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Circular Economy in Real Estate Investment Companies

Case Study: Suomen Yliopistokiinteistöt Oy, Kampusareena

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Circular economy is an arising topic in real estate industry as global resource scarcity starts to concern economy in the society. The aim of this thesis was to find a definition and a concrete meaning for a circular economy in real estate investment companies. The thesis focused on theoretical aspects of a circular economy, on the connection of legislation and other policies to the topic and then on finding practical methods for applying circular economy in real estate investment companies. The thesis was carried out to gain a deeper understanding of what circular economy means in practice.

The study was executed by conducting interviews and by organizing a workshop. Two experts were interviewed to gain opinions on the definition of circular economy in real estate investment companies. A case-study building Kampusareena, owned by Suomen Yliopistokiinteistöt Oy (University Properties of Finland Ltd), was evaluated in terms of present situation of circular economy to find practical measures of circular economy. Qualitative results were analysed and interpreted. The results of the study proved that a circular economy in real estate investment companies concerns mainly resource efficiency in their properties and construction projects; yet the core aspects of a circular economy varies depending on the building type and the phase of life of the building. The results suggest that a circular economy comes already true in real estate investment companies to a certain extent, which indicates that some of the components of a circular economy have been integrated to everyday business before the creation of the concept of a circular economy. Environmental certifications were shown to be one of the tools which benefit the circular economy when again legislation sets limitations. Despite the promising state of sustainability in real estate investment companies, the results showed that there is clearly room for improvement.

The future development needs tools to ease changes in practice and to measure circular economy. Practical actions and tools seem to be the optimal way of making circular economy more concrete and understandable for real estate investment companies. On the basis of the results of the case study future research on development of tools for circular economy in real estate industry is recommended.

Keywords	circular economy, real estate industry, real estate investment company, property development, resource efficiency

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Kiertotalous on noussut esille aiheena kiinteistöliiketoiminnassa, kun maailmanlaajuinen raaka-aineiden väheneminen on alkanut herättää huolta yhteiskunnassa. Tämän opinnäytetyön tavoite oli löytää konkreettinen määritelmä kiertotaloudelle kiinteistösijoitusyrityksissä. Opinnäytetyö tarkasteli kiertotalouden teoriaa, lainsäädännön ja muiden ohjauskeinojen yhteyttä kiertotalouteen sekä etsi käytännöllisiä tapoja toteuttaa kiertotaloutta kiinteistösijoitusyrityksissä. Opinnäytetyö toteutettiin, jotta kiertotaloutta ymmärrettäisiin paremmin käytännössä.

Vastauksia opinnäytetyöhön etsittiin haastattelujen ja työpajan avulla. Kahta asiantuntijaa haastateltiin heidän mielipiteistään kiertotaloudesta kiinteistösijoitusyrityksissä. Esimerkkikohteena ollutta rakennusta, Suomen Yliopistokiinteistöt Oy:n omistamaa Kampusareenaa, tutkittiin kiertotalouden näkökulmasta ja käytännön tapoja kiertotalouteen etsittiin. Kvalitatiiviset tulokset analysoitiin ja tulkittiin.

Opinnäytetyön tulokset vahvistavat, että kiertotalous kiinteistösijoitusyrityksissä on pääasiassa kiinteistöjen ja rakennusprojektien resurssitehokkuutta, vaikkakin kiertotalouden ydinasia riippuu rakennustyypistä ja rakennuksen elinvaiheesta. Tulokset antavat ymmärtää, että kiertotalous toteutuu kiinteistösijoitusyrityksissä jo jonkin verran, mikä viittaa siihen, että jotkin kiertotalouden osa-alueet ovat olleet osa jokapäiväistä liiketoimintaa jo ennen kiertotalouden konseptin kehittämistä. Rakennusten ympäristösertifikaattien osoitettiin osaltaan edistävän kiertotaloutta, kun taas lainsäädäntö asettaa rajoituksia kehitykselle. Vaikka kiinteistösijoitusyritysten kestävä kehitys vaikuttaa lupaavalta, tulokset kuitenkin paljastivat selkeitä kehityskohteita.

Kiertotalouden kehitys tulevaisuudessa tarvitsee työkaluja käytännön muutosten tekemiseen ja kiertotalouden mittaamiseen. Käytännön toimenpiteet ja työkalut näyttävät olevan paras keino, millä kiertotalous saadaan konkreettisempaan ja ymmärrettävämpään konseptiin kiinteistösijoitusyrityksille. Tämän opinnäytetyön tulosten pohjalta suositellaan lisätutkimuksia kiertotalouden työkalujen kehittämiseen kiinteistöliiketoimintaan.

Avainsanat	Kiertotalous, kiinteistöliiketoiminta, kiinteistösijoitusyritys, kiinteistökehitys, resurssitehokkuus

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I praise my family and friends for their endless support: My mother Tarja Asikainen for sharing her knowledge and spending her valuable time on supporting and guiding me, my friend Arina Makarova for agreeing to be my opponent and my friend Stephan Mehnert for constantly pushing and cheering me to complete this thesis.

Despite all the support I got from abovementioned people and organizations, I solely am responsible for any flaws in this thesis. I dedicate this thesis for everyone who supported me and believed in me. This thesis was truly the perfect way to end my studies and the achievement I accomplished fills me with excitement and joy.

Helsinki 24.8.2016
Johanna Markkanen

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Abbreviations and Units

BIPV	Building integrated solar electric generator
BREEAM	Building Research Establishment Environmental Assessment Methodology
CE[1]	Circular economy
CE[2]	Conformité Européenne
CHP	Combined heat and power
CO_2	Carbon dioxide
DH	District heating
EMAS	EU Eco-Management and Audit Scheme

ETA	European Technical Assessment
ETV	Environmental Technology Verification
EU	European Union
kW	Kilowatt
LCA	Lifecycle Assessment
LEED	Leadership in Energy and Environmental Design
NBCF	National Building Code of Finland
O&M	Operation and maintenance
PV	Photovoltaic
RES	Renewable energy sources
TEM	Työ- ja elinkeinoministeriö (Ministry of Economic Affairs and Employment)
YM	Ympäristöministeriö (Ministry of the Environment)

1 Introduction

1.1 Background and Justification

Natural resources have been vastly consumed by humans in the creation of modern world. Industrialization boosted economies in many countries but began also the era of pollution. The black gold, oil, has made modern lifestyle possible providing us electricity, heating and cooling wherever it is needed. Nevertheless the comfort of living has its price: excessive consumption of resources is leading to material scarcity [1, 272]. At the same time as nature is being ripped off, pollutants are emitted to nature in increasing amounts despite the global acts on climate change mitigation. The *World Scientists' Warning to Humanity* [2] declared that "Human beings and the natural world are on a collision course", but this is being ignored. The future needs drastic changes in economic models in order to sustain the Earth for future generations and keep the economy growing. The solution could be a recently emerged model of a circular economy. Less material needs to be enough to make more; thus, circular flows of materials and energy are the key factors in the new economy model. Circularity supports sustainability, and it is clear that circular economy will have a great role in building sustainable societies and business strategies in the near future.

The circular economy model is not well known in the society yet. The concept of the circular economy is fairly extensive and abstract; hence, defining the practical measures of the circular economy is a huge step forward in the development of a sustainable society. Tightening EU directives and Finnish legislation create additional pressure on energy and material efficiencies of buildings and on the handling of environmental issues. Creating a concrete definition for the concept of the circular economy and studying the current state of environmental issues in real estate industry may help finding new points of view and advance sustainability, the economy and the meeting of environmental targets.

1.2 Theoretical Framework

Theoretical part of this thesis focuses on the general concept of the circular economy. The main principles are defined, after which targets and benefits of the circular economy model are presented. Then, the theoretical part introduces measures of the circular economy related to real estate industry on the basis of the general theory. The

current state of environmental policies in real estate investment companies are studied with respect to the circular economy. The link between environmental certificates and possible other measures in controlling and operating buildings is to be found. Legislative issues related to the circular economy and real estate industry are studied and future prospects are to be found in order to identify topics of interest for an empirical research. The research will either support or contradict findings on the basis of the presented theory. The theoretical part of the thesis gives a solid foundation for conducting a gainful research.

1.3 Research Questions, Methods and Scope

The objective of the study was to define the concept of the circular economy in real estate industry from a real estate investment company's perspective in a more understandable and concrete way. This meant finding practical measures for creating a sustainable circular economy model for real estate investment companies by conducting an empirical research. The study attempted to find answers to the following research questions:

1. What is the circular economy in real estate investment companies?
2. How is the circular economy realized in real estate investment companies at the present time?
3. What kind of obligations does legislation related to the circular economy set to real estate investment companies, and what kind of possibilities arise through these obligations and through other possible driving factors?
4. What are the future prospects of the circular economy for real estate investment companies?

Answers to these questions were ascertained by interviewing experts, who were enquired about the present situation and future possibilities of the circular economy, and by a workshop including a real estate investment company. A case-study building was evaluated in terms of the present situation of the circular economy. These two qualitative empirical methods aimed to define the concept of the circular economy and its future in real estate industry. The study focused on the circular economy in Finland and is applicable in Finnish real estate investment companies.

The concept of the circular economy in Finland has been studied previously from a broad, general point of view as a thesis work [3]. Another thesis was written on the circular economy in Finnish real estate industry; it studied the circular economy model as a case-study in industrial premises from the building owner's and user's point of views. The study focused on the current situation analysis of the industrial building and on finding development areas within, but it did not take stand on any legislative issues nor considered the investment sector in real estate industry. [4]. Thereby this study fills in the gap left by aforementioned theses and studies the circular economy in real estate industry from an investment company's perspective.

1.4 Limitations

Limitations of the study are considered to give information to the reader for evaluating the results of this study in an accurate manner. This thesis includes a few limitations which are important to consider. Firstly, the field of the study is new, and only a limited number of prior researches on the circular economy has been carried out. Also, real estate industry has major gaps in the previous researches conducted on circular economy issues. The limited number of previous studies means that there are no right and wrong answers. It leaves room for innovative thinking for the researcher and it should be considered when evaluating the results.

One of the empirical methods of this thesis has a major limitation: The number of interviewees is small. This is, nevertheless, compensated by the workshop. It is important to consider that the findings of this study are applicable in Finland since the research boundary was set to cover conditions and legislation only within Finland. The timetable and the due date also set constraints for the study, which might have limited the outcome of the study.

2 General Concept of a Circular Economy

2.1 Definition

A circular economy (CE) is described at its simplest being an economy model the main principles of which are circular flows of materials and energy. Traditionally, the economy has followed a linear "take-make-dispose" model in which resources are

excavated from the ground and further processed to manufacture products for consumers to be used and disposed as waste at the end of the lifecycle. Figure 1 presents the distinct difference of linear and circular economies.

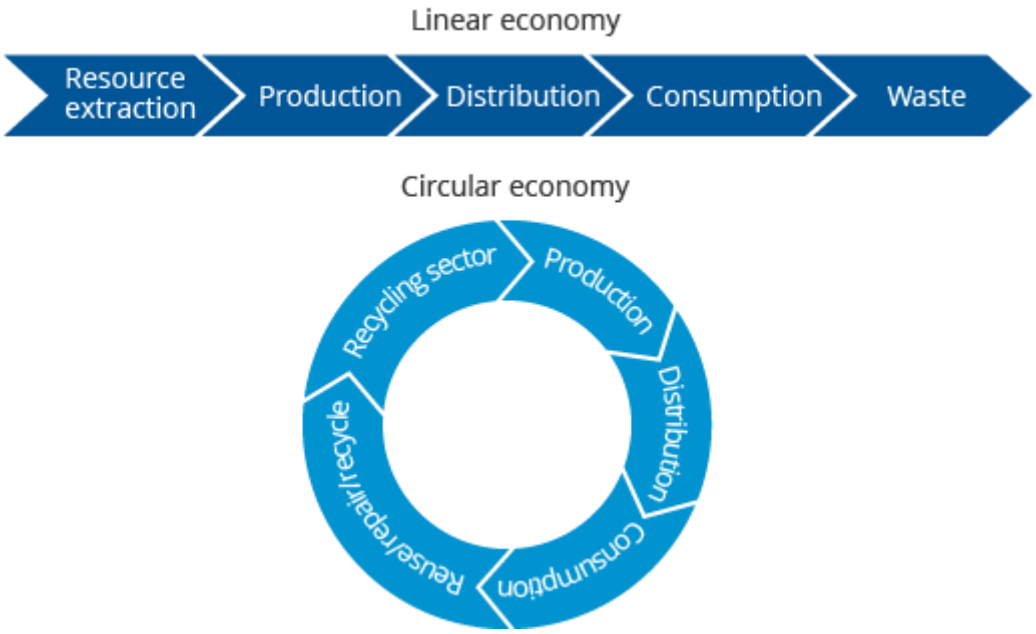

Figure 1. Linear economy vs. circular economy. [5]

Using only virgin materials in production and throwing away used products as waste is not a good basis for a sustainable economy [1, 269]. Humans are inevitably a part of nature; therefore, human economics can be considered as a sub-system of general economics of nature [1, 94]. Earth's natural cycles are an excellent example of how functional and sustainable cyclic systems are: Nutrients from the soil are consumed by a living plant, which converts carbon dioxide and water into oxygen and sugar utilizing the energy from sunlight, and at the end of the plant's life, it is broken down by decomposers releasing nutrients back to the cycle. Hence, circularity, a main principle of sustainability, must be introduced to a human economy by imitating natural ecosystems and their cycles [1, 94].

A definition of the circular economy given by Ellen MacArthur Foundation [6, 7] states that

> A circular economy is an industrial system that is restorative or regenerative by intention and design. It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models.

Thus, the core of a circular economy is a nature-imitating concept of "cradle-to-cradle" instead of traditional "cradle-to-grave" [1, 271]. The focus is on recycling and reusing materials, producing energy from renewable sources, offering services instead of products and aiming towards a zero-waste society. Flows of materials in the circular economy are loops: Another's used product becomes another's resource. Products ought to be designed for full recycling, and the society should provide infrastructure capable of recycling them [1, 270].

2.2 Principles

As stated in the previous chapter, functionality of the circular economy is based on a few main principles. Ellen MacArthur Foundation [6, 22] defined principles of the circular economy as designing out waste, building diverse systems, relying on energy from renewable sources, thinking in systems and treating waste as food or nutrient. These principles convert flows of materials and energy into loops, which in the long run aim to use a little or none virgin material and to minimize the loss of nutrients from the cycle, as shown in Figure 2.

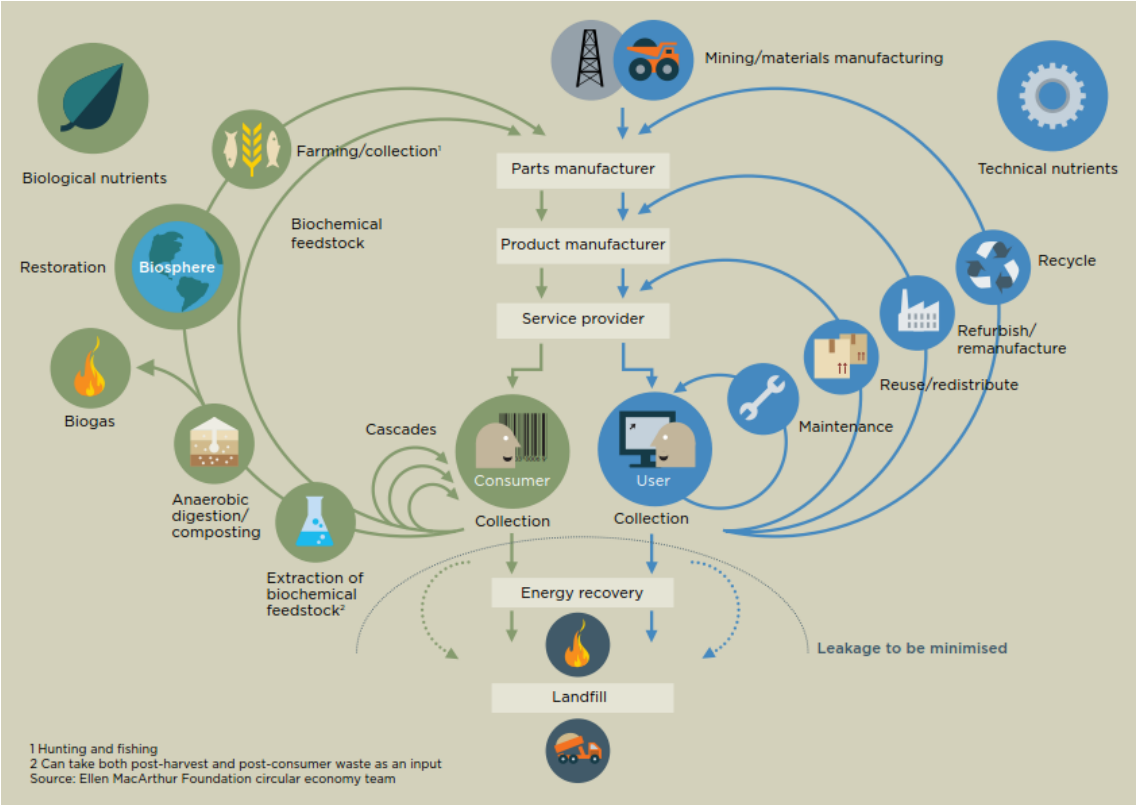

Figure 2. Principles of the circular economy. [7]

The first principle says that waste does not exist any longer if products are designed to act as biological or technical nutrient after its primary use. According to the principle, biological nutrients are non-toxic and compostable, while technical nutrients are reusable with a small effort and minimal loss in quality. [6, 22]

The second principle emphasizes the importance of diverse systems. Adaptability and versatility are to be prioritized in systems to increase resilience towards instability in the world. This principle goes together with the idea of imitating natural systems, which are resilient by nature and adapt to their environment with diversity and complexity. [6, 22]

The third principle urges systems to aim to run on energy from renewable sources. It barely needs justification why renewable energy sources are favoured over non-renewable energy sources; renewable energies are in the core of the circular economy. [6, 22]

The fourth principle is about systems thinking, which is usually applied to non-linear systems. Parts of a system influence one another and relationships of the whole and

the parts with infrastructure, environment and with social contexts are important to be understood. [6, 23]

The fifth principle returns back to the ideology of no-waste mentioned in the first principle. Waste is to be thought as food in the circular economy: It is a biological and a technical nutrient from which parts, products, services and energy can be made of. Whereas the traditional recycling is understood to result in loss in quality in the feedstock, the nutrients in the circular economy can be improved in an upcycling process. [6, 22-23]

2.3 History and Development

The concept of the circular economy is not historical, but parts of it have been existing for a while. Resource efficiency was identified already in the nineteenth century, when waste from meat industry was provided as an input to other industries, but the time of waste exchange did not last long [1, 297]. Resource scarcity hit car manufacturing industry during the Second World War and created the concept of remanufacturing, which aimed to durability in production and repairing old parts to extend the lifetime of cars. Economic benefits of remanufacturing were discovered, and it continued becoming more popular among industries. [8, 37]. Recently, waste recovery started booming again [1, 297]. Industrialization hit the environment with heavy loads of pollutants and caused problems locally as well as globally. The impact of pollution was slowly recognized. Environmental protection started to enter policies and legislation, and thereby affect the global economy on a level never seen before. It must have been realized that the availability of resources on Earth is not sufficient to sustain the current rate of economic growth; global scarcity of resources is now becoming an accepted fact that economies need to deal with. Lieder and Rashid [8, 37] claim that circularity emerged by force, not by development: Industrial revolution accelerated the production and consumption of disposable products changing the relationship between humans and materials. In fact, China's rapid economic growth forced the Chinese to adapt to environmental consequences of their industries in the 21st century by implementing strategy for a circular economy among the first ones in the world. [8, 37]. Yet, it must be noted that the circular economy has been realized in Finnish industries for a few decades: For example, wood industry has had an operating industrial symbiosis even before the current definition of CE [9, 12]. The circular economy boomed in Europe after 2000, first launched as *The Raw Materials Initiative* in 2008 to conserve natural

resources by European Union, then later in 2015 Circular Economy Package was published, which is expected to change the current linear economy in Europe towards a circular one [1, 277; 10].

The definition of the circular economy dates back only a few years to 2012 when Ellen MacArthur Foundation [6, 1] published an extensive report on the circular economy which aimed to inspire readers to “rethink, redesign and build a positive future”. Their statement is strong; the current linear economic model leads to severe consequences, and dramatic changes are needed globally to secure modern world’s living standards. [6, 2]

2.4 Goals and Benefits

The circular economy aims to achieve circular flows of materials and to retain resources as resources; that is, eliminate the concept of waste by designing products to be recyclable, create recycling policies, and utilize renewable natural resources. The idealistic goal is to permanently reuse resources in a way that allows sustainable economic growth. This also means minimizing environmental impacts of the economy. Renewable inexhaustible natural resources provided by the Earth are a necessity in replacing conventional fossil fuels in energy production and in decreasing pollution to the threshold limit that nature can bear. [1, 269-270]

Benefits of the circular economy to the environment cannot be overly expressed. Increasing recycling and reuse rates decreases greenhouse gas (GHG) emissions and extraction of virgin resources, together with minimizing environmental impacts of mining. Recycling consumes greatly smaller amounts of energy compared to the energy consumed in extraction of virgin materials. Promoted usage of biotic materials results in diminishing levels of toxicity and therefore improves the wellbeing of nature and humans. The benefits extend further than just to the condition of the environment. The economy is expected to grow if the circular economy model is adopted on a national level: Seppälä et al. [11] claims that gross domestic product of Finland would grow and thousands of jobs would be created in 15 years. These estimates may even be low since the study covered only limited aspects and possibilities of the circular economy in Finland. Social benefits arise from a sharing economy, which is a part of the circular economy, and the social benefits are not yet shown in any calculations as an added value to the society. The fact remains, that the economic benefits, as well as

the environmental benefits, are of a great worth for the society. [1, 275, 279, 282; 11, 72-73]

2.5 Limiting Factors

Great challenges appear when great changes happen in economic structure, of which some challenges may be unsurpassable. According to a study of Bermejo [1, 270], the circular economy can truly be possible only in decentralized societies. The study claims that the economic structure should be simplified to mimic natural ecosystems and their cycles. A major limiting factor in developing the circular economy is the recycling sector. In order to recycle resources efficiently, or at all, the society needs companies who are dedicated to recycle the resources. Dedication for such business may be dependent on cost-efficiency of the business. Profitability of recycling depends also on the usefulness of the secondary raw material gained from recycling. Then, resource recovery plans need to be implemented to increase recycling rates of resources. At the present moment, recycling rates of 90 % can be achieved in industries, but the remaining 10 % would need drastic changes to get rid of the dependency of virgin materials in production. Rare metals, which are used in tiny quantities in many consumer devices, are difficult to recycle at the present moment, because recycling rare metals require highly technical and expensive recycling centres. Usage of alloys may decrease recycling possibilities of metals; there is no general data of different types of metals used in different alloys; therefore, effective recycling policies cannot be generated for salvaging rare metals. Critical metals used in utilizing renewable energies such as in photovoltaic (PV) panels are barely recycled and soon exhausted, which might endanger the employment of renewable energy technologies if recovery plans for critical metals are not created. [1, 270-271, 273, 276-279, 286]

Attitudes set limits to changes in the economy, and there is no way advancing the circular economy with the traditional approach to the production of goods. Manufacturing products in many different countries set great challenges to the creation of recovery plans. Continuation of landfilling inhibits recycling although it is highly likely that indispensable materials will be mined from landfills later on. The amount of waste being landfilled in Finland is decreasing due to changing legislation, but increasing waste incineration is potentially affecting recycling rates negatively [12]. In the circular economy, waste incineration is the last option for treating waste. A market, which allows competition between companies, is said to limit recycling since free competition

leads to the creation of new products or consumables and eventually increases the amount of materials to be recycled. It is clear that great challenges rise from the circular economy, and it might not be possible to fully implement the circular economy everywhere due to the limiting factors. [1, 271, 278, 286].

3 Circular Economy for Real Estate Investment Companies

3.1 Definition of Real Estate Industry

Real estate industry is a significant part of Finland's economy. Generally speaking, real estate industry refers to real estate investment companies, facilities services, building management, brokerage and real estate agents, property development, real estate finance, and to appraisal and advisory services. Built environment in Finland is worth of as much as 70 % of the total national wealth [13, 2]. In 2013, Finland's building stock consisted of 1.5 million buildings having a total floor area of 449.5 million floor square meters, of which residential buildings counted for 63 %, industrial buildings for 11 %, and business premises for 6 %. Real estate industry offers a workplace for every fifth employed Finn and therefore can be considered as major part of Finnish economy. [13, 9]

3.2 Real Estate Investment Sector

Professional real estate investment companies are investing more and more in Finnish building stock, and also the amount of companies in the field has grown during 21st century. Majority of these companies are Finnish, but international companies show also increasing interest in investment markets of Finland. Investment companies own 10 % of all buildings and properties in Finland, measured in value. That is, 48 million euros worth of buildings from total 480 million euros. [13, 2]

The traditional ways of investing in properties are direct investments by purchasing the building together with the ground it was built on, or buying shares from an apartment house company, or from a real estate corporation. Recently, indirect real estate investment has become more popular: instead of owning a building the investor owns shares from listed real estate investment companies or from real estate funds. [13, 20]. Indirect ways of investment are not further discussed in this study.

Real estate investment companies own majority of office buildings in Finland, that is, 72 % of the office building stock measured in value. In addition to that, professional investment companies own 40 % of commercial properties including hotels, 12 % of industrial premises and a small portion of residential properties, measured in value. One prominent feature in real estate investment sector in Finland is that companies invest largely in new buildings despite the use of the building. [13, 25-27]. This feature promises good chances in creating a circular economy around investments if the company can influence the design of the new building.

3.3 Companies' Motivation to Advance Towards Circular Economy

There are several reasons why real estate investment companies would want to improve their business from a linear economy towards the circular economy. It is important to think and state the motivation behind the will to change the economic structure since real estate investment companies are generally thought to be driven by the profit from their investments. This is partly true: the lifespan of an investment in real estate industry is relatively long; therefore, the business depends greatly on the profit which should correspond to the level of risk related to the investment [13, 3]. The profit comprises rental income and changes in the value of the property, and it is used to cover operational and maintenance expenses of the property during its lifetime [13, 3]. Therefore, real estate investment companies need the profit, and by taking care of the properties, they also maintain the building stock of Finland in a good condition and affect national wealth positively. This benefits the economy of the whole country in the long run.

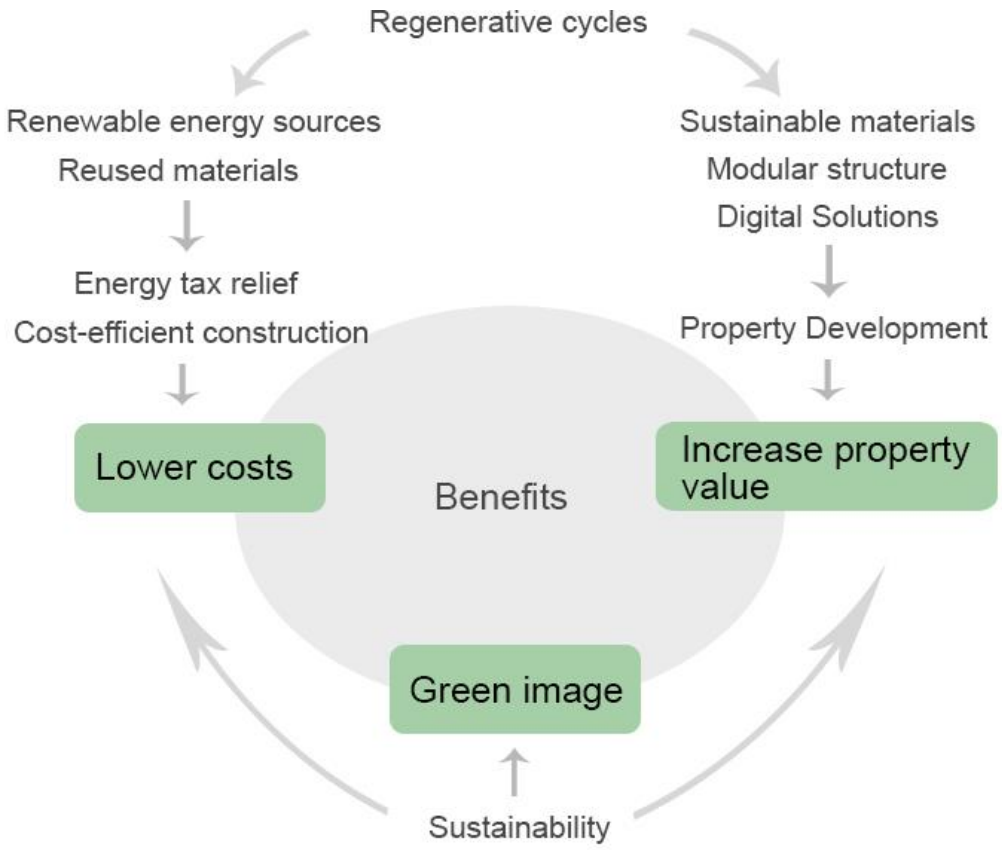

Figure 3. Benefits of the circular economy to real estate investment companies.

Applying the principles of the circular economy into the business would benefit real estate investment companies at least from three different points of view: lower costs from the investment, increased property value, and creation of a green image. There are possible other benefits which are further studied in the empirical research. Figure 3 presents the connection of abovementioned benefits to the circular economy; Figure 3 is derived from the publication of RAKLI [13], and it is a vision of the researcher. The benefits are explained in detail below.

3.3.1 Lower Costs

A significant part of operational and maintenance costs consists of taxes. For example, office buildings are subjected to real estate and energy taxes, which account for a fifth of the total maintenance costs. [13, 42]

Energy taxes can be minimized by changing to renewable energy sources (RES). Finland is one of the few countries who give tax relief for using RES. According to Raatikainen [14], solar panel systems smaller than 50 kW are basically tax-free and the system this size would easily fit onto an average building rooftop. This would be an opportunity for companies to produce electricity for their own, or tenants', use [14]. It is possible to get financial support for solar panel installations from the Ministry of Economic Affairs and Employment of Finland which makes renewable energy option more attractive and cost-efficient: the support can be as high as 30 % of the cost of the investment [15]. Replacing electricity bought from the grid with own electricity production could result in lower operational costs together with increased energy efficiency of the building. One of the key principles of the circular economy is to use renewable sources for energy production, and for these reasons it would benefit real estate investment companies [6, 22].

Other possibilities for lower costs exist also in operation and maintenance (O&M) as well as in renovation. O&M costs can potentially be lowered by investing in own heat energy production. Häkämies [16, 1] studied efficiency of heat pumps in buildings, and the study showed that a heat pump is more cost-efficient heating solution for a building when compared to the costs of district heating from the whole lifetime. In new construction and renovation projects, profitability of a real estate business can be improved by utilizing reused material. Turning waste of others into secondary raw material is cost-effective and may significantly lower costs of property development projects. [16, 1; 17]

3.3.2 Increased Property Value

The value of a property can be increased by actively developing the property. Renovation projects are done in increasing amounts, and they account for 50 % of all construction projects in Finland [13, 17]. Property development is done by working together with a contractor. Real estate investment companies as property owners have the chance to influence the design, usability of the building, energy efficiency, materials and internal cycles so that features of the building are aligned with the principles of the circular economy. Evidence shows that green buildings with superior environmental performance deliver also financial benefits to investors: tenants seem to be willing to pay higher rents and renew lease contracts more probably for energy efficient properties [18, 13].

Environmental certifications can be used to guide designing the new features of the building, which can reduce O&M costs and increase the value of the property. Achieved certification itself increases also property value since it is a verification done by a third party proving a certain level of efficiency and sustainability in the building. [19]. Environmental certifications for buildings are discussed more in Chapter 3.6.

It is clear that property development requires additional investment. Common misconception is that the cost of development of green, or sustainable, buildings is high, but evidence suggests that construction of a green building costs only 2 – 9 % more than the construction of ordinary ones [18, 14]. By assuming higher rental costs and lower O&M costs, the additional investment can be greatly beneficial in the long run.

3.3.3 Green Image

The circular economy would definitely have a positive impact on a green image of real estate investment companies. Green image is usually considered in branding purposes, but it is also a sign of sustainable thinking in the business. Both of the abovementioned benefits in previous chapters are related to creating a green image for a company. Utilization of renewable energies to become more cost-efficient, development of a property to enhance its regenerative and resource efficient features, and choices of sustainable materials would have a positive effect on the outlook of any company – possibly making them a forerunner in the change towards more sustainable society and the circular economy. [20]

3.4 Environmental Policies

A company's environmental policy is a statement of commitment to environmentally sustainable practices. It may also include targets or other commitments to promote sustainability in the business. The situation of environmental policies among real estate investment companies in Finland has not been studied, but environmental policies more generally in real estate industry was investigated by LaSalle [18, 9]. It must be noted that the results do not directly concern real estate investment companies, but they do give an impression of environmental policies in the industry.

Many companies in real estate industry have sustainability programs in use, are currently developing their policies, or are signed up for other programs including reporting practices. The diversity of environmental issues recognized in real estate companies is wide, and they concern mostly climate change, resources and materials, and waste, water and energy issues. Indoor air quality, land use, pollutants, toxins and biodiversity are also among other slightly less recognized issues. [18, 10]

There seems to be a growing interest towards implementation of environmental policies in real estate industry [18, 9]. Despite the fact that quite many companies act according to sustainability principles, LaSalle [18, 15] showed that real estate industry lags behind other industries in implementing environmental policies, and that the existing policies lack consistency.

The relation between environmental policies and the circular economy is a bit grey. Acts such as prevention of pollution, continuous improvement of environmental performance, promotion of recycling, and reduction of consumption of materials are correlated with the principles of the circular economy [6, 22-23]. Also, environmental consideration in an investment process and in renovation of buildings can be named as sustainable acts; thus, it can be said that environmental policies support sustainable economy. The problem seems to be that the statements in policies are separate acts instead of being a consistent strategy aiming towards one specific goal. Also, policies are not coherent among companies as stated in the previous paragraph. Current environmental policies would need to take circularity and regenerative features more into account in order to align with the principles of the circular economy.

3.5 Environmental Certifications for Buildings

Environmental certification is a method for measuring buildings' sustainability in a series of categories. The most common internationally used certifications are BREEAM and LEED. An assessment is carried out by an independent third party, and it evaluates environmental factors such as energy, land use, materials, pollution, waste and water, and human-related factors such as health and wellbeing, transportation, building management and innovation in design. Credits are awarded for achieving set targets, and the final rating reflects on the level of sustainability of the building. [19]

Environmental certifications are commonly known among real estate investment companies. Maija Virta, the former CEO of Green Building Council Finland [21], stated in 2011 that surprisingly many real estate investment companies demand buildings to have an environmental certification, and for example, international franchising stores might only choose to rent a business premise from a LEED certified retailer. Thus, investing a hundred thousand euros for certification is a good business for the retailer. [21]

The development of certifications has been fast, and nowadays it is more and more common to certify a building. According to a sustainability consultant, real estate investment companies have found environmental certifications useful since it makes buildings comparable with each other [Conversation with: Pirjo Niemi-Järvelin]. This kind of comparison is possible when buildings are rated by the same assessment method. Highly rated buildings perform most likely well in energy efficiency, sustainable management of operation and maintenance, low-impact material choices in sustainable design, and in addressing pollution and waste issues [19]. These top-class buildings are presumably on a way towards the circular economy, but the extent of the categories makes it difficult to draw conclusions only based on the final rating. If the scores of each category are not looked over separately, a high rating could potentially lead to false conceptions on the actual situation of building's sustainability. When interpreted correctly, environmental certifications provide reliable information on eco-efficiency and sustainability of buildings. Certifications are already a part of real estate investment industry making it potentially one of many tools in the creation of the circular economy.

3.6 Legislation and Other Policy Instruments

Currently legislation concerning environmental issues sets a certain bottom line for the lowest acceptable environmental performance for real estate investment companies whether it concerns construction, material or energy efficiency, or other issues. Finland being part of European Union is subjected to EU-directives; therefore, the direction of EU-policies practically means also the direction of Finland's policies. This chapter provides a compact review to legislation and other policy instruments related to the circular economy, and briefly looks into the restrictions and possibilities arising from the issues.

3.6.1 Notable Finnish Legislation and Policies

There are several laws that either restrict or advance the development of the circular economy in Finland. Most of the advancing legislation comes from EU, and majority of restrictions come from national legislation. Policy instruments, such as national programs, are guiding tools, which advance environmental and sustainable policies in the society and create a positive impact with respect to the circular economy [22, 21-22].

Construction is regulated by Land Use and Building Act and Decree, which sets limitations to advancing the circular economy in Finland. It sets general conditions and technical requirements for buildings and construction work. Using recycled material in construction might be challenging since building products need to have a proof that they fulfill requirements set by The National Building Code of Finland (NBCF). It seems impractical that the NBCF concerns directly only new construction and does not take a stance on reusing building products. Either way, according to the NBCF, building products need to have either a CE (Conformité Européenne) marking, granted European Technical Assessment (ETA) or other voluntary certification from manufacturer to guarantee that the product meets the legislative requirements. The latter one is the only verification method applicable on reused or recycled materials. A constructor must verify that reused or recycled material meets the requirements of the NBCF by applying for a product approval from The Ministry of Environment or from an approved third party company. [22, 20-21]

Material efficiency is promoted by the national material efficiency program (TEM 2013) set by The Ministry of Employment and The Economy in 2013. The program includes research and education related issues as well as legislative and international issues that aim to promote material efficiency from many perspectives. One of the most interesting targets of the program is a national approach to speed up the formation of industrial symbioses. The program started also the material efficiency auditing in Finland which is slowly getting more foothold in the industry. It seems positive that TEM 2013 program was not enough since construction material efficiency program (YM 2013) was established at the same time. Construction procedures affected by the program include promotion of functionality and adaptability of a building; highlighting the importance of recycled materials in life cycle assessments (LCA) of new buildings; educating building designers and construction workers to corporate material efficiency

in procedures related to their work; creating resource efficiency guides for construction sites to promote recycling and sorting waste; relieving waste legislation concerning health and safety issues; promoting the market for recycled construction materials; incorporating material efficiency perspective in real estate and construction industries' promotion programs. Overall, the aforementioned material efficiency programs are a great improvement and ought to help in the development of the circular economy in Finland. [22, 21-23]

Waste legislation reaches to buildings from many perspectives. Tenants of a building are responsible for their domestic waste management, but it is excluded from this review. Real estate investment companies are most in touch with waste legislation during the construction or renovation of a building. Then again, it is a constructor's responsibility to provide waste management to the construction site [22, 24]. Waste Decree states that construction must produce as little construction and demolition waste as possible, which can thus promote designing recyclable and reusable buildings. Waste Decree states also that if any waste is produced, firstly it must be prepared for reuse, and if reuse is not possible, secondly the waste must be recycled. Last option after recycling is energy recovery from the waste. Utilization of demolition waste in land construction is supported by Land Use and Building Act under a condition that utilization is to be announced to environmental authority. [22, 17]

European Union is laying pressure on energy efficiency of companies and industries. Energy Efficiency Act came into force at the end of 2014. It concerns real estate investment companies, as well as other companies too, if they are classified as large companies having over 250 employees or revenue over 50 million euros, or if they sell or distribute energy. The act states that companies need to go through an energy review every four years, which assesses buildings, industrial and retail businesses and transportation issues of the company from an energy perspective. The assessment is thereby mandatory for large companies, but can also benefit them by reducing operational costs if the improvements suggested in the energy review are implemented in action. Selling own-produced energy have to be declared to Energy Authority of Finland with additional information concerning time, price and consumption of end-user. This part of the law affects only the minority of real estate investment companies who have their own energy production, but could affect more and more in the future if investments in renewable energy sources becomes favored. [23]

3.6.2 Future Prospects of the Circular Economy in European Union

In 2015, European Commission launched a circular economy package which aims to advance the transition of EU towards the circular economy. The package is designed to close the loop of resources by taking into account the whole product cycle. Promises of creating a more than hundred thousand jobs on waste management sector and reducing a significant amount of GHG gases by 2035 sound ambitious. Katainen [10, 2] assures that “These proposals give a positive signal to those waiting to invest in the circular economy”. EU has a clear vision of the direction they are heading to, and actions start taking place during the current Commission’s term of office. [10, 1-2]

Commission’s list of actions, which concerns the circular economy package, is extensive, and actions start taking place in 2018 at the latest. The list includes actions related to production, consumption, waste management, and to the market of secondary raw materials. It separates actions for food waste, critical raw materials, construction and demolition, biomass and bio-based materials, innovation, investments, and for monitoring sectors. Since the perspective of interest of this study is real estate sector, only actions related to real estate investment companies are considered. [24]

Environmental management systems will be affected by the changes of the circular economy package: EMAS (EU Eco-Management and Audit Scheme) is under improvement and will be upgraded to be more efficient, together with environmental technology verification (ETV) programme. Property development sector will be affected by a number of construction-related actions. Utilization of secondary raw materials may become easier and safer due to the development of quality standards for secondary raw materials. Critical raw materials are striven to be extracted from complex end-of-life products. The Commission will publish guidelines for pre-demolition assessments, and demolition waste is to be recycled and recovered more efficiently by the help of voluntary recycling protocol in the industry. These actions will guide property development projects towards the circular economy, but perhaps the most remarkable change will be the action for assessing lifecycle environmental performance of buildings. An ongoing project of European Commission was established to determine the core indicators for the assessment; these indicators will concern environmental hot spots in energy, material and in water related issues throughout the lifetime of a building. The indicators are based on real-life performance analysis of buildings and

will cover new construction and renovation projects in the EU area. The project is expected to succeed if the indicators are applicable in real-life situations and can effectively estimate the environmental performance of buildings. Implementation of the lifecycle assessment will be later promoted by incentives. [24; 25, 1-2].

Cyclic features and green installations of buildings can be affected by actions such as promotion of cost-effective reuse of water. Minimum requirements for reused irrigation water will be set, and integrating water reuse in water planning and management will be promoted by additional guidance. Renewable energy is not included in the action list in any form except that the Commission will review the sustainability of bioenergy. Then again, the financial side of the changes is vastly considered, and financial support is planned to be given for the development of the circular economy and for any innovations related to that. [24]

The plans of EU are truly ambitious, and they may boost the process of transition of economic structure. Pietikäinen [26], a member of European Parliament, emphasized the importance of resources in the transition: EU must improve resource efficiency 30 % by 2030. Previously mentioned action of lifecycle environmental performance of buildings is also highlighted by Pietikäinen [26]. Changes in legislation are to be expected and real estate industry is subjected to tighter regulations concerning resource efficiency and cyclic material flows in buildings in the future. The promotion of circular flows in buildings will not yet be done under regulated laws, but if real estate investment companies act now, they will have an advantage over other companies. Also, their sustainable solutions make them less vulnerable to the future legislative changes [18, 14]. The establishment of the lifecycle environmental performance assessment of buildings will open new opportunities for third party companies to serve assessment services for building owners. The overall impact of the establishment can be evaluated in detail when the extent of legal aspects involved in it is revealed.

3.7 Applying the Principles of the Circular Economy

The circular economy in real estate investment companies has not been studied before as such; thus, it must be defined by applying the known principles of the circular economy. Although, there is no need to start from scratch since recently Dooley [17] studied circular economy in built environment. Dooley identified eight components of the circular economy which appear the most promising in built environment. Findings of

the study are presented in Figure 4, which illustrates the impact of components on each phase of building's lifetime. The components are presented and discussed in further chapters.

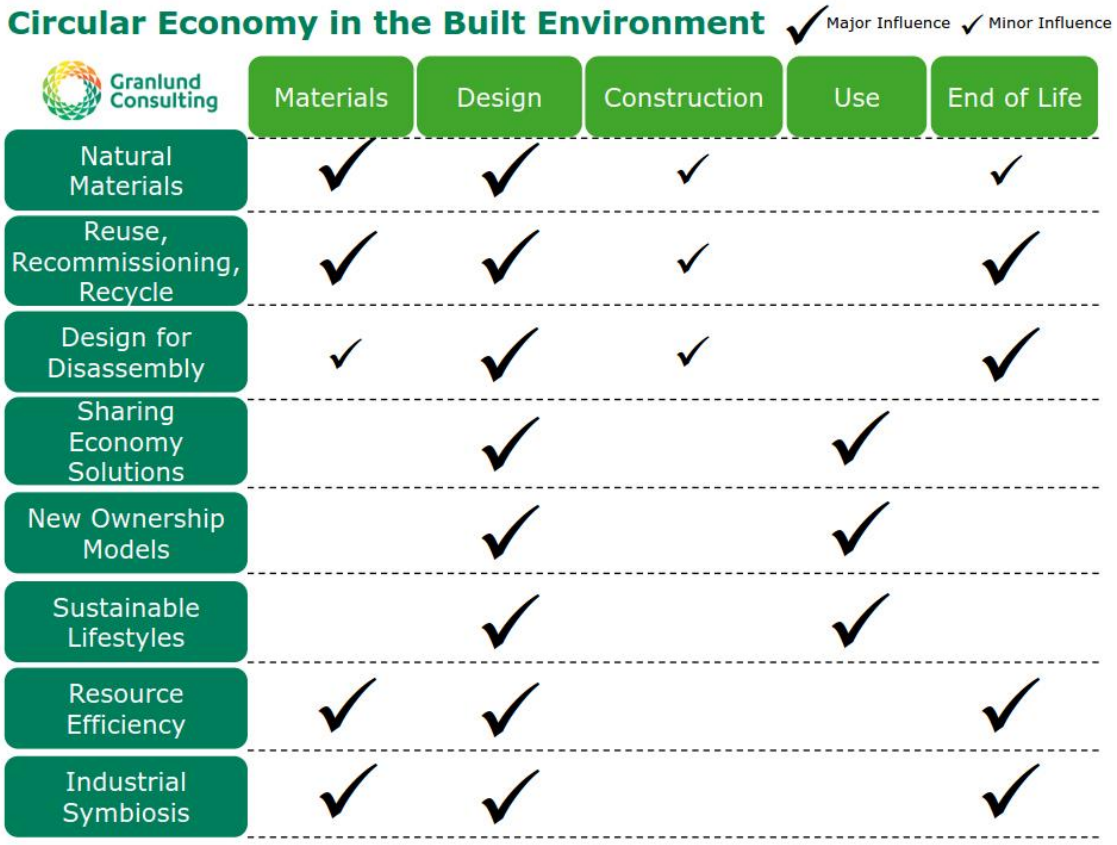

Figure 4. Findings of the previous study on the circular economy in the built environment. [17]

The findings are in line with the principles of the circular economy presented earlier in this study; thus, they are also applicable for real estate investment companies. One difference appeared between the study and the theory of the circular economy as defined by Ellen MacArthur Foundation [6, 7]: Dooley's study did not consider renewable energy sources nor sustainable energy solutions, although they are essential in the circular economy [6, 22]. Also, the study fell short in material section bringing out only natural materials; it is true that natural materials, biological nutrients, are significant in the circular economy, but so are other types of abundant materials, technical nutrients [6, 22]. Neither was water recognized as a resource, even though Bermejo [1, 270] classified freshwater as a renewable, exhaustible resource which should not be consumed in excessive rates in the circular economy. According to Dooley [27], "the core aspects of circular economy are minimising waste and material

consumption" and those issues should be dealt with before focusing on renewable energy and water recycling. It is apparent that Dooley's study has a more practical point of view and interpretations of the main issues in the circular economy vary depending on the researcher.

This chapter presents methods for applying the circular economy principles in real estate investment companies under eight categories. The methods are based on the theory, and they are derived from the principles of the circular economy as presented in Chapter 2.2 and from Dooley's findings. Loops of materials, zero-waste concept and renewable energy sources have been weighted more since they are in the core of the circular economy. A list of applicable methods is presented in Table 1, and the methods are further introduced in the following referred chapters of this study. The list is not definitive and brings up only the main theoretical findings concerning real estate investment companies.

Table 1. Suggestions on applications of the circular economy for real estate investment companies according to the main principles. [6, 22-23]

Principle	**Applicable method**	**Refers to chapter**
1. Cyclic flows of reusable, non-toxic and compostable materials	Usage of abundant and biotic materials	3.7.1
	Sustainable interior design	3.7.1
	Green roofs, facades and walls	3.7.1
	Design for disassembly	3.7.5
	Greywater and rainwater utilization	3.7.4
2. Adaptable, versatile and resilient system by nature	Building integrated solar collector and PV-panel system	3.7.3
	Integrated water recycling and irrigation system	3.7.4
	Sharing economy: Shared spaces	3.7.7
3. Renewable energy sources	PV-system with an energy storage	3.7.3
	Waste heat recovery systems	3.7.3
	Hybrid heating and cooling systems	3.7.3
	Ground coupled cooling	3.7.3
	Investing in power production	3.7.3

	Green electricity purchasement	3.7.3
4. Relationship and influences between the whole system and the parts	New ownership models: Leasing	3.7.8
5. Zero-waste concept and upcycling	Usage of local and recycled materials	3.7.2
	Industrial symbiosis	3.7.6

Majority of the possibilities of the circular economy arises from property development. Design of a building seem to be in a great role and can draw a line between circular and linear economies. Other possibilities concern services provided by or for real estate investment companies.

3.7.1 Sustainable and Natural Materials

The importance of materials and resources in the circular economy is great since one of the first driven factors towards the idea of circularity was the depletion of natural resources [1, 269]. New construction and renovation projects allow changes in materials of a building. Working together with a designer is important for the success of the project; designers should be encouraged to actively look for recycled or reused local materials [28, 104]. It was shown that the lack of interaction between the designer and the company might lead to unsuccessful results in the design and material choices [28, 101].

Diversity of types of materials from construction and from demolition is wide, and many of them are recyclable: metals, wood, glass, plastics, fabrics, paper, cardboard and stone [1, 279]. Durability, recyclability and reusability are desired properties of materials to be used, and Bermejo [1, 279] suggest that steel should be used in the structural elements. Reusing and recycling any material need to be done without lowering the quality of the material; the usage of virgin material can be avoided when the secondary raw material is high in quality [1, 315]. Another suggestion by Bermejo [1, 286] is that the system should be simplified to achieve the circular economy. That is, decrease the number of different types of materials used, use abundant materials, avoid using critical and scarce materials unless it is absolutely necessary, promote the use of biotic materials, and stop using hybrid materials such as alloys which cannot be effectively recycled [1, 286].

Sustainable interior design is as important as the structure of a building when it comes to material choices. A research on environmentally sustainable interior design by Hayles [28] focused on sustainable materials available on the market. Materials were sorted whether they are fabrics, window treatments, surface materials, flooring, or walls and ceilings. The results of the study are presented in Table 2.

Table 2. Sustainable materials for building interior. [28, 104-105]

Category	**Sustainable Materials**
Fabrics	Recycled fabrics
Window treatments	Wood, flax, hemp, bamboo, fabric 100% recyclable composite material
Surface materials	Recycled glass
Flooring	Hard flooring: Cork, bamboo, wood, linoleum, recycled rubber, natural stone, recycled tiles or terrazzo, in-situ concrete Carpets: Recycled materials, wool, organic cotton, bamboo, hemp, jute
Walls and ceilings	Recycled glass, ceramic or porcelain tiles Paper wall covers Water based and clay paints Earth-based plasters Faux stone made with waste products

The study revealed that the most sustainable fabrics are the ones created from recycled fibres; some of them can be extremely durable. Therefore, the use of recycled fabrics should be encouraged. Wood, flax, hemp, bamboo, fabric or 100 % recyclable composite material can be used to make sustainable window treatments. The research failed to define any suitable surface materials, but suggested recycled glass as an example. Hard flooring could be made of fast growing or renewable materials such as cork, bamboo, wood, linoleum, recycled rubber, natural stone, recycled tiles, terrazzo or in-situ concrete. Although concrete is considered as sustainable building material in the study, it does not fully fit into the principles of the circular economy unless it is brought back to material cycle e.g. as recycled concrete aggregate at deconstruction phase. [28, 104; 1, 287]

Recycled materials for carpets are considered as a good option along with wool, organic cotton, bamboo, hemp and jute. Moreover, when it comes to walls and ceilings, mostly recycled materials are recommended: recycled glass, ceramic or porcelain tiles,

paper wall covers made from plant fibres, water and clay based paints, earth-bases plasters and faux stone made with waste products. For further help on material choices, online green building material databases are recommended to be used. [28, 104-105]

An exterior of a building can also include natural materials such as green elements. The main function of green elements in the circular economy is to increase biodiversity of built environment by adapting to the environment [6, 22]. Green structures are favoured traditionally in warmer climates. The most commonly used green structures are green roofs, green walls and green façade. Pros and cons are present in each category, but the benefits might be surprising. It has been shown that green roofs act as an effective insulator, and even R-value data, a measure of material's resistance to heat transfer, is available for a certain types of green roofs. Green façades and walls prevent heat gain of a building by absorbing sunlight. Green walls differ from green facades: facades are separate freestanding structures which can be attached to the building; this feature allows more flexibility in design. From environmental perspective, the most significant benefit of green structures is the connection to biological cycles of nature: these connections are contribution to pollution control and supporting ecological biodiversity in city areas. Installations of green elements require expertise in designing the whole system including maintenance, drainage and irrigation. The lifetime of green structures is dependent on proper maintenance, and that is why tenants of the building need to have the knowledge, or need to be educated up to satisfying level, for proper maintenance. Installation and maintenance costs vary remarkably and are fully dependent on the design and extent of the desired green structure. [29, 9-10, 15-16, 45-46, 48]

3.7.2 Material Efficiency, Recycling and Reuse

Material efficiency is a major part of the circular economy. The first principle states the importance of recycling and reusing materials, and it is closely related to other components of CE as well [6, 22]. Efficient use of materials is the most significant in design and construction phase of buildings. Careful planning enables efficient recycle and reuse of materials keeping them in the loop as long as possible. Choosing local and recycled materials and avoiding the use of virgin materials is the key to material efficiency, not to mention about the possible cost-savings related to use of cheap secondary raw materials. [17]. Industrial symbiosis and design for disassembly are

linked to recycling and reuse; it would be most efficient for real estate investment companies to take them all into account at once in their material efficiency plan to maximise the benefits of recycling.

3.7.3 Energy Efficiency and Sustainable Energy Solutions

Sustainable energy systems are an essential part of the circular economy as the third principle states [6, 22]. When it comes to buildings, energy has a great importance since it is consumed in large amounts as electricity, heating and cooling during building's lifetime. The consumption of energy is controlled by efficient systems, and energy efficiency in buildings is already greatly regulated by legislation as presented in Chapter 3.6.1. Hence, the focus in this chapter is more on the ways of producing renewable energy.

When it comes to sustainable electricity production, there are basically two options for real estate investment companies: to produce their own green electricity or to invest in renewable electricity production. Firstly, the focus is aimed towards own production. For commercial and office buildings, several technologies for own electricity production are available, such as photovoltaic panels, small scale wind turbines, small hydro power generators and biomass digesters. Two latter ones sound inconvenient for densely built urban environment whereas photovoltaic is considered efficient in small spaces. Ikedi and Okoroh [30, 190] suggested in their study that building integrated solar electric generators (BIPV) could be the solution for sustainable energy issues in urban areas. PV-panel systems contribute not just to zero-carbon emissions, but also to the wellbeing of building users as increased natural daylight if installed as innovative sky lighting devices [30, 190]. Energy efficient solar system includes not only PV-panels but also thermal collectors, of which efficiency is based on cooling of PV-cells by heat extraction of thermal collector [31, 888-889].

The potential of solar energy in Finland has been an argued topic for some time because of prejudices on the efficiency of production due to Finland's geographical location. The variation between seasons is immense, but overall production potential in Finland corresponds to the one in Northern Germany. Efficient summertime production can be guaranteed, but the darkness of winter season brings uncertainties to production. Firstly, operational reliability and power balance of a PV-system should be secured with an energy storage system in a building. Secondly, low altitudes of the Sun

in winter season serves a possibility for façade installation; thus, the system would provide an adequate electricity production on a sunny winter day. The Sun's low altitudes in Finland can be seen as an advantage from architectural perspective. [32]

Challenges related to renewable energy production in buildings cannot be neglected. Due to fluctuating solar irradiation, a pilot study should be conducted during the worst cloudy months prior to installations to realistically estimate the production capacity at the site [30, 200]. More challenges arise from construction process: Contractor Forsman [33] claims that the grid connection process is made too difficult and that installing a small solar plant is expensive due to ineffective markets in Finland. Thus, the only current cost-efficient way of installing solar panels seems to be an off-grid installation. There are also doubts concerning small scale wind production in city areas for which solar installations are favoured more [33].

A second option for contributing to renewable energy production, alongside building-integrated production, is investing in renewable energy by other means. This could be an investment for installing their own larger solar or wind power plant from which electricity could be sold to tenants [34]. Wind power plants larger than 500 kW have an access to feed in-tariff in Finland which can make the investment profitable [35]. Another way of utilizing renewable energy sources could be to oblige tenants to purchase only green electricity. It may be questionable if tenants see such obligations related to leasing attractive.

Regenerative heating and cooling methods for a building should be favoured according to the third principle of the circular economy [6, 7]. District heating (DH) is a common way to heat a building in the city area since a vast district heating network is a feature of every large city in Finland [36, 14]. The production of DH is energy efficient since co-production of electricity and heating is common in Finnish combined heat and power (CHP) plants, although sustainability of DH is questionable when coal is used as a fuel. Other energy sources used for heating are oil, electricity, ground heat, wood and peat [36, 14]. The usage of oil should be suppressed in a circular economy on the basis of it being a polluting and exhaustible resource [1, 270]. Peat is considered as slowly renewable natural resource, but in the circular economy its usage rate should not be higher than production rate to prevent exhaustion; practically peat is considered to be as polluting as oil, and on this basis it should be replaced with other renewable fuels [37; 1, 270]. Then again, ground heat fits already into the category of sustainable

renewable sources of heat together with wood, but other possibilities exist also that are not commonly used yet.

Different types of solar thermal collectors, such as heat pipes and tubes, are becoming more known as technology progresses. Heat pipes come in many sizes and shapes: Aluminium heat pipes provide the same level of efficiency that evacuated tube solar collectors do. Efficiency of heat absorption has been tried to improve with coloured coatings, but studies have not been extensive enough to provide significant results. On the other hand, cost-efficiency of a solar collector system can be increased by photovoltaic powered circulation pumps. A great advantage of heat pipes is the possibility of various different designs of the assembly which can be integrated to an existing building as a modular element. One example of an integrated assembly is presented in Figure 5. [31, 119-125]. Building integrated systems of solar collectors and PV-panels show a great promise in creation of the circular economy.

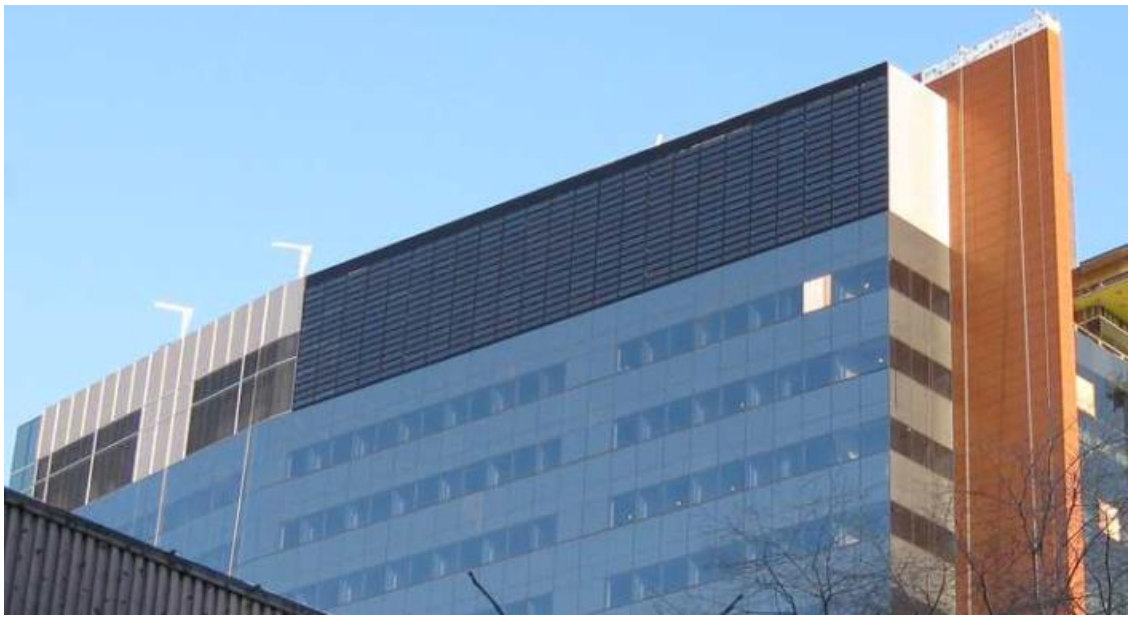

Figure 5. A hybrid solar thermal collector and PV-panel system integrated as part of Concordia University building in Montreal, Canada. [38]

The need for cooling in buildings is significantly smaller in Finland than heating due to relatively cool summer temperatures compared to Central Europe. So far, district cooling is marginally used for cooling in Finland, but the major limitation for utilizing district cooling in buildings is the extent of existing infrastructure. Thus, other promising methods for cooling buildings are to be sought. These new methods include hybrid systems which are combined heating and cooling, ground coupled cooling, and

utilization of cool natural water from lakes or ground. [36, 14-15]. According to the principles of the circular economy, replacement of conventional cooling units with natural cooling systems would suppress the use of potentially toxic cooling mediums in buildings [6, 7].

Energy is inevitably wasted when a building is ventilated and heated at the same time. This wasted energy can be recovered by a waste heat recovery system which transfers the heat from the outlet air to the fresh inlet air. Caution is needed when designing of such a system; overall energy efficiency of the system should be considered to ensure that recovered heat energy exceeds the energy consumed by components of the system. Computational prediction tools for calculation of losses are available and recommended to be used. Optimization of heating and cooling is necessary in any case whether waste heat is recovered or not. New automated systems for heating control arise including optimization according to a weather forecast. [39, 1-2; 40, 85]

Overall, a building's energy system should be adaptable and versatile according to the second principle of CE [6, 22]. Instead of relying on one source of energy, a building could have a few sources in use: in the case of a failure of one source, other sources back up the continuation of building's operation. Therefore, a building is more resilient to changes in energy supply. In reality, such a system could be created in a step-by-step transition from centralized systems towards more decentralized: utilize the existing electricity and heating network, install renewable heating and cooling systems where possible, and integrate renewable electricity production to the building where possible [1, 215].

3.7.4 Water Efficiency and Reuse

Water is counted as one of Earth's resources, and conservation of water via cyclic systems in buildings is a part of the circular economy. Water conservation contributes to not only saving resources but to lessening the amount of chemicals and organic matter released to environment within untreated waste water discharge [41, 1]. Infrastructure for water supply in Finland is extensive in city areas, and waste water treatment plants are an essential part of the system since water supply is regulated by the National Water Supply Act [42]. Real estate investment companies, along with other property owners, could invest in self-supporting water circulation system. Although giving up on centralized municipal water supply is unlikely to happen due to

extensive fresh and ground water reservoirs in Finland, contribution to water conservation is still possible by means of supplying greywater or rainwater to some of building's water consuming elements.

Nowadays, the focus is on water-efficient fittings such as water-saving faucets or waterless urinals. Majority of the fittings use water to a certain extent; hence, they could be combined with the usage of recycled water. Greywater usage and rainwater harvest are both considered as alternative ways of conserving water, but there is potential to be found. Greywater refers to waste water originating from showers, wash basins, kitchen, laundry and tubs, and excludes human faecal matter. Treated greywater and rainwater can be used in toilet flushing, in irrigation of green elements, cleaning purposes, or can be integrated to the cooling system of a building. It should be considered that installation of a greywater system is probably not feasible to every building: greywater utilization requires dual piping in the building; thus, the method is recommended for new construction. Legislative issues related to water quality requirements must be considered since they limit the use of greywater to a certain extent. The NBCF determines regulations and guidelines for water supply and drainage installations for buildings in Finland: due to the quality requirements of water supply, the greywater system cannot be connected to the main water supply; it must be a separate water system within the building. [41, 170, 172, 178, 191; 43, 7]

It should be noted that the design of a greywater system is greatly dependent on the chosen end-use of recycled water [41, 170-174]. Neither greywater nor rainwater can be used without a treatment. Contaminants absorbed by rainwater should be removed, for example, by sand filtration, active carbon adsorption, or reverse osmosis method [41, 196]. The usage of chlorine or other disinfection chemicals are not to be promoted in the circular economy [6, 7]. Treated recycled water could be utilized in irrigation of green structures, if nowhere else, making the system more resource efficient. Integrated water recycling and irrigation system would be in line with the principles of the circular economy also from the perspective of imitating natural ecosystems and providing biological nutrients to the cycle [1, 94].

3.7.5 Design for Disassembly

Material efficiency of a building can be improved by recycling demolition waste in a completely new way which supports the circular economy: when a building comes to

the end of its life, materials from the building can be harvested for reuse instead of wrecking the building into unusable pieces. A harvest is feasible when a building has been designed for disassembly. Real estate investment companies would benefit from a careful planning of material reuse in disassembly. Even a better scenario would be if materials and resources from deconstruction are upcycled and used in new construction or retrofit projects instead of virgin materials. The usage of local upcycled materials have a positive impact on the environment by saving the need of transportation; this also results in fuel cost savings. [22, 2; 17]

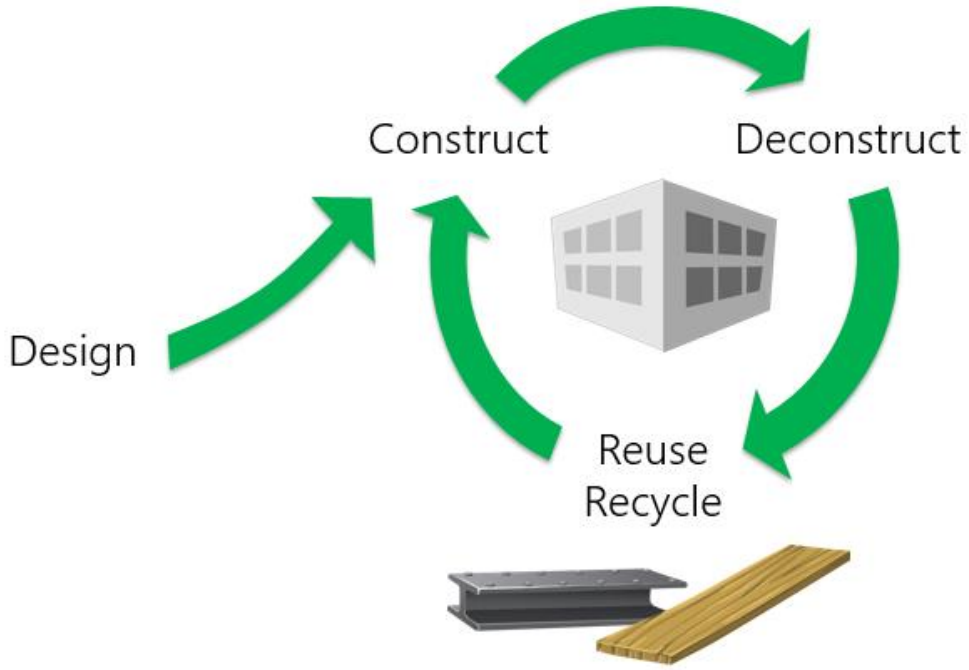

Figure 6. Design for disassembly improves material efficiency of a building. [22]

Abundant construction materials, which have high recycling or regeneration rates, should be used such as steel or wood [1, 279]. A key to a successful disassembly is to construct a building from modular units which can be detached undamaged for later use at another location or in a new construction. Major issues nowadays arise from joints of structures: detaching joints without damaging the material has not been possible due to the current deconstruction methods and partly also because disassembly has not been taken into account in the design phase. As a result, materials scavenged from deconstruction until now have lost quality and value as a resource. After implementing disassembly plans into design phase of construction, material scavenging and reuse will become cost-effective and savings are significant since a building designed for disassembly is worth a lot more at the end of its life.

Design for disassembly should be included in building design process as a part of good and sustainable construction manners, as presented in Figure 6. [22, 19-23; 17]. For further information of integrating design for disassembly into architectural and lifecycle planning process, readers are directed to Talja A [22]. Real estate investment companies could develop a companywide plan for material efficiency and reuse over all properties. Material efficient construction and disassembly could be a part of a larger circular economy strategy.

3.7.6 Industrial Symbiosis

Resource efficiency, recycling, reusing and upcycling materials have a symbiotic connection, which has been known for over a century, but not very well implemented through time [1, 297]. This connection is known as industrial symbiosis. Main idea of such symbiosis is an exchange of resources among businesses to close the loop of materials. Water, energy and services can also be exchanged within the business cluster. Waste no longer exists when the output or side-product of one company can be used as input of another company. This kind of action not only recycles or reuses material, but adds also value to the material. It is no wonder that exchange of materials in the network of companies is profitable. [1, 297; 12]. Industrial symbioses are in the core of the circular economy supporting many of its principles [6, 22-23].

Real estate investment companies could be connected to industrial symbioses via material or energy exchange [1, 297]. There is no evidence what kind of symbioses investment companies are drawn to; thus, only suggestions can be made. One possibility could be closing material loops in construction projects; recycling construction waste and incorporating recycled materials in new construction or renovation. For this possibility to turn out as a long-lasting symbiosis, it would need a functioning co-operation of several companies or properties. Applications of industrial symbiosis in real estate industry need further research to find more possibilities.

3.7.7 Sharing Economy

The second principle of the circular economy promotes adaptability and versatility; in buildings, this means adaptability of spaces and their use. It is known better as the concept of a sharing economy. Traditionally, companies have always owned or rented

their business premises, but if the space is not fully and constantly occupied by the owner, the space is underused compared to its maximum capacity. Habits of using spaces change over time, and according to Dooley [17], the trend nowadays is that the needed space for basic use is decreasing in size. Buildings can be designed for less than the estimated peak use. Renting spaces for short-time occupancy is becoming the new trend of the sharing economy; larger groups can rent, for example, a local auditorium for their annual meeting, or anyone can rent a desk office space for two days use possibly making new professional connections at the rented office space. Several companies can share a business premises together in shared hubs. Making use of the maximum capacity of spaces is cost-effective. Sharing economy would not have been so easily executed in the past, but current technology enables sharing spaces. Smart phone applications are an effective way of searching, renting and paying for spaces. [17]

3.7.8 New Ownership Models and Services

Systems thinking, the fourth principle of the circular economy, states that parts of a system influence one another. Functional circular economy is built on loops of materials and resources, but there is a driving force enabling cyclic flows; that is services. They are immaterial, but important since services connect and close loops between users, manufacturers and other operators in the economy affecting the whole system. [6, 23, 58]

In the circular economy consumers buy services instead of products [6, 58]. This means that products are designed to be durable and to last over a long period of time. Manufacturing a durable and repairable product is more expensive, but it is no problem since consumers do not own products any longer, they only pay for using it. This is called a new ownership model. [17]. There is potential for new ownership models in real estate investment companies. One possibility is an installation of building integrated energy efficient appliances which are leased for the use of tenants [34]. By investing in durable and repairable appliances, the company would extend the lifetime of their appliances; hence, the company gain potentially more profit from leasing.

4 Case Study: Suomen Yliopistokiinteistöt Oy

A case study is an important part of the empirical research of the study. In this chapter, the case study company and the building are presented. This enables the reader to gain deeper understanding of the empirical research and its results.

The case-study company is Suomen Yliopistokiinteistöt Oy (SYK). It is a major Finnish real estate investment company whose main field of business is to construct, maintain and develop properties for universities and their partners. SYK Oy aims to become the leading campus developer in Europe. Taking part in the research concerning the circular economy suits them well in their attempt for being the forerunner in the field. SYK Oy owns 18 campuses in 13 locations in Finland. Each campus has a campus strategy for creating a foundation on the future land use of campus areas and for strengthening the functional co-operation between SYK Oy and the universities. Smart technological solutions are already implemented in the campus strategies to promote the development of the circular economy and a better quality of life. [44; 45]

Figure 7. The case-study building Kampusareena in Tampere, Finland. [46]

Kampusareena is the case-study building which is later examined in the empirical research. Kampusareena is located at the university complex in Tampere, at Hervanta

district. The construction of Kampusareena was finished in 2015, and both the design and construction were influenced by an environmental sustainability assessment. The used assessment method was BREEAM International Bespoke 2010 with a final rating of Very Good on a scale of Pass, Good, Very Good, Excellent and Outstanding [19]. Kampusareena is in shared use of Tampere University of Technology and other companies. The building includes teaching facilities, restaurants, a cafeteria, a library, offices and retail spaces making it a mixed-use building. The building is designed to be an innovative environment for both studying and business. Highlights of the building exterior are an extensive green roof and the solar panel installations that provide electricity and shading as shown in Figure 7. Energy efficiency, adaptability and renewable energy production have been the key features in the sustainable design of the building. [47]

5 Empirical Research

5.1 Methodology

The research focused on defining the concept of the circular economy in real estate industry from a real estate investment company's perspective as stated in Chapter 1. The theoretical part of the study introduced the general concept of the circular economy, its definition, principles, goals and limitations. Then, the current state of the circular economy in real estate investment companies was studied. The theoretical part of the study was a necessity in order to gain a deep understanding of the connection of the two subjects being studied. Motivational and obligatory factors that drive the development of the circular economy were important to discover. The lack of previous research on the topic and growing understanding of the phenomena being studied allowed deductive reasoning on applications of the circular economy in real estate investment companies. The suggested applications were the basis for the empirical research to find out what the circular economy meant for real estate investment companies, how it was currently realized in real estate investment companies, what kind of obligations legislation related to the circular economy set for the companies and what kind of possibilities arose through these and other possible driving factors, and what kind of future prospects would the circular economy hold for real estate investment companies.

Two different methods were used in the empirical research: an interview and a workshop. First, the interviews took place with two interviewees. The method of

interview was chosen to be online, asynchronous, in-depth interview, which collected qualitative data. Open-ended questions sent via email is a cost-effective way of interviewing allowing multiple interviews to happen at the same time despite the location of the interviewer and interviewees. Major benefits of the chosen method were electronic data collection, which requires little or no editing before analysis, and efficiency of the method with respect to time. Data collection period was determined based on the number of questions and on the desired quality of the answers. By giving enough time for interviewees to process their answers, it was hoped to give more thought-through answers that are high in quality. [48, 1284, 1288]. The Time-Quality factor was significant due to the fact that the studied topic is fairly unknown and little data is available on it. The interviews were carried out first to make use of the results in the workshop. After qualitative interviews, a workshop was organized with the case-study company to investigate how they had succeeded in implementation of the circular economy in the chosen property, and how the property could be developed from the perspective of the circular economy.

A Big Room workshop is a qualitative method replacing conventional meetings and conferences. It is defined as an interactive meeting, in which several different working methods can be used on the basis of desired outcome of the workshop. It aims to control a process as whole including all individual components of the process. A workshop method is an efficient way to produce qualitative data in a short period of time since it takes into account the needs of all participants and is based solely on group work. [49]

The particular working method used in the Big Room workshop of this study was Open Space method. The basic principle of Open Space method is presented in Figure 8.

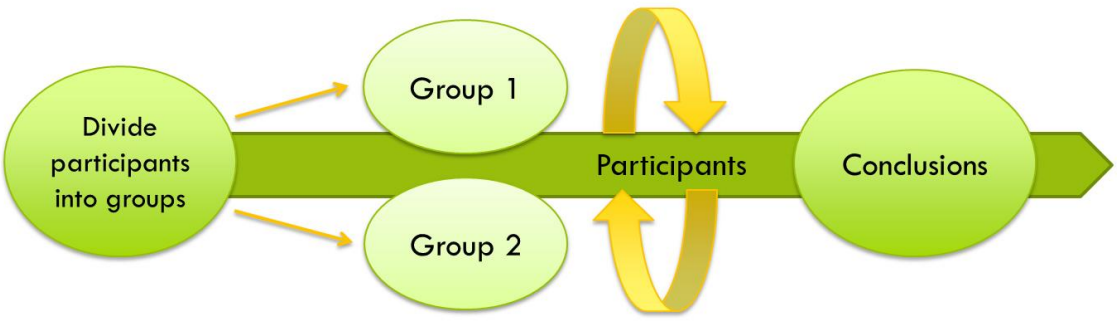

Figure 8. Open Space method for the workshop. [50]

Topics of interest were grouped with respect to relevance. The workshop had three participants from the case-study company SYK Oy who were divided into groups to innovate new ideas from the topics of interest. An introduction to the basics of the circular economy in real estate industry for the participants preceded the actual workshop. Experts, who were responsible for organizing the workshop and giving the introduction, were leading the conversation under each topic and took notes in the workshop. Openness of Open Space method relies on the fact that participants can move freely despite being grouped in the beginning; in this way no participant faces the feeling of being thoughtless nor giving no outcome for the workshop [50]. Data gathered from the workshop was processed into digital form by an assistant.

Additional data was gathered from the BREEAM Certification of the case-study building: the circular economy was studied from the perspective of BREEAM and compiled with the workshop data. Points of interest in the data were its similarities and dissimilarities with the theoretical methods of applying the circular economy in real estate investment companies. Processing the qualitative data yielded interesting and partly dissenting results, on which conclusions were made by the researcher.

5.2 Interviews and Interviewees

Interviews were conducted in early June 2016 as a questionnaire sent to the interviewees who replied within a given schedule. Two interviewees were chosen from a group of experts in their fields. Interviewees presented their professional views from both real estate industry and from development of the circular economy.

- Ritva Rissanen, Director of Real Estate Management Group at Granlund Consulting Oy.

Rissanen holds a master’s degree in engineering and has specialized in building construction technology. During the 25-year-career she has gained experience working for a contractor and a research institute, and currently she is a director in a real estate consulting company. Her broad understanding of real estate management was an asset for this research. [51]

- Ken Dooley, Manager of Sustainability Group at Granlund Consulting Oy.

Dooley has worked internationally as a consulting engineer for over 10 years. He is finishing his DSc (Doctor of Science) at Aalto University. Alongside his duty as a manager, he currently works on research projects, design competitions, energy innovations and on developing circular economy. This research benefitted greatly from his innovative character and knowledge on the circular economy. [51]

5.3 Interview Questions

Ten questions were asked from the interviewees, and the questions were as follows:

Q1. In your opinion, what would circular economy mean in real estate investment companies?
Q2. What challenges do you see in the change of use of a building e.g. in the case of a change of ownership?
Q3. How common is it to consider recyclability of materials and structures in new constructions and renovation projects?
Q4. How is greywater utilized in buildings?
Q5. How important is utilization of greywater in internal cycles of a building is in your opinion, and why?
Q6. What advantages and disadvantages are associated with ecological green structures (e.g. green roofs, interior green walls) in buildings?
Q7. Wellbeing and satisfaction of building users is measured, for example, with Granlund Pulse. How do you feel about a similar digital service which would measure the wellbeing of a building (e.g. real time measurement of energy self-sufficiency, energy balances)?
Q8. What motivates real estate investment companies to change from a linear economy model towards a circular one?
Q9. How would a real estate investment company benefit from a circular economy strategy which would be used to create and control circular economy issues of multiple properties?
Q10. How do see the future of circular economy in real estate industry?

Interview questions were provided in Finnish to one of the interviewees. Questions were translated in a best possible manner, but they are not official translations of the original English version. In cases where any differences occur, the English version shall prevail. Interview questions in Finnish are presented in Appendix 1.

5.4 Workshop and Participants

The workshop was organized at the case-study company's premises, more precisely in the case-study building Kampusareena. It took place in June 2016. The duration of the workshop was two hours, and the results were obtained within the reserved time. In total, six people participated to the workshop: A facilitator and an expert from Granlund Consulting Oy, the researcher, and three participants from SYK Oy. The participants from SYK Oy were chosen to present high level of knowledge of the case-study building and influential position in the company:

- Aki Havia, Director, SYK Oy
- Jarmo Perkiö, Manager of Maintenance, SYK Oy
- Olli Niemi, Research and Development, SYK Oy

An introduction was given to the participants of the basics of the circular economy after which the Big Room workshop was held. The method of workshop was earlier described in Chapter 5.1. Kampusareena was examined from the perspective of the circular economy with respect to eight topics of interest. The studied topics in the workshop were grouped into two groups as shown in Table 3.

Table 3. Topics of interest studied in the workshop.

Group 1	**Group 2**

• Natural materials
• Resource efficiency
  ○ Materials
  ○ Energy
• Reuse and recycling
• Design for disassembly
	• Industrial symbiosis
	• Sharing economy
	• New ownership models
	• Sustainable lifestyles

Points of success at Kampusareena's circular economy were identified, and targets of improvement were developed. All participants had a chance to share ideas under every topic to gain more innovative results.

6 Results

The following chapter will present results from the empirical research. The results for different methods will be presented separately to be able to distinguish between them before making conclusions. First, major findings from the interviews will be highlighted. Answers from the interview questions will be processed in numerical order. Then, results from the case-study building will be shown and interpreted. The relevant results will be presented in a table. Lastly, a short summary of the results will be given.

The objective of the study was to define the circular economy in real estate investment companies and to find out how well the circular economy is adopted in aforementioned companies. Also, legislative and other motivational factors were to be found out to determine what drives the companies towards the circular economy. Lastly, the study aimed to understand the future of the circular economy in real estate investment companies. The study was conducted by examining the theory of the circular economy and of real estate industry. Relation of environmental policies and certificates was studied to understand how well they support the circular economy. In the lack of previous research, the general concept of CE was adopted to practice to find possible applications of CE in real estate investment companies. The empirical research, more precisely interviews and the workshop, were conducted to either support or contradict with the theoretical findings presented in earlier chapters and to make new findings concerning the circular economy.

6.1 Major Findings from the Interviews

Circular economy in real estate investment companies has a wide definition which varies according to who is asked to interpret it. It is still a relatively unknown topic for many. For real estate investment companies, the circular economy obviously concerns their properties and construction work. CE has a different meaning depending on the building type and the phase of life; the core aspects of CE related to these two building types are illustrated in Figure 9. In new construction and renovation projects, the emphasis is on removal of waste from construction process and on minimization of virgin material usage. That means, choices of materials in design phase of a project are important. In existing buildings, the focus is on resource efficiency in operation. Practically, it means minimizing used resources as well as maintaining equipment in a

good condition. Resource efficiency of existing buildings could have a consistent measuring system which measures utilization rates of buildings such as CO_2 per person or CO_2 per person hour. [52; 53]

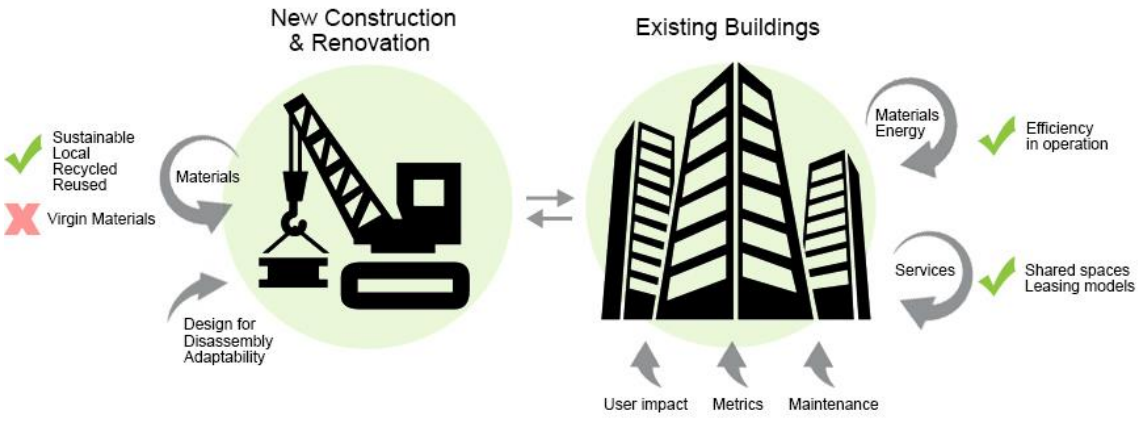

Figure 9. The core aspects of the circular economy for new construction & renovation projects and for existing buildings according to the major findings of the study. [52; 53; 55]

Real estate investment companies may face challenges from a circular economy point of view when properties are being sold or bought. Problems arise, when a bought property is going under major renovation such as change of use. Land Use and Building Act and Decree sets significant restrictions to major renovations: use of a building is usually determined in city plans and the change of use may require changes into the city plans. Smaller renovations, which do not include the change of use of a building, are more easily done from a legislative point of view. From a circular economy point of view, it means that real estate investment companies may be less willing to invest in properties which do not suit to their intended usage. Legislative restrictions lead investors looking for efficiently designed newer buildings: this has been seen in the capital area in Finland for a while, and a vast number of offices are not currently in use [54]. It is a hit back since in a functional circular economy spaces are in an efficient, shared use and no resources are wasted. This issue highlights the importance of a sustainable design of a new construction. Adaptability of spaces is highly important to avoid underuse of buildings, and it must be a priority in the design phase. [52]

Design for disassembly of a building increases property value, but may cause harm later with valuation when a property is being sold. From a circular economy point of view building that sort is worth a lot more than a one without disassembly design. If market does not add monetary value, it may be difficult to get the full value in sales.

This indicates that additional value created by the circular economy to buildings is dependent on the market situation. [53]

Circular economy is not commonly paid attention to at the present moment in construction projects. Energy efficiency is already regulated by law, but material efficiency is neglected on a high level. Recyclability of materials and structures is not considered, because there is little information available about recycling options of construction materials. Some material producers do highlight the sustainable features of their products, but not many. This is partly a wake-up call for material producers to start producing and advertising materials suitable for reuse and recycling, and suitable for the circular economy. The lack of information is not the only reason for disuse of recyclable materials in construction: cost of an investment determines choices of materials. Moreover, recycling construction or demolition waste is not yet profitable business, for why recyclable materials are not commonly used. Costs of the whole lifecycle of a building are not commonly considered. Choosing reusable and recyclable materials, also designing for disassembly, could lead to a cost-effective business, but the awareness of real estate investment companies and designers on cost-effectiveness should be increased. Consulting companies could be the key factor in raising the awareness: life cycle cost analysis combined with a circular economy strategy could help balancing costs and savings from the choices of sustainable materials. [52; 53]

Reuse of water as a part of resource efficiency was theoretically considered important, also by an expert, but it is rare to utilize greywater in Finland. It is simply due to the reason that Finland has large fresh and ground water reservoirs and that water is a cheap resource. Utilization of greywater or rainwater would make sense only in buildings, which consume excessive amounts of water. Real estate industry generally focuses only on climate change mitigation and not on water conservation. Therefore, water reuse is not feasible in the circular economy in Finland, although in countries with a different climate and with smaller water reservoirs it would be an important part of CE. [52; 53]

Green elements of buildings act as carbon sinks, collect rainwater and increase biodiversity in the area. As a building material, green elements are important in buildings from the perspective of the circular economy, but they bring benefits to the nature on the cost of the building itself. For example, planning of a green roof requires

special attention as well as special maintenance. Thus, costs of an investment are increased, and green elements create possible stress into the building materials shortening the lifetime of the materials. This contradicts with the principle of the circular economy of not lowering the quality of materials. It may seem that green elements cause downcycling of building materials. Green elements should be considered only in buildings with a short lifetime and a proper design to prevent negative impact on the building and on the materials. The main benefit of green elements to real estate investment companies is the green image and outlook of the building, for which a price has to be paid when costs increase. [52; 53]

Services are a part of the circular economy as they replace products. Developing digital services can help advance the circular economy and even bring new tools for controlling, measuring and sharing information of buildings. Hypothetically, energy self-sufficiency or energy balances could be measured with a simple application, which would bring information readily available for who it concerns. This and other types of applications need stay simple, illustrative and easy to use since earlier problems have occurred because services were too complex and not practical to use. Services measuring information of buildings could increase awareness of building users, strengthen decision making and thereby improve the operational performance of buildings. [52; 53]

Circular economy in real estate industry seems to be at a turning point. Investment companies need motivation and drivers for the transition from the linear economy to the circular one. The most significant motivation for real estate investment companies is cost savings, as well as legislation and green image. Tenants can be an influential driving factor by demanding environmentally friendly and sustainable choices, which then can initiate acts that support the circular economy. Environmental certificates are already common in real estate industry and advance the circular economy as they are, although certificates are not fully a proof that the circular economy is realized in the building as described in Chapter 3.5. An interesting fact is that environmental certificates are a driving force for material producers to develop more sustainable products. That means, the demand from the current certification boom is already supporting marketing of sustainable construction materials. But, the creation of the circular economy in real estate investment companies needs something a bit more than only an environmental certification. A circular economy strategy should be created so that it results in maximum cost savings. But, a CE strategy can yield much more than

only savings: a CE strategy gives leverage for marketing and branding in an instance, and in a long term, companies gain an advantage in management of risks related to material shortages. A company with a CE strategy has a clear vantage in the future if and when resources start to run low and when the competition over resources gets harder. But as mentioned earlier, the definition of the circular economy in real estate industry has been unclear and many operators in the industry are ignorant or flustered. There are no real tools or metrics available for evaluating the benefits of the circular economy for companies. Development of such tools and metrics is presumably happening. Climate change mitigation can be measured quite easily with CO_2 related metrics since it is the main greenhouse gas emitted into atmosphere. Then again, resource scarcity is not that simple to measure; one suggestion is CO_2 footprint of products, which would be a comparable unit between different materials. It does represent the scarcity of resources in a way, if the amount of emitted CO_2 is proportional to the availability of the resource. Also, it does reveal other relevant aspects of the circular economy since recycled, reused and local products probably have lower carbon footprint than virgin products. Measuring the circular economy of an existing building can then again be measured by utilization rates CO_2 per person or per person hour, as mentioned earlier in this chapter. The amount of produced waste could also be measured simply by comparing how much waste is reused or recycled and how much leaks out from the loop to incineration and landfills. More developed waste metrics would also take into account the quality of waste since upcycling secondary resources have a greater value in the circular economy than only recycling. Measuring quality changes of materials would need a coherent scale, which could applicable for different material types. It is questionable what kind of metrics can and will actually work. Developing metrics for the circular economy requires further empirical research in the industry. [52; 53]

The concept of the circular economy in real estate industry is at a stage where it has a little concrete and practical meaning. As a term, it creates a concrete definition for responsibility, sustainable development and green values. A decade ago these terms were in a similar situation than where the term circular economy is now; hence, this could mean that in a few years CE is more known and adopted in real estate industry. Advancing the circular economy in the industry needs a concrete definition and goals, product development, clear actions and processes, realistic metrics, and above all, changes in practices. [52; 53]

6.2 Case-Study Results

Circular economy of the case-study building Kampusareena was studied in the workshop and by analysing BREEAM score sheet of the building. Design, construction and use phase of the building were studied separately in the workshop, but combined as a whole package for the results. It was found out that Kampusareena fulfils already many aspects of the circular economy. Also, many ideas were produced in the workshop such as how the building's use phase and the end of life could be improved from the perspective of CE. Currently implemented practices and ideas for improvement are presented in Table 4 according to different components of the circular economy. The practices that arose from the BREEAM score sheet analysis are indicated by an asterisk (*) and all other practices and ideas without an asterisk originate from the workshop results.

Table 4. Circular economy in Kampusareena. [55; 56; Lassila AP, conversation on 2016 Jun 29]

Component of Circular Economy	**Implemented practices**	**Ideas for improvement**
Sustainable and natural materials	• Materials with low emissions (M1 classification)* • Materials with a low environmental impact over a full lifecycle of the building* • Green roof: Enhancement of site ecology, a new ecologically valuable habitat* • Insulation with a low embodied environmental impact*	• Wood as construction material
Resource efficiency: Material choices, recycling, reuse	• Reuse of land* • Recycled aggregates (crushed rocks) used in construction* • Protection of construction material at site to prevent losses* • Sorting and recycling construction and operational waste* • Life cycle assessment	• Recycling steel structures • Recycle possibilities for gypsum boards • Reuse of goods within building users
Resource efficiency: Energy production, sustainable energy systems	• Energy efficient construction site* • Renewable energy production: PV-panels* • Strategy for energy efficiency • Minimisation of CO_2 emissions* • Demand controlled ventilation	• Internal energy balances and energy storage • Ground heat

	and lighting • Energy metering: Tracking of energy consumption	
Resource efficiency: Water	• Water efficient construction site* • Water efficient fittings* • Slowing down runoff water	• Storage for runoff rainwater
Design for disassembly		• Recycling steel structures
Industrial symbiosis		• Energy balance system with other operators in the building • Symbiosis of services
Sharing economy	• Efficient use of spaces • Adaptability: Movable internal walls • Shared spaces*: desk offices, conference rooms, auditoriums, library, restaurant • Acoustics for user comfort • Building open 24/7 for users	• Real-time sharing of information of sustainable practices in the building to users • Participatory design of shared spaces
New ownership models and services	• New model for renting spaces	• Leasing PV-panels
Sustainable lifestyle	• Environmentally sustainable construction practices* • Environmental management system for the university office	• Platforms for guiding sustainable lifestyles of building users

The design of Kampusareena included sustainable and natural material choices. Construction materials which have a low emission classification (M1) and materials with a low environmental impact over the full lifecycle of the building were chosen for the building design. The green roof installation provides a new ecologically valuable habitat. Sustainable insulation with a low embodied environmental impact was chosen for the building. More natural materials could have been used such as wood as a construction material. [55; 56]

Resource efficiency in Kampusareena is already on an advanced level concerning all three factors: materials, energy and water. The site was previously constructed; thus, the land was now reused for a new construction. The building was constructed onto a site with a low ecological value. Also, crushed rocks were reused in the construction work. Environmentally sustainable construction practices were followed at the time of construction, as well as materials were protected at the site to prevent losses, and

construction waste was sorted and recycled. Energy and water efficiency was also followed at the site; these all indicate that environmental aspects are highly taken into account in construction and naturally are a part of the circular economy in real estate investment companies. Sustainable practices are partly due to legislative requirements and also partly driven by the demands of BREEAM. [55; 56]

The workshop results strengthen the understanding that life cycle assessment (LCA) in the design phase of a project influences the circular economy. If LCA is taken into account in design, it may affect material choices, recycling and disassembly of the building. An environmental management system for the university office was in use and partly affecting reuse and recycle of operational waste. Targets for improvement were identified: recycling steel structures and gypsum boards were considered, as well as reusing goods within building users [Lassila AP, conversation on 2016 Jun 29]. The latter one was not considered in the theoretical part since it is related to tenants and not to the real estate investment company itself. Also, platforms for sustainable lifestyle guidance for building users were mentioned. This indicates that users are an important factor of an existing building. [55]

Kampusareena had their own electricity production by PV-panels and a charging point for electric cars. Renewable energy sources are of a great importance in the circular economy; thus, Kampusareena's energy solutions are greatly supporting CE. An energy efficiency strategy and a demand controlled ventilation and lighting were advanced features of the building. More renewable energy sources could be considered to be used such as ground heat. A development project for controlling internal energy balances and energy storage was suggested and would greatly benefit the energy efficiency of the building. Water efficient fittings, such as waterless urinals, were contributing to water conservation. Although it was previously concluded that water reuse and recycling is not feasible in Finland and can thus be excluded from the circular economy, water efficiency is usually considered in buildings. The driver for water conservation in this case may be the demand from BREEAM since otherwise water conservation would not make a significant impact in Finland. [55; 56]

There were two components of CE which were not found from the case-study building at all. Design for disassembly was a completely unheard of and so was industrial symbiosis in real estate industry. Topics did bring forth thoughts and conversation about the possibilities of them in the building. Recycling steel structures at the end of

lifetime of the building would be part of disassembly, but since disassembly was not considered at the design phase, it most likely yields lower quality of the secondary raw material. Nevertheless, even if disassembly was not considered in the design, it is still beneficial for the company to plan a cost-effective deconstruction when the building's lifetime is nearing the end. A significant result was that a building's desired lifetime affects the need for design for disassembly. It was noted that when the lifetime of a building is short, design for disassembly is highlighted and can potentially lead to major cost-savings. But when the lifetime of a building is long, disassembly is not as important as adaptability of spaces in the building. [55]

Industrial symbiosis was the most unknown component of all and seemed to be the most difficult to execute in an existing building. Symbiosis requires planning and at least two-three parties to create a symbiosis. There was a possibility for future symbiosis inside the operators of Kampusareena, which would involve a system following and controlling energy balances between the operators. Also, a suggestion was made that services could be exchanged as in symbiosis, but from a theoretical point of view it has a little relation to the actual industrial symbiosis. [55]

Kampusareena had many features of a sharing economy, most of them related to spaces and their use. The building was designed to be shared and the spaces are provided around the clock for users. Acoustics was considered important in specified spaces for the comfort of users. This is a new factor which was not anyhow related to the theory, but shared spaces would not probably be used if they do not satisfy the user. Thus, acoustics is actually a side-component related to shared spaces. Kampusareena was designed to be adaptable: movable internal walls allow changes in spaces without a major full-building renovation. As mentioned in the previous chapter, adaptable building is more attractive from a business point of view since major renovations and changes in use are restricted by Land Use and Building Act and Decree. Sharing economy brought up an idea of sharing information to building users [Lassila AP, conversation on 2016 Jun 29]. It could make the building more attractive if information of sustainable practices, renewable energy production, energy consumption, recycling and occupancy rates, and of produced waste were visible and shown in real time for users. Transparency of operation could attract more users, steer users for conscious and sustainable lifestyle, and thereby affect the circular economy of the building. Information as a part of CE was not considered in the theory, but it

seems that for buildings having many users it may be a part of efficient circular economy in existing buildings. [55]

New ownership models were a part of Kampusareena as a new model for renting spaces. The importance of different building types was brought up as the result of new ownership models. The previous chapter stated that the circular economy means different things for buildings in different phases of their lifetime. It seems that the circular economy would also be different depending on the building type: buildings for branding purposes such as headquarters, buildings for production and buildings for leasing may all have different focus to the circular economy when cost-efficiency is considered. Some components of CE may be more valuable for headquarters and their image than for other building types. [55]

Other major findings were made outside the categories in Table 4. For an existing building, users were seen crucial and an essential part of the building operation. Flows of users affect flows of materials in and out of the building, and can have a significant effect on the circular economy of the building. For a new construction projects, users have less significance, but should be considered since buildings are made for use for the users. Theoretically, users are not a direct component of the circular economy in buildings, but they are the part that executes sustainable lifestyles in buildings; hence, they are a part of the circular economy of buildings. [55]

As a summary of the case-study results, many components of CE were identified in Kampusareena building. Resource efficiency and sustainable material choices were most paid attention to and were considered as the most advanced features of the building. Also, the building's sharing economy was properly designed and working in practice. Then again, a disassembly plan and an industrial symbiosis were not found from the building, and seemed to be fairly unknown components. New ownership models and services were making their way to the operation of the building. BREEAM assessment was a part of the design and construction phase of the building and it has most probably affected some of the features concerning CE. The study of BREEAM Scores of Kampusareena from the perspective of CE revealed that the building achieved credits related to sustainable construction, materials, land use, energy efficiency, water efficiency and to shared spaces. The requirements of the achieved credits were not anyhow related to disassembly, industrial symbiosis, nor to new ownership models, which suggest that BREEAM in this case was guiding mostly

sustainable construction work and material choices and is not completely in line with the principles of CE. This fact was already considered in Chapter 3.5; thus, results support the theory that environmental certifications are a tool in use that already partly advances the development of the circular economy, but the scoring should be interpreted carefully to gain realistic understanding of a building's sustainability.

7 Discussion and Conclusions

The circular economy (CE) is a new economic model responding to the depletion of natural resources. The topic arose to news lately and has been talked about without a comprehensive and universal understanding. Sustainability is needed in the society to sustain a sufficient amount of resources for the future generations. The circular economy is a way to provide sustainable economic growth that the society needs on the edge of material shortages and climate change. Real estate investment companies as property owners are major material and energy consumers. Adopting the circular economy in their business contributes to sustainable economic growth, shows admirable example for other industries, and benefits companies financially. The circular economy in real estate investment companies had not been previously studied; neither did it have a clear concrete definition to proceed with. This study attempted to define and examine CE in real estate investment companies, to find motivational and obligatory driving factors, and to take a peek into the future of CE in these companies. Hence, results of the study are essential and substantial providing valuable insights and new information of the topic.

What is the circular economy in real estate investment companies?

CE in real estate investment companies concerns their properties and construction work. The definition and meaning of CE varies whether one studies existing buildings or construction and renovation projects. The results suggest that the core of CE depends on the phase of life of a property. If different phases are not distinguished between and if the core aspects of circular economy of each phase are not highlighted, it may be questionable whether the circular economy is cost-efficient for a real estate investment company. The full circular economy can be implemented in any building, but from a cost-efficient point of view the core aspects bring the most benefits. CE for

new construction and renovation projects should focus on minimization of virgin material usage, removal and recycling waste from the construction process, and on designing a resource efficient, adaptable and disassemblable building. The importance of the two latter features should be considered case by case; buildings with a short lifetime should have a design for disassembly, and buildings with a long lifetime should highlight adaptability due to restrictions in legislation. Then again, CE for existing buildings should focus on resource efficiency in operation. Users of a building are to be incorporated in a CE strategy of an existing building. A previous study on CE in built environment otherwise supported these findings but failed to highlight building users as an affecting factor in the circular economy. It was significant to separate the meaning of CE for different properties: this is a major result and it would be beneficial for the industry if it would be further. Surprisingly, renewable energy production and use did not have as valuable meaning in practice as it had in theory even though it is considered important – however, not as important as material efficiency.

How is the circular economy realized in real estate investment companies at the present time?

The study showed that parts of CE are already being realized in real estate investment companies. The driving factors behind this arise greatly from legislation and less from policy instruments such as voluntary environmental policies. The study claimed that environmental policies, which are stated in growing amounts among real estate investment companies, only support parts of the circular economy without actually belonging to CE according to the definition. Legislation forces companies to recycle waste and to become more energy efficient, but, surprisingly, voluntary sustainability assessments are a major driving factor in real estate industry that advances CE. Environmental certifications seem to be more of a rule than an exception in real estate investment companies. It was greatly beneficial for the study that the case-study building has been assessed using BREEAM and the scores could be reflected to CE of the building. Although, it should be kept in mind that the environmental certification in this case had a weighting on resource efficiency and took no stand on disassembly, symbiosis, nor on new ownership models and services. This result was expected based on the theoretical findings and the experience of the researcher on the content of requirements of environmental certifications.

At the present moment CE is being paid attention to in real estate investment companies really well concerning resource efficiency and sharing economy, but still all components of CE had room for improvement. It cannot be said if the results are intentional or happened by chance: it should be noted that the results are concluded based on only one case-study building and on one company. Therefore, the results may not apply for every company and for every building. Environmental certification requirements, which guide design and construction of new buildings, may already progress CE unnoticeably. Nevertheless, a more complete and deeper circular economy in real estate investment companies needs appropriate, intentional and strategic planning and knowledge above all. The study suggests that future research should be done on defining circular economy strategies separately for buildings at different phases of lifetime.

What kind of obligations does legislation related to the circular economy set to real estate investment companies, and what kind of possibilities arise through these obligations and through other possible driving factors?

The transition from the linear economy towards the circular economy is mainly driven by financial factors and cost-savings. This was a clearly an expected result that appeared in both interview answers and in the case-study supporting the underlying theory. Other motivation for real estate investment companies arises from the creation of a green image which is purely beneficial for branding purposes. Surprisingly, the case-study showed that for existing buildings users are considered valuable for the business and they can set demanding drivers concerning the circular economy and sustainability. Then again, legislation sets straightforward rules for the construction process and waste management, but it was seen more as a limiting factor than as a driving factor in Finland since legislation restricts major renovations in the case of change of use of a building. It is contradictory that at the same time as national programmes are set to advance material efficiency, reusing and recycling construction materials has been made difficult with verification processes. Reuse of old buildings for another use seems practically impossible due to legislation. It causes many buildings to stand empty and alone without any use. The study claims that legislation is limiting the circular economy in Finland and it sets certain limits for real estate investment companies that just have to be accepted until legislation is changed. The study cannot take a stand on the full extent of legislation related to the circular economy due to the

scope and time limitations of the study. The possible gaps could be filled with further research with a full scope of legislative aspects.

What are the future prospects of the circular economy for real estate investment companies?

Although the circular economy has been a fairly unknown topic in real estate industry, the few completed researches on the issue have provided plenty of data and knowledge. The development seems fast, but there is still much to be done in the future. Changes coming from the Circular Economy Package of the European Union will hit Finland within the next few years affecting real estate industry. It is clear that real estate investment companies, who are adapted to and prepared for the circular economy in advance, will have a vantage over other companies. But, responding to the rising demand of creating the circular economy in a business needs realistic tools and metrics. A previous study of the circular economy in built environment did not comment on measuring the circular economy; neither had the measuring a theoretical foundation, but obviously it has a huge meaning in practice. It is important to develop tools to ease the changes in practices and to measure circular economy. The tools are important for making the concept of the circular economy more concrete and applicable in real estate investment companies. This seems urgent and the study highly recommends further research and experimentation on the possible tools for the circular economy.

The study succeeded in answering all research questions. Circular economy in real estate investment companies have been made more understandable in this study providing theoretical background, definitions and concrete methods. A circular economy strategy was not developed in the study, but practical measures were found as a result of the empirical research. The results can be further applied for real estate investment companies to create a suitable circular economy strategy. Many significant and partly unexpected results appeared, and it means that the topic is quite unknown and has many features that theory alone cannot answer. The scope of the study was a limiting factor, but it was a necessity considering the extent of the studied topic within the given time. The study provided a valuable insight to the practicality of the circular economy in real estate investment companies and gave prospects for many topics of further investigation which would be of great help for the development of the circular economy.

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Appendix 1. Finnish Translation of the Interview Questions

Q1. Mitä mielestäsi kiertotalous kiinteistösijoitusyrityksissä voisi tarkoittaa?

Q2. Mitä haasteita voi nousta esiin kun kiinteistön käyttötarkoitus muuttuu esimerkiksi omistajanvaihdoksen yhteydessä?

Q3. Kuinka paljon materiaalien ja rakenteiden kierrätettävyyttä otetaan huomioon korjaus- ja uudisrakentamisessa?

Q4. Miten harmaata vettä hyödynnetään rakennuksissa?

Q5. Kuinka tärkeää harmaan veden hyödyntäminen rakennuksen sisäisissä kierroissa mielestäsi on ja miksi?

Q6. Minkälaisia hyötyjä ja haittoja ekologisista vihreistä rakenteista (esimerkiksi viherkatot, sisäilmaa puhdistavat viherseinät) on rakennuksille?

Q7. Rakennusten käyttäjien hyvinvointia ja tyytyväisyyttä sisäolosuhteisiin mitataan digitaalisesti esimerkiksi Granlund Pulsen avulla. Mitä ajatuksia sinulla herää samantyyppisestä digitaalisesta palvelusta, mikä seuraisi rakennuksen hyvinvointia (esim. reaaliaikainen energia-omavaraisuuden mittaus, energiataseet)?

Q8. Mikä motivoi kiinteistösijoitusyrityksiä siirtymään lineaarisesta talousmallista kiertotalousmalliin?

Q9. Miten kiinteistösijoitusyritys voisi hyötyä kiertotalousstrategiasta, jolla voisi luoda ja hallita useiden kiinteistöjen kiertotaloutta?

Q10. Minkälaisena näet kiertotalouden tulevaisuuden kiinteistöalalla?