industry, one focuses on the tourist industry and one city even named itself as resource wisdom city. Two of cities did not mention any specific industry focus. All cities described their position in relation to regional area and other cities in the same area. All big cities and one small city positioned themselves as central cities in the area while other four small cities did not have special central role in the area and three of them mentioned a name of some other city that has the central role in the area.

The energy transition was understood in every city in the same way: the transition from the traditional centralized energy production to the decentralized energy production. The share of renewable energy sources, such as solar energy, wind power, geothermal heat and bioenergy, is constantly increasing (A, B, F & H). Cities B, E and H said that energy efficiency thinking will increase and at the same time, intelligent energy systems will have even bigger role in the future. However, especially two of the cities (B & E) wanted to highlight that the energy transition is not a new topic for cities but the rate of change and pressure e.g. to reduce emissions have accelerated further. In addition, even seven cities said that the energy transition has not been highlighted from citizens' point of view and city has not had especial pressure to develop energy systems because of consumers' willingness. The city H summarized the situation in the following way:

"The energy transition should be more noticeable in this city. The conversation has just been begun among the citizens and consumers. The changes can be seen as an energy efficiency development such as investments in private real estate in decentralized energy production (e.g. solar panels) at the moment, but the real energy changes are still waiting."

Many informants highlighted that discussion around CE has increased especially during past two years, but the earlier discussion related to sustainable development and cities environmental protection are in the background. According to two big cities (B & H), terms "carbon neutrality, CE and resource wisdom" have the same target, enhancing the vitality and sustainability but the utilization of the concepts has been increased last years. The city B summarized the difference between the similar terms in the following way:

"After we had created the resource wisdom roadmap, we thought that resource wisdom is such as sustainable development vol. 2.0. However, the CE is become more popular term nowadays, and especially the economic viewpoint is highlighted in this discussion. Earlier discussion around sustainable development highlighted more environmental and social values."

All cities highlighted that the emphasis of economic approach and e.g. possibility to enhance regional vitality (such as new business development) with CE opportunities is one of the biggest differences if compared to sustainable development discussion. Six of the cities (A, B, D, E, F & G) also commented, that the recycling has been organized in cities already long time and not all actions are new. When the informants were asked to analyze relationship between objectives of energy transition and CE, the cities E and H summarized that energy transition

is easier to understand and the energy issues have very significant role inside the development of CE objectives.

The survey respondents seemed to have sufficient knowledge of the topic of the study being able to answer the questions. The term “sustainable development” was most familiar since 95 % of respondents agree or strongly agree understanding. The understanding of terms “circular economy” (87 %), “carbon neutrality” (84 %) and “energy systems” (83 %), were also agreed or strongly agreed according 80 % of respondents. According to the survey terms “resource wisdom” (62 %) and “energy transition” (53 %) were least understood. The results of the survey show that energy or waste company's representatives are most familiar with the different terms. The municipal officials and employees has the second-best understanding of terminology of the study and the municipal decision-makers were least popular with the terms. This is not surprising because both energy and waste company’s representatives and municipal officials and employees have to be experts these issues due to their daily work. If compared to the informants of the survey, these results differ a bit, because according to the informants, energy transition is easier to understand than the CE. The difference can be explained by the different situation when answering. In the interviews, there was discussion between the interviewer and informants and the interviewer was able to open the questions if needed while in the survey respondents answered only based on his or her own knowledge.

5.1.1 Circular economy projects

All interviewed cities share opinion about that the common attitude has become significantly favorable during last two years. However, four cities (A, C, D & H) highlighted that actions related to CE are in the very beginning but are going to become more significant in the future. For example, municipalities have started thinking about CE targets with their own legal responsibilities such as planning and construction (cities B, C & D). According to cities A, B, D and E, the popularity has increased in the cities due to increased discussion about CE and resource wisdom at national-level. Cities A, B and C also highlighted that the local, active

development actors (e.g. individual manager or a company) have been the driver behind the increased interest towards CE projects. The city B summarize that these issues are positive whether the predicted threats are true or not, if actions really enhance the regional vitality and well-being. All big cities and one small city are already joined in the FISU-network and started enhancing CE with FISU initiative. One city describes that CE and resource wisdom principles have been implemented already even the management system of the city that enables development in all sectors:

"The resource wisdom has been integrated into our entire city management system as well as the annual economic and action plans. For example, in annual budget process, each sector of the city organization brings its own resource wisdom actions as a part of action plan of the next year's budget."

Two small cities had applied to the FISU-network but were not accepted yet. However, they are promoting the same targets themselves. Another two small cities have been considering joining collaborative national CE-related projects but decided to enhance same issues without bureaucracy (e.g. reporting responsibilities). Six cities have calculated the FISU-indicators (greenhouse gas emissions, material losses and the ecological footprint) per resident in the city area and big cities (B, E & H) have determined their material flows. Furthermore, the local food pools have been developed during last years and e.g. the purchase of smaller batch from multiple suppliers has been eased. In addition to national level projects, cities A and E have a particular CE project which aims to develop CE and resource wisdom first in the city organization and through that whole city area. The targets are e.g. implement resource wisdom principles to the city strategy, decision-making processes and the budget. The interest towards national CE and carbon neutrality projects, FISU- and HINKU-networks, according to the survey results are introduced in **Table 9.**

Table 9 Survey respondents interest towards national FISU and HINKU projects

Participation or interest towards national circular economy or carbon neutrality projects (total number of respondents, N = 60)	**N**	**%**
Our municipality is a part of HINKU Forum	19	32 %
Our municipality would like to join HINKU Forum	21	51 %
Our municipality is a part of FISU-network	4	7 %
Our municipality would like to join FISU-network	17	30 %

Four respondents represented FISU-municipality and 19 respondents were a part of HINKU Forum. The 51 % of respondents who were not a part of HINKU Forum yet, would like to join HINKU Forum in the future. On the other hand, 30 % of the respondents who were not a part of FISU-network, would like to join FISU-network in the future. These differences are not surprising, because HINKU Forum is easier to apply and join compared to FISU-network. In addition, HINKU Forum has been established already in 2008 whereas FISU-network in 2015. The 46 % of respondents said that they have had CE projects in their municipality. However, it should be recognized that there were not definition for CE project whereas all respondents have answered according their own understanding. A couple of respondents also mentioned that there is a lot of actions in their municipality but these actions are not defined as projects. According to 25 respondents (47 % of respondents), their CE projects are some kind of recycling or resource wisdom initiatives such as studies related to material flows, minimizing food waste or educating municipal workers related to CE. According to 18 respondents (34 % of respondents), projects have related to energy sector such as wastewater heat recovery or biogas projects. A couple of respondents also mentioned that the municipality do not have special projects right now but companies are enhancing CE and e.g. industrial symbiosis on their own.

The biggest group of initiators for CE projects were municipal officials and employees with 57 replies (49 % of respondents). The representatives of municipal waste companies were the second biggest group of initiators with 25 replies (22 % of the respondents) behind the CE projects and the third group were the representatives of municipal energy companies with 17 replies (15 % of respondents). The representatives of municipal development companies have started projects according 12 replies (10 % of the respondents) and other companies operating in the municipality have begun initiatives according 14 replies (12 % of the respondents). The citizens and representatives of municipal water supply and sewerage companies were not being significant initiators behind the projects. This was in line with the interview results. The citizens have not been initiators for CE or energy initiatives according to seven cities (A, C, D, E, F, G & H). Instead of

that, the role of active representative of municipal development company or similar had been a significant (A, D, F & G) as well as the role of municipal waste companies (A, B, C, D, E, G & H). The role of municipal officials of employees have seen more as an implementer than as an initiator of the projects.

Cities did not talk only about the CE actions of city organization but also described the circular business in their area. At the moment, the CE actions has started with the initiatives focusing on city organizations, but for example city E told that the final objective of the city is to increase the vitality of the area: city aims the regional development and thus wants to develop better environment for circular business. City wants to induce companies to enhance new services and products in the area, e.g. related to smart city planning. Many cities highlighted that it is hard to separate CE discussion into actions of cities and actions of the companies and city A summarize the discussion as following:

"When talking about a municipality or a city, it is not possible to divide the "municipal activities" and "other actors' activities"; the city also includes e.g. private firms and the co-operation with the city and all other actors should be close."

Cities have already planned actions that enables enhancing CE even better in the future. Cities A and C noted that the special characteristics of the area must be taken into account when implementing circular solutions. However, the problem was identified to be the weak knowledge sharing in the area. This is why they identified a need for CE knowledge facilitator. Two of the big cities (B & H) highlighted the increasing international cooperation as a driving force for circular business development and some cities (A & E) highlighted especially the importance of regional development. Regional cooperation is especially important between small cities who do not have enough resources in their own area (e.g. not enough material flows). All informants highlighted the significance of the experiment culture within the circular business development. Cities expressed their interest to hear and learn from concreate CE examples the other cities. They also highlighted the importance of knowledge sharing, as for example the consumer-oriented experiments are highly valued by cities. In addition, all big cities (B, E & H) and one small city (C) told that to enhance circular business in the future, the next step is to begin really

implementing the references, not development only strategies and reports. They are waiting for fresh experiments and innovative ideas from the companies.

5.1.2 Energy sector projects

All cities mentioned the local energy and/or waste company has a key role in energy sector projects. In all cities, there is at least one energy company owned by the city, but they were seen to work quite independently despite of the cities ownership. Cities A, B, C, D and E highlighted those the increase of initiatives by local energy companies during last years. Additionally, according the cities A and E the international pressure (e.g. the EU level emission reduction targets) have begun to appear widely at the urban level. The cities E and H said that the transition is necessary due to the pressure from both the private and public sector. All cities have created and published some kind of energy efficiency contract or municipal review of renewable energy utilization. Cities A, B, D, E, F and H have checked the energy efficiency of their own buildings, such as ice stations, kindergartens and public swimming pools. The city C told that they have started requiring also owners of other buildings to show energy efficiency certificates. Some cities have implemented energy efficiency initiatives with ESCO companies but currently, there are not significant ESCO project ongoing. However, three cities highlighted that energy efficiency improvements will be connected to renovation targets of buildings even harder in the future. The energy efficiency projects have started from the buildings and moved forward e.g. the transportation sector and development energy efficiency of the streetlights. All big cities (B, E & H) and two small cities (D & F) told that city has been at least discussing about changing the executive cars of the city to electricity or gas cars instead of traditional petrol-driven or diesel cars. Some cities have purchased also public transportation with the requirement for electricity or gas fuel usage. These procurements have been pilot projects currently but all cities highlighted that the development of mobility, especially public transportation and cycling traffic, will be one of the biggest development areas in the circular cities in the future. Cities believed that integration of smart technology and mobility would be even more significant in the future.

The broad change in energy system projects has been the transition towards utilization of small, decentralized solutions instead of concentration of development only centralized energy production. Five cities said that decentralized energy solutions have become more popular in the public buildings, e.g. the facades of the buildings are fitted with solar panels. Cities F & H also believed that heat pumps and similar technologies are going to become popular in the future. Two of the cities (A & F) were wondered if it is possible to optimize energy production to match changing seasons and for example instead of burning fuels increase the utilization of solar energy during summers. One significant way to implement and enhance circular and intelligent energy systems was identified to be city pilot areas. Even six of the cities (B, C, E, F, G & H) have already some pilot area (even called as resource wisdom area) in which they e.g. encourage citizens to build zero energy houses or to favor decentralized energy resources. Some cities told that they have promised lower rent site prices for those citizens follow these new requirements. These areas are in a key role with testing circular solutions and cities have e.g. invested in car-free areas or wood construction. These pilot areas are developed in tight cooperation with many different actors. However, the biggest results have achieved by investing in the improvements of centralized energy production such as developments for power plants combustion technology or increasing the share of renewable fuels instead of fossil ones (cities A, B, C, F & H). The city H summaries their development targets and envisaged about the role of people in the future:

"We are developing this centralized and decentralized system at the same time and aiming at an innovative system out of the discussion focus on either a centralized or a decentralized solution… We have been thinking also communal models where people are able to produce and share energy together."

There were not broad differences when the local decision-makers, the municipal officials and employees and the energy or waste companies' representatives evaluated guiding factors of the future energy system planning. The opinions of all respondents are introduced in **Table 10.**

Table 10 Evaluation of guiding factors for future energy system planning

These factors guide the planning of future energy systems in our municipality	**Strongly disagree (1) or Disagree (2)**	**Neither agree nor disagree (3)**	**Agree (4) or Strongly agree (5)**
The emission reduction targets set at EU level	13 %	26 %	62 %
The emission reduction targets sert at national level	9 %	21 %	70 %
Laws and regulations	1 %	12 %	88 %
The objectives set by the municipality	8 %	12 %	81 %
The objectives set by the province	20 %	22 %	58 %
Economy	2 %	8 %	91 %
Technological development	3 %	12 %	85 %
The wishes of the residents in the area	15 %	17 %	68 %

All the asked factors were quite highly valued (support from more than 50 % of respondents). The most significant factor is the economy; even 91 % of all respondents agree or strongly agree this choice. The second significant guiding factor were laws and regulations with 88 % of agree or strongly agree replies. The technology development was also very highly agreed with 85 % of agree or strongly agree replies. The wishes of the area's residents was agreed or strongly agreed by 68 % of respondents. Between different targets, such as the targets set by the municipality or province or the emission reduction targets set at EU or national level, the goals set by the municipality were seen as the most significant within 81 % of respondents agree or strongly agree this choice. In addition, respondents were asked to evaluate if the pursuit of sustainability and carbon neutrality have significant influences both at the moment and in the future: These results are shown in **Table 11.**

Table 11 Impacts of pursuit of sustainability and carbon neutrality to the municipal responsibilities at the moment and in the future

	Strongly disagree (1) or Disagree (2)		Neither agree nor disagree (3)		Agree (4) or Strongly agree (5)	
The pursuit of sustainability and carbon neutrality has a significant impact of following municipal responsibilities:	Already now	In the future	Already now	In the future	Already now	In the future
Land use and construction	22 %	6 %	25 %	14 %	53 %	80 %
Zoning	24 %	8 %	25 %	13 %	51 %	78 %
Water supply and sewerage	23 %	8 %	30 %	23 %	48 %	70 %
Energy management	9 %	3 %	12 %	5 %	79 %	93 %
Waste disposal	6 %	2 %	13 %	8 %	81 %	91 %
Environmental protection	9 %	5 %	18 %	10 %	73 %	85 %

The results show that the current megatrends, pursuit of sustainability and carbon neutrality, already have impacts to the different responsibilities of the municipality. According the survey respondents, those megatrends affect most to the waste disposal when 81 % of respondents already see the impacts. In the future, even 91 % of the respondents believe that there is a significant impact to the municipal waste disposal. There is also a significant impact to the energy management when 79 % of respondents agree or strongly agree the impacts at the moment and even 93 % of respondents in the future. At the moment 73 % and in the future 85 % of respondents see the impacts for environmental protection. Growth of impacts increases significantly in the categories land use and construction with 27 % growth, zoning with 28 % growth and water supply and sewerage with 23 % growth.

Table 12 introduces respondents' opinions whether their city needs support for the development of energy systems already at the moment and in the future. The question did not take into account who is responsible about these actions but only tries to collect information if needs are changing. There already is need for energy systems development both in existing and new residential and industrial areas and cities told that of course they already worked with these improvements.

Table 12 Cities current and future needs for energy systems development

	Strongly disagree (1) or Disagree (2)		Neither agree nor disagree (3)		Agree (4) or Strongly agree (5)	
We need the following support for the development of energy systems in our municipality:	Already now	In the future	Already now	In the future	Already now	In the future
Planning new energy systems for residential areas	23 %	10 %	30 %	21 %	47 %	69 %
Planning new energy systems for industrial areas	25 %	11 %	29 %	18 %	46 %	71 %
Planning energy systems changes in existing residential areas	18 %	9 %	28 %	15 %	55 %	76 %
Planning energy systems changes in existing industrial areas	16 %	8 %	33 %	18 %	52 %	75 %
Evaluation and comparison of energy production options	12 %	6 %	18 %	10 %	70 %	84 %
Assessment of investment costs	8 %	5 %	13 %	9 %	78 %	86 %
Implementation of energy system investment	8 %	6 %	25 %	13 %	68 %	82 %
In-use support for new energy systems	12 %	6 %	33 %	14 %	56 %	80 %

However, their needs are going to increase in every single subsection. The biggest needs are for evaluation and comparison energy production options and on the other hand with assessing the investment costs. Growth of needs increase significantly in the planning of energy systems for industrial areas with 25 % growth and in in-use support for new energy systems with 24 % growth. Both support needs for new energy systems planning for residential areas and planning energy systems changes in existing industrial area will grow 23 % in the future. The informants from the four cities (A, D, F & G) summarized that there is the need for a comprehensive expertise that help cities to evaluate clear financial and technical benefits and value of investment in long-term.

5.2 Drivers and barriers for circular business

There are both several drivers and barriers for circular business in Finnish urban ecosystems. The external macro environment factors are collected with PESTE categorization to the political, economic, social, technological and environment classes and later in chapter six compared with factors found from the literature. It should be recognized that this categorization is not unambiguous and some factors can be allocated differently.

5.2.1 PESTE drivers for circular business

Drivers based on interviews are shown in **Table 13** and the results of the survey are introduced in **Table 14.**

Table 13 PESTE categorization for circular business drivers

PESTE-factor	Examples from interviews
Political drivers	• **EU and national level objects** e.g. emission reduction targets, carbon neutrality targets • **Laws and regulations** e.g. landfill regulations, recycling responsibilities • **Cooperation opportunities** e.g. national and international networks, province level cooperation • **Commitment and interest of municipal decision-makers** e.g. municipal council initiatives to participate CE networks such as FISU or HINKU
Economic drivers	• **Financial support** e.g. available subsidies e.g. EU initiatives such as UIA (Urban Innovative actions), private investments by companies or even private person • **Cost savings** e.g. clear repayment period of investment e.g. due to energy savings • **Risk sharing opportunities** e.g. with new pilot areas planning
Social drivers	• **Opportunities for increase vitality** e.g. development of new business and job creation • **Increased research and knowledge** e.g. pilots and lessons learned e.g. from universities • **Education for municipal officials and decision-makers** e.g. to insert and share knowledge e.g. lifecycle cost thinking instead of planning annual budget • **Changed values** e.g. city strategy: ambitious targets set by the city itself e.g. carbon neutrality by 2050
Technological drivers	• **Digitalization** e.g. developing information technology e.g. for collect and share data • **Technology development** e.g. robotic and sensor technologies for recycling
Environment drivers	• **Pursuit of sustainability** e.g. due to resource scarcity • **Globalization** e.g. threats from the world e.g. air quality in metropolises • **Brand benefits e.g.** sustainability values and pioneering reputation

Table 14 Evaluation of drivers based on the survey

These factors are drivers for circular economy in cities and municipalities	Strongly disagree (1) or Disagree (2)	Neither agree nor disagree (3)	Agree (4) or Strongly agree (5)
Financial drivers (e.g. cost savings)	3 %	5 %	93 %
Laws and regulations (e.g. subsidies and funds)	2 %	8 %	90 %
Technological drivers (e.g. developing technology)	0 %	5 %	95 %
Informational drivers (e.g. possibilities for information sharing)	3 %	20 %	78 %
Environmenetal drivers (e.g. emission reduction)	7 %	21 %	73 %
Brand benefits	13 %	18 %	69 %
Social drivers (e.g. job creation)	6 %	16 %	78 %

The targets set by the EU or countries are seen as significant political drivers for CE. All big cities (B, E & H) and four small cities (A, C, D & F) told that both the EU and national level objects, such as emission reduction targets, have increased pressure to develop CE in urban ecosystems. Both the informants from the cities and the survey respondents (even 90 % of agreed) highlighted the significance of laws and regulations as drivers. For example, a prohibition inhibiting to export bio waste to the landfills has forced cities to change their actions as well as the sharpened recycling regulations and responsibilities. Due to CE and resource wisdom development is quite new topic in many cities, they highlighted the need for sharing best practices and experiences with other cities. In addition to national level networks, especially cities in rural areas wanted to the share practicalities with cities nearby or at province level. International cooperation mentioned as a driver by two big cities (B & H) and one small city (C) due to it has been workable way for idea sharing and knowledge transfer.

City strategy and especially commitment and interest of political decision-makers are very important drivers according to all cities. In order to municipal officials and employees be able to enhance CE and resource wisdom principles in city organization, there must be strategical decision made first (cities A, B, C, D, E & H). Cities told that circularity and sustainable development are especially developed in environmental departments, but city strategy push the whole organization forward. Even six cities (B, C, E, F, G & H) have noticed their council initiatives

and interest have been increased measurably during two last years. The politicians have proposed e.g. applying to FISU-network or engaging in HINKU Forum. However, informants noted that there is still huge need for education for municipal officials and decision-makers in order to enhance e.g. their actions in the board of municipal energy companies' boards. Furthermore, the economic support for CE projects was a significant driver according both all the cities and the survey results (93 % of respondents agreed). To develop new solutions for circularity there have to be more investments made by private companies, even by private people or subsidies e.g. from EU. Some cities also highlighted that financial support and joint investments help the risk sharing. In order to get funds cities have applied e.g. to UIA initiatives recently. Expected cost savings motivate both for the city and for companies e.g. to participate energy efficiency initiatives. Investments for CE and e.g. decentralized energy production will be increased when repayment period of investment decrease according to seven cities (A, B, C, D, E, G & H).

Opportunities for enhancing vitality in the municipal area was the most important social driver according the all informants. All cities were interested in CE projects and business that are able to enhance new business development. Both the informants and the survey respondents (78 % agreed) valued opportunities to create workplaces. Additionally, the research and increasing knowledge from the universities boost circular business. For instance, City C told that they have cooperated with local University and University of Applied Sciences with piloting a new, communal resource wisdom area. Another social driver was the education provided for officials and decision makers, this will enable better quality of decisions in many levels (e.g. with budgetary planning). Compliance with the annual budget would be changed to follow lifecycle cost evaluation at least with procurements. Changed attitudes and for example as ambitious targets set by the city itself e.g. related to carbon neutrality by 2050 are drivers as well. The city E summarized the changing attitudes both internally and externally as follows:

"*We heard a good comment from our committee recently. Four of years ago when this committee started, the different environmental, energy or climate related decisions had to push forward and it was much harder atmosphere to work. However, nowadays the attitudes have changed radically and these topics are promoted as the top projects of the city – you do not have to start discussions e.g. by validating the relevance of energy issues. Perhaps the attitudes has been changed due to the global threats and increased information.*"

Digitalization, technology development and increased research and knowledge boost CE at the moment and all big cities (B, E & H) and the survey respondents (78 % agreed) highlighted information technology opportunities for collecting and sharing data in urban environments. Many cities have e.g. published new applications for public transportation and one city even had application for recycling office furniture. Technology development was as the most significant driver according to the survey respondents (95 % agreed) and for example city A believes that robotic and sensor technologies will develop a lot e.g. for supporting material recycling in the future.

The root cause behind the increased interest towards circularity is the general pursuit of sustainability; all interviewed cities wanted to enhance biodiversity of the nature and ensure sustainable future for the next generations. The survey results show that 73 % of respondents agreed or strongly agreed environmental drivers for enhancing CE. Furthermore, the globalization has increased the awareness of worldwide environmental problems such as air quality problems in metropolises. Enhancing environmental issues have experienced as important that cities have started to pursue brand benefits; cities A, B, C, D, F and G told that pursuit of sustainability values influence positively fame of the city. Additionally, 69 % of respondents agreed or strongly agreed brand benefits as drivers for CE.

5.2.2 PESTE barriers for circular business

Such as drivers, there are both several barriers for CE in Finnish urban ecosystems and these barriers based on interviews are shown in **Table 15.** Furthermore, impression of barriers based on the survey is introduced in **Table 16.**

Table 15 PESTE categorization for circular economy barriers

PESTE-factor	Examples from interviews
Political barriers	• **Uncertainty of energy policies** e.g. related to emissions and subsidies • **Inefficiency of laws and policies** e.g. no recycling requirements in all houses • **Lack of strategy and political support of the city council** e.g. unsystematic actions towards CE in the city
Economic barriers	• **Unclear economic benefits** e.g. self-financing is too high, difficulties with measurement of true benefits, no financial incentive for energy savings • **High cost and risks** e.g. long payback time of investments hamper implementation of decentralized energy systems • **Lack of resources** e.g. lack of time and development employees • **Bureaucracy** e.g. unclear benefits in networks with high reporting requirements
Social barriers	• **Lack of skills and knowhow** e.g. substance knowledge of decision-makers • **Resistance to change** e.g. common attitudes towards environmental issues • **Lack of actions and pilots** e.g. movement from strategies to actions
Technological barriers	• **Expensive new technology** • **Weak data management opportunities** e.g. platforms for information sharing
Environment barriers	**N/A**

Table 16 Evaluation of barriers based on the survey

These factors are barriers for circular economy in cities and municipalities	Strongly disagree (1) or Disagree (2)	Neither agree nor disagree (3)	Agree (4) or Strongly agree (5)
Financial barriers (e.g. high costs)	3 %	9 %	88 %
Laws and regulations (e.g. unclear policies)	11 %	22 %	68 %
Technological barriers (e.g. lack of technologies)	18 %	18 %	64 %
Barriers for cooperation (e.g. lack of partners)	23 %	25 %	52 %
Lack of skills and knowhow	16 %	17 %	68 %
High uncertainty (e.g. high risks)	13 %	28 %	59 %

As political barriers for circular business development are seen uncertainty of energy policies. City E told that e.g. new EU regulations related to energy efficiency in public buildings in 2019 have already started to increase discussion around the construction requirements and the roles between cities and construction companies. Cities A and B highlighted the invariably continuing discussion around the emissions of wood fuels. There are inconsistencies between energy subsidies for

public and private buildings; if the investment is made for the public building the energy funds are subsidized but if e.g. the private housing cooperative wants to invest to the solar panels they are not subsidized. Additionally, high uncertainty of EU level directs chancing in the future hampers companies to make investments. The inefficiency of laws hinders the comprehensive recycling e.g. recycling bio-waste is required only in housing cooperatives with five houses or more and city F saw that lots of bio-waste end up to burning e.g. instead of biogas production. Also 68 % of survey respondents share the opinion that laws and regulations such as unclear policies act as barriers. Regionally one of the biggest political barriers is the lack of support from the local municipal council. Cities told clearly that if there is no strategic political willingness and commitment to enhance CE and sustainability it is very hard to implement circular business with the city. Three cities (A, D & G) told that enhancing circular business have been difficult due to unsystematic development targets in city organization. City G also noted that the political commitment might be hard to get at the moment because cities have other broad decisions to made e.g. related to public healthcare improvements.

Unclear economic benefits are one of the main barriers for circular business development according to both interviews and according the survey (88 % agreed). Cities A, F and G highlighted the difficulties related to measurement of real economic benefits whereas cities C, E and F said that the risks for investing new circular business are too high for small and medium size companies. Cities A and) told that city organization itself have to always consider carefully if the self-financing is too high compared to benefits. Furthermore, according to city E the energy efficiency investments are not popular in companies due to low energy prices and thus low incentives for cost savings. High costs, risks and long payback time of investments hamper implementation of decentralized energy systems according to cities A, E and F. Also 59 % of survey respondents saw high risks as barriers for CE. Cities A and C highlighted that the recent, significant investments e.g. to the centralized energy production hamper the new investments in the near future. In addition, lack of resources is one of the biggest problems inside the city organizations. Cities A, B, C, D and G told that they do not have enough time and

employees for development tasks and one of them even told that they do not have any kind of development manager in their organization. City G also said that lack of resources and bureaucracy have inhibited them to participate any CE network in which are significant reporting responsibilities. City D added that bureaucracy for funding applying is significant barrier.

As a social barrier for circular business can be seen the lack of skills and knowhow both according to the informants and the survey respondents (68 % agreed). Problems are met e.g. related to best value creation opportunities for waste according to cities A and F. City A told that weak substance knowledge and orientation of decision-makers, e.g. as the member of board of city owned company, hamper development of circular business. In addition, the resistance of change and old opinions e.g. related to solar economy inefficiency in Finland hamper the circular business development according to cities A, C and F. Lack of decision makers' and municipal officials' interest can limit the development responsibilities only to the environmental department of the city. One big challenge for cities is the movement from reports to real actions according to cities A, B, C and F. In addition, expensive new technology obstruct circular solutions implementation. Cities (A, E & F) said that expensive technology with long payback time does not encourage to invest decentralized energy production. Also technology fast development direct investors to wait even better solutions and thus investments are postponed. Lack of suitable information sharing technologies such as open platforms for recycling data management was mentioned as a current barrier according to cities A, B, D, E and G. Instead of that, there were not any environmental barrier for CE according the interviews.

5.3 Municipal decision making and strategies affecting circular economy

CE development in cities and municipalities has focused on strategy level decisions during last years – cities have started to create e.g. resource wisdom roadmaps and set their short-term actions and long-term targets towards 2050s. For example, city F told that they have decided to abandon utilization of fossil fuels in the long run

whereas short-term the city organization itself is going to use only carbon-free electricity. Informants in cities B, C, D, E, F, G and H told that local decision makers' interests towards CE have significantly increased during the latest council period (2013-2017). Only one city told that climate strategy is not accepted because of difficult political climate. The interest of local decision-makers has been arisen e.g. as initiatives for participating FISU or HINKU network or similar. The political-decision making related to CE follows normal decision-making process in cities. The strategic decisions are accepted in the municipal council and broad investments at least municipal executive board. In addition, there are several preparatory committees but often CE related issues are organized in the environmental committees. Informants told that there are no differences between CE projects and other projects. However, cities highlighted that the political acceptance can be applied if the targets and benefits are tangible and concreate.

The CE and carbon neutrality targets are written into the city strategies or separate energy or climate strategies. Cities D, E, F and G told that they have separate energy or climate strategy or program. Rest of the cities have written principles and targets into city strategy. According to the 26 % of survey respondents, they have separated energy strategy in their municipality and according to 30 % of respondents, they have separated environment or climate strategy. The respondents of the survey were analyzed how different megatrends and themes are implemented in their municipal strategies and the results shown that the theme *environmental protection* was mostly mentioned in the strategical level (74 % of respondents agreed). *Sustainable development* had the second biggest coverage in municipal strategies (68 % of respondents agreed) and the *renewable energy sources* had the third biggest coverage (66 % of respondents agreed). On the other hand, the coverage of *circular economy* and *resource wisdom* in strategical level were quite weak because even 43 % of respondents did not see the resource wisdom and 38 % of respondents the circular economy as a part of municipal strategy. However, the informants highlighted that both energy and climate issues including circular economy and resource wisdom targets will be noted in the municipal strategy even stronger in the future. Many cities are updating the municipal strategies at the moment due to the

new council period started in June 2017. Cities A, B, E, F, G and H saw that procurement strategy has a key role of implementing CE principles in practice. However, they told that there are not yet strict rules for sustainable procurements and especially lifecycle thinking is lacking. Procurements based on mostly purchase prices, not evaluation lifecycle costs or long-term quality. This is consequence from annual budgetary and planning. The city A summaries the current situation as following:

> *"Integrating the circular economy takes time. Sustainable development and circular economy thinking are new issues and assimilation is difficult in cities: First the municipal officials have to understand the opportunities, secondly the buyer must understand principles and take these into account with procurements and finally municipal decision-makers have to understand these principles because they should accept the investments."*

Cities B and F highlighted that planning must be change from annual budgets to long-term. However, several problems are met because of measurement of lifecycle costs or benefits is difficult. Informants told that the common understanding is that sustainable solutions are more expensive. However, one city told that they have also positive experiences: they had required that rubbish vans must use biogas as fuel and instead of that requirement, the purchase price was been even 10 % cheaper in comparison to petrol or diesel vans. Cities said that sustainable principles should be part of actions in every department in city organization. However, only one city has been applied resource wisdom and CE principles as a part of the management systems of the city. Cities C and E told that they are going to implement principles to investment planning and budgets. Another significant way to enhance CE might be joint purchasing in which cities were purchasing electric busses or solar panels together and thus decreasing prices and risks.

In addition to the different strategies, cities are participated different programs e.g. related to energy efficiency and set targets through these contracts. The FISU cities are going to implement actions through five FISU sectors in cycles. Targets are set first in the near future e.g. between 2017 and 2021, then next cycle extends to 2025, then the third period to 2030 and finally FISU cities aim carbon neutrality, zero waste and globally sustainable consumption by 2050. Furthermore, cities have already begun to measure the realization of set targets. Cities A, B, C, D, E, F and G have created the CO2-report at least once. In this report, emissions are expressed

as CO_2 equivalents that enables municipalities to follow development of their emissions over years as well as compare emissions with other municipalities and give base e.g. to optimize their energy consumption based on statistics. City E has vision that CE actions will be increased when the measurement and then comparison between the cities will be easier. Cities also told that different environmental balance sheets help them to follow annual development. According the survey result, the measurement, modelling and utilization of the data is not efficient at the moment. For example, even 48 % of respondents answered that they have not calculated greenhouse gas emissions per capita. Even 28 % did not know whether the greenhouse gas emissions were calculated or not. According to only 8 % of the respondents, the results have been exploited and the follow-up action has been started, according to 13 % of the respondents, the results have partly been exploited and according to 3 % of respondents, the results of the study have not been exploited at all. The utilization of other calculations is introduced in **Table 1** in **Appendix 5**. In addition to municipal strategies, cities have political leverage through companies owned by city. The political decision makers participate board of companies and create the ownership steering policies. Four cities told that they are going to update and to tighten up the ownership policies e.g. in energy companies owned by them.

5.4 Networks and partnerships affecting circular economy projects

The study aimed also to clarify what kind of partnership models and cooperation support CE projects and circular business in urban ecosystems. According to interviews, in addition to cities, there are several other active actors in circular business field. Next the roles of different actors and then used networks and partnerships are introduced.

5.4.1 Roles of different actors

According the interviews, the role of city is to influence both through its own companies and as a city organization in general level. Cities A, B, C, D, E and G

highlighted the role of city through zoning and land use planning. For example, informants told that they have boost transition to decentralized energy resources by enabling e.g. solar panels or other property-specific solution already with zoning. The target is that new areas are as ready for circular solutions as possible and e.g. wooden apartment building is seen to increase significantly in the future. Inside the city organization, all cities noted the role of technical department, land use and planning department, public construction or similar as a key actor when enhancing energy efficiency, mobility and other CE actions. The city managers noted as key actors due to strategical definition of policies according to cities A, B, F and G. The covenant of Mayors for Climate & Energy is example of agreement in which city managers or officials have concluded optional emissions reduction targets in their region. According the survey respondents, the role of city is highlighted through strategical decision-making and the actions made by municipal official. When 51 respondents have opened these roles, 51 % of them saw that the political decision-making guides the future development of energy systems. Cities B, C, D, E and H highlighted the role of city organization as an inspirer and initiator for the region due to cities open the discussion and collect the other actors to cooperate. This has happened for example through FISU network. In addition, the discussion has been increased in province level during last years. Even if the role of citizens were not significant at the moment according to cities A, C, D, E, F, G and H, cities believed that they must increase also the knowledge of residents and e.g. active citizens related to recycling even strongly in the future.

The role of energy company, whether it is owned by city or not, is very strong with energy systems development. Cities A, B, C, D, F and G said that the local energy company has a key role in energy systems development; this was in line with the survey results. Cities B, C and D highlighted that it is easier to implement new solutions and pilots through the energy company. However, city F mentioned that energy companies can also decrease the level of experiment if they are not open for new solutions. Informants believed that the targets and the strategy of city will direct the energy companies' actions even stronger in the future. The city D also noted that cities must be discussed if it is possible or not to keep its return

expectations as high as before, especially if there is need for broad investment with high risks. In addition to energy companies, municipal waste companies are also very important actors in circular business development according to all informants. Waste companies work is often not limited only in one municipality and thus has a key role with developing CE practicalities in province level. Cities A, B, C, D and H wanted to highlight that the traditional recycling is already in a high-level due to waste companies actions and long-term development. However, the city E pointed out that the level of recycling has decreased due to last changes in waste laws. The quality of recycling services (such as number of recycling points) has declined when the rights of municipal waste companies have been limited.

In addition, different development companies and research organizations work closely with CE targets both as resources and authors according to cities A, D, F and G. The development companies have also a significant role to activate the local companies and entrepreneurs to develop circular business. All informants and survey respondents highlighted the need for new circular business and new active firms. According to cities B, D and H, CE development depends on the actives of the CEOs and environmental directors of the companies. Cities highlighted that there is especially need for companies that can link digital solutions to enhancing circular business and smart city development. Another type of companies needed is actor who can enhance the data usage e.g. for more efficient utilization of material flows. Cities A, B, C, D, E, F and H said that role of different research organizations is significant in knowledge creation and transfer. Cities highlighted also the roles of Finnish Environment Institute (SYKE), Motiva and The Finnish Innovation Fund Sitra. The Centre for Economic Development, Transport and the Environment (ELY) and provincial federations have also significant roles with promoting competitiveness, well-being and sustainable development and curbing climate change in regional level.

5.4.2 Networks and partnerships

The targets of different networks are strongly intertwined over the knowledge transfer and changing ideas and best practices e.g. between other cities. Cities also acknowledged finding cooperation partners, e.g. for joint procurements as another target. There are already several different networks such as FISU network and HINKU Forum. Due to similarity of these networks, one city noted that they have not yet wanted to join any network before careful analysis of the reporting resources compared to clear benefits for the city. However, cities which had already participated some networks, were very satisfied especially the knowledge and practices sharing through these networks. According the all big cities B, E and H that have been already developed CE for a while, the regional networks and relationships have been generated in projects and initiatives are significant base for future development. Cities B, C and H pointed out also the significance of the international cooperation and lessons learned from cities abroad.

According to interviews, there were not specific partnership models used in CE projects. Instead of that, CE and especially circular business development focuses strongly on networking and value co-creation and cities highlighted especially the cooperation between the public and the private sector, especially together the local firms and organizations. A good example of enhancing circular business is the biogas network – three cities told that they have biogas ecosystems where both city, waste and other private companies and wastewater treatment plants co-operate with the refinement and production of biogas. Cities B and C have a kind of resource wisdom steering committee in which CE is enhanced in general level. This committee includes all significant actors from the area, e.g. CEOs from energy and waste companies and all department managers from city organizations. The city G also told that when implementing fast pilots, also the citizens can be activated to test and then give feedback for developers. Cities C, F, G and H believed that community spirit, sharing economy and e.g. different leasing solutions will become more popular in the future.

The role of partnerships is highlighted in single projects related to CE. Cities A, B, G and H mentioned that successful contract base agreement is often base for longer partnership. However, they highlighted the role of companies to define benefits also from the viewpoint or city or regional. This will lead also to acceptance by political decision makers. Cities told that there is no different between contracts of CE projects if comparing other projects. The contract based agreements are made in the beginning of the projects and all responsibilities are agreed based on these negotiations. The only difference might be the number of different actors in CE projects. City A highlighted that due to multidimensional characteristics of CE projects, there is need for wide range of different actors in broad CE initiatives and this affects sometimes challenges. However, cities rather see the cooperation as a positive issue and informants highlighted the possibilities to make fast pilots when there is many actors sharing the common risks, e.g. when implementing new and innovative residential areas.

All cities highlighted the need for increasing concreate circular business actions in their area. Cities told that investments do not need to be profitable immediately. However, they are open to join and cooperate to initiatives in which the financial potential and benefits are able to be clarified somehow faithfully in the long-term. Now cities have made different agreements for energy savings and carbon neutrality targets in their strategies and the next step is to start the concrete actions to achieve these ambiguous targets. In these actions, the cooperation between public and private sectors will be emphasized even stronger in the future. Cities A, D, E, F and H told that there is need for material bank or similar and someone who is able to connect data from different resources and enhance circular business by enhancing information sharing. However, cities also understood that there are problems related to benefits sharing and data ownership. The city E highlighted the need for smart urban planning and companies who can connect the data straight to the reports and thus enable more efficient usage of data.

6 ANALYSIS AND DISCUSSION

The aim of this study was to research how to enhance circular business in urban ecosystems and this chapter answers the research questions. **Table 17** links the set questions with the chapters including answers.

Table 17 Research questions answered

Chapter	Research question(s)
6.1 Interesting insights of drivers and barriers	**RQ1:** How to enhance circular business in urban ecosystems?
6.2 Networks and cooperation supporting circular business	**RQ1.1:** How (municipal) decision-making processes affect circular business? **RQ1.2:** What kind of partnership models support circular business in urban ecosystems?
6.3 How to promote the circular business in urban ecosystems in the future?	**RQ1:** How to enhance circular business in urban ecosystems?

6.1 Interesting insights of drivers and barriers in urban ecosystems

The drivers and barriers for circular business have been explored in the macro level with PESTE analysis in this study. The findings from literature and empirical research are collected in **Table 18.**

Table 18 PESTE analysis – Key drivers and barriers for circular business in urban ecosystems

	Drivers*	Barriers*
Political	Global targets ⁂ National targets ⁂ Laws and regulations ⁂ Political incentives ⁂ **(Local) cooperation opportunities** ⁎ **Local political environment** ⁎	Unclear and inefficient policies ⁂ Lack of incentives ⁂ **Lack of local political acceptance** ⁎
Economic	**Business potential** ⁂ Funding ⁂ Cost savings ⁂ **Risk sharing opportunities** ⁎	High costs and risks ⁂ Uncertainty of future ⁂ **Lack of resources** ⁎
Social	**Environmental consciousness** ⁂ **Opportunities to increase vitality** ⁂ **Changed attitudes** ⁂ Education for municipal officials and decision-makers ⁎	Weaknesses of public consciousness ⁂ Decision-makers' weak awareness ⁂ Lack of demand from consumers ⁂ **Lack of information and knowledge** ⁂ **Lack of actions and pilots** ⁎
Technological	Technology development ⁂ **Digitalization** ⁂	Lack of technologies ⁂ **Lack of databases** ⁂ Expensive new technology ⁎
Environment	**Pursuit of sustainability** ⁂ Sustainability brand benefits ⁂	N/A ⁂

*) Symbols = ⁂ theoretical & empirical findings, ⁎ only empirical findings, **bolded = very important**

According to the results of this study, cities can be divided roughly into two categories: cities in which CE development has already been started strongly and cities in which CE development is just in the beginning. Due to the differences in the current state, the drivers and barriers met with CE development differ at least partly. **Figure 19** summarizes the most significant drivers and barriers and provides a proposed decision for cities in different development phase.

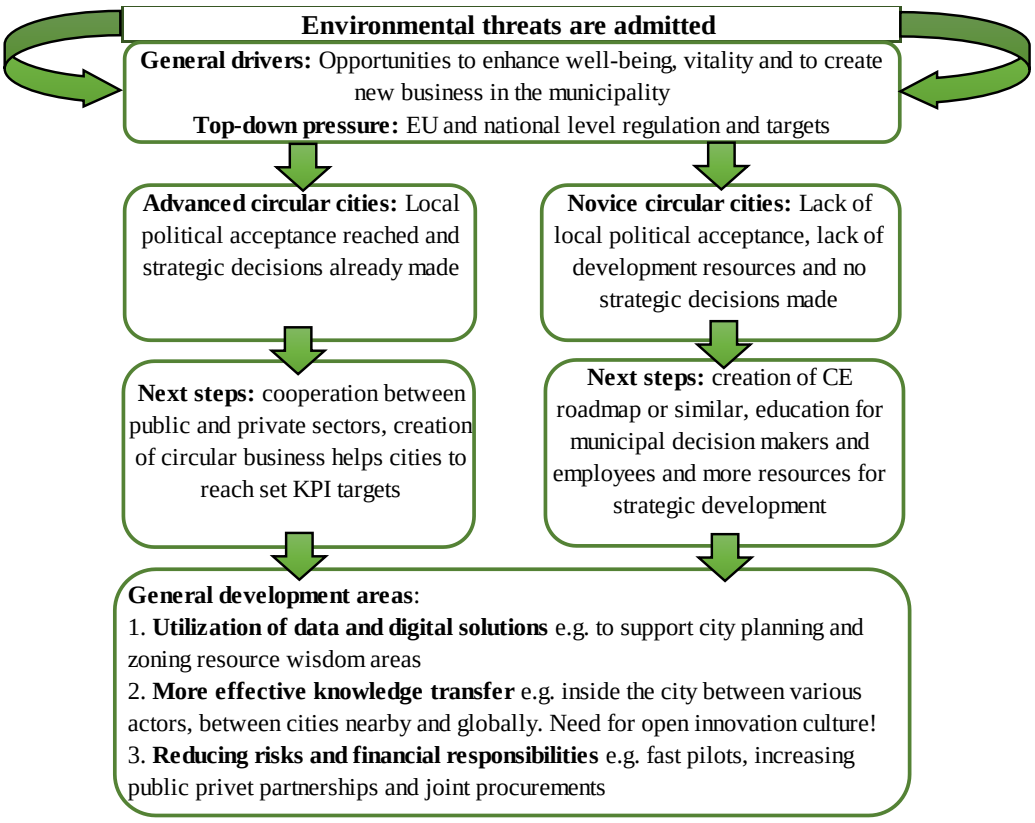

Figure 19 Summary for circular business drivers and development needs in different cities

A driver behind municipalities that have already engaged in CE widely has been the favorable political climate in the municipal council. This kind of municipalities have started creating (or already created) resource wisdom roadmaps and producing separate strategies with the long-term environmental targets related to carbon neutrality and zero waste future. Municipal councils have pledged their support in the long-term targets. Additionally, the environmental issues are found to be important widely in municipal organizations and even all municipal departments observe their actions from the resource wisdom point of view e.g. when planning annual budgets. These cities are now focusing on further actions and highlighted the need for even tighter cooperation between the public and private sectors.

Companies that can help cities to reach the set targets both in short and long-term are desired partners.

The common features in municipalities that have not yet been engaged in CE development are the lack of political acceptance, the lack of broad CE knowledge and especially the lack of resources in city organization. They would need first to map their current state and CE targets similarly to the more advanced cities. Additionally, the lack of political acceptance as well as resistance and unconsciousness inside the city organization have been barriers for the development. These municipalities would need first CE related education for both the municipal decision-makers and the employees. The CE targets should be agreed in a city strategy (or similar) before it can be enhanced. However, these cities were often suffering from the lack of the resources. Even the position of a development manager has been terminated and therefore the strategic development of the city is difficult. In these cities, CE development should be started by increasing the knowledge, providing references and examples about more advanced cities, and then creating the current state analysis e.g. with the help of subsidies. These cities announced the need for clear, easily adopted actions and benefits instead of useless, expensive and vague consulting reports. These cities were also uncertain on whether they wished to participate in FISU, HINKU or similar projects due to heavy reporting obligations against the benefits.

According to the empirical and theoretical results, the increase in environmental consciousness as well as changed attitudes and values have acted as key boosters behind the cities' interest towards CE in urban ecosystems. Climate change and resource scarcity have been agreed as real threats widely (e.g. Lacy & Rutqvist, 2015; Murray et al., 2015), which have also changed the common attitudes in municipalities. The political decision-making and e.g. ambitious targets by Paris Agreement 2015 have guided the pursuit of sustainability widely. Both the current literature (e.g. Dong et al., 2016; Mathews & Tan, 2011) and empirical findings of this study emphasize the power of political decisions, targets, laws and requirements when pursuing CE. Cities highlighted both EU-level and national

level targets as strong drivers for their actions in urban ecosystems. It can be said that in recent years top-down approach, such as global and national requirements for emission reducing have been even stronger driver for CE and energy systems development. However, due to importance and effectiveness of political directives, these can also hinder circular business e.g. if regulations for emissions are unclear. In the worst case, cities and companies are not able to make investments due to fear of unflattering and changing political regulations. As already said before, also the local political climate is underlined as both a driver and a barrier – if there were no interest towards enhancing environmental issues in the city, it has been hard to take these issues into account. However, based on the results of this study, the awareness of CE has increased in most of the cities in recent years and thus there is a favorable political acceptance for further actions.

The economic approach cannot be over-emphasized as a driver and a barrier when pursuing CE in urban ecosystems. According to both the current literature (e.g. Rizos et al., 2017, p. i) and the empirical findings of this study, the economic viewpoint is vital when aiming circular business. Hence, the predicted business potential related to CE development is a significant economic driver. In practice, the prediction of business potential or defining clear economic benefits with new business opportunities is difficult. For example, informants noted that fast developing technologies hinder investments in the current ones – risk to invest in technology that will be soon outdated is too high. The high costs of investments prevent investments to be implemented whereas cost savings are clear drivers. However, cost savings do not motivate that much if they are expected to be realized only in the long term. Decision-makers are discouraged to rely on accumulating benefits in the long term when management is based on annual planning. Risk aversion e.g. with cooperation between cities or private and public sector was one of the factors appeared strongly in the empirical findings. The joint procurement and joint investments and thus sharing the common risk could enable circular business testing in urban environment. Another way to reach quick results both in increasing knowledge about the lucrativeness of the project and the concreate

functionality of the circular business products or services, is to invest in fast experiments in cooperation with the public and the private sector participation.

In addition, it must be emphasized that the most important mission of the municipalities is to enhance the regional vitality and well-being. All informants said that circular business that is able to increase and enhance the well-being and the vitality is more than welcome. The weaknesses of public consciousness as well as weaknesses in awareness of decision makers have still been seen as barriers for circular business implementation. However, the informants told that education of municipal officials and decision-makers has already developed the awareness and it must be considered when educating new municipal councils in the beginning of new municipal council period. Additionally, informants highlighted that due to the lack of time and resources, the information, research results and education have to be based on very simply examples and they have to be shown in explicit terms. One of the barriers for circular business according to the empirical findings was the lack of real actions and pilots. Informants said that e.g. after the creation of resource wisdom roadmap it is extremely important that the real pilots and actions with clear targets will be implemented and tested as soon as possible. One circular business potential can be seen with actions that are able to answer straight and develop e.g. the targets and KPIs set by the cities.

Technological development and especially digitalization provide new opportunities also for the circular business development. However, also the current literature (e.g. Raedemaeker et al. 2011) find that the lack of technologies complicates the development. Informants also highlighted that the investments are missing because of the expensive new technologies. Therefore funds and subsidies are needed especially for R&D and testing new innovative solutions such as smart technologies for recycling or enhancing digital solutions as a part of urban planning. Even if digitalization was seen as one of the biggest drivers for circular business, the lack of the efficient utilization of the data is still a barrier. There are still many problems to solve data collection responsibilities, data ownership and utilization possibilities. Cities require data facilitators and solutions e.g to link the data straight to the reports

that have to be made in different projects. Also, the solutions that support measurement and comparison of effectiveness are needed. In conclusion, the need for knowledge transfer and more efficient communications channels cannot be over-emphasized. Cities highlighted the knowledge transfer needs both between different actors dealing with circular business inside the cities as well as between other cities nearby. FISU cities already had positive experiences between each other and highlighted the network support as one of the most significant benefit for participating in a FISU project. Furthermore, some of the cities have already cooperated with other circular cities globally. In all level of knowledge transfer, cities wanted to emphasize the benefits gained from changing ideas and experiences about the best practices, lessons learned and failures.

6.2 Networks and partnerships supporting circular business

The role of the cooperation and the partnerships were highlighted already in driver and barrier analyses. To understand networks and cooperation supporting circular business even deeper, the key actors have been collected in the network map introduced in **Figure 20.** According to the empirical findings of this study, the cooperation simulates the Triple Helix Model (Etzkowitz & Leydesdorff, 2000) in which academia, industries and cities have a trilateral relationship. In circular business development, there is still a huge need for new research and new technologies and innovations. On the other hand, these innovations should be developed further and tested both in close cooperation between research institutions, companies and cities.

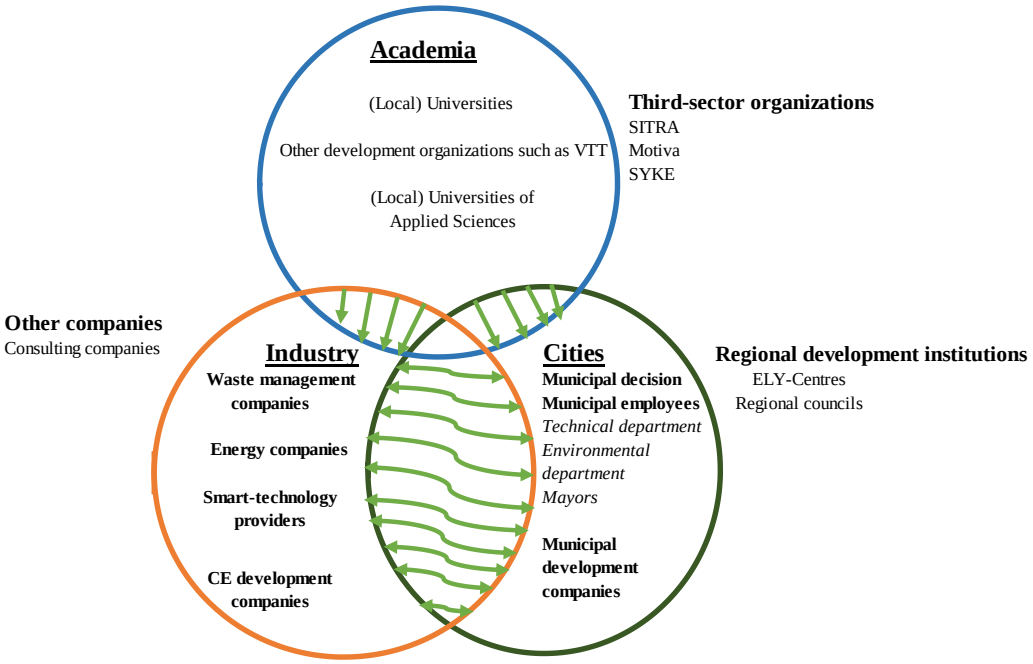

Figure 20 Key actors for circular business development in cities and municipalities

The role of academia and other knowledge institutions is traditional – research is needed to support both R&D processes in companies as well as to provide advanced knowledge for municipal officials, employees, and decision makers. For example, universities and universities of applied sciences comprise a stakeholder group in regional areas' development projects. The institutes have participated in different development groups and had development and research responsibilities e.g. related to the intelligent ICT solutions. The role of academia will be emphasized if fast experience culture becomes more common. In addition to academia, the third sector's organizations have been identified as supporting stakeholders in circular business development. These different research, development or funding organizations such as Motiva, SYKE (Finnish Environmental Institute) and Sitra enhance circular business development in urban ecosystems especially by providing networks and increasing knowledge for other stakeholders. Similar results have been gained according to the circular city study made by Prendeville et al. (2017). According to them, knowledge institutions support cities to understand CE possibilities on a city scale and to develop circular business through research, collaboration and experimentation.

The role of the cities is highlighted through the political decision-making. The findings of this study show that it is hard to develop circular business widely in municipalities which have not taken CE into account at a strategic level. There might be some projects and businesses related to CE but the wider picture is lacking in some cities. In the advanced circular cities where CE and resource wisdom topics have already been on a political agenda for a while, the role of the cities has been to facilitate and initiate CE projects. Since roadmaps or strategies with short and long-term targets and actions have been accepted in the city councils, the next step is to transfer responsibilities and pressure even stronger towards companies in the area. The completely identical results are noticeable according to the study made by Prendeville et al. (2017, p. 16): *Municipalities see themselves as 'facilitators rather than financiers' and are reluctant to invest in new infrastructure to replace incumbent unsustainable systems (e.g. energy) as this is seen as too expensive*. Furthermore, there are similar differences between cities in their research: some of the cities have already created strategies for next 30 years but some of the municipalities still make strategies for one city council period. Their study emphasized also the same need for communication as this study: visual representations and concreate examples are needed when informing decision-making.

The most active and important stakeholders inside the city organization have been the technical and environmental departments and in the beginning of new initiatives, city mayors have had a key role with their supportive attitude. According to Prendeville et al. (2017), a city mayor or similar have a key position when cities are establishing initiatives or high-level strategy documents. The findings of this study show also that in couple of smaller cities, the role of a local development company or even an active individual development manager has been vital. Additionally, both ELY Centre and regional councils support regional development of CE. Especially small, rural municipalities highlighted that the regional level cooperation between province and the cities nearby will be emphasized in the future.

Companies have naturally very important role in the circular business development inside the urban ecosystems. According to this study, the role of the companies is emphasized as circular product and service providers. Cities will need concreate solutions to reach their ambitious targets both in short and long-term. Roughly speaking, there is a need for two types of business: circular business solutions enhancing truly circularity (new innovations) and circular business solutions preventing detriments caused by the current linear business. In the context of the energy systems development in urban areas, the energy companies have still a strong role and the municipal waste companies are key actors in waste management and recycling. Additionally, the IT or similar companies which can support digitalization and smart solutions development in urban ecosystems are needed. If cities have not yet made e.g. the resource wisdom roadmaps or some other necessary reports, there might be a need also for consulting companies.

Many cities propose increasing the effectiveness of their ownership policies and therefore there will be even stronger pressure for municipal companies to start to follow objectives made in cities. The tight cooperation between the private and public sector enhancing the same targets has been noticed to be a significant factor for successful CE development. The interviewed cities do not need any specific partnership but they highlighted the normal contract based practices for managing responsibilities and obligations. The need for public-private partnerships might be emphasized when cities have made easy energy efficiency improvements and need expertise for second level solutions. The public-private partnership is also one way for sharing risks among several partners when the broad investments are needed. Ellen McArthur Foundation (2015) has listed six different policy types that enhance the top-down approach of CE. To summarize the current state of political decision-making affecting circular business development in municipalities, the findings of this study are collected in **Table 19**.

Table 19 Mapping the results of the study to different top-down approach of CE (framework adopted from Ellen McArthur Foundation, 2015)

Policy approach	Situation in Finnish cities and municipalities
Knowledge development	• CE projects that aim to increase information and awareness of different stakeholders (both firms and public sector) • Typical in pioneer cities often with tight collaboration between research institutes such as universities ➔ **This kind of projects are founded but there is still need for knowledge transferring especially in novice circular cities**
Collaboration platforms	• The aim is to utilize expertise and networks of broader stakeholder groups such as in collaboration with businesses and the public sector ➔ **This kind of collaboration may already exist but it will be emphasized when circular cities move further (from strategy creation level to practices)**
Business support schemes	• CE projects aiming regional companies and business to develop innovative circular business • Motivational background for policymakers' support are vitality and well-being benefits for region ➔ **There is a huge need for new innovative circular business**
Public procurement and infrastructure	• The procurement and infrastructure strategies promote CE development directly e.g. with responsibility requirements ➔ **This is one of the current development fields in cities. Many of them are updating requirements and see that resource wisdom principles can be taken into account through cities own procurements e.g. by changing executive cars to use renewable fuels**
Regulatory frameworks	• Regulations to support CE development to help collaboration such as companies, citizens and knowledge developers' actions inside the urban ecosystem ➔ **No clear regulations recognized related to cooperation but cities are facilitators for cooperation for different stakeholders in urban ecosystems. The open innovation culture is needed if solutions are wanted to stretch over the limits of the traditional city planning**
Fiscal frameworks	• Cover all national strategies and actions that aim at fiscal incentives for a CE ➔ **This approach is already highly affected and guides municipal development e.g. through CO2 emission reduction targets and recycling requirements**

6.3 How to promote circular business in urban ecosystems in the future

The objective of this study was to enhance circular business development by understanding the current state of circular business generally and especially related to circular energy systems development in urban areas. In the context of the energy

systems development, three focus areas have been defined in this study. These actions support especially the CE targets related to slowing and closing resource loops (Bocken et al. 2016a). Slowing strategy is pursued in urban ecosystems especially with energy efficiency initiatives and by enhancing public transportation. Closing strategy is highlighted in cities with innovative using of waste heat potential, enhancing industrial symbiosis as well as by supporting recycling and waste collection and the most valuable usage of these material and energy loops.

The first way to enhance circular energy systems in urban areas is to develop energy production: both by enabling transition from the traditional centralized energy production to the decentralized opportunities and by increasing the usage of renewable energy resources instead of non-renewable resources. Secondly, the energy utilization and efficiency should be considered even wider. Currently, most of the municipalities have executed energy efficiency initiatives in the buildings owned by themselves. In the future, companies will be more under pressure and additionally, municipalities shall optimize the whole energy system infrastructure in their cities. Cities can e.g. research the waste heat utilization opportunities and thus decrease the need for energy resources. The district cooling solutions are also quite rare currently but they might become more common in the future. The third development area is the transportation and the utilization of fuels in mobility. Cities want strongly to enhance both the utilization of electric cars and biogas vehicles depending on the fuel supply in the area. There are for example biogas production initiatives ongoing in many cities interviewed and naturally, these cities will use biogas as transportation fuel immediately it is possible.

Currently, many cities have started to develop smart city or resource wisdom areas in their region with several stakeholders: cities, companies and universities creates together new resource wisdom residential areas. These innovative areas are places both for testing, implementation and developing e.g. modern energy solutions such as regional district heating and cooling solutions, centralized structural parking and shared courtyards as well as intelligent building technologies, ICT networks and other smart city opportunities. However, there will be also development needs in

old infrastructure even if cities concentrated on promoting these new innovative circular city areas. There might be development potential in buildings' energy efficiency, mobility development and the usage of energy leakages such as waste heat from the industry in the old residential areas. These improvements shall be developed in tight cooperation between energy companies, technology providers as well as the owners of the infrastructure such as housing cooperatives or cities. Also, a strong development of old landfill sites into resource wisdom areas are recognized. Cities and waste companies aim to utilize waste according to the CE principles and enhance circular business by providing favorable conditions for new innovative companies at the same time. The key development areas related to energy systems development are summarized in **Figure 22** based on the resource wisdom roadmap framework adopted from Sitra, (2015b). Currently, different smart city solutions and resource wisdom areas are cities' way to enhance circular energy systems principles in practice. When cities pursue these objectives, the sustainable well-being and vitality values are highly emphasized.

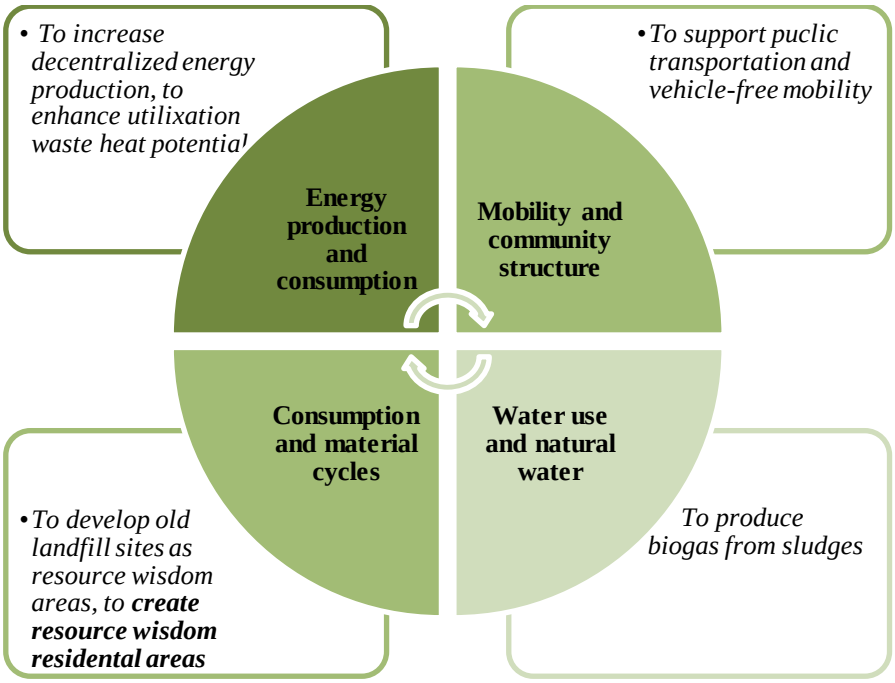

Figure 21 Circular cities' development areas in energy sector

Cities have had a role as initiators in the systematic adoption of the CE principles among different sectors in urban areas. City strategies, resource wisdom roadmaps

or similar guide circular business development widely. Even if there are already many concreate circular business development projects, the development of CE has been based on the top-down approach in which legislation and policies, supportive infrastructure and an increase in the social awareness have a key role (Lieder & Rashid, 2016). However, according to the results of this study, next step in developing circular business in urban ecosystems is to increase bottom-up approach even more. In the bottom-up approach, collaborative business models, product design, supply chain and workability of information and communication technologies are highlighted (Lieder & Rashid, 2016). Cities have already positive experiences of circular business developments in tight cooperation with several stakeholders in smart or resource wisdom residential areas. The need for collaborative business models will increase and especially public-private partnerships will be highlighted: cities need to realize their ambitious targets. Companies are in a key role in transition, and cities demand fast experiments regardless of the positive or negative results of the experiments.

The need for enhancing data tools and measurement as well as better usage of digitalization opportunities were highlighted as a significant development when pursuing circular business. These were possible development themes with the UIA-initiatives. They have found that by contributing measurable and replicable resource-efficiency solutions (such as standards indicators), CE targets can be better achieved. The current data which has been already collected in different reports (e.g. CO2-reports) and agreements (e.g. energy efficiency contracts) should be better utilized. Many cities highlighted the need for action-based suggestions for further actions. Cities also emphasized the need for circular business in which improvements are clearly mapped to their KPIs. One opportunity is to focus on the utilization of the methods defined by Dong et al. (2016b). Cities have already calculated their ecological and carbon footprints but the regional input-output analysis as well as the lifecycle analysis in companies could be better used. More efficient measurement and data collection will boost the CE development both in cities and companies positively forward.

7 CONCLUSIONS

Circular economy is a widely discussed topic in urban ecosystems. According to this study, discussion around the CE and circular business development has increased in Finnish cities and municipalities especially during last two years. Adopting CE principles has been started often through some project, such as participating in FISU or HINKU networks, and in creation of both short and long-term targets. Another very important target has been to increase CE related knowledge of municipal actors. Because of the wide range of the approach under the umbrella of CE, municipalities have collected or will collect different sectors in resource wisdom roadmaps or similar strategies. Additionally, smaller agreements such as energy efficiency contracts have been accepted. Next, both theoretical and managerial implications are shortly described and finally, the limitations and recommendations for further research areas are defined.

7.1 Theoretical & managerial implications

The CE as a term has gained attention especially in the recent years as mentioned in literature and the results of this study. The targets under the umbrella of CE aim to same objectives such as sustainable development and these terms are often blurred (Geissdoerfer et al., 2017). The informants of the cities as well as the respondents of the survey pointed out the difficulties with these several approaches for the same issue and criticized CE and energy transition as a new topic for municipalities. Both the literature and practice should be focused on showing the results of the CE development with concreate examples and evaluation of the effectiveness of the solutions. Furthermore, especially the current literature is lacking studies related to circular business development on macro level. Many studies concentrate on bottom-up examples but comprehensive circular city studies are needed to understand the systematic change on macro level.

According to this study, there are two categories for cities depending on their previous actions: advanced circular cities where strategic agreement has been

agreed or will be accepted now in the beginning of new municipal council period started in June 2017. The novice circular cities still need assistance for catching the general view of the CE opportunities. However, the focus will continue even more on the concreate solutions and practically enhancing e.g. carbon neutrality and zero waste targets. Hence, there is a huge need for companies being able to enhance circular business and create both products and services that help municipalities to achieve the set targets both in the near future as well as in the long run. The bottom-up approach will be highlighted in urban ecosystems in the future, even if the top-down approach has a vital role as a guidance. Furthermore, there is a need for developing measurement tools and enhancing data utilization. When targets have been set, it is important to be able to measure the effectiveness of executed actions and thus understand which are the most effective ways to enhance CE principles.

7.2 Limitations and areas for the future research

The CE transition has just started in Finnish cities and municipalities and this study was mostly focused on actions already undertaken in early stages and clarified strategic decisions made in cities at present. However, CE is a topic which develops quickly and thus more research is needed in the future. Because this study focuses on analyzing CE development by understanding macro environment challenges in municipalities, there is a need for studies concentrating more on meso- and micro-level approaches. It would be valuable to analyze the success and effectiveness of circular, smart and recourse wisdom areas that are significant in circular cities and circular business development in urban ecosystems. By researching those areas and actions closer, the specific barriers and drivers for circular areas development can be found. This kind of research can be executed e.g. by defining a couple pilot areas from the early stages (e.g. from authorization and zoning the area) and the following different development phases and thus evaluating the entire projects. After the planning and construction phases, it would be useful to follow how circular economy principles set to the area will affect to the behavior of the residents in the area; are they able to decrease utilization of cars, for example.

Furthermore, PESTE analysis or similar can be executed from CE firms' point of view – how companies enhancing circular business see the current political, economic, social, technological and environmental factors and what are the effects for their businesses? It would be also interesting to compare these drivers and barriers with the findings of this study. Another interesting research area might be the internal drivers and barriers for circular business development in companies. This kind of research might be able to provide interesting insights of reasons why firms do not easily change their business models from linear to circular. Altogether, it should be remembered that this study has been limited only researching eight cities in Finland and hence provide only examples of circular cities in transition. However, it is obvious that the redirection has already started in urban areas and it will accelerate in the future. Thus, the subject is extremely topical for cities worldwide when they try to answer the challenges of urbanization, climate change and sustainability.

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APPENDICES

Appendix 1. Number of inhabitants in case cities (2015)

City	Number of inhabitants 31.12.2015
Jyväskylä	137 368
Kotka	54 319
Kuopio	112 117
Mikkeli	54 665
Rovaniemi	61 838
Turku	185 908
Vaasa	67 619
Varkaus	21 638

Appendix 2. Analysis of case city webpages

Summary – City X	**Yes**	**No**	**Further information**
CE has been mentioned in webpages of the city			
CE has been mentioned in strategy of the city			
Sustainable development has been mentioned in webpages of the city			
Sustainable development has been mentioned in strategy of the city			
City has been participated in CE/sustainable development projects			
Energy companies owned by city			
Heating systems			
Waste companies owned by city			
Other Energy/Waste companies in the city area			
Industry			
Regional cooperation projects			

Appendix 3. The structure of interviews
(Available in English on request)

KIERTOTALOUSHANKKEET KUNTA- JA KAUPUNKISEKTORILLA – HAASTATTELUTUTKIMUS

D2W-projektin ***(D2W: From data to wisdom – Approaches enabling CE)*** *keskiössä ovat uudet tiedon hyödyntämiseen pohjautuvat toimintatavat ja ratkaisut, jotka mahdollistavat kiertotalouden mukaisen liiketoiminnan edistämisen yrityksissä ja verkostoissa. Projektin eri kokonaisuudet 1) innovaatiot & liiketoimintamallit 2) verkostot ja kumppanuudet sekä 3) tieto & viisaus linkittyvät vahvasti yhteen eri tutkimuslaitosten ja yrityskumppaneiden välisen yhteistyön tuloksena. Tutkimuslaitoksia projektissa edustavat VTT, Lappeenrannan teknillinen yliopisto sekä Tampereen teknillinen yliopisto. Yrityskumppaneina toimivat BMH Technology, Fortum, Solita sekä UPM. Projektissa tehdään sekä yleistä tutkimusta projektiyrityksissä että käsitellään case-yritysten esille nostamia kiertotalouteen liittyviä teemoja.*

Nämä haastattelut liittyvät diplomityöhöni, jonka tarkoituksena on tutkia kiertotalouden esteitä ja mahdollistajia kuntien ja kaupunkien ekosysteemien kehityksessä. Erityisenä kiinnostuksen kohteena ovat kuntien ja kaupunkien energiajärjestelmiin liittyvät kiertotaloushankkeet. Aihepiiri nousi esille Fortumin osalta, joka on kiinnostunut energiamurroksen tuomista vaikutuksista kiertotalouden ja kestävän kehityksen mukaisen liiketoiminnan edistämiseen. Haastattelujen tarkoituksena on kerätä tietoa siitä, millaisia kiertotaloushankkeita kunnissa ja kaupungeissa on toteutettu, millaisia toimijoita hankkeisiin osallistuu sekä kuinka hankkeita toteutetaan käytännössä. Lisäksi haastattelujen avulla tutkitaan, kuinka hankkeisiin liittyvä päätöksenteko toimii ja kuinka projekteja voitaisiin edistää yhdessä muiden alueen toimijoiden kanssa. Diplomityön tavoitteena on analysoida ja luoda mahdollisia uusia toimintamalleja kiertotaloushankkeiden edistämiseksi.

TAUSTATIEDOT

Haastattelun aika ja paikka:

Haastateltavan nimi ja asema kaupungissa/kunnassa:

Edustajan tausta:

1. **Kuinka kuvailisitte kaupunkianne lyhyesti?**
    a. Visiot, arvot

2. **Kuvailkaa, kuinka kestävä kehitys näkyy kuntanne toiminnassa**
    a. Kuinka taloudelliset, sosiaaliset ja ekologiset periaatteet näkyvät?
    b. Missä toiminnoissa/päätöksissä/asiayhteyksissä kestävä kehitys nousee esille?
    c. Mikä rooli kunnan eri toimijoilla on kestävän kehityksen edistämissä?

3. **Millaisia kestävän kehityksen mukaisia projekteja tai kehityshankkeita kaupunkinne on toteuttanut?**
    a. Millaisia vaikutuksia näillä hankkeilla on ollut?
    b. Millaisia haasteita hankkeiden toteuttamisessa on tullut vastaan? Kuinka näitä on voitettu?

ENERGIAMURROS KUNTIEN JA KAUPUNKIEN TOIMINNASSA

Energiamurroksella tarkoitetaan siirtymävaihetta pois perinteisestä keskitetystä, uusiutumattomien luonnonvarojen käyttöön pohjautuneesta sähkön ja lämmöntuotannosta kohti puhtaampaa, uusiutuviin luonnonvaroihin perustuvaa energiantuotantoa. Aihepiiri on ajankohtainen Suomen kunnille ja kaupungeille, jotka tulevat kohtaamaan lähivuosina runsaasti haasteita energiajärjestelmien uusimiseen liittyen. Tutkimuksen tarkoituksena on selvittää, millaisia haasteita energiamurrokseen liittyen on jo kohdattu ja millaisia muutostarpeita nähdään tulevaisuudessa.

4. **Miten meneillään oleva energiamurros näkyy kuntanne kaupunkinne toiminnassa?**
    a. Mitä ymmärrätte energiamurroksella?
    b. Onko energiamurroksen myötä tullut esille joitakin uusia vaatimuksia kunnan/kaupungin toimintaan liittyen? Keneltä vaatimukset tulevat?

c. Kuinka alueen asukkaat ovat kokeneet energiamurroksen? Miten tämä on näkynyt kunnan/kaupungin suuntaan?

5. **Mihin kaupungin toimiin energiamurroksella on vaikutuksia?**
    a. Asuinalueiden rakentaminen: kuinka alueen energiaratkaisuja lähdetään suunnittelemaan? Kuinka alueen asukkaiden toiveet huomioidaan?
    b. Liikenneratkaisut: onko kaupungilla tarve muuttaa liikennejärjestelyjä kestävämpään suuntaan?
    c. Onko kaupungissanne huomioitu energia-asiat osana strategiaa? Onko jopa luotu oma energiastrategia?
    d. Muita vaikutuksia?

6. **Määritelkää kuntanne/alueenne tärkeimmät energiajärjestelmiin liittyvät verkostotoimijat ja sidosryhmät?** (asukkaat, voimayhtiö, rakennusyhtiöt tms.)
    a. Kuvailkaa verkoston yhteistyömuotoja, kuinka verkostossa toimitaan?

7. **Kuinka energiajärjestelmiin liittyvä päätöksenteko toimii?**

    a. Kuka valmistelee hankkeita? Ketkä kaupungin/kunnan edustajat/yksiköt työskentelevät energia-asioiden parissa?
    b. Mitä muita (ulkoisia) eri toimijoita hankkeiden eri vaiheissa on mukana?
    c. Miten hankitaan tietoa päätöksenteon tueksi? Onko havaittavissa osa-alueita, joihin tarvitaan ulkopuolista apua ja tukea?
    d. Kuinka lopulliset päätökset tehdään, milloin ja kenen toimesta?

8. **Minkälaista tukea kunta/kaupunki tarvitsee tulevaisuuden energiajärjestelmien toteuttamisessa?** (Esimerkiksi: suunnittelu, eri vaihtoehtojen arviointi ja vertailu, investointikustannusten arviointi, toteutus, investointi, käyttö ja kunnossapito)

9. **Mikä rooli kaupungin omistamilla voimayhtiöillä/jäteyhtiöillä/jätevesiyhtiöillä on kaupungin toiminnassa?**
    a. Kuinka kaupunki toteuttaa omistajanohjausta energiayhtiöissään?

10. **Millainen rooli voimayhtiöillä/jäteyhtiöillä/jätevesiyhtiöillä on energiamurroksessa?**
    a. Kuinka vastuut jakautuvat kaupungin ja voimayhtiön välillä?
    b. Kuinka yhtiöiden kanssa kommunikoidaan kaupungin/alueen tarpeista?

Kiertotalous kunnan tai kaupungin toiminnassa

Kiertotalous on talouden malli, joka pohjaa arvon maksimoimiseen tuotteen tai palvelun elinkaaren aikana. Kiertotalouden avulla pyritään vähentämään neitseellisten luonnonvarojen käyttöä, eliminoimaan jätteiden syntyä ja siirtymään pois perinteisestä lineaarikulutuksen mallista. Erilaiset liiketoimintamallit kuten tuotteen tarjoaminen palveluna, tuotteen elinkaaren pidentäminen sekä tehokas uudelleenkäyttö ja kierrätys auttavat yhteiskuntaa siirtymään kohti kestävämpää, luonnon kantokyvyn huomioivaa resurssikäyttöä. Energia- ja jäteyhtiöt toteuttavat kiertotalouden mukaista toimintaa tarjoamalla uusiutuvilla raaka-aineilla tuotettua energiaa, parantamalla energia- ja resurssitehokkuutta sekä tehostamalla aineiden kiertoa yhdessä alueen muiden toimijoiden kanssa.

11. **Mitä kiertotalous teille / kaupungillenne merkitsee?**

12. **Kuvailkaa, kuinka kiertotalous näkyy kuntanne/kaupunkinne toiminnassa?**
    a. Miten määrittelette kiertotalouden osana kuntanne toimintaa?
    b. Millaisia kiertotaloushankkeita (esimerkkejä) kuntanne alueella on ollut viimeisen 5/10 vuoden aikana?
    c. Kuinka pitkään hankkeet ovat kestäneet?
    d. Mihin kunnan toimintaan kiertotaloushankkeet ovat liittyneet?
    e. Millaisia hankkeita on suunnitteilla? (esim. palvelut, liikennejärjestelyt,?)

13. **Millaisia energiasektoriin liittyviä kiertotaloushankkeita teillä on ollut/on suunnitteilla?**

    a. Millaista (kiertotalous-)hankkeita teillä on ollut/on suunnitteilla energiajärjestelmiin liittyen?
    b. Mihin kunnan toimintaan nämä kiertotaloushankkeet ovat liittyneet?
    c. Mitä yhteisiä päämääriä näette kiertotalouden ja energiajärjestelmien kehittämisessä?

14. Kuinka kiertotaloushankkeet ovat saaneet alkunsa? Kuka tai mikä taho on tehnyt aloitteen kiertotaloushankkeesta? (asukas, voimayhtiö, poliittiset vaatimukset)

15. Millaisia ajureita hankkeiden takana on?

a. Mikä on edistänyt hankkeiden toteutusta? (tuet, poliittiset kannusteet)
b. Onko havaittu:
    i. taloudellisia ajureita (esim. tuet ja rahoitus)
    ii. lainsäädännöllisiä ja poliittisia ajureita (esim. kannustava verotus, ohjaava lainsäädäntö)
    iii. teknologisia ajureita (esim. uudet teknologiat kehityksen mahdollistajana)
    iv. tiedon jakamisen mahdollisuuksia (esim. läpinäkyvyyttä ja informaation jakamista helpottavat alustat)
    v. ekologisia ajureita (esim. resurssien rajallisuus, haitallisten ympäristövaikutusten ehkäisy)
    vi. toimitusketjuun liittyviä ajurit (esim. oimitusriippuvuuden hajauttamisen potentiaali)
    vii. markkinoiden tarve ja liiketoimintapotentiaali ajureina (esim. markkinapotentiaali, synergiaetuja jonkin muun toiminnan edistämisen kanssa)
    viii. organisaationaaliset ajureita (esim. yritysten ympäristövastuuohjelmat)
    ix. brändihyötyjä (esim. differoitumispotentiaali)
    x. lisääntynyt tietoisuus ajurina (esim. estävyyden tavoittelu maailmanlaajuisesti)
    xi. sosiaalisia ajureita (esim. työpaikkojen luominen)

16. Mikä on hidastanut/estänyt hankkeiden toteutusta?

a. Millaisia hidasteita tai ongelmia on kohdattu?
b. Mitkä on koettu suurimmiksi riskeiksi?
c. Onko havaittu:
    (**Huomio haastatteluun**: jos on havaittu, pyydä konkreettisia esimerkkejä)
    i. taloudellisia esteet (korkeat kustannukset)
    ii. lainsäädännölliset ja poliittiset esteet (monimutkaiset ja ristiriitaiset säännökset)
    iii. teknologiset esteet (teknologioiden puute)
    iv. yhteistyön esteet (yhteystyökumppaneiden puute)

v. tiedon tai osaamisen puute (puuttuva tiedon kierrättäminen)
vi. rakenteelliset ja institutionaaliset esteet (toimialojen esteet, mm. vahva tuki lineaarisille malleille)
vii. organisaationaaliset esteet (sisäisen yhteistyön puute)
viii. korkea epävarmuus (korkeat riskit)
ix. sosiaaliset ja kulutuspuolen esteet (epävarmat markkinat)

17. Millaista hyötyä kiertotalouden mukainen toiminta on tuonut kuntanne toimintaan?

a. Miten hyödyt ovat näkyneet lyhyellä ja pitkällä aikavälillä?
b. Miten hyötyjä on mitattu?
c. Miten toimintaa on jatkettu hankkeen päätyttyä? Onko toiminta saatu jatkuvaksi? Jos on, niin miten?

18. Millaisia haittoja kiertotalouden noudattaminen on tuonut kuntanne toimintaan? Millaisia ongelmia on esiintynyt?

a. Kuvailkaa, kuinka kiertotalous on vaikuttanut kunnalle syntyviin kustannuksiin ja niiden muodostumiseen?
b. Onko hankkeita jouduttu lopettamaan negatiivisten vaikutusten vuoksi?

19. Kuinka kiertotalouden mukaista toimintaa voitaisiin kehittää toiminnassanne?

a. Missä kunnan toiminnassa näette tarvetta kiertotalouteen liittyville palveluille/ratkaisuille?
b. Onko toteutettujen hankkeiden myötä ilmennyt tarve uudenlaiselle yhteistyölle tai verkostoille?

20. Kuinka kiertotaloushankkeisiin liittyvä päätöksenteko toimii?

a. Kuka valmistelee hankkeita?
b. Mihin osa-alueisiin tarvitaan apua ja tukea?
c. Mitä eri toimijoita hankkeiden eri vaiheissa on mukana?
d. Miten hankitaan tietoa päätöksenteon tueksi?
e. Missä vaiheessa päätökset syntyvät ja kenen toimesta?

21. Kuinka kuvailisitte sidosryhmiä ja yhteystyökumppaneita kiertotaloushankkeissa?

a. Eroavatko sidosryhmät muista hankkeista? Miten?
b. Mitkä asiat ovat vaikuttaneet yhteistyökumppaneiden valintaan? Mihin kriteereihin valinta on perustunut?

c. Miksi yhteistyötä tehdään? Mitä ovat motiivit yhteistyön taustalla? (Tavoitteet ja ajurit)
d. Miksi yhteistyötä ei tehdä? Mitä rajoittavia tekijöitä yhteistyölle mahdollisesti on? (Esimerkiksi julkisten hankintojen aiheuttamat vaatimukset)

22. Millainen rooli kunnallisilla kehitysyhtiöillä on kehityshankkeissa?

23. Millaiset kumppanuusmallit tukisivat kunnan/kaupungin toimintaa kiertotaloushankkeissa?

a. Millaisille uusille toimijoille tai sidosryhmille on tarvetta projektien eri vaiheissa?
b. Onko jokin hankemuoto koettu erityisen onnistuneeksi? (esim. ESCO-malli) Mikä siitä on tehnyt erityisen onnistuneen kunnan näkökulmasta?

Appendix 4. The structure of Webropol-survey

(Available in English on request)

Open your mind. LUT.
Lappeenranta University of Technology

Kiertotalous kunta- ja kaupunkiekosysteemeissä - kyselytutkimus

Tutkimuksen tarkoitus ja tavoite

Tämä kysely liittyy diplomityöhöni, jossa tutkin kiertotalouden esteitä ja mahdollistajia Suomen kuntien ja kaupunkien toimintaympäristön kehityksessä. Erityisenä kiinnostuksen kohteena diplomityössäni ovat kuntien ja kaupunkien energiajärjestelmiin liittyvät kiertotaloushankkeet.

Työssä selvitään kiertotaloushankkeiden nykytilaa, selvitetään kiertotaloutta edistäviä ja hidastavia tekijöitä kuntien ja kaupunkien toimintaympäristössä, tutkitaan kiertotaloushankkeisiin liittyvää päätöksentekoa sekä kiertotaloustoimintaa tukevia kumppanuusmalleja. Työn tavoitteena on analysoida ja luoda mahdollisia uusia toimintamalleja kiertotaloushankkeiden edistämiseksi.

Kyselyyn vastaaminen vie aikaa 5-10 minuuttia. Hienoa että osallistut tutkimukseen, kiitos jo etukäteen vastauksistasi!

1. Kuntamme nimen saa mainita tulosten esittelyn yhteydessä *

Lupa koskee ainoastaan kunnan nimen julkaisemista. Kysely on anonyymi vastaajan osalta eli vastauksia ja vastaajia EI voida yhdistää toisiinsa tulosten esittelyssä.Vastaajien henkilöllisyydet jäävät ainoastaan tutkijoiden tietoon. Toteutettava diplomityö ja mahdolliset tieteelliset julkaisut tulevat olemaan julkisia asiakirjoja.Tieteellisillä julkaisulla tarkoitamme kansainvälisiä artikkeleita tieteellisissä aikakausilehdissä sekä konferensseissa.

◯ Kyllä, kuntamme nimen voi mainita sekä diplomityössä että mahdollisissa muissa julkisissa tieteellisissä julkaisuissa

◯ Kyllä, mutta kuntamme nimen voi mainita vain diplomityössä

◯ Ei, kuntamme nimeä ei saa mainita lainkaan

2. Yhteystiedot

Vastaajan yhteystiedot jäävät ainoastaan tutkijoiden tietoon. Yhteystietoja käytetään mahdollisten tarkentavien lisäkysymysten esittämiseen sekä tutkimusten tulosten toimittamiseen kyselyyn vastanneille. Mikäli et halua antaa yhteystietojasi, jätä vastaamatta.

Etunimi _____

Sukunimi _____

Sähköposti _____

3. Kunta/Kaupunki

4. Jos edustamasi kunta ei löydy valikosta, kirjoita se tähän:

_____

_____

_____

5. Valitse roolisi: *

- ☐ Poliittinen päättäjä
- ☐ Kunnan viranhaltija tai muu työntekijä
- ☐ Kuntaomisteisen energiayhtiön edustaja
- ☐ Kuntaomisteisen jäteyhtiön edustaja
- ☒ Kunnallisen kehitysyhtiön edustaja

Joku muu, mikä?

☐ _____

6. Tehtävänimikkeesi

Esimerkiksi: hankepäällikkö, kunnanjohtaja, energia-asiantuntija

_____

Energiamurroksen vaikutukset kunta- ja kaupunkisektorilla

Energiamurroksella tarkoitetaan siirtymävaihetta pois perinteisestä, uusiutumattomien luonnonvarojen käyttöön pohjautuneesta, pääosin keskitetystä sähkön- ja lämmöntuotannosta kohti puhtaampaa, uusiutuviin luonnonvaroihin perustuvaa energiantuotantoa. Tämän osion tarkoituksena on selvittää, millaisia haasteita kunnissa on jo kohdattu energiamurrokseen liittyen sekä millaisia muutostarpeita nähdään tulevaisuudessa.

7. Seuraavat termit ovat minulle tuttuja kunnassa olevan työni tai luottamustoimeni kautta: *

1 Täysin eri mieltä	2 Jokseenkin eri mieltä	3 Ei samaa eikä eri mieltä	4 Jokseenkin samaa mieltä	5 Täysin samaa mieltä

Energiamurros	○	○	○	○	○
Energiajärjestelmät	○	○	○	○	○
Kestävä kehitys	○	○	○	○	○
Kiertotalous	○	○	○	○	○
Hiilineutraalius	○	○	○	○	○
Resurssiviisaus	○	○	○	○	○

8. Seuraavat teemat tulevat vahvasti esille kunta- tai kaupunkistrategiassamme: *

	1 Täysin eri mieltä	2 Jokseenkin eri mieltä	3 Ei samaa eikä eri mieltä	4 Jokseenkin samaa mieltä	5 Täysin samaa mieltä
Energialähteet	○	○	○	○	○
Uusiutuvat energianlähteet	○	○	○	○	○
Ympäristönsuojelu	○	○	○	○	○
Ilmastonmuutoksen ehkäisy	○	○	○	○	○

Kestävä kehitys	○	○	○	○	○
Kiertotalous	○	○	○	○	○
Resurssiviisaus	○	○	○	○	○
Hiilineutraalius	○	○	○	○	○
Aurinkotalous	○	○	○	○	○

9. Onko kunnassanne tehty erillinen energiastrategia? *

○ Kyllä, kunnan alueella, milloin ensimmäisen kerran (vuosi): _____

○ Kyllä, maakunnan alueella, milloin ensimmäisen kerran (vuosi): _____

○ Ei

10. Onko kunnassanne tehty erillinen ympäristö- tai ilmastostrategia? *

○ Kyllä, kunnan alueella, milloin ensimmäisen kerran (vuosi):

_____

Kyllä, maakunnan alueella, milloin ensimmäisen kerran (vuosi):

○ _____

○ Ei

Kunnan ja kaupungin tulevaisuuden energiajärjestelmien kehitys

Energiatehokkuuden tavoittelu, päästövähennykset sekä kehittyvät teknologiat ovat käynnistäneet energiajärjestelmien laajan muutoksen. Aihepiiri on ajankohtainen Suomen kunnille ja kaupungeille, jotka tulevat kohtaamaan lähivuosina runsaasti haasteita energiantuotannon ja -jakelun uusimiseen liittyen: vanha infrastruktuuri edellyttää korjaustarpeita ja toisaalta uudet, hiilineutraalit energiantuotantotavat ovat varteenotettavia vaihtoehtoja esimerkiksi uusia asuinalueita suunnitellessa.

11. Seuraavista asiat ohjaavat kuntamme tulevaisuuden energiajärjestelmien suunnittelua:

	1 Täysin eri mieltä	2 Jokseenkin eri mieltä	3 Ei samaa eikä eri mieltä	4 Jokseenkin samaa mieltä	5 Täysin samaa mieltä
EU-tasolla asetetut päästövähennystavoitteet *	○	○	○	○	○

Kansallisen tason päästövähennystavoitteet *	○	○	○	○	○
Lait ja asetukset *	○	○	○	○	○
Kunnan itseasettamat tavoitteet *	○	○	○	○	○
Maakunnan itseasettamat tavoitteet *	○	○	○	○	○
Taloudellisuus *	○	○	○	○	○
Teknologian kehittyminen *	○	○	○	○	○
Alueen asukkaiden toiveet *	○	○	○	○	○
Joku muu, mikä? _____	○	○	○	○	○

12. Kestävyyden ja hiilineutraaliuden tavoittelu vaikuttaa **jo tällä hetkellä** merkittävästi seuraaviin kuntamme tehtäviin:

	1 Täysin eri mieltä	2 Jokseenkin eri mieltä	3 Ei samaa eikä eri mieltä	4 Jokseenkin samaa mieltä	5 Täysin samaa mieltä
Maankäyttö ja rakentaminen *	○	○	○	○	○
Kaavoitus *	○	○	○	○	○

Vesihuolto *	○	○	○	○	○
Energiahuolto *	○	○	○	○	○
Jätehuolto *	○	○	○	○	○
Ympäristönsuojelu *	○	○	○	○	○
Joku muu, mikä? _____	○	○	○	○	○

13. Kestävyys ja hiilineutraalius vaikuttavat **tulevaisuudessa** merkittävästi seuraaviin kuntamme tehtäviin:

	1 Täysin eri mieltä	2 Jokseenkin eri mieltä	3 Ei samaa eikä eri mieltä	4 Jokseenkin samaa mieltä	5 Täysin samaa mieltä
Maankäyttö ja rakentaminen *	○	○	○	○	○
Kaavoitus *	○	○	○	○	○
Vesihuolto *	○	○	○	○	○
Energiahuolto *	○	○	○	○	○
Jätehuolto *	○	○	○	○	○

Ympäristönsuojelu *	○	○	○	○	○
Joku muu, mikä? _____	○	○	○	○	○

14. Onko kunnassanne viimeisen viiden vuoden aikana toteutettu seuraavia selvityksiä tai toimenpiteitä? *

	Kyllä, selvityksen tuloksia on hyödynnetty ja jatkotoimenpiteisiin on ryhdytty.	Kyllä, selvityksen tuloksia on hyödynnetty osittain.	Kyllä, mutta selvityksen tuloksia ei ole hyödynnetty lainkaan.	Ei.	En osaa sanoa.
Laskettu kasvihuonekaasupäästöt asukasta kohden	○	○	○	○	○
Laskettu materiaalihäviöt asukasta kohden	○	○	○	○	○
Laskettu ekologinen jalanjälki asukasta kohden	○	○	○	○	○
Uusiutuvan energian kuntakatselmus, _____	○	○	○	○	○

millä alueella (kunta, maakunta vai muu alue):				
Resurssiviisaus-tiekartta	○	○	○	○ ○
Energiavirtamallinnus	○	○	○	○ ○
Materiaalivirtamallinnus	○	○	○	○ ○

15. Kerro lyhyesti, kuinka edellämainittujen selvitysten tuloksia on hyödynnetty kunnan toiminnassa:

_____

_____

_____

16. Kuntamme **tarvitsee jo nyt** seuraavanlaista tukea alueensa energiajärjestelmien kehittämiseen:

	1 Täysin eri mieltä	2 Jokseenkin eri mieltä	3 Ei samaa eikä eri mieltä	4 Jokseenkin samaa mieltä	5 Täysin samaa mieltä

Uusien asuinalueiden energiajärjestelmien suunnittelu *	○	○	○	○	○
Uusien teollisuusalueiden energiajärjestelmien suunnittelu *	○	○	○	○	○
Olemassa olevien asuinalueiden energiajärjestelmien muutokset *	○	○	○	○	○
Olemassa olevien teollisuusalueiden energiajärjestelmien muutokset *	○	○	○	○	○
Energiantuotannon vaihtoehtojen arviointi ja vertailu *	○	○	○	○	○
Investointikustannusten arviointi *	○	○	○	○	○
EnergiajärjestelmäInvestoinnin toteutus *	○	○	○	○	○
Uusien energiajärjestelmien käytönaikainen tuki *	○	○	○	○	○
Joku muu, mikä? _____	○	○	○	○	○

17. Kuntamme **voisi tarvita tulevaisuudessa** seuraavanlaista tukea alueellisten energiajärjestelmien kehittämiseen:

	1 Täysin eri mieltä	2 Jokseenkin eri mieltä	3 Ei samaa eikä eri mieltä	4 Jokseenkin samaa mieltä	5 Täysin samaa mieltä
Uusien asuinalueiden energiajärjestelmien suunnittelu *	○	○	○	○	○
Uusien teollisuusalueiden energiajärjestelmien suunnittelu *	○	○	○	○	○
Olemassa olevien asuinalueiden energiajärjestelmien muutokset *	○	○	○	○	○
Olemassa olevien teollisuusalueiden energiajärjestelmien muutokset *	○	○	○	○	○
Energiantuotannon vaihtoehtojen arviointi ja vertailu *	○	○	○	○	○
Investointikustannusten arviointi *	○	○	○	○	○
EnergiajärjestelmäInvestoinnin toteutus *	○	○	○	○	○
Uusien energiajärjestelmien käytönaikainen tuki *	○	○	○	○	○
Joku muu, mikä? _____	○	○	○	○	○

18. Aseta seuraavat energiajärjestelmien kehitykseen osallistuvat toimijat tärkeysjärjestykseen (1=tärkein, 11=vähiten tärkeä)

	1	2	3	4	5	6	7	8	9	10	11
Kunnan poliittiset päättäjät	○	○	○	○	○	○	○	○	○	○	○
Kunnan viranhaltijat	○	○	○	○	○	○	○	○	○	○	○
Kunnan omistama energiayhtiö	○	○	○	○	○	○	○	○	○	○	○
Kunnan omistama jäteyhtiö	○	○	○	○	○	○	○	○	○	○	○
Kunnan omistama vesihuoltoyhtiö	○	○	○	○	○	○	○	○	○	○	○
Kunnallinen kehitysyhtiö	○	○	○	○	○	○	○	○	○	○	○
Yliopistot tai muut oppilaitokset	○	○	○	○	○	○	○	○	○	○	○
Alueen teollisuusyritykset	○	○	○	○	○	○	○	○	○	○	○
Muut alueen yritykset	○	○	○	○	○	○	○	○	○	○	○
Alueen asukkaat	○	○	○	○	○	○	○	○	○	○	○
Muut toimijat, mitkä? _____	○	○	○	○	○	○	○	○	○	○	○

19. Kuvaile lyhyesti energiajärjestelmien kehitykseen osallistuvien toimijoiden rooleja. Missä vaiheessa projekteja eri toimijoiden roolit korostuvat?

_____

_____

_____

20. Seuraavat toimijat osallistuvat kunnan energiaratkaisuihin liittyvään lopulliseen päätöksentekoon:

	1 Täysin eri mieltä	2 Jokseenkin eri mieltä	3 Ei samaa eikä eri mieltä	4 Jokseenkin samaa mieltä	5 Täysin samaa mieltä
Kunnan viranhaltijat, ketkä _____ tarkalleen: *	○	○	○	○	○
Kunnan poliittiset päättäjät *	○	○	○	○	○
Kunnanvaltuusto *	○	○	○	○	○
Kunnan omistaman energiayhtiön edustajat *	○	○	○	○	○

Kunnan omistaman jäteyhtiön edustajat *	○	○	○	○	○
Kunnan omistaman vesihuoltoyhtiön edustajat *	○	○	○	○	○
Alueen teollisuusyritykset *	○	○	○	○	○
Muut alueella toimivat yritykset *	○	○	○	○	○
Joku muu toimija, mikä? _____	○	○	○	○	○

21. Voit halutessasi kuvailla energiaratkaisuihin liittyvää päätöksentekoa omin sanoin.

_____

_____

_____

Kiertotalous kunnan ja kaupungin toiminnassa

Kiertotalous on talouden malli, joka pohjaa arvon maksimoimiseen tuotteen tai palvelun elinkaaren aikana. Kiertotalouden avulla pyritään vähentämään neitseellisten luonnonvarojen käyttöä, eliminoimaan jätteiden

syntyä ja siirtymään pois perinteisestä lineaarikulutuksen mallista. Erilaiset liiketoimintamallit kuten tuotteen tarjoaminen palveluna, tuotteen elinkaaren pidentäminen sekä tehokas uudelleenkäyttö ja kierrätys auttavat yhteiskuntaa siirtymään kohti kestävämpää, luonnon kantokyvyn huomioivaa resurssikäyttöä. Kunnat ja kaupungit voivat edistää kiertotalouden mukaista toimintaa alueellaan tukemalla uusiutuvilla raaka-aineilla tuotettua energiaa, parantamalla energia- ja resurssitehokkuutta sekä tehostamalla aineiden kiertoa yhdessä alueen muiden toimijoiden kanssa.

22. Kuvaile lyhyesti, kuinka kestävä kehitys näkyy kuntanne toiminnassa:

_____

_____

_____

23. Onko kunnassanne toteutettu kiertotalouteen liittyviä hankkeita? *

Kyllä, millaisia?

○ _____

○ Ei

24. Onko kuntanne osallisena tai kiinnostunut seuraavista kansallisista kiertotaloutta edistävistä hankkeista:

☐ Olemme HINKU-kunta

☐ Haluaisimme tulevaisuudessa olla HINKU-kunta

☐ Olemme FISU-kunta

☐ Haluaisimme tulevaisuudessa olla FISU-kunta

☐ Joku muu, mikä? _____

25. Millaisia kiertotaloushankkeita alueellanne on tällä hetkellä menossa tai suunnitteilla? Kuvailkaa lyhyesti hankkeen nimi ja tavoite.

_____

_____

_____

26. Kenen aloitteesta kiertotaloushankkeeseen on lähdetty? *

☐ Kunnan viranhaltija tai muu kunnan työntekijä, kuka (esimerkiksi ympäristöjohtaja, kehitysjohtaja): _____

☐ Kunnallisen kehitystyhtiön työntekijä

☐ Kunnan omistama energiayhtiö

☐ Kunnan omistama jäteyhtiö

☐ Kunnan viranhaltija

☐ Kunnan omistama vesihuoltoyhtiö

☐ Kunnallisen kehitystyhtiön edustaja

☐ Alueella toimiva yritys

☐ Alueen asukas

☐ Joku muu, mikä?

27. Kuinka alueellisten energiajärjestelmien kehittäminen liittyy kiertotalouden edistämiseen?

_____

_____

_____

Kiertotalouden edistäminen alueella

Kiertotalouden edistämisessä muun muassa yhteistyöverkoilla sekä tiedon ja osaamisen jakamisella on keskeinen merkitys. Tämän osion tarkoituksena on selvittää, mitä hyötyjä kiertotalouden mukaisesta toiminnasta on kunnille ja kaupungeille, mitkä tekijät edistävät alueen kehittymistä kiertotalouden suuntaan sekä mitkä tekijät estävät kunta- tai kaupunkiympäristöä kehittymistä kiertotalouden suuntaan.

28. Mitä hyötyjä kiertotalous voisi tuoda alueellenne? *

- ☐ Edistää alueen elinvoimaisuutta
- ☐ Edistää energiatehokkuustoimenpiteitä
- ☐ Lisää paikallisen uusiutuvan energian käyttöä
- ☐ Luoda yrityksille uusia liiketoimintamahdollisuuksia
- ☐ Parantaa asukkaiden hyvinvointia
- ☐ Luoda työpaikkoja
- ☐ Muuta, mitä: _____

29. Seuraavat tekijät edistävät kiertotalouden mukaista toimintaa kunnissa ja kaupungeissa:

	1 Täysin eri mieltä	2 Jokseenkin eri mieltä	3 Ei samaa eikä eri mieltä	4 Jokseenkin samaa mieltä	5 Täysin samaa mieltä
Taloudelliset ajurit, esimerkiksi kustannussäästöt *	○	○	○	○	○
Lainsäädännölliset ajurit, esimerkiksi tuki- ja avustuspolitiikka *	○	○	○	○	○
Teknologian kehittyminen *	○	○	○	○	○
Lisääntyneet tiedon jakamisen mahdollisuudet *	○	○	○	○	○
Ekologiset ajurit, esimerkiksi päästöjen vähentäminen *	○	○	○	○	○
Brändihyödyt *	○	○	○	○	○
Sosiaaliset ajurit, esimerkiksi työpaikkojen luominen *	○	○	○	○	○
Joku muu, mikä? _____	○	○	○	○	○

30. Seuraavat tekijät hidastavat kiertotalouden mukaista toimintaa kunnissa ja kaupungeissa:

	1 Täysin eri mieltä	2 Jokseenkin eri mieltä	3 Ei samaa eikä eri mieltä	4 Jokseenkin samaa mieltä	5 Täysin samaa mieltä
Taloudellisia esteet, esimeerkiksi korkeat kustannukset *	○	○	○	○	○
Lainsäädännölliset ja poliittiset esteet, esimerkiksi monimutkaiset ja ristiriitaiset säännökset *	○	○	○	○	○
Teknologiset esteet, esimerkiksi teknologioiden puute *	○	○	○	○	○
Yhteistyön esteet, esimerkiksi yhteystyökumppaneiden puute *	○	○	○	○	○
Tiedon tai osaamisen puute *	○	○	○	○	○
Korkea epävarmuus, esimerkiksi korkeat riskit *	○	○	○	○	○
Joku muu, mikä? _____	○	○	○	○	○

31. Seuraavat aihepiirit ovat haastavia kiertotaloushankkeissa:

	1 Täysin eri mieltä	2 Jokseenkin eri mieltä	3 Ei samaa eikä eri mieltä	4 Jokseenkin samaa mieltä	5 Täysin samaa mieltä
Valmistelu *	○	○	○	○	○
Päätöksenteko *	○	○	○	○	○
Rahoituksen saaminen *	○	○	○	○	○
Yhteistyökumppaneiden löytäminen *	○	○	○	○	○
Aikataulutus *	○	○	○	○	○
Toteutus *	○	○	○	○	○
Tulosten seuranta *	○	○	○	○	○
Tulosten ylläpito *	○	○	○	○	○
Joku muu, mikä? _____	○	○	○	○	○

32. Voit lopuksi kertoa vapaasti, millaiseksi koet kiertotalouden esteet ja mahdollisuudet tulevaisuudessa? Voit myös halutessasi kuvailla vapaasti millaiseksi näet kiertotalouden osana kunnan tai kaupungin toimintaa tulevaisuudessa.

[Keskeytä]

0% valmiina

Appendix 5. Analysis of the survey

Table 1 Utilization and invocation of different measurements and calculations in municipalities based on the survey (N=116)

Calculation	Yes, the results of the study have been exploited and the follow-up action has been started.	Yes, the results of the study have partly been exploited.	Yes, but the results of the study have not been exploited at all.	No, we have not.	I do not know.
We have calculated greenhouse gas emissions	8 %	13 %	3 %	48 %	28 %
We have calculated material losses per capita	1 %	5 %	1 %	58 %	36 %
We have calculated ecological footprint per	3 %	8 %	3 %	54 %	32 %
We have executed Review of renewable energy	8 %	17 %	5 %	30 %	40 %
We have executed resource wisdom roadmap	3 %	2 %	1 %	60 %	35 %
We have modelled energy flows	1 %	3 %	3 %	55 %	38 %
We have modelled material flows	3 %	2 %	1 %	60 %	35 %