EXAMINING THE ROLE OF WASTE-TO-ENERGY IN A CIRCULAR ECONOMY IN FINLAND WITH MEETING EXAMINA ZERO-WASTE GOAL

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Author: Joel Peart
Discipline: Corporate Environmental Management
Supervisor: Tiina Onkila

ABSTRACT

Author
Joel Peart

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Abstract

As the concept for circular economy gains traction in the world and the EU pushes for the transition from a linear economy to a circular economy model, the role of waste-to-energy is crucial in a circular economy as it is the last chance to extract value out of material at the same time as providing an alternative energy source, henceforth bringing together a closed-loop system. A functioning circular economy will also have minimal waste generated which is sync with the idea of zero-waste. How all these aspects really work together is the focal point of this Master's thesis where the aim is to see how the three factors of waste-to-energy, the circular economy and a zero-waste goal work together in accomplishing their respective objectives and to access their performance and potential in Finland using other Nordic countries as benchmarks. A qualitative research method of four semi-structured interviews with experts in Finland involved in various circular economy was supported by secondary sourced data on the other Nordic countries and if found that WtE has additional benefits to Nordics compared to other countries due to district heating utilization of excess steam that provides heat during the long winter months so henceforth offers higher energy efficiency. The state of the circular economy in Finland was harder to ascertain with the difficulty in showing concrete examples of a CE due to misunderstanding of the relatively new theoretical term and the many related terms. The overall conclusion for Finland was that a zero-waste goal was not the correct aim to have as this could still mean high incineration, instead Finland should look at the exemplarily example of Denmark which aims to be incineration free in the future. There would still be a role for WtE, only to a less extent, dealing with hazardous and residual waste. The role of recycling will grow in line with a true CE model which means that energy sourced from WtE will decline, As a result Finland should plan accordingly and invest less in WtE infrastructure and more in other alternative energy sources.

Keywords
Waste-to-Energy, Circular Economy, Finland, Zero-Waste

Location
Jyväskylä University School of Business and Economics

Author's address Joel Francis Peart
Corporate Environmental Management
School of Business and Economics
University Jyväskylä

Supervisor Tiina Onkila, Ph.D.
Post-Doctoral Researcher
Corporate Environmental Management School of Business and Economics Jyväskylä University

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1. INTRODUCTION

1.1 Background

This thesis will seek to assess the situation in Finland in regards to its waste-to-energy and circular economy situation and their performance,compatibility and potential with comparisons to the Nordic examples of Sweden, Denmark and Norway.

The importance of this study is based in the crucial role that waste-to-energy plays in the circular economy as underlined by the European Union's new economic model for Europe as well as its implications globally. Although WtE is found in fourth position out of five in favorable options for waste under the EU's waste hierarchy (Waste Framework Directive, 20008), its significance for CE is that it solves the problem of waste by providing an energy alternative. By diverting waste from landfill, sorting and recycling before incineration to provide local energy security and efficiency whilst lessening the demand for fossil and non-renewable fuels, it effectively plays an important role in a CE(CEWEP, 2014).Waste-to-energy (WtE) refers to the process of waste treatment that creates energy in the form of electricity, heat, or fuel from a wide range of conversion methods (World Energy Council, 2013). The re-use of a waste material has led it to become a resource material and in doing so created a so called 'closed loop-system' that is the basis of the circular economy. The circular economy concept is defined as an economic model where the cycle of raw materials, starting from design to production onwards to distribution, consumption, collection and recycling result in the minimization of resources escaping each phase. This in theory results in a reduction of costs, reduction on natural resources dependence, boosts growth and jobs and limits harmful waste that affects the environment and ultimately adds to global warming (European Commission,2014).

In 2015 the European commission unveiled their circular economy strategy that aims to bring in binding legislations on numerous aspects including waste policy and regulations. Numerous EU frameworks and directives will be reviewed and will place binding and non binding targets for each member state (European Commission, 2015). These legislations are meant to move the EU in line to resource efficiency agendas established under the Europe 2020 strategy and the EU's Environmental Action Program. Under the umbrella of the Europe 2020 strategy of smart, sustainable and inclusive growth are found five objectives, one of which under climate change and energy sustainability has the specific targets of 20-30% reduction in greenhouse emissions from 1990 levels, 20% of energy to originate from renewable sources and a 20% increase in

energy efficiency. Looking further into the future is the zero landfill goal which is part of the ambitious 2030 Energy Strategy (European Commission, 2015).

1.2 Research Motivation

The motivation for writing the thesis on the concept of the circular economy came about from the researcher writing a course work on the subject during the degree that resulted in a deep interest into the topic. Further self reflection into the subject brought up a personal experience from the researchers youth in the Republic of Ireland where the neighbouring rural community had a rudimentary biogas plant that provided heating to some 5 houses through the collection of animal waste from the surrounding farms. The question that then presented itself was "If this could be done on a small scale some 20 years ago in Ireland, what is happening in Finland at the current time?"
The author having lived in Vaasa was made aware of regional waste management company called Stormossen that specializes in the recycling and re-use of municipal waste. Stormossen is a leading example of municipal waste to energy projects in Finland. In 2005 a proposal was made by University of Vaasa and University of Jyväskylä to produce upgraded biogas and utilize it in city buses and other vehicles. The plan launched in 2015 with numerous other cities in Finland set to follow. This example of a municipal WtE project gave the basis for the idea on the research topic.

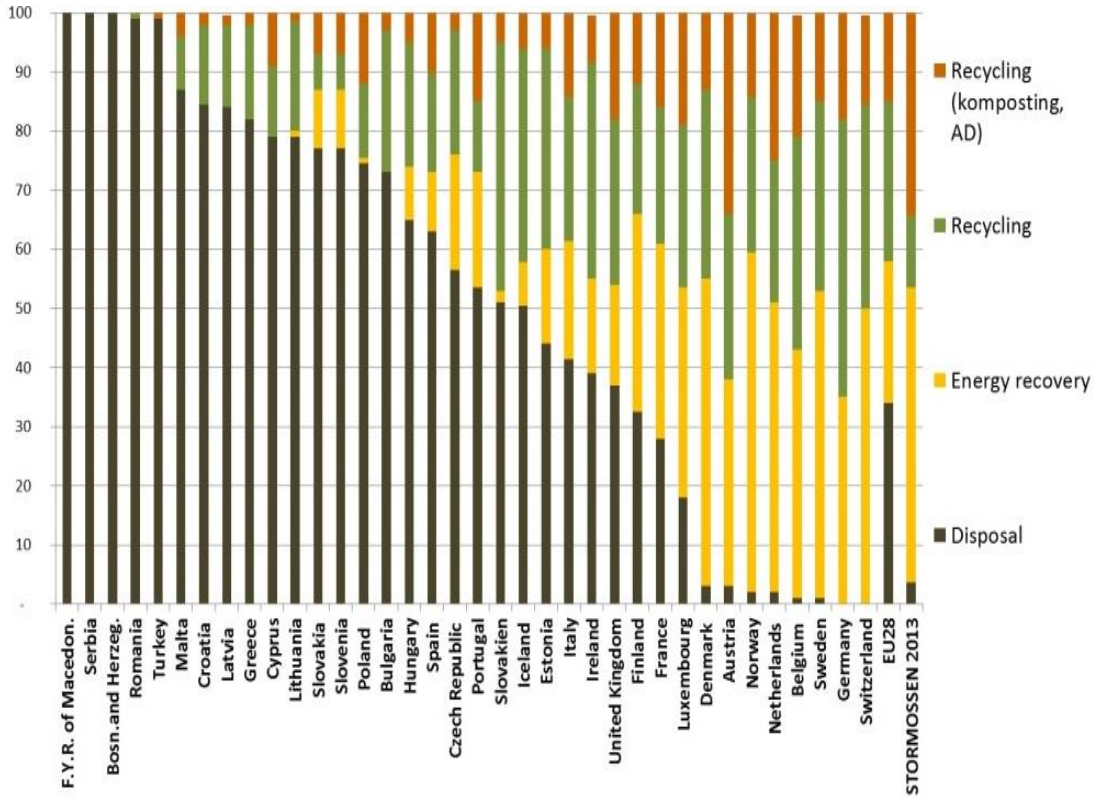

FIGURE 1 Municipal waste management by category in European Union 2013 (Stormossen, 2013)

As FIGURE 1 shows, according to Eurostat (2012)& Stormossen (2013) the statistics on waste management show Finland to be considerably behind such comparatively similar countries of Norway, Sweden and Denmark which are world leaders in waste-to-energy performance in levels of low amounts of landfilled waste and high levels of energy recovered through waste-to-energy processes. Furthermore as CE is a relatively new concept and there are a perceived limited number of studies on circular economy issues it is assumed that further research can only serve to be insightful and beneficial.

1.3 Research Problem

The overall aim of this thesis is to analyze Finland from a WtE performance perspective and to look at how it relates to the bigger picture of a circular economyand how compatible the zero waste goal is, in relation to WtE and CE. To identify topics of interest,qualitative empirical research will added with secondary sourced data using the examples of Denmark, Norway and Sweden

as model examples in performance.Empirical research based on qualitative data obtained from professionals in different positions involved with WtE and CE projects in Finland will shed light on how Finland is currently performing, resulting with the ability to compare Finland to the other aforementioned countries. Following from this the main research question to be investigated is stated as:

What is the role that waste-to-energy in Finland offers in implementing a CE and reachinga zero-waste goal using the examples of Sweden, Denmark and Norway as benchmarks.

1.4 Former Research in the Field

Numerous studies have been done that look at WTE in the circular economy(Pan, Du, Huang, Liu, Chang & Chiang, 2015; The Ellen MacArthur foundation, 2015; Bechtel, Bojko & Völkel, 2013). The common theme is often to look at implementation methods and strategies of sustainable development in a particular country or region.

The zero waste vision in Europe has been studied in itself, from an industrial approach it has been seen as a way of collaboration in industry to achieve symbiosis. The vision is for industrial networks to eliminate wasteful consumption of resources (Curran & Williams, 2011). However it does not take into account that for WTE to succeed in the long run it needs a steady source of feed material. A zero waste vision may then have contrasting goals with WTE networks.

Country comparisons studies have been made with Nordic countries as the focus (Williams, 2011; Fiani,2014). The circular economy in Denmark and France finds similar issues in that the involvement of stakeholder participation in CE and drastic changes in product life cycles in key (Fiani, 2014). WTE success factors based on the Swedish WTE model and how they could transfer to be implemented in the USA is look at by Williams (2011) who finds that although a country (USA) may have the potential there are still many barriers to a country successfully implementing a proven model such as in Sweden.

Studies in Finland have tended to focus on the emissions aspects of WTE processes and the technical and engineering implications of renewable energy. However one study that is similar to this one is by Pimiä, Kakko, Tuliniemi & Töyrylä (2013) that looks at the organic waste streams in Finland that are used in energy and biofuel production. The study includes European Commission based laws and regulations that affect how waste is utilized in municipal solid waste processing.

Nevertheless to date and best of knowledge, no studies have been done that come close to satisfying the criteria set out in this study which is to look at the three interrelated aspects of WtE, circular economy and a zero waste goal with Nordic countries used as comparisons in order to be able to compare better the standing of Finland.

1.5 Thesis Outline

The thesis will compromise of five chapters. Starting with a brief introductory chapter that will give background information to the intended topic and why there is current need for such studies to be carried out. Research motivation will underline the personal reasons for this study and research problem will present a clear research goal. Former research on related topics will be commented on and the outline presented. Chapter 2 of theoretical framework will introduce four main concepts that act as the theoretical basis. They include the zero waste goal, EU law and legislation, the circular economy and waste-to-energy.

Chapter 3, data and research methodology presents the methodology behind the data collection methods and analysis approach. Chapter 4, results, will present the collected data. Finally chapter 5 of conclusions will summarise what was found from the data and what implications it has for Finland in general.

2. THEORETICAL FRAMEWORK

The theoretical background will focus on the core interconnected areas of waste-to-energy, the circular economy model, the zero waste goal and also the European Union's legislations and directives that affect these aspects will be introduced.

2.1 The zero waste goal

Throughout this research the terms zero landfill and zero waste will be considered as the same concept even though technically there are some discrepancies. There are some who are of the opinion that zero landfill is not the same as zero waste.For example Lombardi (2011) argues that zero waste to landfill is not zero waste as it implies that the alternative for waste, burning it for energy WtE, is an acceptable form of waste management. The negative side is it destroys resources forever and doesn't reduce waste or protect natural resources. Ultimately claims of zero-waste-to-landfill by a company when the alternative is they incinerate is a form of green washing (Lombardi, 2011). To begin with we need to create a clear understanding of what a zero waste target means as the underlying goal of the research topic is to find out what sort of impact WtE in a CE has in reaching a zero waste target. The term 'zero waste' was first coined by Paul Palmer in the 1970's and as a concept it has been adopted and adapted over time, location, industry and perception (Zaman, 2014).The first working definition is given as:

"Zero Waste is a goal that is both pragmatic and visionary, to guide people to emulate sustainable natural cycles, where all discarded materials are resources for others to use. Zero Waste means designing and managing products and processes to reduce the volume and toxicity of waste and materials, conserve and recover all resources, and not burn or bury them. Implementing Zero Waste will eliminate all discharges to land, water, or air that may be a threat to planetary, human, animal or plant health. "

(The Zero Waste International Alliance, 2004)

Curran & Williams (2012) add that zero waste is a whole-system approach meaning that the whole life cycle is targeted not just the end of life phase. This means that waste is eliminated rather than managed throughout the cycle, meaning zero waste of resources, zero emissions, zero waste in production, transportation and end of life phase. Crucial to this is also the way in which waste is considered; instead of a problem it should be considered a potential resource.

The term 'zero waste' has only recently come to public attention through the European Commission's recently published directive called *Towards a circular economy: A zero waste program for Europe*. Put forward in 2014 it is still in the adoption phase as European Parliament and EU members states seek to ratify the proposal.

FIGURE 2 EU's Waste Hierarchy adapted from Directive 2008/98/EC on waste (Waste Framework Directive, 20008)

FIGURE 3 shows the EU waste hierarchy with its five steps order from desired (most sustainable) to least desired (least sustainable) which all play parts in aiming for zero landfill. Stages one to three deal with the product related aspect while stages four and five are waste related. WtE is found at stage four which is termed as recovery and is the second to last preferred method of waste management (Waste-to-Energy Research and Technology council 2009). The hierarchy was introduced to EU legislation in 2008 under the Waste Framework Directive (WFD) which member states are obliged as mandatory to introduce into their national waste management laws (Van Ewijk & Stegemann, 2014). It is noted however that simply following the waste hierarchy might not necessarily save natural resources or even result in the best environmental outcome. For example EU incentives are said to favor the lower part of the hierarchy over the top part (Zero Waste Europe, 2014; Van Ewijk & Stegemann, 2014).

Additionally as the top level of the hierarchy is not under control of waste managers it results in poor policy support. Also the perceived lack of guidance in deciding on the level of the hierarchy to receive investments is what limits the hierarchy. Solutions to these problems may include the redefining of waste,

adoption of associated collection practices and stricter guidance on the implementation of the hierarchy (Van Ewijk & Stegemann, 2014).

2.2 European Union Environmental Legislation and Directives

The reduction of greenhouse gases has been a global concern for a lengthy number of years. The recent success in implementing an encompassing plan has just recently been finalized with the Paris Climate Agreement of December 2015. Keeping concentrations of C02 stable in the atmosphere is according to Blesl (2010) needed to keep temperature increases below 2 *C on a global scale and will require an ambitious climate policy. The 2* C temperature barrier is one of the main targets agreed upon by 195 ratifying member countries. Government agreement has been reached on a wide range of issues including the emissions mitigation of 2*C, meeting every 5 years to set more ambitious plans that are based on new scientific information, transparency to the public and to other countries on national success in meeting targets and many other agreements based on mutual support and adaptations. In order to track progress in achieving targets each country submitted national climate action plans (INDCs) (European Commission, 2016.) Although already agreed upon, the agreement is only due to enter into force in 2020.

The European Union has been a powerful player in pushing for climate change and after the limited success of the Kyoto Protocol and Copenhagen 2009 it has introduced ambitious climate and energy policies that utilize CE practices and zero waste goals as the basis for its targets. The EU has three targets.
The first is the 2020 climate and energy strategy put forward in 2007 and enacted into legislation in 2009, it contains three main targets:

- 20% cut in greenhouse gas emissions (from 1990 levels)
- 20% of EU energy from renewable
- 20% improvement in energy efficiency

The pact is related to Europe 2020 as it shares the same goals. Europe 2020 is a growth strategy that incorporates the three mutually related priorities of being a smart, sustainable and inclusive economy(European Commission, 2015).

In order to meet the targets, action is taking in several areas. An emissions trading system (ETS) targets industrial level emissions which account for around 45% of total GHG emissions, the other 55% is made up of housing, agriculture, waste and transport (excluding aviation). As a result of 2020 achievements, the EU will gain energy security as well as create jobs in the green sector and make the EU more competitive (European Commission, 2015).

Secondly is the 2030 climate and energy framework which builds on the 2020 strategy in that targets are increased as follows:

- At least 40% cuts in greenhouse gas emissions (from 1990 levels)
- At least 27% share for renewable energy
- At least 27% improvement in energy efficiency

The framework was adopted in 2014 and is a sort of half way point from the 2020 energy package and the 2050 low-carbon economy target. This will naturally result in a shift from operational costs of energy plants and move towards investment expenditure. However energy system costs should not differ substantially from the necessary costs in renewing an ageing energy system that would naturally need upgrading. EU Member countries address fairness and solidarity measures in order support lower income countries in meeting these goals as they require more investment effort in comparison to gross domestic product (European Commission, 2015).

Third and finally is the 2050 low-carbon economy strategy which aims at reaching a drastically climate friendly and low energy consuming European union. Its ambitious aim of 80% emissions reductions from 1990 levels is its main goal and will mean clean technologies playing an important role. In order to cut total emissions, different sectors need to contribute to low-carbon transition in accordance to their technological and economic potential with each sector having expected reduction capabilities. In order of potential for cutting emissions the power generation and distribution sector has the most potential followed by residential and tertiary, industry, transport, non CO2 agriculture and ending with other non CO2 sectors (European Commission, 2015).

When taking into account the role of WtE we can see that there is a large potential for contribution into the aforementioned sectors especially power generation and transport. By 2050 electricity is set to vastly replace fossil fuels in transport and heating. Electricity will be generated from various renewable sources such as wind, solar and water and biomass (European Commission 2015). Waste that is processed through various conversion methods into different forms of energy can be used to create electricity by acting as a feedstock to drive electric turbines. Transport emissions will aim to be decreased by minimum 60% of 1990 levels as petrol and diesel engines become more efficient it is still not enough to reach these levels even with the help of the introduction of hybrid and electric cars. WtE again can provide a source of electricity for electric and hybrid powered cars. Furthermore biofuels will be utilised increasingly in transport and aviation too and will utilize a growing number of methods in turning bio wastes into biofuels (European Commission, 2015).

European Union and member state legislations interact with each other in the way that member states have legislation based on EU legislation but are not

necessarily always mutual. In Finland waste legislation is largely based on EU ones yet include in some cases stricter standards in comparison to the EU legislation. Alternatively Finland has some waste legislations that are not even covered under EU legislation (Ministry of the Environment, 2013).

European Union legislative proposals on waste include directives on waste, waste packaging and landfill which are open to new proposals and are regularly amended and updated (European Commission, Environment,2016). Meanwhile Finland also has an all encompassing Environmental Protection Act as well as numerous legislations, decrees and decisions on general waste, end-of-waste, waste treatment and recovery, and specific waste type, products and activities (Ministry of the Environment, 2013).

As of the beginning of 2016 Finland is now under EU obligation to limit the amount of biodegradable to 35% of its 1995 level in order to reduce greenhouse emissions as stated in the Landfill Directive (1999/31/EC). This means that no more than 10% of total material can be found to be organic. The options to deal with this waste include to incinerate, or to utilise into biofuel or biogas forms and in the directive there is no stipulation as to what method is to be used although biofuels and biogas carry a higher retail price than incineration and should henceforth be the preferred method. Biowaste is classified as numerous materials such as food waste and garden and park waste however a number of biomaterials are not included in the category by the European Commission, these include forestry and agricultural waste, manure and sewerage sludge, natural textiles, paper and processed wood(European Commission,Biodegradable Waste 2014; EUR-Lex 1999.)Similarly the Government Decree on waste incineration states that energy released from combustion must be recovered and that emissions to air and water must be measured continuously (Finlex, 151/2013).

In order to increase the production capacity of energy from renewable energy sources, Finland introduced two production subsidies in 2011. One was The Act on Production Subsidy for Electricity Produced from Renewable Energy Sources (1396/2010) that introduced a feed-in tariff subsidy for electricity obtained from renewable sources. The other was The Government Decree on the Promotion of Electricity from Renewable Sources (1397/2010) in that biogas producing facilities could be accepted into the feed-in tariff system as well. This meant that a feed-in tariff became available for new biogas power plants, new wood-fuelled power plants and timber chip power plants. (Energiavirasto, 2016&Finlex 1396/2010).The Feed-in tariff system works as an incentive for producers to invest in renewable energy as the subsidy compensates for the initial investment costs (Ministry of Employment and the Economy, 2014). The process is under the Energy Authority of Finland that sets standards, approves qualification and pays out the feed-in tariff to producers for a maximum for twelve years (Energiavirasto, 2016).

2.3 The Circular Economy Concept

The concept of the circular economy has come about as a result of the realisation that current societal trends in levels of resource extraction and consumption in order to live the way we do might mean we leave future generations with less ability to provide for themselves (EMF, 2015). A WWF report in 2014 confirmed the fear that the earth's carrying capacity was being exceeded. In order to regenerate the natural resources currently used we would need 1.5 planet earths due to the increase of the world's ecological footprint. The Ecological footprint is the total hectare area need to supply the ecological goods and services that humans use (Living Planet Report, 2014.). The link between consumption and environmental deterioration is why the role of economy is under the spotlight. The role of economy and how to change it is under debate, some fields of thought are of the opinion that economic growth needs to become a steady-state economy that slows down and eventually stops (Jackson, 2009). On the other hand is the opinion that continuous growth is key to providing a better future for future generations (The World Bank, 2012).

The circular economy offers itself as a fitting answer on how to maintain growth and decrease negative impacts as it is based upon the strategy of sustainable development where economic development is achieved through high efficiency and low emissions where all raw materials and energy are kept and re-used to a maximum degree. The idea is to keep the resulting influence of economic activities on the natural environment to an absolute minimum (Wu,2014).

The origin of the CE concept is found to have its roots in numerous schools of thought that have helped to bring it from a generic concept into a developed and refined ideology that lends practical application into modern economic systems and industrial processes. The six schools of thought are given as cradle to cradle, performance economy, biomimicry, industrial ecology, blue economy and regenerative design (EMF, 2015).

2.3.1 The Linear Model vs. Circular model

The current global economic model can be termed as a liner `take, make, dispose model what relies on large quantities of cheap and readily accessible energy and raw materials (EMF, 2015). This linear model has directly led to depletion of resources, pollution increases and a rapid loss of biodiversity that threatens the very existence of the earth's system function (Jackson, 2009).

The answer to this problem can be found in the antonym of liner; circular and namely the circular economy which as a basic economic definition can be termed as:

"The Circular Economy is an economic model wherein planning, resourcing, procurement, production and reprocessing are designed and managed, as both process and output, to maximize ecosystem functioning and human well-being" (Murray, Skene & Haynes, 2015).

The key reasons for a circular economy is that it as well as being a better performing and more relevant economic model it is necessary for sustainable development. The so called three pillars of sustainability are economic, environmental and social aspects that must combine to equal a sustainable outcome to an action. Sustainable development is meant to meet the needs of the present without compromising the ability of the future generation to meet theirs (Circular Ecology, 2015).

As FIGURE 2 shows the circular economy concept is based on two interconnecting ideas; closed loop economy and design to re-design thinking. Features of a CE include low levels of energy consumption, low emissions of pollutants and a high efficiency of energy and materials that leads to an industrial economy that is by intention and design, restorative and generative. The CE has both biological and technical material flows. Biological 'nutrients' are designed to re-enter the biosphere as safely as possible and technical 'nutrients' are designed to circulate without entering the biosphere.An idealistic CE will be a system of reduced waste through design prevention, the recapture of nutrients and the recycling of materials as well as most importantly the use of renewable energy (EMF, 2015; Murray et al,. 2015).

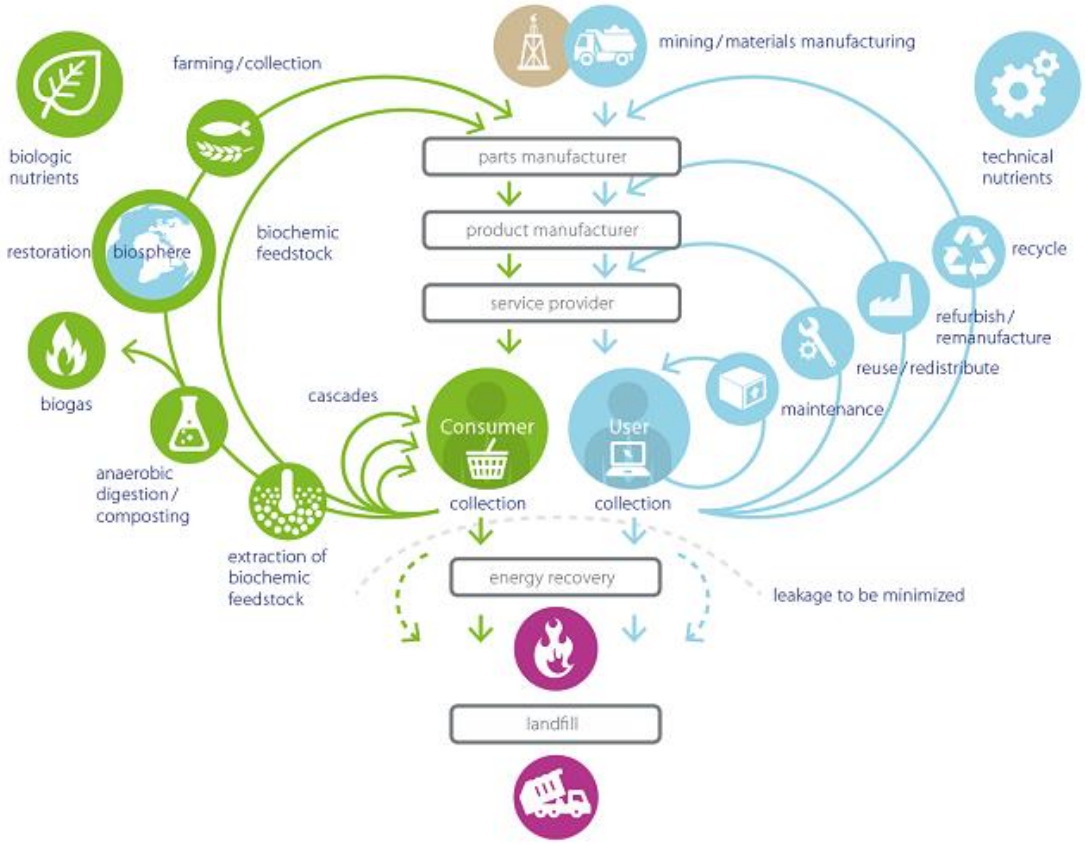

FIGURE 3 Circular Economy System Diagram (Ellen MacArthur Foundation, 2015)

2.3.2 Moving Towards a Circular Economy: Benefits &Challenges

According to the Circular Economy Communication (2014) the CE is an opportunity to reinvest in our economy by making it more competitive and sustainable. However sacrifices and changes need to be introduced, so in order to do this, certain measures have been introducedby the EU to cut resource use, reduce waste and booster recycling in the European Union. Much as already been mentioned of the environmental benefits of the CE, aside from that there is alsoa major business case for CE as on a macro economicallevel improved efficiency of resources can bring economic benefits will affect all of society's stakeholders and market participants and is hailed as an economic opportunity worth billions (EMF, 2012).

The economic and practical benefits of a CE affect three interest groups of the consumer, companies and the economy as a whole. Starting with how economies will benefit from a CE is the net material cost savings that through improving resource productivity and resource efficiency along the value chain that decrease material input by 17%-24% by 2030 is said to represent a savings potential of 630€ billion per year for European industry. Furthermore GDP increases of 3.9% are modelled for Europe by creating new markets and new

products (Circular Economy Communication, 2014).The second major benefit is the mitigation of price volatility and supply risks. Extraction of raw materials that are nearing their supply limits can result in spikes in pricing and volatility; this can be mitigated by reducing downstream demand by introducing circularity of materials that lessen upstream demand by avoiding material loss due to inefficiencies in the linear value chain (EMF, 2012). In addition there is the growth multiplication factor of the three main macroeconomic sectors and resulting positive employment prospects. Primary, secondary and tertiary sectors will experience shifts with the tertiary sector of services expected to experience the most growth. EMF (2012) reports that half a million jobs in the recycling industry were created in Europe that would rise significantly under CE conditions by an estimated 400,000 more jobs by 2030 depending on successful implementation of the EU waste legislation. Furthermore, where before economic growth required resource use, it will help 'decouple' the two aspects that will allow for sustainable growth whilst not relying on resource exploitation and consumption (Circular Economy Communication, 2014). Finally Kok et al (2013) bring attention to the crucial point that CE is in fact an economic opportunity before an environmental necessity.

Companies are set to benefit from the CE in numerous ways with new profit pools offering the most obvious benefit potential. Growth opportunities are evident in reverse cycle solutions and services that have given birth to the so called 'reverse' sector that include collection, remanufacturing, recycling and the secondary market (EMF, 2012). Another major benefit that pioneering firms can benefit from is the first-mover advantages into CE activities that can consolidate market share, consumer trust and expansion ability (Preston, 2012).

Consumers as with companies are recognised to both share the net benefits of a CE. In theory the consumer will have access to products that have reduced obsolescence that means they are built to last longer which will result in lower ownership costs and higher convenience with less repairs and returns associated with products. Choice for the consumer is said to be increased due to product specification to become the norm over standardization. There are also secondary benefits to the consumer with typical products in CE being so called 'two-in-one' products meaning a product or some aspect of it may have secondary usage during or after its life time such as carpets acting as air filters or packaging as fertiliser (EMF, 2012).

Of the challenges in moving towards a circular economy it is generally acknowledged that although the need to find a new economic system that encompasses the challenges of resource scarcity and climate change has been recognised, there is still a short-sightedness in how it is approached. CE is mentioned in many strategies and action plans using various concepts and at EU and national (Finnish) level (SYKE, 2014).

The problem as Preston (2012) states is that the term is inconsistently used by governments and companies and that although the concept is growing in awareness, the level of awareness is starting from a relatively low point. A reason for this as EMF (2012) points out is that CE is largely still a theoretical construction and that the focus so far has been on business cases of CE implementation in companies. The transition to a CE is predicted to take many years as the existing systems structure of values, societal, organisations, institutions, financial methods, policies and regulations, will undergo transitions to eventually form new structures (EC Circular Economy Communication, 2014; Kok, Wurpel & Wolde, 2013).Similarly SYKE (2014) adds that simply changing specific production processes is not what is needed, rather the transformation of the entire production and consumption system.

From a financial obstacle standpoint there is firstly the significant upfront investment costs that business may be unwilling to bare as immediate cost savings may not be guaranteed. This creates a bottleneck that is further hindered by a so called lock-in if not changing becomes the norm. This has come about from shareholder short-term mentality where quarterly results are more important than the long term agenda. This is slowly changing however with a shift from linear management thinking to visionary long term management (Kok et al., 203). In order to transform a company's core business model there needs to be platform for investment and experimentation which in turn relies on a clear, strong and predictable policy framework (Preston, 2012).

From an institutional obstacle standpoint there are still government policies and political barriers that hinder CE transition. Excessive resource used is still often encouraged due to market subsidies and subsidies on incumbent industries (Preston, 2012). Also value chains are highly complex and in a CE will most likely become even more so, with production and consumption taking place globally there is then the legal complexities as national governments do not have the ability to regulate the whole value chain. Within the value chain there is the question of ownership at specific points, share of responsibilities, costs and liabilities. Henceforth there will need to be a form of circular governance that supports self-regulatory action by business and social actors (Kok et at., 2013). A recent European Commission Communication on a zero waste program for Europe has itself been presented with some obstacles with the definition of recycling seemingly to be too vague and open to risk of wrong interpretation by member states in their calculation if national recycling targets. A major difference between member states is recognised in relation to their respective waste management levels.
Waste disposal methods, monitoring instruments and statistical representation of production and management of waste are not uniform across the EU (Paper Industry World, 2014).

From an infrastructural obstacle standpoint as with institutional obstacles the value chain takes centre stage. Kok et al., (2013) states that as value chains are

designed for a linear economy, reverse infrastructure and exchange of materials is limited by low capacity of reverse logistics. Adding reverse logistics further adds to the complexity of value chains. There is also a lack of an exchange system for information as well as materials between actors, especially in the case of information sharing there is the issue of confidentially and trust which results lower levels of sharing. As trust is a pre-condition for value co-creation and innovation, lack of trust needs to reversed in order to facilitate CE transition (Kok et al., 2013).Cooperative arrangements are needed when implementing CE operations and may require them to adjust their operations and share information which may affect their commercial concerns, business model, market intelligence and brand position which create a sort of paradox as it has be recognised that businesses are more likely to collaborate when then do not compete directly, this may hinder the transition to a CE unless addressed (Preston, 2012).

From a societal and value related obstacle standpoint is found a problem in that our modern day society values product ownership and material consumption and that public awareness to the importance of the CE is limited. While more companies are showing CE leadership traits, many are still unaware of the urgency needed to transition or even have doubts on the scientific evidence (Kok etal., 2013). Lack of consumer enthusiasm for a so called green premium associated with purchasing sustainable or cradle to cradle products and services is also a barrier. In order for businesses to gain value from consumers, the consumer needs to understand the value in the concept of the product or service. This could be addresses by certifications of CE standards by an independent organization (Preston, 2012).

From a technological standpoint there are still numerous obstacles. To start with there is limited attention applied to the end-of-life phase in current product designs that sees products designed for their physical attributes rather than addressing the needs of the user during its use and its eventual reuse or recycling. There is also limited availability and quality of recycling material as for one, recycling often leads to downcycling where waste products are converted into other products of less quality and of reduced functionality. In the stage of recycling there are limitations as to the extent at which complex materials can be sorted and separated successfully. Separation between the biocycle of biodegradables and the technocycle of plastics etc, is lacking in application and scope.
This is shown in the current problem with biodegradable and conventional plastics, with shopping bags as an example where bioplastic bags are contaminating the recycling of ordinary plastics (Kok et al., 2013).

2.4 Waste to Energy

The need of WTE has arisen from the interconnected phenomena that is happening on our planet that is the need for energy and the problem of waste. As the global population continues to rise and standards of living rise likewise, the reliance on fossil fuels as an energy source is becoming untenable as the reliance on fossil fuels is having detrimental effects with exploitation, pollution and GHG emissions all threatening the sustainability of the planet.Furthermore as the so called 'energy crisis' of reaching a shortage of crude oil becomes closer to the present day, alternative power solutions have brought about energy sourced from renewable sources (Lam, Ng, Ng, Ng, Aziz, & Ng, 2013).

Energy and waste policies and systems both share mutual concern to the environmental impacts that include reductions of GHG, soil contamination, and water table contamination. An example of this mutual concern is an energy and climate bill presented by Sweden in 2009 that integrates energy and climate policies as one. The problem of waste is henceforth seen as an answer to energy needs. WTE has become one of the most commonly used technologies in Europe used to address waste management with municipal solid waste (MSW) showing the most potential (Guziana, Song, Thorin, Dotzauer, Yan, 2014).

The importance of WTE is evident when one considers the EU energy policy that includes two binding targets for 2020 that consist of a 20% share in renewable energy sources and a 20% reduction in greenhouse gas emissions from 1990 levels. Important to note is that WTE is in some part classified as a renewable energy source by the European Directive on Renewable Energy Sources whose definition of biomass includes the biodegradable share of municipal and industrial waste (WtERT, 2009). Furthermore these targets act as stepping stones to further reductions by 2050. For example the low carbon economy 2050 roadmap stressed the importance of electricity in the future, which means the need for non-fossil fuel sources of energy such as WTE becomes greater.
In addition are a further two waste policies that promote WTE. One is the Landfill Directive where EU member states have been under obligation to reduce the amount of biodegradable municipal waste going to landfill. The other is the Waste Framework Directive which promotes recycling and recovery. Recovery is classified as WTE provided the process such a incineration meets certain efficiency stands (Guziana et al,. 2014).

According to Brunner & Rechberger (2015) WTE meets the two main goals of waste management. First the protection of men and environment as emissions of incineration as an example are so technologically advanced that compounds released to the air, water or ground are not threatening to humans and the

environment. The second goal is resource conservation and materials recovery, which WTE processes by nature positively affect.

Feedstock	Conversion Method	End-Products

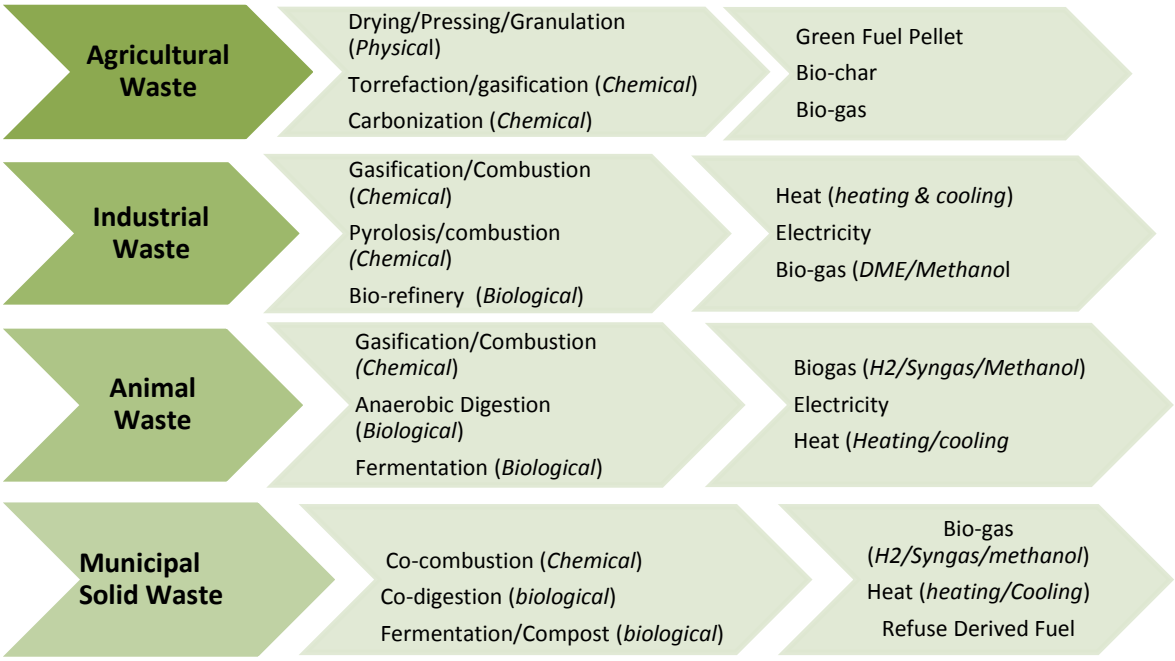

FIGURE 4Technology tree of waste-to-energy utilization (Adapted from Pan et al,. 2015)

2.4.1 Waste-to-energy technologies

As FIGURE 4 shows, energy can be derived from four main source categories, using various conversion technologies that result in various energy products. Agricultural wastes, industrial wastes, animal wastes and municipal solid wastes can be turned into end products through processes that relate to feedstock types. Examples of conversion processes include gasification, carbonization, combustion, bio-refining, anaerobic digestion, fermentation and co-digestion and pyrolosis. These methods fall under 4 category types which are categorized by their conversion base of physical, thermal, chemical or biological reactions. The more readily utilized methods that are commonly used are combustion, gasification and anaerobic digestion (Pan et al., 2015).
Combustion also known as incineration is the most established method as it is the most reliable and proven method to burn mass amounts of waste and its economic feasibility results it in being a commercially popular method to deal with municipal solid waste (MSW). Although it is the most economic method its downfall is its efficiency which varies but can be as low as 25% (Annual Energy Outlook, 2015.) Incineration methods are however flexible and can utilize different waste streams pre-treated or not. Its popularity is also down to the fact that low investment costs are obtainable as a result of the ability to

integrate a new energy unit to an existing power plant and grid (Moora, Voroneva &Uselyte, 2012).

MSW is also highly treatable in order to gain maximum energy performance. By sorting MSW before incineration to remove glass, metals and other non-combustible materials, energy efficiency is increased and emissions are decreased. Further optimization of MSW is gained through shredding, high pressure steaming to compact the waste and removal of moisture to insure better combustion. Naturally the process of incineration results in emissions of compounds and elements, fortunately these can also be mitigated by use of carbon scrubbers that filter out heavy compounds and by proper MSW utilization before incineration. Steam produced from heat is used to power turbines that generate electricity, district heating to provide central heating to homes and businesses and finally ash remnants from incineration can be used as secondary aggregates in construction and building materials (Pan et al.,2015).

Gasification is the process of thermal treatment of a solid or liquid carbon based feedstock (biomass) into a gaseous fuel through a process of thermal-chemical reactions at high temperatures in excess of 700 *C, with a gasification medium such as air, oxygen or steam (Belgiorno, De Feo, Della Rocca, Napoli, 2002; McKendry, 2001). Bio-mass feedstock supply chains commonly originate from the forestry and paper industry as pulp and paper mill sludge,animal and farm waste and municipal sewerage sludge (Pan et al.,2015).The popularity of gasification as a biomass renewable resource is that both developing countries and modern societies are able to utilize the method to suit their needs. There are two main gasification system types that are favored respectively by developed and underdeveloped countries. Fixed-bed gasifiers offer a simple low technology system that can provide electricity to rural areas derived from traditional biomass such as animal waste. Fluidized-bed systems are larger and more complex and are used predominantly in developed nations (McKendry, 2001).

The primary products from gasification are char, tars, oils and gas. Tars and oils can be processed again through extraction, upgrading and synthesis into secondary products ready to be used as energy sources such as gasoline and methane. Gas is used in energy recovery systems of gas turbines, engines and boilers to produce the secondary product of electricity (Belgiorno et al., 2002).A third and more relevant gasification system to the current time and as a result of rapid development in renewable technology is plasma gasification.
As a more advanced gasification system it offers lower environmental emissions, and higher energy retention capabilities (Moustakas, Fatta, Malamis, Harambous & Loizidou, 2005).

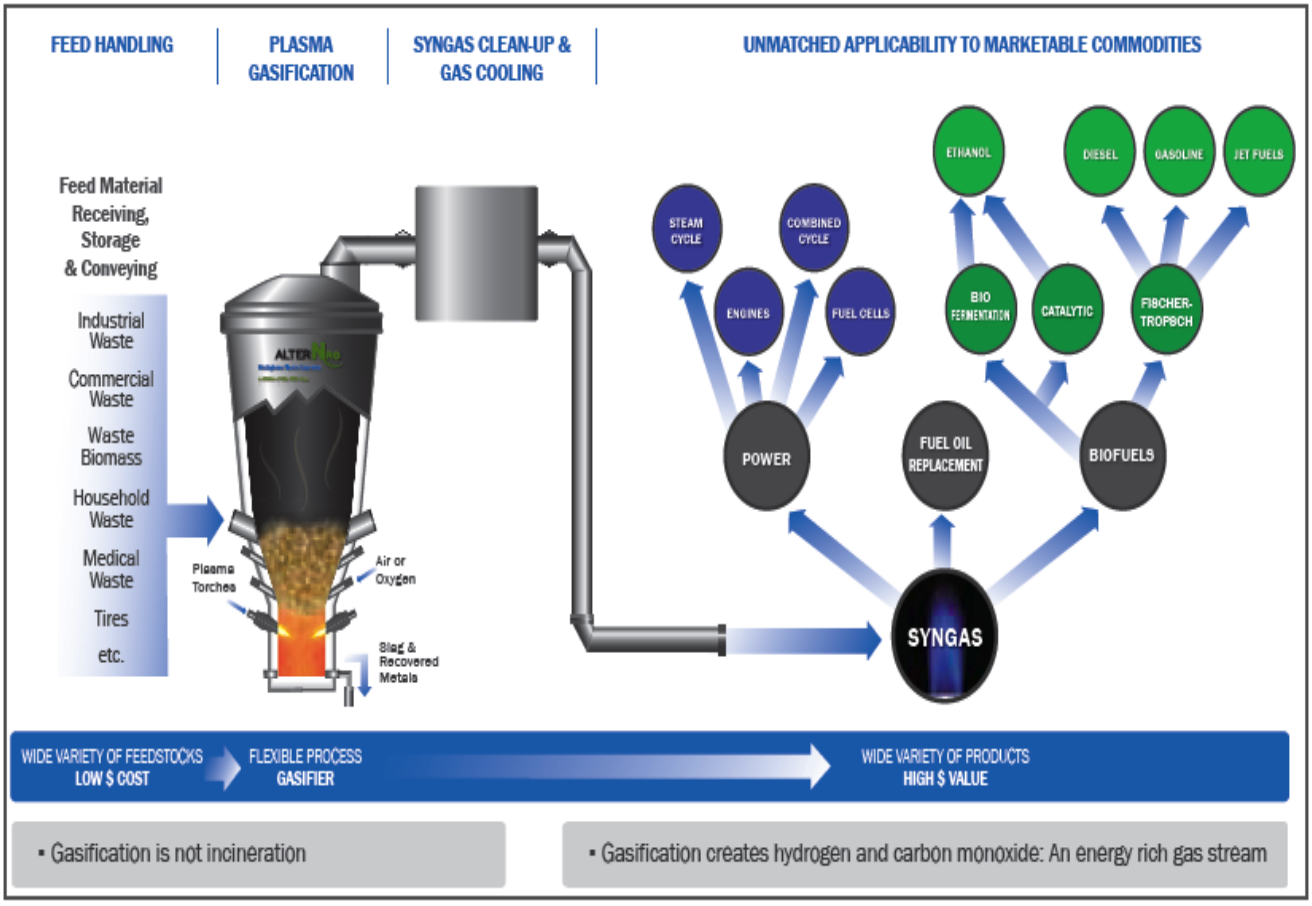

FIGURE 5Gasification method of WTE (Westinghouse Electric Corporation, 2015)

Its main selling point is its ability to deal with hazardous waste material as well as more varied feedstock options in comparison to normal gasification plants. Hazardous waste generated in roughly 19 industries is a problem for Europe, landfilling and incineration of hazardous waste ensues pollutants while exporting of hazardous waste to other countries to be disposed of is expensive and more difficult due to the minimization of transboundary transportation in the EU due to environmental protection policies (Moustakas et al., 2005). As is illustrated in FIGURE 5 plasma gasification has multi feedstock options and produces a syngas that is multioptional based on power and biofuel variations.

Anaerobic digestion, also termed as bio-gasification is a collection of versatile technology processes where biodegradable materials are broken down by micro-organisms in an oxygen free environment resulting in biogas that can be further utilized as an energy source. Due to low energy yields from certain sole substrate feedstock such as manure, co-digestion of mixes of bio-solids is often favoured (Anaerobic Digestion Market Report, 2015 & Pan et al,. 2015)The idea of anaerobic digestion has been known to man-kind as far back as Mesopotamian times two thousand years ago. Widely used throughout the

word and favoured in developing nations it has only recently began to gain traction in developed countries and Europe as landfill and methane emissions come under scrutiny (Kranert, Kusch, Huang & Fischer, 2012).

The popularity of anaerobic digestion is down to its versatility in feedstock type acceptance, its relative simplistic technology and maybe ultimately its greatest asset is that it turns the detrimental effects of the greenhouse gas of methane into an asset by harnessing its energy potential and by decreasing waste to landfill and henceforth methane emissions to the environment(Jingura & Matengaifa, 2007). Biomass Feedstock comes in the form of crops, food waste, animal waste and MSW. Biogas extraction is done under two main forms, under control in a digester or collected from landfill. Digesters are airtight containers that facilitate the microbial decomposition of animal manure, agricultural waste, municipal and industrial waste. Landfill gas starts to be obtainable after two to three years of storage and when layers of waste create the needed oxygen free environment. Gas is collected in a pipe collection system running throughout the landfill site (Consumer Energy Commission, 2016; Pimiä et al., 2014).

2.4.2 Waste to Energy: The Potential

Waste-to-energy plays an integral part in a circular economy as it simultaneously addressing three important issues of energy demand, waste management and greenhouse gas emissions. Henceforth a system of WTE implementations and growth of permanent supply chains should be seen as a viable option today as WTE has reached an established and mature technology with varied waste stream capability, emissions control measures and a high efficiency level (Pan et al., 2015).

The advantages that WtE brings are plentiful. Waste as a material is a cheap commodity and means less of energy demands are placed on non-renewable energy sources. The utilization of waste means less is being incinerated and giving off emissions and less is going into landfills and which take up valuable land and also less greenhouse gasses are emitted into the atmosphere from decomposing organic materials (Pan et al., 2015; Avfall Sverige, 2014).

Cucchiella, D'Adamo & Gastaldi (2014) admit that although WTE can reduce carbon emissions and offset the need for fossil fuels thus being an effective method in fighting climate change it is still only one aspect of waste management. In order for waste management to perform better, WTE must be harmonized with source reduction, recycling and landfilling.
In addition Brunner & Rechberger (2015) add that WTE removes the risk involved with resources volatility in availability and price of oil and minerals.

The 1970s and 2010s saw peaks in resource price which resulted in a boom in waste recycling.

In Finland the Circular economy is said to be worth a potential 2.5 billion euro. Waste-to-energy processes naturally have a significant share of this figure. Its strengths are its technological expertise and cleantech operations. However currently only some 54%* of waste is recycled or reused (Sitra, 2015). When looking at Finland's position amongst the EU-28 in terms of recycling, landfilling, composting and energy recovery we see Finland has a fairly stand out position in that there is the high spike between the percentage of landfilled waste from well performing countries with under 5% landfilling and countries with over 10%. Denmark and a number of other countries are found to have under 5% while Finland has over 30% (Eurostat 2012; Stormossen, 2013).

Figure 5 shows that in the case of WTE through incineration to create electricity and heat in Europe in 2006 it stood at 38 billion kilowatt hours and by 2020 is predicted to be at least 67 billion kilowatt hours up to a potential 98 billion kilowatt hours (WtERT, 2009).

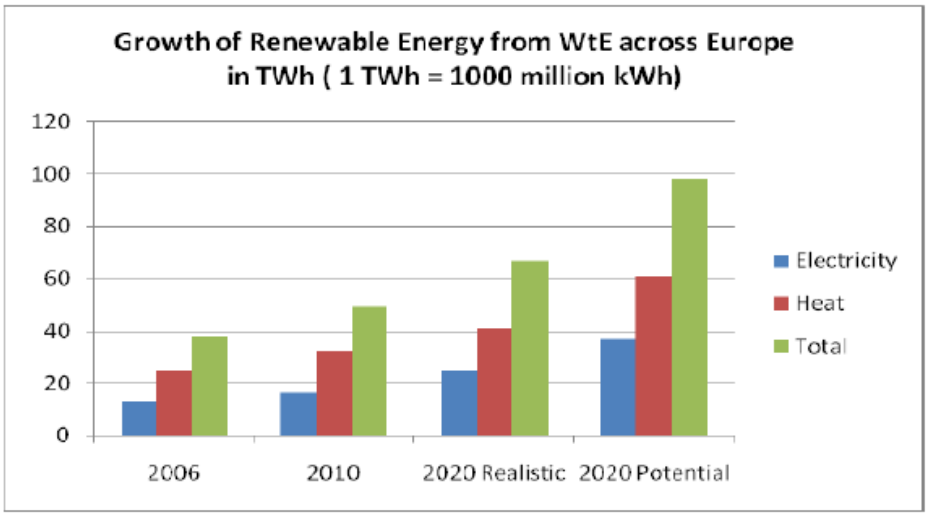

FIGURE 6 Growth of Renewable Energy from WTE across Europe (WtERT, 2009)

In order to implement WTE supply chains Pan et al (2015) state some key steps that need to be taken. Key to the effectiveness are policy mechanisms that need to target the barriers that include regulation, institution, finance and technology. A resulting strategy in WTE supply chain implementation in theory will first establish policy and governmental responsibility, internalize externalities, social acceptance and investor mobilization. As well as provide economic incentiviztions and price support mechanisms such as feed in tariffs. Finally is the use of a performance evaluation program. The potential of WTE systems is often down to amounts and composition of solid waste which in turn is

impacted by a variety of factors that include and geographical location, climate, economical standing and cultural norms (Pan et al,. 2015).
The versatility of WTE means in Africa for example, biogas can be obtained from rudimentary methods of anaerobic digestion of cow manure, while in developed and overpopulated countries may favour and benefit from incineration of MSW to create power. In Finland there can be variations in the potential of WTE methods as Rasi et al., (2007) point outs that in studies to measure the biogas composition of three different biogas production plants in order to ascertain their potential as biofuels, it was found that from samples taken from a municipal landfill, a municipal sewage sludge digester and a farms biogas plant, there were varying levels of methane content between each method as well as variations between time of year with winter yielding the lowest methane content especially from the municipal landfill source.

However Finland is naturally blessed with a natural feedstock for bio energy and biofuel production. Wood based waste and namely waste products from the forestry industry. This biomassalthough already in use, has been gaining in popularity over the past decade and is predicted to grow as Finland seeks to produce 38% of its energy needs from renewable resources before 2020. Forestry biomass as a feed stock can include a wide range of products that include black liqueur, bark, sawdust, tree stumps, roots and even small trees. Forestry biomass is compatible with conventional WTE plants that provide district heating, combined heat and power production and biodiesel and biogasoline (Routa, Asikainen, Björheden, Laitila & Röser, 2013).

Evidence of the growth potential of biomass from forestry is shown in the intentions of a foreign companyto build in Finland what would be the world's first biodiesel refinery using the by-products of logging as a raw material. With an investment of around 1 billion euro it signals a significant step in building a low-carbon circular economy (Yle, 2016).

3. DATA AND RESEARCH METHOD

This section includes the research methodology choice, the data collection method, the data analysis approach and the research reliability and validity.

3.1 Qualititive research

This study makes use of the qualitative approach rather than the quantitative approach as the nature of the study topic of CE and WTE in Finland as verbal descriptions of real life situations as understood from human perceptions is seen as a more relevant and fitting approach than that of the quantitative numerical analysis of a relationship between variables (Stake, 2010; Silverman, 2014).

The case for qualitative method in this situation is strengthened by Ghauri & Gronhaug (2005)who state that qualitative research is of particular relevance when previous insight about a phenomenonis lacking which implies that qualitative research tends to be exploratory and flexible due to unstructured problems due to modest insights.

It should be taken into consideration that although qualitative research is a suitable method for this study, it is not without its limitations. Most notably is the criticism that is too subjective, personalistic and impressionistic which is to say thatfindings usually rely too heavily on the researchers unsystematic opinion on what is important to include. Too often research is narrowed down from the beginning leaving the reader unaware of the basis for the researcher omitted certain areas (Bryman & Bell, 2007). Further critique of the method according to Stake (2010) is that it pays off little in advancement of social practice and contributions to an improved and disciplined science, is a slow and partial process with new questions emerging more frequently than new answers. The ethical risk involved are also said to be considerable.

3.2 Data Collection

In qualitative research the data collection method favoured are focus groups, group interviewing and observations, unstructured and semi-structured interviews. An important point to consider in qualitative research is that no single interview by itself has any value to the researcher; only by taking into account other interviews can any meaning be obtained (Bryman & Bell, 2007).

Qualitative interviewing according to Byrne (2004) is an especially useful research method for obtaining an individual's attitudes, views, interpretations, experiences, opinions and values and that less restricted questioning are more likely to get a more considered response than closed questions. Qualitative interviewing when done well is able to reach a level of complexity and depth that in comparison to a survey based approach is not reachable(as cited in Silverman, 2014).

This study utilizes the semi-structured interview method. As opposed to a structured interview with its likelihood to utilize closed questions, the semi-structured interview can use open questions as well as closed questions and allows the interviewee to develop and expand their response. Although this means that answers are more challenging to analyse, it also gives more in-depth insight and richer content (Stokes, 2011). In order to carry out an semi-structured interview the interviewer should develop a rapport with the interviewee and be ready to compromise by slightly changing the wording and/or order of questions as well as offer some probing by asking follow-up questions that were not originally in the schedule if felt necessary (Bryman & Bell, 2007; Silverman, 2014).

Semi structured interviews were conducted with four individuals during March to May of 2016 in Jyväskylä and Helsinki. The 18 questions were separated into the three topics of firstly zero-waste, then WtE and CE and their opinions on the other Nordics were also questioned. A final question asking if they would like to add anything was used which proved beneficial to gaining additional and clarified data. A digital recording device was used and interviews lasted from just over half an hour to just over an hour. The interview candidates were chosen based on their varying roles in CE and WTE related company type and roles, this was to give the chance to explore the differences in opinion throughout different business sectors in Finland. The interviewees were as follows:

- The managing director of Mustankorkea, a municipal recycling and waste management facility just outside the city of Jyväskylä.
- The research and development manager for the city of Jyväskylä
- The senior lead on circular economy at the Finnish Innovation fund SITRA in Helsinki.
- A circular economy specialist at SITRA.

In addition to the primary data collected by the researcher, secondary data was obtained from the internet in forms of publically available agency reports, news publications, and government reports from Nordic countries. The sources were as follows:

- Avfall Sverige, 2015) Towards a Greener Future with Swedish Waste-to-Energy the World's Best Example
- Braw, E. (2014) Five countries moving ahead of the pack on circular economy legislation. The Guardian.
- Brewer, A. (2016). Circular Economy in the Nordic Region-on the right path. Circulate
- CIWM. (2016). Packaging Waste Recovery- A European comparison
- Khodayari, R. (2016). Sweden: Waste too valuable to throw away.NIB.
- Morch, T. (2015). The Circular Economy is gaining momentum
- Hoydal, M. (2016) Facts about the Nordic Region. Business and Economy. Norden
- Dovik, (2015). Nordic nations scrap over household waste.The Local
- Kiørboe, N & Milios,L. (2015). Circular Economy and Bio-economy in the Nordic
- Ragn-Sells (2015). Ragn-Sells: Position paper on the EU framework on the Circular Economy.
- Reichel, De Schoenmakere, Gillabel. (2016). Circular Economy In Europe. Developing the Knowledge base. European Environmental Agency Report No 2/2016.
- Norden. (2015). Moving towards a circular economy – successful Nordic business models.
- European Union Committee of the Regions. (2016). Visiting circular economy top initiatives in Denmark.
- Eurostat. (2016). Press release - Environment in the EU. Each person in the EU generated 475 kg of municipal waste in 2014.
- European Environmental Agency. (2013). Managing municipal solid waste- a review of achievement in 32 European countries.
- European Environment Agency. (2016). More from less — material resource efficiency in Europe 2015 overview of policies, instruments and targets in 31 countries.
- Frank, B. (2014). Circular Economy in Växjö, the Greenest City in Europe
- RenoSam & Ramboll. (2006).Waste- to -energy in Denmark.
- Nordic Report Waste Management Sector. (2016). Competition in the Waste Management Sector – Preparing for a Circular Economy.
- Sonerud, B. (2015). An Introduction to the Circular Economy in Scandinavia. Circulate.
- WWF (2012). Denmark waste to energy.
- Becidan, M. Wang, L. Fossum, M. Midtbust, H-O. Stuen, J. Bakken, J.I. Evensen, E. (2015). Norwegian Waste-to-Energy (WtE) in 2030 Challenges and Opportunities. Chemical Engineering Transactions. VOL. 43
- Zero Waste Europe (2015). Press Release: Landfill ban? A false path to a circular economy.
- Zero Waste Europe. (2014). Zero Waste?

- Kristiansen, T. (2016). Northern European Approach to Practically Zero Waste. Macau International Environmental co-operation Forum and Exhibition.

3.3 Data analysis

This thesis undertook an inductive thematic method of analysis. Thematic analysis is a tool for identifying analysing and reporting patterns and themes from data sets resulting in an organised and described in rich detail set of data. From the data there needs to be something of importance that relates to the research question. The theme is found from extracted meaning or patterned response from the data set. Thematic analysis is a favoured approach for its simplistic, less time consuming and more flexible approach in comparison to others methods (Boyatzis 1998; Braun & Clarke, 2006).

Inductive thematic analysis specifically was chosen as inductivism as a methodological approach is one which allows for limited data collection from a small sample in relation to the research area or topic (Stokes, 2011). Also inductive approaches although not universally associated to qualitative research, are more likely to be as are deductive approaches to quantitative research. Inductive and deductive thematic analysis differ mainly in that a deductive approach aims to test a theory; an inductive approach aims to generate new theory from emerging data(Gabriel, 2013).The main goal in thematic analysis is to provide descriptive understandings of answers, in the inductive option the themes are strongly linked to the data from which they emerge from using little pretermined theory, structure or framework (Braun & Clarke, 2006).

According to Ryan & Bernard (2003) researchers look for themes using a variety of techniques that include scanning qualitative data for repetitions, indigenous typologies or categories, metaphors and analogies, transitions, similarities and differences, linguistic connectors, missing data, theory-related material. The methods used in this study made use of two methods. Repetition as well as similarities and differences. Repetition was utilized as its one of the easiest ways of identifying themes it simply takes note of recurring topics. The frequency of reoccurring concepts strengthens the theme but it is up to the researcher to determine at what point a theme is identified in the first place based on how many repetitions constitute a theme. Similarities and differences were also used which takes pairs of expressions from the same interviewee and/or different interview and looks at how they differ or have similarities, in a systematic way.

3.4 Research reliability and validity

Reliability and validity are the two central concepts that support the credibility of a scientific research. In its simplest form reliability is gained from the stability of findings while validity refers to the truthfulness of findings (Silverman, 2014). According to Bryman & Bell (2007) reliability and validity has more salience in quantitative research and that adaptations need to be in place when applying it to qualitative research. A deeper terminology of reliability and validity in qualitative research is offered as; 'the measures of quality, rigour and wider potential of research achieved through certain methodological and disciplinary principles and conventions.' Albeit with less salience of measurement issues as seen in quantitative research.

Reliability pertains to the degree of consistency and replicability that instances would be assigned to a same category by different observers or by the same observer at a different occasion. The repeatability of the study is under scrutiny and the likelihood that the same research would produce the same results when done again by the same or different researcher (Bryman & Bell, 2007; Stokes 2011).One main way of satisfying reliability criteria is to include being transparent and detailed throughout the research report in order to demonstrate the level of repeatability (Silverman, 2014). This was demonstrated through a descriptive research strategy and data analysis explanation that to the best of the researchers abilities aimed to demonstrate that study could be replicated again at a later time by same or different researcher. Furthermore reliability is strengthened in the data collection part of qualitative interviewing if interviews are recorded and transcribed (Cresswell, 2007). Both of these functions were carried out in the research.

Validity refers to the degree that a research is able portray and respond to its objectives and concepts as planned to (Stokes, 2011). On a wider perspective validity is seen as the extent to which an account is accurately represented to a social phenomena to which it refers to and how findings can be generalized across social settings something which can be problematic as qualitative research tends to utilize case studies and small samples that may not accurately represent the generalizebility across a wider scope (Bryman & Bell, 2007; Silverman, 2014). Validity enhancement was obtained with some basic provisions which included the clarification of interview questions after they had been asked in cases when respondents were hesitant to answer, in those cases extra explanation of the questions were given to ensure proper understanding. Secondly in the transcription phase the text was edited to omit repetitive words, phrase corrections, off-track comments and poor word usage. This is what is known as the "abriged/intelligent" protocol that is meant to clarify rather than change the transcripted data (Guest, MacQueen & Namey, 2012).

4 RESEARCH FINDINGS

This chapter will present the main themes that arose from the data analysis. In the majority of themes there will also be the inclusion of secondary data analysis of records and reports from other Nordics that serves to support the 1st hand data by showing similarities or differences. Throughout the research findings section any direct reference and quotations from the interview sources will be categorized as follows:

- The managing director of Mustankorkea (A)
- The research and development manager for the city of Jyväskylä (B)
- The senior lead on circular economy at SITRA (C)
- A circular economy specialist at SITRA (D)

3.5 The journey to zero waste and zero landfill is more important than the goal.

The idea of zero waste/zero landfill was understood in a straightforward way as the idea where the re-use, recycling and energy utilization of waste is maximized with the minimalization of landfilling (A, C, B). Interviewee D expands on this with deeper insight.

> *"It's important but not the only aspect of CE. To create an economic system that doesn't create landfills. From a conceptual level the idea of waste should be abolished. In reality we don't really have waste; we have materials in the wrong place. Economies should be designed so that waste doesn't end up in landfills as that value is lost. We need to create an economic system that doesn't create landfills." (D)*

The consensus was that in practice the idea was impossible or near to impossible to achieve, however the process and result were a worthy idea to pursue.

> *"As a goal it is quiet challenging for cities but I strongly believe that we are going in that direction with cities in Finland. The funding is the main problem for finding new solutions, I can't say it will be easy but it's not impossible." (B)*

Interviewee (A) from the municipal waste company offers a less optimistic view.

> *"Yes I think so, it's not possible to use everything, you have all kinds of difficult waste that it's hard to find use for them afterwards and you can never reach zero. Of course it's very important and it's kind of ultimate goal but if we can reach it I'm uncertain. It's important to have in mind but you have to accept that it's not reachable. Maybe after 20 or 30 years and it depends more on the manufacturers they have to consider what materials they use, we (mustankorkea) cannot make it possible." (A)*

Interviewee C sums up the general sentiment that having a zero waste/zero landfill goal has greater implications in general.

> *"It's not about just getting rid of waste. It's important in the long term as a philosophy in not just trying to get rid of waste but to change societies into following CE." (C)*

The secondary data on the subject brought up the following evidence that the road to creating an economic system that doesn't create landfill is tricky. Zero Waste Europe (2015) sees a landfill ban as being a false path to a circular economy. Studies have shown that Copenhagen for example with its zero waste to landfill policy has a residual waste amount six times higher than Treviso in Italy which has a 'zero-waste strategy'. The crucial thing to note is the slight difference in terminology between 'zero-waste to landfill' and 'zero-waste strategy', has different practical implications. From 7 European countries with landfill bans, contradictorily Norway has seen decreases in recycling and Denmark has even seen a rise of waste generation by 37%.

Sweden for instance has zero waste initiatives gaining traction and currently only landfills around 1% of its waste (Richard, 2014). On the other hand, it is claimed a zero waste to landfill policy, which Sweden has, in fact distorted statistics without improving performance. The scenario given is where countries can continue to function as linear economies, even increasing waste generation, just as long as waste is incinerated or recycled (Zero Waste Europe, 2015).

In advancing towards a CE some steps are proposed by Zero Waste Europe (2015) which include high taxes on landfill as well as WtE incineration in combination with lower taxes on landfilling of stabilised waste. This is believed to be more effective than a landfill ban in prevention, preparation for re-use and recycling of materials.

3.6 Clear strengths of waste-to-energy in Finland

Respondents B and C both mention the technological know-how with highly educated engineers coming from universities and research centers. Respondents D and A mention the particularly high efficiency and value of WtE due to Finland's cold winter climate.

> *"Combined district heating and cooling and electricity is an advantage as the long cold winters creates even more value for the heat. It incentivizes burning stuff for heat." (D)*

> *"The utilization of the excess heat from gasification. Excess heat can be used as district heating which is especially handy for northern countries. Energy efficiency in Finland and Nordics is very high, 80% to 90% compared to southern Europe where energy efficiency is around 40% because they can use only the electricity and not the heat." (A)*

WtE is cited to benefit the Nordics in many ways. Primarily in district heating and combined heat and power (CHP) from WtE thatis used to heat large indoor spaces and large water sources efficiently saving energy and greenhouse gas emissions as buildings account for a large part of total energy use (WWF, 2012). For Norway WtE provides increased energy efficiency and local renewable energy sources with WtE accounting for over 50% of total district heating. Furthermore as Norway has had a total landfill ban on biodegradable waste since 2009, this ban can only be fulfilled if WtE in unison with material recycling can process the waste (Becidan, Wang, Fossum, Midtbust, Stuen, Bakken, Evensen, 2015).

Denmark has said to benefit from so called 'low gate fees' as one of the lowest in Europe this has in turn led to efficiently operated facilities and extensive energy recovery resulting in WtE providing the cheapest source of heating in Denmark. For over a decade as with other successful countries, Denmark has shown that local government influence in waste sector as being key with waste management being publically controlled rather than privately controlled. UK in comparison to Denmark as an example of privately run waste management has less widespread WtE and at a high cost (RenoSam & Ramboll, 2006).

3.7 Clear weaknesses of waste -to -energy in Finland

Respondent B cites the economic situation in Finland as having an effect and the lack of money and resources which would bring about quicker development. The main weakness was evidently the inability to plan and legislate with the future in mind. Respondent A clarifies:

> *"I think the legislation is one thing, it changes too much, there is no solid legislation. 10-15 years ago Finland focused mainly to RDF, planning small sites around Finland, but then the EU legislation came where there were strict rules for clean burning and monitoring of emissions. It would have been so expensive to meet all those regulations so it was a wrong guess, a wrong policy at that time and we had to turn to other European countries who had large waste incineration plants that's we are a little behind other countries." (A)*

Evidently predicting the future was always going to be difficult, respondents A, C and D have concerns over what decisions have been made in the past and the potential not to learn from them.

> *"10 Years ago an incineration plant the megawatt hour(Mwh)price was 50-60e.*
> *The 10 year forecast on megawatt hour price was 80-90e...now it's 22e!*
> *All projects are invested in to get money and the low price of energy is stopping this, one needs other reasons such as promoting renewable energy and good image and enhance the local economy here."(A)*

> *"Finland has been quiet late in building these incinerators and now are still investing a lot into them and already they are quite an old fashioned method, they could be looking for more advanced next generation technologies." (C)*

> *"A potential problem in the future is over-capacity of incinerators due to the trend nowadays to build them. The plants create a lock in, as the big plants with long investment plans need a constant fuel supply."(D)*

Competition for the waste is between the private and public sector and respondent A sees this lack of current clear waste law that has not been clarified for some 20 years as an issue. He suggests household waste be property of public companies and business waste be property of private waste companies.

> *"There is huge competition between private and public sector and when we talk about municipal waste its only around 2% to 3% of all waste in Finland, the problem is who owns the transportation of municipal waste and who has right to*

household waste, this has been going on for 20 years. Private sector is trying to take all the valuable household waste and leave the worst stuff to the municipalities. There should be rules as to who owns the waste. I think that private companies should take care of the companies and public companies take care of households. Our waste law is not very clear right now."(A)

From secondary sources it is evident that although other Nordics and Denmark in particular have exemplary WtE systems, they are becoming dependent on their society's wasteful consumption patterns as this provides the fuel source. The problem being that in the Waste Hierarchy, waste minimization is not ranked high enough(WWF, 2012). For example although Sweden has a good reputation on the whole, it also is finds itself at the top spot in electronic goods consumption with an average of 23kg per person annually purchased (European Environment Agency, 2016). Having waste as a resource can lead to creating an incentive to increase rather than decrease the amount of produced waste and as with the case of Sweden it leads to the importation of waste that requires logistical issues that impact the environment and create a market for a commodity (WWF, 2012).Too often it seems waste management policies focus on downstream policy options rather than prevention, design or reuse policies (European Environment Agency, 2016).

3.8 Role of municipalities

The mentioning of the role that municipalities play in supporting waste to energy production is brought up specifically with the so called 'biogas eco-system' (C), that allows for the viable utilization of biogas for public transport using Sweden as the perfect example.

"Sweden has a storing eco-system on biogas production and use. It requires a public assistance" (D)

"With bio-waste and sludge, the municipalities have been very active in building biogas plants. Also in order for these plants to be financially viable there needs to be the demand from cars trucks and buses and the municipalities have bought them in order to create the market which makes investing on these plants a good option from both private and municipal." (A)

An example of how municipalities assist in creating demand for biogas is offered.

"City of Jyväskylä has around 200 cars which they have leased from companies, in future the idea is to lease 200 more every 5 years, so in the future they will be bio-fouled. Waste trucks can also be converted in to biogas fuel power. The city has

authority in tendering process of waste collection so have demanded that tenders are using biogas trucks." (A)

The role of municipalities is also evident amongst secondary data from other Nordics. Nordic Report Waste Management Sector (2016) illiterates that "at present, municipalities in the Nordic countries often both administrate and participate in the markets for waste management. Municipalities have both the right, and the obligation, to collect and treat household waste. In all the Nordic countries, municipalities fulfill their duties in a variety of ways; these include using in-house departments, the direct awards of contracts, side-by-side competition and public procurement" (Nordic Report Waste Management Sector, 2016,p.25).

Ultimately the role of municipalities and their power basis is based on theirconstitutional autonomy which allows municipalities to independently choose how to manage their local waste markets (Nordic Report Waste Management Sector, 2016). Sweden for example can trace its successful sustainable waste management to the interplay between municipalities, their companies, private and state companies. Admittedly there are aspects at stake to consider, so risk taking and courage has been needed to make large infrastructural change (Avfall Sverige. 2015). The strength of municipal decision making is evident in the city of Växjo, Sweden for example touted as "the greenest city in Europe." Its rise to prominence came through the unified results of unanimous decision by politicians to be fossil fuel free, a long tradition of environmental work and the wish to inspire and spread the circular economy concepts (Frank, 2014).

3.9 Interpretations of the circular economy are vague and diverse

When asked about what a definition of the circular economy means in their opinion the response was that along with circular economy, many other terms for other related concepts often overlap and that a simple definition for the circular economy is not applicable.

"Terminology: we speak about resource efficiency and resource wisdom and we have similar words for CE. Also that direct English to Finnish translations can add to the confusion."(B)

> *"There are several definitions and it's hard to define. It's a concept and a vision so there shouldn't be one definition. But roughly it's an economy where materials keep on circulating in the economy so one is able to extract the maximum potential of the value in materials and products. An aspect of systemic design planning for the economy of products, services and business."(D)*

Respondent B is of the opinion that the word 'circular economy' is not understood in terms of what it can mean for the company. Respondents D and C talk about how CE and different other relatable concepts are complex when companies consider the idea and how they inter-relate to each other.

> *"The word as such is still quit unknown and companies don't understand what it means and what possibilities it would give them and what advantages for the future it could give. Business needs also more courage moving forward. More examples need to be shown that proves CE can be done." (B)*

> "*At Sitra and at universal level, climate change and resource efficiency and CE is discussed but where and how do they link is not that clear has not been given much attention." (D)*

> *"Due to the separation of CE and carbon neutrality for example we try to create this vision of both CE and CN. Society should not just be thinking about what to do about waste." (C)*

From secondary datait's clear that the majority of countries including the Nordics have a weakness in defining the concept of CE within their national policies. The common problem is seen where key concepts remain undefined, relying on vague and all-encompassing notions. This vagueness leads to difficulties in any sort of assessment on progress to CE objectives. Furthermore there is the difficulty in measuring the degree of circularity under the current European measurement system (European Environment Agency, 2016).

On the other hand it's positive to see that this problem is acknowledged and addressed. Brewer (2016) writes that due to the Nordics strong cultural similarities, sustainability is being mainstreamed into the mindset of politicians and the people leading to an acceptance and understanding of the change in processes in a society. Key to proliferating the idea of CE to the business community is a clear and predictable legislation that enables business to respond in the desired way (Brewer, 2016).

3.10 Importance of economic basis for circular economy

One of fundamental ideals of the circular economy to appear is that a positive economical basis is needed for its success. Which is to say that recycling and re-use of materials to a higher level is possiblebutcurrentlyat a price that doesn't always make any business sense.

> *"I think the important word here is economy, whatever one does with waste, one should always calculate how much does it cost to make it re-usable. I would say that CE is something that you do to save natural resources in an economical way. One can re-use and recycle everything...if you don't think about money."(A)*

> *"As I said I think the economy is the main problem. It's easy to put target numbers on the table but nobody ask how much it will all cost. The bigger picture is not often looked at and LCA is important." (C)*

Respondents A and D highlight the issue that as a new concept, changing from a linear to circular economy will naturally take time. In an ideal CE, recycling and re-use of materials takes precedence over WtE, however until the technological ability to do this at a profit is not available then WtE has a legitimate business case.

> *"Current economy has been developed to be very efficient in a linear perspective. As a transformational issue, all large transformations will take a long time (decades) to happen and will require effort of time and resources. It's not simply making one decision in parliament."(D)*

> *"At the moment the technology needed to recycle is very expensive. Currently WtE is the more economic solution than recycling, in the future with technological advancements, solutions and cheaper then recycling will become more." (A)*

> *"It can be more economical to incinerate waste and use it as energy rather than recycle."(A)*

Secondary datafrom other Nordics also shows that a sound economic basis is needed and that due to the growing economic profitability, the cooperation between Nordics is very successful in sharing good practices, promoting innovative business models that ultimately show that the principles of a circular economy can also be applied to a functioning economy and that in fact the Nordics more than most other European countries has the greater potential as it

finds itself collectively and individually to be a large municipal waste generator (Kiørboe& Milios, 2015). Although the circular economy is often touted as being needed for reasons such as solving the global environmental problem, emissions reductions and exploitation of natural resources, the necessity of a circular economy is due to the growing strong belief that the current linear model is unsustainable and that the circular economy model has a strong business case for the future as studies show that globally the economy would benefit from the a circular economy(Norden Policy Brief, 2015). The importance of an economic basis and economic incentive is echoed by Swedish waste recycling company Ragn-Sells (2016) in their position on the drafting of the Framework on the Circular Economy by the European Commission. They underline some basic economically based necessities such as 1. It must more profitable to recycle and re-use materials than to incinerate or even extract virgin natural resources 2. Demand should be stimulated by an economic incentive.Furthermore the CE is becoming increasingly popular as a concept due to its solutions based approached to reaching economic development within the all important environmental constraints(Reichel, De Schoenmakere, Gillabel 2016)

In addition Ragn-Sells (2016) expands on the need for an economic basis by adding that once waste is a seen as a valuable resource then a change in the waste and recycling industry is needed as current public sector and municipal mandates do not sufficiently promote the circular economy. The company explain what they see happening in Sweden and other Nordics where they operate that "more and more businesses understand that their waste is a resource, and they seek holistic solutions and services to protect the value in their materials and to be more resource-efficient." And that due to the growing economic opportunity of waste "the EU Framework should clearly define the role of the public sector and secure an open market with equal competition." (Ragn-Sells, 2016 p.2).

3.11 Circular economy projects in practice in Finland

Aspects relating to CE have been done for some time in Finland, the unique system of bottle recycling for money is the perfect example. (C) Currently the growth in all encompassing CE projects in Finland seems to follow a standard format which is based around experimental and so called 'pilot' projects by cities and municipalities that approach different themes that although are related to CE or fall under the scope of CE yet are not termed as CE projects as such, respondent (B) explains;

> *"We had a test-bed or living lab for SITRA where we had a joint project called 'towards research wisdom' which started 3 years ago and ended last summer.*

During that project we tried to develop an area model for cities to fight against climate change. Begins with experimenting, the project with Sitra we tried different small trials, we divided the whole idea of resource wisdom into 6 themes which were sustainable energy, water saving, food, waste and materials, sustainable wellbeing. Main goals being no CO 2 emissions, no waste and no over-consumption. Resulting in a roadmap to resource wisdom which is very close to circular economy."(B)

"Now eight cities in Finland use same or similar methods to do their own roadmaps to resource wisdom. We have a network with them (FISU) Finnish sustainable communities administered at SYKE and MOTIVA." (B)

Respondents C & D from Sitra also explain that targeting specific focus areas is their mode of operation. Also due to EU regulation pressure, the government has commissioned a national roadmap to CE.

"We have several focus areas. Textiles, it's close to consumers so easy to understand. Technology industry which is an export industry on finding new CE business models, remanufacturing of equipment etc. The third is the nutrient cycle from agriculture trying to keep fertilizer and nutrients from the sea. We are also working on facilitating a national roadmap of CE in Finland with ministry of environment"(D)

"With CE the government is more interested in implementing these issues according to EU regulations of course. Sitra is preparing a national roadmap for CE."(B)

Respondent C carries on with the notion of the targeting of one specific area that addresses a CE related issue and how they at Sitra are actively trying to bring about a change in business attitude whereby smaller companies and not only corporations can make a business case for CE.

"it's mainly large corporations who are active in CE as they work with material flows and resources so it's natural for them to try and get more value out of the resources. It's our job at Sitra to get SME's involved. Start-up companies are looking to offer CE solutions specified to one area e.g. food, sharing economy etc. "(C)

Typical all encompassing circular economy projects from other Nordics are found amongst secondary data sources with plentiful examples being found in Sweden and Denmark and to a less extent in Norway. As Sonerud (2015) points out, there is variation amongst the Nordics in their progress towards a circular economy, whilst all Nordics have a strong history of recycling, Norway is seen to be lagging with its circular economy development, a reason for this is offered where the term of CE is used differently throughout different countries. In Sweden and Denmark the trend seems to be found in so called 'flagship

initiatives' that aim to show that the circular economy can function fully on a miniature scale before being applied nationally and globally. Denmark for example has recently launched the "Full Circle Island" project that aims to make the small isle of Samsø the first place in the world with a fully implemented circular economy.Similar initiatives include Naestved Resource City, Kalundborg Symbiose and the Nordhavn project all which aim to prove that the circular economy concept can be realized in practice in (EU Committee of the Regions, 2016). The above examples from Denmark are often based around the idea of symbiosis which is to say that when applied to an industrial model it means that one company's waste is another company's resource (Braw, 2014). The Idea of flagship initiatives is also found in Sweden, an example is Växjö Reuse Village which aims to showcase how a medium sizes town can also be a functioning society with a circular economy (Frank, 2014).The strength of Danish and Swedish CE projects can be found in their legislation that has been implemented from EU directives well ahead of other EU countries (Braw, 2014).

3.12 Nordics lead by example with EU mandated targets

The following select targets were taken from revised legislative proposals of The European Commissions, Circular Economy Package, and discussed from Finland's perspective. 1) The A common EU target for recycling 65% of municipal waste by 2030.2) A common EU target for recycling 75% of packaging waste by 2030. 3) A binding landfill target to reduce landfill to maximum 10% of all waste by 2030. The level of optimism to these targets varied and as respondents C and D reveals, the targets themselves have come under criticism;

> *"There was criticism on recycling targets as they were lower than the previous target. The fact that CE is more than just waste and recycling so one can't only look at these percentages." (D)*

> *"the 1st is hard to reach but the other two are quite realistic. Even maybe too easy." (C)*

- ***A common EU target for recycling 65% of municipal waste by 2030***

> *"With recycling we can utilize as energy but that's a different thing, but to recycle materials is very hard."(A)*

> *"For Finland these targets on municipal waste haven't really changed in the past 10 years. MSW has gone from landfill to incineration but recycling rates have been stuck at the 30-35% level, Finland's target for 2016 was 50%. There*

haven't been any sizable actions towards this figure. It's challenging for Finland and other countries, some countries have high MWS recycling, Germany, Austria, and Switzerland. It shouldn't be impossible as other Europeans do achieve over 50%.On a philosophical level 2/3 of waste should be recyclable."(D)

- ***A common EU target for recycling 75% of packaging waste by 2030***

"With packaging at 75% I think it's possible, in Finland we are almost there if we take into the account the waste that comes directly from the producers and manufacturers where production residues which can very easily be recycled. Waste from households with varying materials is quiet hard to separate so it needs cooperation with manufacturers and waste management companies. At EU level it needs a lot of work. We recycle 90% of glass bottles and aluminium but one has to consider the other things for example plastic food packaging might contain around 7 types of plastics and it's impossible to separate and recycle."(A)

"Packaging waste: is sort of another story, the way of calculating these % has been changed so that plays a big role, some countries might measure it differently. It takes into account recycling as well as re-use, it makes a big diff as Finland has very high rate of re-use, bottles for example. So I think Finland has already nearly reached this level."(D)

- ***A binding landfill target to reduce landfill to maximum 10% of all waste by 2030.***

"The last target yea its possible and its already been achieved in many European countries, I have just seen statistics from Germany, Sweden, Denmark, Holland and Austria, they have already reached that, Finland has around 17% going to landfill. However with Romania, Bulgeria etc over 90% goes to landfill."(A)

"Landfilling is under criticism also, in the long term under CE landfill could reach zero, zero waste is different though. Some countries are nearly on zero lanfill (C)

Secondary sources on the select three targets applied to the Nordic countries showed that largely targets can be met if not even met already. However the 1st target proves to be more difficult potentially achieve.

- ***A common EU target for recycling 65% of Municipal waste by 2030***

It's worth to note that municipal waste accounts for 10% of total waste, its importance comes from the link to overall consumption patterns and the wide range of material compositions (Eurostat, 2016).

Firstly one should look at the amount generated before analyzing the recycle percentage. As of 2014 Denmark had the highest rate of MSW generated followed 11 places down was Finland, Sweden was 4 places behind Finland and Norway a further 5 places behind. The reason for this is attributed to amongst other things, the disparity in how each country classifies its MSW (Eurostat, 2016). According to Eurostat (2016) Recycling means "any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes, except use as fuel." However from 2014 statistics it's evident that the Nordics favour incineration over recycling with at least 50% of MSW being incinerated in Denmark, Finland and Sweden. The stats for recycling were Denmark 27%, Sweden 33% and Norway 27% with Finland at 18% (Eurostats, 2016). This shows they are someway off the 65% for 2030 but progress towards this is suggested to become easier when priorities are set and definitions adhered to, the case of Sweden and Norway for example shows that recycling stats can even decrease, as Sweden imports waste from Norway the incentive to recycling in Norway is overtaken by the economic advantage of exporting waste (Dovik, 2015). If Norway can be considered behind Denmark in Sweden it can maybe act to show that at following 2006 to 2010 projections 2020 will be reached with little growth in MSW recycling. This is without any planned policy measures however and future recycling rates could well be more positive by 2030 with the right measures in place (European Environmental Agency, 2013).

- ***A common EU target for recycling 75% of packaging waste by 2030***

2013 figures of packing waste that is recycled shows Sweden at just over 70%, Denmark at around 65%, Finland at just under 60% and Norway around 55% with Norway and Finland having a noticeably high percentage of packaging waste going to WtE (eurostat, 2013). Sweden leads the way and according to Braw (2014) this can be attributed to Sweden having passed a law requiring packaging manufacturers to recycle more of their material and Sweden by 2020 aims to recycle 85% of paper-based packaging materials, up from today's 65%.
Mink (2016) of Tetra Pak further explains Sweden's strong stance on packaging waste as "One should aim high as we look towards 2030. For us, that means implementing the waste hierarchy, meaning that no packaging should go to landfill. This would require separating at source and obliging EPR scheme organisations to collect all packaging materials and by doing that, you create an incentive to sort out the waste and sell it to a recycler" (Mink, 2016).
In terms of meeting targets of packaging recycling Denmark shows that even though they do not have a producer compliance system they still exceeded targets in all but one category of material (glass). Wood, plastic, aluminium,

steel and paper/cardboard all exceeded targets by a minimum of around 10% up to over 30% (Chartered Institution of Waste Management, 2016).

- ***A binding landfill target to reduce landfill to maximum 10% of all waste by 2030.***

Exact numbers and percentages vary by source and by year but it's widely recognised that Sweden and Denmark are at 1% waste to landfill and Norway is at under 10%. With landfilling rates so low, the discussion is now on a proposed landfill ban that by 2025 would ban all recyclable materials from landfill and according to Mink (2016) Sweden is well on its way due to the fact that Swedenhas been working onit for over twenty years so the experience is there, the knowledge is there, the technologies are there to a large extent. The only thing that needs work on now is the framework.The reasons the Nordics have reached such low levels can be found in their landfilling tax systems where tipping fees and taxation make an alternative to landfilling the better option financially. In addition Sweden for example added a ban on landfilling of organic waste as well as a ban on waste that can be used in WtE (Khodayari, 2016).

3.13 Nordic benchmarking WtE and the circular economy

The idea of benchmarking Finland in comparison to other Nordics is to compare performance against exemplary countries and to possibly copy their best practices and learn from successful examples. Respondents C and D admit that benchmarking is a useful approach.

> *"We should benchmark those countries as they look at these issues from a bigger context."(B)*

> *"Benchmark them and keep working to the bigger picture and get shared understanding between politicians and experts." (C)*

In terms of where Finland stands with CE the feedback was positive with the belief that Finland may be behind in certain select areas but on a wider general sense they are even leading the way. Furthermore the opinion why Finland may be trailing behind the other Nordic nations is based only on the fact that Sweden had a considerable head start, which is positive as it implies Finland is more or less equal, when one takes time scale into consideration.

> *"I think Finland is in the lead in the sense of CE from a conceptual and expertise level. Apart from Nordics the Netherlands and Switzerland work on CE as a topic.*

For example you can benchmark CE to renewable energy where Sweden and Denmark are ahead, but that's just one aspect. In Finland we have it in our government program which is quiet exceptional, I'm not sure if other Nordics talk about it in their government programs (D)

"In the vision of CE I think we are ahead, but in some sectors and procedures other Nordics are more advanced, even though they may not even call it CE. "(C)

"Certainly one of the reasons is that in Sweden they started a lot earlier, but the question is why didn't Finland start so early? In principle Finland is always a little bit late than Sweden in many aspects" (B)

"We are catching up when we should be thinking about taking a lead. Some countries rely on running at capacity by importing waste and that not a good long term strategy. One weakness is service business, from Sweden with its service business and business development marketing activities which is something Finland has to learn and enhance, we have very good technological solutions which in many ways can be seen as superior to other Nordics, but our ability to market and sell them and internationalize is our Achilles heel."(D)

One practice in particular that impressed the respondents and was something that could be taken from the other Nordics was the example of food waste as respondents B and D mention, the whole concept of food and waste is changing fast.

"The reduction of food waste and utilization of food waste, and how could government incentivize this for society." (D)

"The large amount of ways of dealing with food waste, either giving away or composting. Also the new applications (rescue application) for food from shops and restaurants that would otherwise be thrown out. Also some restaurants that prepare food from waste food. The so called 'waste-to-taste idea'." (B)

Respondent A with an intimate knowledge in waste statistics and facts gives a catalogue of clear comparisons between Finland and Sweden when it comes to WtE.

"In general it's very good; Sweden has a lot of incineration plants. The weakness is that they have different regulations and laws for example in Norway they have an incineration tax so it's more expensive so they export waste to Sweden.

Norway's plants don't work at full capacity as they don't have enough waste. I think the laws should be more or less the same in all Nordics."(A)

"Sweden has recycling of municipal waste at around 50% and Finland around 35%, in Sweden and Denmark only 1% of waste goes to landfills. They have started earlier 5-10 years. Sweden for example has been and is more wealthy than Finland so have had money and time to turn to green. The Green party has been there several decades. Geographically Sweden is twice as big yet most people are centralizied in southern Sweden. In Finland people are more scattered. In bigger cities it is easier to collect waste and make solutions that are more economically feasible. Waste material from industry needs to be processed in mass to be made feasible and countries with large populations and cities and businesses will have easier time. Big industry such as metal and pulp and paper have a role to play, they already re-use as much as possible." (A)

Secondary data sources show of the many large companies in the Nordics which are already taking ambitious and important steps towards more circular business models, while smaller and sometimes lesser-known companies are making the circular economy happen, this should serve to inspire and encourage businesses to make creative and innovative steps in the same direction(Norden, 2015). Inspiration and encouragement are the key drivers in creating circular business models and companies from the whole business chain must learn to collaborate (Morch, 2015). The Nordics are often looked at as exemplary models when it comes to society, welfare, healthcare education and business. This has come about from its closeness of multiple factors from linguistic and geographic proximity, similar institutional environments, close history and culture. Henceforth this has facilitated growing regional economic activity and growth of integration through mergers and acquisitions (Hoydal, 2016). A fitting example is the recent acquisition of the Nordic circular economy company Ekokem by the Fortum group.

3.14 WtE an integral part of a CE in Finland for now

As WtE is situated at the last stage of the loop in a circular economy its crucial role is that it is the last moment where value can be saved from any materials before and during incineration.

"As WtE is the last stage in the hierarchy anyway, as the last point where one can close the loop, it's the last chance to extract value.WTE is one aspect of the CE, and is import for the end-life of products.More discussion is on the energy flows of

CE but not as much as how renewable energy and carbon neutrality fits into the CE."(C)

"New energy and new economic value to the area, especially biogas from bio waste. Good for the area economy as it increases employment and circulates money within the area."(A)

Admittedly waste will be an issue for a long time to come before a functional CE could be in place. Respondent B points out that for Finland, WtE is a crucial source of energy as solar and wind power capabilities for example are not an option for Finland as it may be for other countries. Also that even hazardous and residual waste is better to burn for energy rather than landfill until new methods for processing valuable materials is created.

"It's ideological to think that we will never have any waste. We will continue having waste for decades so incinerators do have a role, there will always be residual waste, it may even be better to burn hazardous waste rather than dump it. In Finland we need heat during winters, and solar and wind power cannot provide this like WtE can. So has a very large role." (D)

"Even the last bit of waste is better to burn for energy rather than leave to landfill. We need to create new methods to gather valuable materials."(B)

WtE in Norway for example has shown that it hasn't been able to follow as successfully the examples of Sweden and Denmark. Norway has even shut down three plants in 2011 and current plants suffer from low profitability due to over capacity as its cheaper for them to export waste to Sweden instead (Becidan et al, 2015).

Furthermore questions can be raised about the longevity of WtE in the Nordics in the future as it's predicted that northern Europe will see a decrease in WtE capacity due to increased pressure from resource, carbon and energy policies that push for closed loops for materials and nutrients. WtE would still be in demand for remaining residual waste only. This decrease would continue also as energy supply becomes more fossil-free (wind, solar, hydro etc.) resulting in energy from waste becoming less desirable as it changes in classification from "clean" to "dirty" energy (Kristiansen, 2016).

It seems that for Denmark at least WtE is but a stop-gap measure for now as Denmark is already in the process of planning to leave the incineration age behind with goals by 2050 to be fossil fuel free, which includes shutting down of WtE incinerators. They are doing this as the current system of high incineration is said to create perverse incentives that are contrary to waste reduction, recycling and reuse that ultimately has affected energy policies

resulting in the blocking of cleaner technologies from taking over (Zerowaste Europe, 2014).

4. DISCUSSION

This chapter will be a discussion ofthe findings in more detail and trying to tie together the meanings and implications in relation to the research questions. The three main topics of the thesis will be divided and discussed as subchapters.

4.1 Zero-Waste Goal

The idea of a zero-waste goal brought forward some disparities of the term what it actually implies in theory. Firstly the term 'zero waste' and other related terms such as 'zero-waste to landfill' and 'zero landfill' mean slightly different things but following the zero-waste goal idea it was widely agreed by interviewees that reaching absolute zero is not a possibility as such and that reaching the 1% level and absolute minimization of landfilling still qualifies. Recognised as a function in a CE, all interviewees agree on its importance even though the ultimate goal is only a theoretical possibility. Overall what can be drawn from the data is that a zero waste goal leads to bigger and better implications on the whole. With a zero waste goal the philosophy of a CE is born where society starts to see waste differently, from simply trying to divert waste from landfill, to not even considering the idea of waste, instead recognising it as material of value that can be circulated.From secondary sources it becomes evident that a zero waste goal contrary to belief does not always compliment the formation of a CE. The role of WtE and the incineration of waste before it would otherwise be landfilled is important yet what ultimately counts is the reduction of waste generation in the first place. The way forward for zero waste is evidently in a zero waste strategy as opposed to an outright landfill ban as Zero Waste Europe (2015) gives examples of the latter not having its intended results as Sweden and Denmark whilst being close to zero waste to landfillare still incinerating large amounts which leads large amounts of residual waste that ultimately is landfilled. It is suggested landfilling and indeed WtE be taxed higher to incentivise recycling.

To summarise,three topics of zero-waste, WtE and CE do not necessarily mutually assist each other. While WtE performs a valuable function in a CE and helping reduce waste to landfill, the demand for energy creates a demand for waste as fuel which as such does not compliment a CE where waste is preferably prevented in the first place, re-used or recycled.

4.2 Waste-to-Energy

Waste-to-energy for Finland and the Nordics was found to be of particular importance due to the value obtained from the WtE process which can be said to be significantly more than for other southern European countries. Due to long winter months the demand for heat is constant and this is where combined district heating can utilize the excess heat from incineration and gasification to heat houses, business and municipal buildings on a district scale. Henceforth the energy efficiency of WtE in the Nordics is said to be up to 90% where as it's around 40% in southern Europe as the excess heat is often left unutilized.
For all the positives associated with WtE there is evidently much concern for a host of problematic and counter-productive issues that WtE brings. Firstly is what the European Environment Agency (2016) describe as a wrong approach to waste management policies as they focus more on the downstream options such as incineration when what is needed for a CE is a policy of prevention, design and re-usage. This is evident in the Nordics as an example of this policy as WtE is becoming dependent on the societies consumption patterns as a fuel source resulting Denmark can show to have absolute minimal waste to landfill yet still top the table of municipal waste generation. The problems of WtE in Finland did not bring to light the same concerns as the Nordics rather it brought to light its own national concerns that revolve aroundlaws, legislations and decision making. The concern for the future is that Finland may have not learned from its past in that passing legislation has been slow and not factored in for future changes in the market place that has resulted in low energy prices, stricter EU laws and the constantly changing technology used in incineration and gasification processes. As a result development of WtE infrastructure is hindered by its ability to turn a profit which is something that can be changed by adding a responsible image to WtE by enhancing the local economy and promoting renewable energy rather than just being an investment opportunity. This is encouraging as it signifies a shift towards the ethos of a CE.

One key driver of WtE was found to be the role of municipalities which came up in the interviews on numerous occasions. As municipalities have what is called as constitutional autonomy it allows them to make decisions largely independent of national level, this is shown in various locations in various Nordic countries where WtE is more advanced based on the unanimous agreement from leaders and the interplay between private and state companies within that municipality. Naturally the role of municipality is large due to the fact that waste management operations are a duty of the municipality. The success of WtE infrastructure depends on the overall viability of a project which municipalities have helped by creating a demand for the resulting energy forms and creating infrastructure to accommodate it such as bio-fuel pumping stations and public vehicles to create a market for bio-fuels which is happening in Jyväskylä and Vaasa for example.

When questioned on the importance of WtE in a CE for Finland at the present time the respondents' overall opinion of importance was that as WtE is the last stage before disposal it is the defining moment when any remaining value can be extracted and kept in circulation and henceforth an important part of a CE. The role of WtE was also held in high regard as the time taken to reach a funtioning CE is some way off and waste will not cease to be an issue. Furthermore WtE is seen as a better option for dealing with hazardous waste which might suggest its longevity is enhanced for the future and the fact that technology keeps developing to incinerate more cleaner and efficiently. Finally WtE for Finland is mentioned as having added value in that other alternative energy sources such as solar and wind power have less potential which places more demand for WtE.
Interestingly the secondary data from the Nordics showed a less optimistic outlook on WtE especially when considering its future role in a CE. Norway has taken up a 'waste export' orientated role as it's financially a better option for them. As the EU's circular economy package pushes for the closed loop of materials and nutrients it is predicted that this will increase the stricter policies on energy generation and emissions leaving the WtE role based mainly around residual and hazardous waste. Denmark it would appear recognise this and are taking this in mind with the long term goal which is to be fossil fuel free by 2050 which includes the eliminationof incineration.

4.3 The Circular Economy

The terminology for what a circular economy means is recognised as fairly straightforward, the problem arises when taking the theory into practice as the respondents had two general opinions that firstly there are many other terms and concept used that are related and as such there is a misunderstanding of where and how these different terms link to CE. Secondly there is the difficulty in showing concrete examples of working CE's and it is this that stops companies from understanding what a CE means for their company. The same problem is more endemic for the Nordics and CE in general as the key concepts remain undefined and instead vague and general terms are used in national policies. This weakness in national policy further affects the ability to access CE progress and to take a measure of circularity. Ultimately for Finland the key as Brewer (2016) states, will be in making CE legislation clear and predictable so that business can respond in the desired way. The respondents made it clear also that economy is the key word to take from circular economy and that a financially economic basis is key which is to say that a CE cannot operate purely on an environmental and natural resources concern basis. The opinion is that WtE is an economic solution to waste at the moment but that in the future recycling will be become more economically feasible due to advancements with technological know-how. This is what Ragn-Sells (2016)

sees happening in the near future and strongly urges the EU framework to clearly define the public sector role and make sure there is an open market and equal competition as after all the growing economic opportunity of waste is going to create a large group of competing business operations who want to get their hands on a share of the value from waste.

The respondents all for the most part had experience in working with CE projects through also through co-operation and mutual assistance with each others respective companies, so much of the dialogue was similar. CE projects in practice in Finland as in other Nordics show that a trusted format of city and municipal scale projects are in fact commonplace. Often being referred to as 'pilot' projects they tend to have certain focus areas that they specialise in to show how that aspect can flourish, water saving or particularly of late, wood waste projects and the sharing economy. In Finland some eight cities have bigger ideas where roadmaps to resource wisdom are being implemented and even more encouragingly the government due to EU regulation pressure has taken pre-emptive steps and commissioned a national roadmap to a CE. Whilst large projects are of importance the fact that SITRA for example are all about the smaller areas to with trying to shift focus from large companies down to smaller companies to show that a business case can be made for start-up companies too in CE. Sweden and especially Denmark show more advanced and larger examples of functioning CE projects with various cities, towns and dedicated industrial areas implementing closeto full circle systems.

Regarding the three targets taken from the circular economy package there were some clear concerns from the respondents even though the opinion was that for Finland the targets were largely achievable as was the secondary data on Nordics, the 1st target of *recycling 65% of Municipal waste by 2030*was seen as problematic. Firstly the concern from the SITRA respondents were that CE goes beyond simple percentages and that waste and recycling alone is not enough to aim for in the circular economy package and secondly that the current package was amended from the earlier version to include slightly lower percentage goals. The goals of *A binding landfill target to reduce landfill to maximum 10% of all waste by 2030*&*A common EU target for recycling 65% of Municipal waste by 2030* were seen to me already met or close to being met by Finland and other Nordics, the attention was turned to the fact that in the EU there is the wide disparity of less developed countries to reach it. For Finland the *recycling 65% of Municipal waste by 2030*goal was seen as hard to reach for reasons touched upon in previous questions which are that as such to this date recycling is complex and expensive when compared to incineration for energy. Currently recycling rates were given as between 18% to 35% when even the 2016 goal was 50% which shows that Finland would need to make drastic changes to catch up and reach 65% by 2030 but as quoted by numerous respondents it's not impossible but will be a challenge.

Finally it was also agreed that benchmarking is a useful approach to driving CE forward. The respondents showed awareness to other Nordic practices and trends and admitted to being behind or ahead of other countries on various aspects. Finland was said to need to learn from the others to look at context and to consider the bigger picture of CE, not just to excel at particular practices but to think about taking the lead, not just catching up the other Nordics.

5. CONCLUSIONS

The study set out to find out about the circular economy in Finland and how the three aspects of WtE, CE and the zero-waste goal interrelate and actually benefit each other in reaching their respective objectives, using comparison Nordic countries to add comparability. Although the statistics on waste management by category put Finland behind the other Nordics with lower energy recovery and lower recycling rates and with higher disposal rates (Eurostat, 2012), onereason is put down to simply being slow to start the process of WtE implementation in comparison to other Nordics. Key to success is planning for the future rather than catching up which is where Finland is said to have gone wrong in the past.The added benefit to Finland of WtE is that there is a higher energy efficiency from WtE as excess heat is utilized in district heating which is needed for the long winter months. The circular economy in Finland is more difficult to ascertain as Preston (2012) mentions the term is used inconsistently and is still largely a theoretical concept that is too concentrated on business cases when in reality it includes a web of structures including societal values and organisations, institutions, policies and regulations (EMF, 2012; EC Circular Economy Communication, 2014). In Finland the problem of understanding how the theoretical concept translates into practice is furthered by number of related and similar terms and also what they mean in practice. The example of the bottle recycling scheme in Finland is used as a good example of CE, the future will depend on how large and small companies can be encouraged to see CE as business opportunity and not just a social and environmental responsibility.

The overall conclusion is that having a zero-waste goal that relies on the incineration of waste, even though it provides an energy source, does not contribute to a CE and in fact is detrimental to it as in theory it allows a country to still operate as a linear economy, consuming and incinerating large amounts. As Curran & Williams (2011) mentioned, a zero-waste vision has contrasting goals with WtE. In order to have a fully functioning CE, society needs to completely re-evaluate what it considers as waste and each stage of the waste hierarchy needs to keep hold of the value as much as possible during the stages of prevention, re-use, recycling and to recovery which implies that that the role of the recovery stage is made less important as there is less material to extract value from. This would place the recovery stage as less important in the future and WtE would be assigned to only minimal amounts of hazardous and residual waste. Finally to conclude, in a perfect CE the energy sources will not be sourced from WtE as much as it is today, even though now for technological and financial reasons it makes sense, the future will inevitably bring technological advances to make recycling the better option for waste, this would implicate that Finland should concentrate on other alternative renewable

energy sources rather than investing in future WtE infrastructure, if they are to truly progress to a CE model.

5.1 Limitations of the research

Using a sample size of 4 individuals somewhat limited the scope of the generalizability of the primary data. Furthermore using secondary data of other Nordics, sourced from internet sources in order to act as a benchmarking reference to compare the answers of the respondents led to some limitations. As such the author was free to pick and choose which sources to use and what content to consider important which somewhat lessens the scientific credibility especially as the sources on relevant, up-to-date data was often not from academic journals but news articles and blogs.

The data collection method used a semi-structured interview method but for time and practicality reasons the respondents were not often prompted with additional or clarification questions however the transcript often would go slightly off-topic. However it would give very good data even though it was not relevant to the exact question which maybe suggested the format should have been a more open ended interview or even focus group approach.

5.2 Suggestions for further research

As this was a study that looks at the relationship of 3 factors, further studies dedicated to eitherzero-waste, zero waste to landfill, WtE or CE would benefit by gaining a more exclusive in-depth look concentrated on the single concept and would maybe gain more relevant data. Also as this was a qualitative method study, a quantitative method study on the same subject might be able to show different data sets which could also be compared to this study. Due to the relatively new concept and fast growing concept of CE, it could be worth to make a longitudinal study by making 5, 10, 15 year apart data collections in order to show how the concept has developed and grown. Furthermore as this study featured only minimal references to the technological aspect of the CE and WtE it would be a good addition to make studies that more evenly includes the technological and business& social aspects of the topics. Finally as this study suggests the transition away from WtE, further studies should be done on how this can be done and what other energy sources are available for Finland in the future.

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APPENDICES

Questionnaire

- Name -
- Company -

Zero waste

1. **What is your job and how is it related to waste-to-energy and circular economy?**

2. **How would you define the idea of the zero waste/zero-landfill goal?**

3. **Is there much discussion of the topic of 'zero waste' within your company?**

4. **How important do you consider the topic of zero waste?**

Waste to energy

5. **How would you define the term of Waste-to-Energy?**
6.
7. **Explain a typical WtE project in Finland?**

8. **What are the main strengths of Finland in WtE?**

9. **What are the main weaknesses/problems in Finland with WtE?**

10. **What is you impression on WtE in other Nordic countries? What are their strengths and weaknesses?**

11. **What could Finland learn from other Nordic countries with WtE issues?**

Circular economy

12. **How would you define the circular economy?**

13. **How the circular economy is currently implemented in Finland?**

14. **What are the main problems with the idea of the circular economy?**

15. **Explain the role of waste-to-energy in a circular economy and its importance?**

16. How realistic is the whole concept and how realistic are some main targets?

- ***A common EU target for recycling 65% of Municipal waste by 2030***
- ***A common EU target for recycling 75% of packaging waste by 2030***
- ***A binding landfill target to reduce landfill to maximum 10% of all waste by 2030.***

17. What are your impressions of the circular economy in other Nordic countries?

18. What could Finland learn about circular economy from other Nordic countries?

19. Is there anything you would like to add?

Thank you very much