Financing a Sustainable Future

Green Bond Sustainability Experiments and Sustainability Transition

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Financing a Sustainable Future: Green Bond Sustainability Experiments and Sustainability Transition

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A thesis submitted in partial fulfillment of the requirements of Lund University International Master's Programme in Environmental Studies and Sustainability Science

Submitted May 12, 2020

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Abstract:

Global warming has become a scientific consensus. Climate change induced impacts on both natural and human systems have been observed. Climate financing for mitigation and adaptation has increased over the years, but it is still far from what is needed according to the 1.5 ˚C scenario by the Intergovernmental Panel on Climate Change. The concept of green bond was developed as an innovative way to attract investments in climate mitigation and adaptation and other environmental protection projects. In spite of the wide discussion in the financial field as well as the implementation on different regions, there is no comprehensive analysis examining how green bonds funded projects facilitate sustainability transitions.

This thesis addresses this knowledge gap by investigating green bond sustainability experiments in Sweden, particularly in the largest green bond issuer Kommuninvest, mapping how the green bond sustainability experiments are undertaken, and investigating how they influence sustainability transitions. This study has been conducted by gathering data from content analysis of published reports and documents from official websites as well as a semi-structured interview, and analyzing using a "four-step scheme" in the strategic niche management framework.

This thesis found that networks for green bond sustainability experiments are built on the existing business networks in Kommuninvest. Green bond sustainability experiments articulate the expectations of most stakeholders. Learning processes are characterized by developing the green bond framework, monitoring and evaluating performance, and summarizing experience. It was also found that elements at landscape-level, like climate change, put pressure on established regimes, creating opportunities for green bond sustainability experiences to develop. Market preference and "supportive ecosystem" of citizens and governments at regimes level align with the green bond sustainability experiences, making further adjustments on established regimes possible. The key challenges for further facilitating sustainability transitions are increasing accessibility of project information, engaging civil society, and developing a more formal learning process.

Learnings from the green bond sustainability experiments may inspire other countries, especially developing countries, in utilizing green bonds to finance climate change mitigation and adaptation projects. Existing challenges summarized as well as potential solutions suggested in this thesis might also be valuable to the countries where green bond sustainability experiments have already been undertaken.

Keywords: Climate Change; Strategic Niche Management; Multi-Level Perspective; Green Bond; Sweden;

Word count: 11 853

Acknowledgements

At this moment, a lot of fabulous people and splendid moments appear in my mind. I really appreciate what I experienced in LUMES for the past two years. I am thankful for all teachers and staffs in the LUMES programme, who create such a unique interdisciplinary and internationally research environment together. I feel grateful for having my caring and supportive classmates, who make LUMES into an extended family.

I would like to express my sincere gratitude to my supervisor Fanny Christou for consistently guiding me during the whole thesis process. Her continuous encouragement, detail-oriented feedbacks, tenderness and great patience make this process a pleasant journey of exploration.

I would like to thank Björn Svensson for supporting me with his sharp and logical mind. My grateful thanks are also extended to Alice Schneider, who inspired me timely with a stimulating discussion. I would also like to thank Halley Rainer for generously offering her time to read through my thesis.

The contribution of Kommuninvest is truly appreciated. I admire the professional work that is being done by this organization, as well as its passion to facilitate sustainability transitions. A special thanks goes to Björn Bergstrand, whose constructive insights in great details are of great value for my research. This thesis would have never been possible without his help.

I would also like to thank my dear friends, Johanna, Karolina, Luise, Hanniyah, Hyerim, Anna, Freya, Farzana, Anneke, Lydia, Kelly and Lavinna…for the quality time we spent together. And thank you Amanda for being there for us!

My deepest gratitude goes to my family. Thank you for always believing in me and supporting me in pursuing my dreams. You gave me the courage and strength to explore the world!

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Abbreviations

CICERO	Center for International Climate Research
CO_2	Carbon Dioxide
ESG	Environmental, Social and Governance
GHG	Greenhouse Gas
GWh	Gigawatt Hour
ICMA	International Capital Market Association
IPCC	Intergovernmental Panel on Climate Change
MLP	Multi-level Perspective
SEB	Skandinaviska Enskilda Banken
SEK mn	Million Swedish Krona
SDG	Sustainable Development Goals
SNM	Strategic Niche Management
RI	Responsible Investment
RQ	Research Question
tCO_2	Tonnes of Carbon Dioxide
TWh	Terawatt Hour

1 Introduction

1.1 Problem definition

According to the Intergovernmental Panel on Climate Change (IPCC), there is sufficient evidence indicating that anthropogenic activities have significant impacts on climate systems (Pachauri et al., 2014). Greenhouse gas emissions from human activities reached the highest in recorded history, which has led to approximately 1.0°C of global warming compared with pre-industrial levels (Masson-Delmotte et al., 2018). Widespread impacts on natural and human systems have been observed across continents and oceans, for example rising sea level, melting cryosphere and changing precipitation etc. (Stocker et al, 2013; Field et al., 2014). Reducing the rate and magnitude of global warming can have positive influences on lowering the climate change-induced risks on natural and human systems (Field et al., 2014). As the IPCC 1.5°C special report indicates, limiting global warming to 1.5°C compared to 2°C is likely to reduce the likelihood of severe climate change impacts (Masson-Delmotte et al., 2018). However, it is challenging to reach the 1.5°C goal without engaging people as agents of change and striving for a significant transition in existing systems (Wright, 2010; O'Brien, 2018).

Currently, there is still a huge gap between climate ambition and available climate finance (UNFCCC, 2017). A recent study on the global landscape of climate finance indicates that global annual climate finance has been increasing gradually over the years and reached approximately USD 546 billion in 2018, but it is still relatively insufficient compared with the estimated investment demand under a 1.5 ˚C scenario (Buchner et al., 2019). According to the IPCC, an annual investment between USD 1.6 trillion and USD 3.8 trillion would be needed in the supply-side energy system alone for the transition (Masson-Delmotte et al., 2018). In light of the ongoing climate crisis and shortage of funds, joint efforts from governments, businesses, multilateral institutions and civil society are of great urgency to finance a sustainable future (UNFCCC, 2017).

Green bond was initiated as one of the solutions to tackle the financial demands by the World Bank and Skandinaviska Enskilda Banken (SEB) in 2008 (Nassiry, 2018). Existing research about green bonds focus, to a great extent, on the performance of green bonds as financial products, or analyze green bonds from an investor perspective, investigating the impacts of investment on green bonds with environmental, social, and governance (ESG) for investors who are interested in adding responsible investment (RI) to their portfolios. This existing research include, for example, green bonds certification mechanisms (Ehlers & Packer, 2017), global and regional green bond market (Wood & Grace, 2011; Wang & Zhang, 2017; Morel & Bordier, 2012), investors' expectations on

investigate benefits (Tang & Zhang 2018); green bond premium (Zerbib 2019), financial performance (Ehlers & Packer, 2017), environmental risks and market efficiency (Hong et al, 2019) etc. However, little academic research has been done on green bonds funded projects with a social perspective, investigating how green bonds projects could influence sustainability transitions in society.

1.2 Research aim and questions

In light of the current challenges of the climate crisis and climate finance shortage, as well as the knowledge gaps on green bonds and sustainability transition mentioned above, this thesis studies green bond sustainability experiments led by the largest issuer in Sweden, Kommuninvest, and investigates how green bonds funded projects contribute to the sustainability transitions in society. Nordic countries are viewed as the pioneers of green bonds, especially on local green finance (Nassiry, 2018). Summarizing the Nordic experience, particularly Swedish experience on green bonds, can provide learnings from the most innovative green bond sustainability experiment, and shed light on the developing countries about how green bonds could be utilized in facilitating sustainability transitions.

This thesis aims to answer the following research questions (RQ):

RQ1: How are green bond sustainability experiments undertaken in Sweden?

RQ2: How do green bond sustainability experiments facilitate sustainability transitions?

1.3 Contribution to sustainability science

Sustainability science is an emerging interdisciplinary field that attempts to understand the interactions between science and society and look for innovative solutions for sustainability challenges (Kates et al., 2001, Jerneck et al., 2011). How to harness science knowledge, bridge scholarship and practice, and enhance the social capacity to navigate a transition towards sustainability are core and fundamental questions in sustainability science (Clark and Dickson 2003; Kates et al., 2001). This thesis bridges the novel green bond sustainability experiments with scientific research on sustainability transition, seeking potential improvement of incentive structure in the market, to tackle the challenge of climate change. Hence, it is relevant to sustainability science in terms of the core theme and sustainability challenges. This thesis mainly applies a problem-solving approach (Cox, 1981), which attempts to strive for tactical actions and efficiency improvement under existing systems, while critically questioning current institutional structures that create system lock-in of unsustainable situations. The combination of problem-solving and critical approaches is in line with the reflexivity in sustainability science (Jerneck et al., 2011).

Built on the existing research on sustainability transition and sustainability experiments, this thesis provides a concrete example on how to utilize an existing framework in sustainability science to analyze a specific type of sustainability experiment at a variety of scales and levels. Findings of this research contribute to filling the knowledge gaps on how local sustainable finance funded projects facilitate the sustainability transition process. It also contributes to bringing together disciplines across economics, sociology and environmental science, as well as filling knowledge gaps between the Global North and Global South on green bond sustainability experiments to a certain extent.

1.4 Thesis outline

This thesis consists of eight sections. Following the first introduction section, Section 2 provides the background of the green bonds, including an explanation of what green bonds are, a description of the development of green bonds on a global and regional scales, as well as a brief introduction of green bonds in Kommuninvest.

Section 3 introduces theoretical backgrounds about sustainability transition and sustainability experiment, which are the key concepts in this research. A theoretical framework, strategic niche management, is also introduced in this section, and this framework is utilized in the analysis section.

Section 4 is about methodology, which includes justification of context selection, methods for data collection and ethics issues in the research. Methods for data collection consist of both content analysis and a semi-structured interview.

Section 5 shows the initial results from the data collection, mapping green bond sustainability experiments in Kommuninvest. It sets a foundation for analysis and discussion.

Section 6 outlines the analytical processes, which includes analyzing the niche development in green bond sustainability experiments, investigating relevant landscapes and regimes, as well as exploring potential alternative pathways to sustainability transitions.

Section 7 interprets findings from results and analysis in relation to existing research, and discusses how the Swedish experience of green bond sustainability experiments can inform sustainability transitions in developing countries. It also suggests the limitations in this research and recommendations for further research.

Section 8 is a conclusion section that summarizes key findings and contributions.

2 Background

2.1 What are green bonds?

Green bonds refer to fixed-income securities that support projects with positive environmental impacts (Ehlers & Packer, 2017). The concept of green bond was initiatively developed under the partnership between the World Bank and Skandinaviska Enskilda Banken to fulfill Nordic investors´ demand of low risk (AAA-rated) financial products that support climate mitigation and adaptation (Wood & Grace, 2011). Green Bonds, as a constituent part of green finance, have the potential to internalize environmental externalities with the market mechanism (Green Finance Study Group, 2016). It works through attracting investment from capital markets to environmentally beneficial projects and raising awareness of climate change induced financial risks (Reichelt, 2010). However, there is not a universal definition of environmentally beneficial projects, hence different organizations offer various certification of green bonds according to their standards in defining "green" and the "shades of green" (Ehlers & Packer, 2017).

2.2 The development of green bond

The World Bank (2019) summarized the milestone events that accelerate the development of the green bond market. The development of Green Bonds can be traced back to 2007, when the European Investment Bank issues their "Climate Awareness Bonds" (Mathews & Kidney, 2012). In 2014, the International Capital Market Association (ICMA) introduced the Green Bond Principles, which laid the foundation for the further development of the green bonds market (The World Bank, 2019). In 2016, there was a significant increase in the green bond market, with the total insurance over $100 billion (Ehlers & Packer, 2017). However, the total market share of green bonds in the global bond market is still relatively small (Ehlers & Packer, 2017), which indicates a potential opportunity of further development.

2.3 Global and regional green bond market

The green bond market consists of supranational issuers like European Investment Bank, advanced economies issuer like Europe and USA, and emerging market economies (EMEs), especially China. In 2019, global total green bond issuance surpassed $257.7 billion, with an increase by 51% compared with 2018 (Climate Bonds Initiative, 2020). The USA, China and France are the largest insurance countries (Climate Bonds Initiative, 2020).

Almost all regional markets have experienced an increase of green bonds issuance in 2019. The European market was the key driver of the growth in 2019, with a 74% increase compared with 2018, and the issuance volumes reached $116.7 billion (Climate Bonds Initiative, 2020). A recent study

showed that European investors are informed of climate issues and willing to invest in sectors that have highly positive impacts on climate (Almeida et al, 2019). It also indicated that European investors valued green credentials in their decision making for investment, and they view policy as the most important factor to scale up the market.

When it comes to innovation in green bonds practice, Nordic countries have been at the forefront, especially for local green bonds issuance (Nassiry, 2018). Nordic issuers contribute to the world green bonds market with innovative practices in concept development, external reviews, impact reporting, aggressive platforms, stock exchanges etc. (Filkova, 2018). Issuance from Nordic regions reached $19 billion, which accounts for approximately 6.7% of global green bonds markets (Filkova, 2018). Sweden leads the green bonds market in Nordics, which represents 53% of total Nordic issuance and the largest issuer in Sweden is Kommuninvest (Nassiry, 2018). Kommuninvest is the research target in this paper.

2.4 Green bonds in Kommuninvest

Kommuninvest is a "municipal cooperation" founded in 1986 (Kommuninvest, 2019, p.47). It provides finance service for Swedish **municipalities**, regions, municipal companies and other local government actors (Kommuninvest, 2020c). Kommuninvest is the biggest lender to the Swedish local government sector and one of the largest credit institutions in Sweden, with a total asset of USD 50.6 billion and a loan portfolio of USD 43.8 billion in 2019 (Kommuninvest, 2019).

Kommuninvest is owned and controlled by their member municipalities and regions, and it consists of two parts, namely the limited liability company *Kommuninvest i Sverige AB* and the cooperative society *Kommuninvest Cooperative Society*. The former provides credit and financial advice and the latter owns the credit market company (Kommuninvest, n.d.a). In this paper, Kommuninvest refers to the whole organization.

Triple-A rated from both international credit rating institutions, Moody's and Standard & Poor's and jointly guaranteed by local municipalities, Kommuninvest is regarded as a highly reliable and credible financial organization, which enables it to raise funds as at a lower cost than commercial banks (Oakley, 2006). Hence, the green bonds issued in Kommuninvest have competitive advantages in the capital markets for investors who seek for both secure return and responsible investment.

Kommuninvest's green bonds finance edible projects that potentially contribute to the sustainability transitions towards a "low-carbon and climate-resilient" society (Kommuninvest, n.d.b). According to Kommuninvest (n.d.b), the Green Bond proceeds are exclusively allocated to finance climate mitigation or adaptation projects or other environmentally beneficial projects. It works through

issuing green bonds by Kommuninvest and distributing proceeds as green loans to local eligible projects in various municipalities, county councils or regions (Kommuninvest, n.d.b).

3 Theories

In order to answer two research questions (1) how green bond sustainability experiments are undertaken, and (2) how green bond sustainability experiments facilitate sustainability transitions, this section provides theoretical backgrounds about key concepts in research questions, namely, sustainability transition and sustainability experiment. This section also introduces a theoretical framework, strategic niche management, which is applied in the analysis section.

3.1 Sustainability transition

Transitions refer to "transformation processes", during which significant and fundamental shifts happen in society (Rotmans et al, 2001, p.15). It is commonly used by interdisciplinary researchers to describe complex social, institutional and technological changes that drive the movement of dynamic equilibrium from an unsustainable system to a more sustainable system (Hölscher et al, 2018; Loorbach et al, 2017).

According to Loorbach (2017, p.607-608) transition processes are characterized by "nonlinearity", "multilevel dynamics", "coevolution", "emergence", "variation and selection". "Nonlinearity" means that transitions are usually triggered by disruptive changes, which are developed in a gradual way. "Multilevel dynamics" refer to a nested perspective that transitions happen at multiple levels, and there are interactions among different levels of landscape, regime and niches (Kemp, 1998). The interactions of disruptive changes at multiple levels lead to the complex system changes. "Coevolution" refers to the nonlinear casualties, that various factors influence each other at the same time, hence there is no single reason or cause. "Emergence" is tightly linked with the concept of coevolution. It implies that transitions are the result of co-evolutionary changes emerging into a new equilibrium. "Variation and selection" refer to the diverse approaches that address transitions, among which the experimentation and learning-by-doing are essential to novelty (Loorbach et al, 2017, p.607-608). The typology of experimentation will be further elaboration in the later section.

Sustainability transitions were defined as "long term, multi-dimensional, and fundamental transformation processes through which established socio-technical systems shift to more sustainable modes of production and consumption" (Markard et al., 2012, p.956). However, this definition has been developing as the subject progresses. Sustainability transition is goal-oriented, which refers to an endogenous character to tackle sustainability challenges (Smith et al., 2005). Government and civil society are the key actors for sustainability transitions, and their actions to internalize externalities are essential (Elzen et al., 2011) to overcome the tragedy of the commons (Kraak, 2011; Lant et al., 2008).

The focus of sustainability transition was initially on "socio-technical systems", and later it was extended to "socio-institutional systems" and it developed towards a recognition of "socio-ecological, socio-economic, and socio-political systems". (Loorbach et al, 2017, p.603).

The socio-technical approach is commonly applied to socio-technical systems, for example sectors like energy supply, water supply, transportation and waste management (Joerges,1998; Markard et al, 2012). This approach stems from science, innovation and technology studies. It focuses on historical technological innovation in social context. Multi-level Perspective (Geels, 2002), Path Dependency, Strategic Niche Management (Hoogma er al., 2002; Raven, 2005), Technological Innovations Systems are the main analytical lenses in the socio-technical approach (Loorbach et al, 2017).

The socio-institutional approach is commonly used to tackle ongoing environmental problems societal systems, where institutional structures and infrastructures form system lock-ins (Suurs, 2009). These systems are influenced by incumbent power, culture, discourse, regulation, agency to a great extent (Loorbach et al, 2017). Examples can be found in the education, finance and health care sectors. The socio-institutional approach has its root in social science studies like sociology, economics, political science, geography etc. (Loorbach et al, 2017). Transition Management and Multi-actor Perspective are the main analytical lenses in the socio-institutional approach (Loorbach et al, 2017).

The socio-ecological approach derives from ecology and resilience theory (Holling, 1973), expanding from analyzing the stability in ecosystems to socio-ecological systems (Cote & Nightingale, 2012). Sectors like agriculture, forestry, fisheries or biodiversity can be seen as socio-ecological systems. Socio-ecological approach focuses much on understanding the system vulnerability and transformative capacity (Loorbach et al, 2017). The main analytical lenses include resilience, planetary boundary, adaptive and transformative capacity etc. (Loorbach et al, 2017).

Considering the characteristics and specialties of the green bonds funded projects in Kommuninvest, which are mostly allocated in the energy, infrastructure, transportation, and waste management sectors, this paper applies the socio-technical approach in analysis, but it also takes insights from socio-institutional approaches when analyzing the influence of relevant elements in regimes, for instance incumbent political power, culture or discourse in Sweden. To answer the first and second research questions, strategic niche management, which is one of the main analytical frameworks in socio-technical approach, will be utilized in the analysis section. Further elaboration on this framework will be conducted in section 3.3.

3.2 Sustainability experiment

Experimentation plays an essential role in sustainability transition theories, which distinguishes sustainability transition research from boarder social sciences research (Markard et al., 2012; Van den Bosch, 2010). According to Sengers et al (2019), an inclusive, practical, problem-oriented initiative that drives systemic innovation through social learning processes can be seen as an experiment. These initiatives are commonly conducted in a situation that is facing uncertainty and ambiguity. A recent review summarized the different types of "experimentations" (Sengers et al., 2019). It conceptualizes experiments in sustainability transition into five categories, which are Niche Experiment (Weber et al, 1999), Bounded Socio-technical Experiment (Vergragt & Brown, 2007), Grassroots Experiment (Seyfang & Smith, 2007), Transition Experiment (Van den Bosch & Rotmans, 2008) and Sustainability Experiment (Berkhout et al., 2010). According to this review, five types of experiments above vary in their definitions, normative orientations, theoretical foundations and analytical emphasis and main actors (Sengers et al., 2019).

Sustainability experiments are defined as designed initiatives which aim to stimulate a highly innovative social-technical configuration for sustainable development (Berkhout et al., 2010). It indicates that these initiatives are planned, goal-oriented actions rather than spontaneous occurrences. Highly innovative is the feature that distinguishes these initiatives from dominant, prevailing, conventional solutions (Berkhout et al., 2010). Social-technical configuration implies that these initiatives have both social and technical dimensions and take place in real societal context instead of in a laboratory. The formats of sustainability experiments can be rather diverse as a consequence of the innovations at all societal levels (Sengers et al., 2019). They could be both top-down solutions from governmental decisions and bottom-up grassroots actions, so some features of sustainability experiments might also be found in other type experiments (Wieczorek et al., 2015). It leads to a problem that one transition project defined as, for instance, a sustainability experiment could also be described as another type of experiment to a certain extent (Verbong et al., 2010).

Drawing insights from geography and innovation studies in late-industrializing countries context, sustainability experiments discuss the alternative pathways for sustainable development (Berkhout et al., 2009). The conventional pathways of development require substantial resource consumption and pollution emissions for developing countries to "catch-up" to developed countries (Abramovitz, 1986). Environmental convergence was regarded as a parallel with economic convergence (Strazicich and List, 2003). However, researchers in sustainability experiments attempted to explore "greener" development models that avoid environmental convergence and generate sustainability gains (Berkhout et al., 2017). The analytical emphasis of sustainability experiments is transitional linkages,

which are defined as the structures or interactions that facilitate movements and exchanges of people, technology, knowledge, capitals and institutions (Wieczorek et al., 2015). Sustainability experiments are influenced by the Multi-level Perspective and Strategic Niche Management, highlighting the actors at multi-scalar innovation networks (Sengers et al., 2019).

In this paper, the practices of funding environmentally beneficial projects with green bonds in Kommuninvest are viewed as green bond sustainability experiments that are planned to reify highly novel socio-technical configuration for environmental, social and economic gains. These projects are planned, goal-oriented, practice-based initiatives conducted in social contexts, which potentially can lead to system innovation for sustainability transitions in Sweden.

3.3 Theoretical framework

This section introduces a theoretical framework: strategic niche management, which will be utilized as an analytical tool to facilitate the analysis. To get a better understanding of what a niche is and why it is significant in sustainability transition, this section will start with an introduction of a multi-level perspective, where essential concepts of niche, regime and landscape are elaborated.

3.3.1 An introduction of Multi-level Perspective

Multi-level Perspective (MLP) is a middle-range theory that bridges grand theory and abstracted empiricism to explain the social behavior, institutions, and transition in the society (Geels, 2011). It conceptualizes the dynamic patterns at various scales and provides an analytical framework that includes three levels: niches, socio-technical regimes and socio-technical landscape (Rip and Kemp, 1998; Geels, 2002, 2005, 2011).

Regimes refer to the established, dominant and stable configurations in a societal system (Loorbach et al, 2017). In the context of MLP, the socio-technical regimes shape and stabilize prevailing socio-technical systems with established practices and semi-consistent rules (Geels, 2004). These practices and rules can be institutional regulations, lifestyles, routines, capabilities, etc. (Geels, 2011). Due to the stabilizing mechanisms, socio-technical regimes are commonly facing the issues of path dependency and socio-technical systems lock-in (Unruh, 2000). Hence, innovations usually take place in incremental ways, and gradually develop, adjust and accumulate into stable trajectories (Geels, 2011).

Niches are the spaces where radical innovations occur, which can be research and development labs, governmental supported projects or demands-driven market niches etc. (Geels, 2011). As the seeds of disruptive changes in societal systems, niches are perceived as fundamental factors for sustainability transitions (Loorbach et al, 2017). Niche actors usually refers to entrepreneurs or start-

ups who are devoted to supporting radical innovations to be emerged into established regimes or even leads to significant shifts in regimes (Geels, 2011).

The socio-technical landscape refers to a wider exogenous context that can affect the development of niches and regimes (Rip and Kemp, 1998). It provides an overall social, economic, political, material, technical backdrop or context, where the society exists and sustains (Geels, 2011). Development at landscape level is relatively slow, and changes happen at niches or regimes levels have relatively limited impacts on landscape in a short term (Geels, 2011).

Sustainability transition occurs as a consequence of the dynamic patterns interacting with each other at the levels of niches, socio-technical regimes and socio-technical landscape (Loorbach et al, 2017). Geels (2005) summarized the characters of the transition process with MLP framework, which includes the development and accumulation of niche innovation; pressure on regimes from the changing landscape; and new development of niche-innovation due to the changes of regimes. This transition process was conceptualized as the multi-phase model of transitions, with the whole process divided into four phases, namely emergence or predevelopment, take-off, acceleration and stabilization (Rotmans et al., 2001). Under this multi-phase model of transitions, the mechanism of path dependency and socio-technical systems lock-in are further elaborated (Geels, 2002; 2005).

3.3.2 Strategic Niche Management Framework

The introduction of MLP above provides an elaboration of what niches, regimes and landscapes are and how they interact with each other, which sets a foundation for understanding the framework that will be introduced in the following part.

Strategic Niche Management (SNM) is defined as a "programmatic approach" to sustainable innovations (Berkhout et al., 2010, p.267). It views niche development as a process that enables innovations for a desirable transition (Kemp et al., 1998). Technical innovations are essential in forming socio-technical configuration, hence they are viewed as the fundamental factors for SNM analysis (Schot et al., 1994). However, it does not necessarily mean that SNM is a technology-oriented approach that focuses only on connecting technological and social elements (Schot & Geels, 2008). Instead, SNM focuses on creating and managing niche innovations to stimulate the dynamic changes in socio-technical systems (Berkhout et al., 2010).

According to studies on SNM (Kemp et al., 1998, 2000; Schot and Geels, 2008; Berkhout et al., 2010), niche development can be divided into three crucial processes, including (1) Network Formation, which means building social networks that engages relevant actors and enables resource acquisition; (2) Articulation of Expectations, which refer to the process that gathers voices from relevant

stakeholders or actors, articulates and negotiates expectations, as well as guides innovation; (3) Learning Process, which embodies technical niches into border practice and eventually emerge these innovations to the incumbent social-technical configuration. In the learning process, experiments or practices in local projects are considered to be significant (Fleck, 1994). It is emphasized that the learning process should be technical-social optimization, implying that both technical aspects, for instance technical design or infrastructure, and social aspects for instance culture or user preferences should be taken into account (Berkhout et al., 2010).

In light of the "four-step scheme" developed by Berkhout et al. (2010, p.267), this paper analyzes the Green Bond sustainability experiments in Sweden with the SNM framework. This "four-step scheme" includes (Berkhout et al, 2010, p.267), (1) mapping experiments and setting overview of niches (Raven, 2005); (2) analyzing experiments with the three processes mentioned above; (3) investigating relevant regimes and landscape; and (4) developing alternative transition pathways (Berkhout et al, 2010).

4. Methodology

4.1 Context selection

This thesis aims to uncover green bond sustainability experiments in practice and analyze how green bond sustainability experiments facilitate sustainability transition. Green bonds as a low-risk fixed income financial product with medium to long maturity term, match with the needs of projects for climate mitigation and adaptation to a great extent (Reichelt, 2010; Wood & Grace, 2011; Ehlers & Packer, 2017). It is because that, on the one hand, climate mitigation and adaptation projects usually require relatively long-term and continuous investment. On the other hand, a low-risk financial product usually indicates a low investment return in capital markets, which means the less cost for the green bonds issuers to acquire investments.

Although Sweden is not the biggest issuer in the world green bond market, it was selected as a target country to get further investigation on the green bond sustainability experiments due to its innovative credits. Besides the innovative practices, Sweden also stands out in the green bonds market because of its profound experience, sufficient online information, transparent reporting, and available external reviews etc. These factors contribute to investigating the projects at a relatively detailed level, as well as increasing the objectivity and reliability of the research. Kommuninvest is selected because it is the largest green bonds issuer in Sweden (Filkova, 2018), and also because it is the largest provider of Swedish local government's sustainable investment (Kommuninvest, 2019).

4.2 Data collection

In general, the difference between quantitative and qualitative research lies in what type of data to collect and how to analyze collected data (Bhattacherjee, 2012). Quantitative research usually requires collecting numeric data, like scores, to conduct controlled experiments, while quantitative research usually obtains data through, for instance, interviews or observations, and analyzes it with qualitative techniques (Bhattacherjee, 2012).

Qualitative research is usually seen to be contextual, which means studying phenomena in a certain context (Brinkmann & Kvale, 2005). Answers to the RQs in this thesis are expected to be descriptive, making it suitable to conduct qualitative research.

Qualitative data used in this research is mainly collected from documents and reports available on the official websites. Additional data is collected from a semi-structured interview for data that is not available in published documents and reports.

4.2.1 Secondary data and content analysis

According to Krippendorff (2018, p.24), content analysis refers to "a research technique for making replicable and valid inferences from texts (or other meaningful matter) to the contexts of their use". Content analysis research as a technique indicates that it should include certain "reliable" and "replicable" procedures to produce valid results (Krippendorff, 2018, p.24). These procedures can be understood as "analytical constructs" to acquire useful contents from collected text or data to answer research questions (White & Marsh, 2006, p.27). By drawing conclusions from texts to contexts (White & Marsh, 2006), researchers get new insights on certain experiments or phenomena.

In light of the conceptual framework for content analysis developed by Krippendorff (2018, p.26), this thesis applies content analysis for texts from the documents and reports that are available on the official website of Kommuninvest, as well as other published documents if it is found to be relevant (Figure 1).
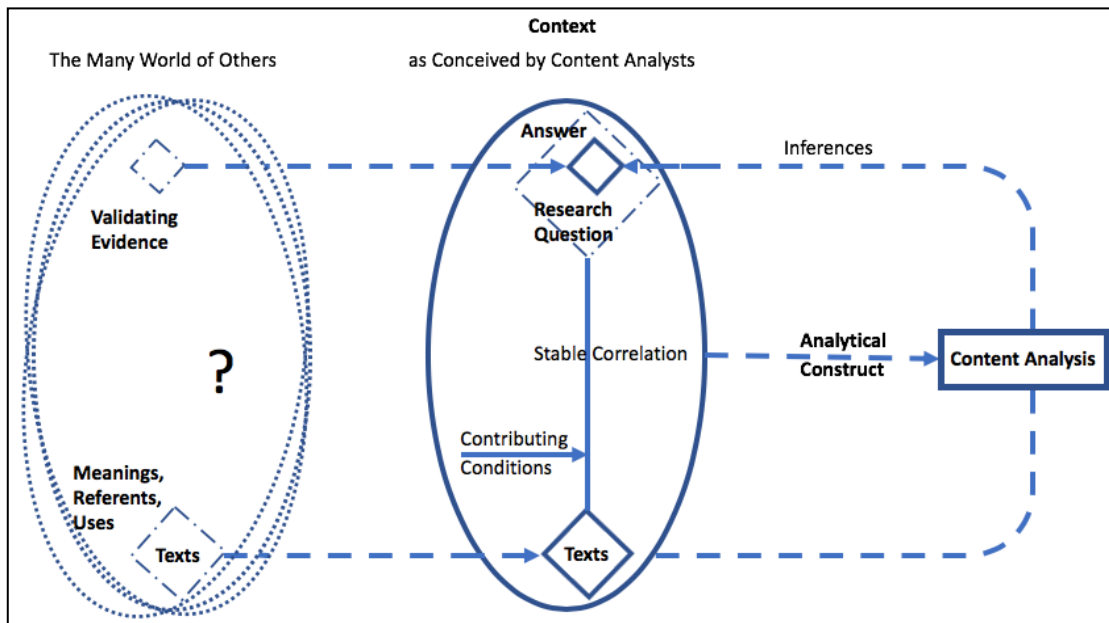
Figure 1. A framework for content analysis. Adapted from *Content analysis: An introduction to its methodology* (4th ed., p.36), by Klaus Krippendorff, 2018, Copyright 2019 by Sage publications.

As it is illustrated in Figure 1, answering research questions is the ultimate goal of content analysis. Answers for research questions come from both validating evidence collected directly and inferences out of content analysis (Krippendorff, 2018). Content analysis generates inferences from texts that are selected, using certain analytical constructs (Krippendorff, 2018). These texts "acquire significance in the context of their use" (Krippendorff, 2018, p.40). Analytical constructs can be developed from different "sources of certainty", as following previous experiences, expert

knowledge and experience, established theories, and embodied practices (Krippendorff, 2018, p.180).

In this thesis, analytical constructs are derived from established theories, which refer to the theories on sustainability transition and sustainability experiments, as well as relevant theoretical framework, SNM. According to White & Marsh (2006), for qualitative coding, the initial focus should be on the research questions instead of a priori codes. Hence in this case, the focus should be answering two research questions, how green bond sustainability experiments are undertaken and how they facilitate sustainability transition. The documents and reports available on the official websites are selected according to the relevancy for the topics, green bond and sustainability transition. Texts from selected documents and reports are interpreted and conceptualized in accordance with the SNM framework. Particularly, the texts that are related to the context of *expectation*, *network* and *learning* in SMN framework, as well as the concepts of *landscapes*, *regimes* and *niches,* are recorded and analyzed.

A total number of 11 reports and documents from Kommuninvest and 8 from external stakeholders are identified, among which 16 are used in content analysis (Appendix I). When it comes to the same type of annual documents released in different years, this thesis analyzes the texts and from the latest version that are available during the research period.

4.2.2 Semi-structured interview

The aim of conducting the semi-structured interview is to collect additional data that is not available in published reports and documents. An interview guide is developed, using the framework developed by Kallio et al. (2016). It includes the following five phases (Figure 2).
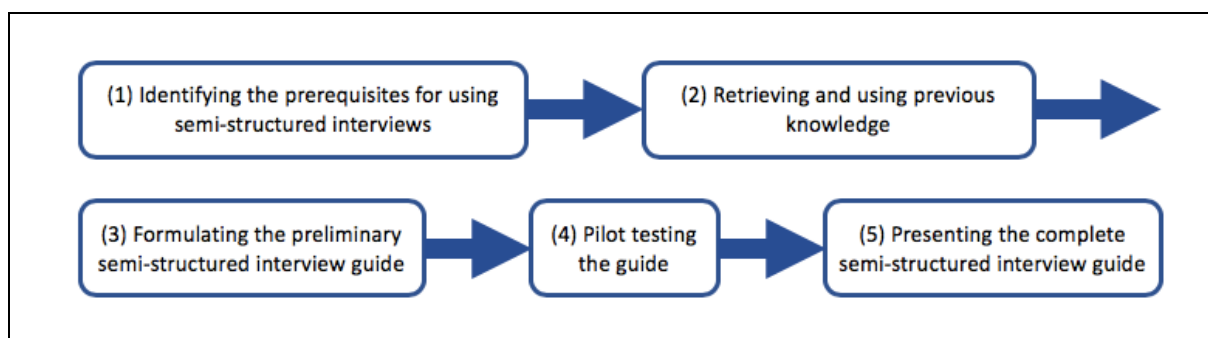
Figure 2. A framework for a qualitative semi-structured interview. Adapted from "Systematic methodological review: Developing a framework for a qualitative semi-structured interview guide", by Hanna Kallio et al., 2016, *Journal of* advanced nursing, 72(12), p.2962. Copyright by 2016 John Wiley & Sons Ltd

In phase one, this thesis identifies the need of conducting a semi-structured interview to collect information that is not provided in published documents and reports. Considering the fact that most of the published documents about green bonds available at the official websites of Kommuninvest

have a strong emphasis on communicating positive impacts or results of existing projects to potential investors, it is necessary to get additional information to facilitate the analysis. The additional information includes but are not limited to the following aspects: for example, challenges of green bond projects in Kommuninvest, the networking and learning processes, as well as specific project information, etc. Besides, a semi-structured interview is considered to be an appropriate method to investigate a person's perceptions (Barriball & While 1994). By conducting semi-structured interviews on the key actors who lead the Kommuninvest green bonds and green loans program, first-hands insights on the top-level design can be acquired.

The aim of the second phase, retrieving and using previous knowledge, is to obtain a comprehensive understanding of the subject (Kallio et al., 2016). Previous knowledge can help prepare the interview by providing concepts, theories and frameworks (Turner 2010). In this thesis, previous knowledge refers to theories and frameworks on sustainability transitions and sustainability experiments, as well as concepts about green bond. This previous knowledge sets a conceptual basis for developing an interview guide.

In the third phase, a semi-structured interview guide is formulated based on the previous knowledge. Generally speaking, interview guide refers to a list of planned questions that will be used to guide conversations between interviewees and interviews towards the research topic (Whiting 2008; Krauss et al. 2009; Cridland et al. 2015). A semi-structured interview guide has the advantage of flexibility, making it possible to adjust the orders of questions and ask additional questions based on the answers from interviewees (Turner, 2010; Cridland et al., 2015). In this thesis, a semi-structured interview guide is formulated in a participant-oriented way, which means the interviewer is not leading the conversation, and the interview has an open-ending. In this way, it allows spontaneous answers from the interviewee's personal experience and feelings.

The fourth phase, pilot test, is essential to check the coverage and relevancy of the content and make necessary adjustments to improve the interview questions (Barriball & While 1994; Kallio et al., 2016). According to Kallio et al. (2016), internal testing, expert assessment and field-testing are the three ways that are commonly applied in pilot test. This thesis uses internal testing to check, improve and confirm the interview guide. Applying internal testing means having other scholars or researchers in the research group to evaluate the interview guide (Barriball & While 1994). It is chosen because that, on one hand, other researchers can help point out mistakes or potential improvements in the interview guide, and on the other hand this method is particularly useful when the other two methods are not very feasible for this case.

The last phase is to finalize the semi-structured interview guide. The semi-structured interview guide used during the interview is attached as Appendix II at the end of this thesis.

The author of this thesis identifies five key actors, (1) the leaders of Green Bonds Program in Kommuninvest, (2) the author of *Kommuninvest Green Bonds Impact Report 2018* and (3) the analyst of the impact report, (4) head of Sustainability Department in Kommuninvest, and (5) deputy CEO of Kommuninvest. As it is mentioned above, interview is used as a method to collect additional information that is not provided by available documents and reports, so the actors who potentially have profound insights on the Green Bonds and Green Loans Programme in Kommuninvest are the target interviewees for this research. An investigation on these actors indicates that actor (1), actor (2) and actor (4) are the same person. So, three invitations were eventually sent through both emails and LinkedIn. The actor (1)(2)(4) agreed to be engaged in this research and be interviewed. Actor (3) is no longer involved in the work, and this actor directed the author to the actor (1). And there is no response from actor (5) is received. An online interview was conducted with the actor (1)(2)(4) on March 19th, 15:30-16:30 (CET) via Google Meet.

4.3 Research ethics

Ethics is of great significance to produce morally sound academic research (Brinkmann & Kvale, 2005), and it is addressed in this thesis. According to Fisher & Anushko (2008), academic research should address the privacy and confidentiality issues of individuals who are involved in the research process. Data collected for this research are mainly from secondary data, including published reports and documents on the official website of Kommuninvest and external stakeholders. Additional data were directly obtained from an interview. All of the secondary data acquired from published documents and reports on official websites are cited with proper attributions. When collecting the data from interviews, it is vital to obtain informed consent from interviewees, due to the exploratory and open-ended nature of semi-structured interview (Marshall, 1992). The interview was conducted according to the ethical criteria proposed by Bhattacherjee (2012). The purpose of this research was communicated before the interview. Interviewees were informed that their participation is voluntary, and that the information gathered during the interview would be used in this research.

Another ethical aspect is avoiding potential harmful or exploitative conflicts of interest. It is essential for the objectivity of research that data analysis and interpretation are not influenced by external interest forces (Fisher & Anushko, 2008). This research is not sponsored by any company or organization, and the author does not have any conflict of interest or mutual beneficial relationship with the organization that is studied in this research.

5 Initial Results

This section provides initial results summarized from the content analysis of published reports and documents from official websites, as well as data collected from a semi-structured interview.

This section will serve as the first step of the "four-step scheme" developed by Berkhout et al. (2010, p.267). Four steps refer to (1) mapping sustainability experiments, (2) analyzing niche development processes, (3) investing relevant regimes and landscapes, and (4) exploring potential pathways towards sustainability transitions.

5.1 An overview of the green bonds in Kommuninvest

Green bond funded projects in Kommuninvest are viewed as sustainability experiments, which are designed to explore innovative ways to finance sustainability transitions. The novelty of green bond sustainability experiments mainly lies in the business model, rather than technologies. To map green bond sustainability experiments in Kommuninvest, this section starts with an overview of the research target.

As it is stated in the background section, Kommuninvest is the largest provider of sustainable finance to Swedish local government. By the end of 2018, Kommuninvest had issued five green bonds, which acquired a total amount of SEK 20.4 billion (USD 2.3 billion) investment from capital markets, making Kommuninvest the largest issuer of green bonds in Sweden (Kommuninvest, 2019). With the proceeds from green bonds, Kommuninvest had financed 227 projects by the end of year 2018, through lending green loans to 109 Swedish local governments (Kommuninvest, 2019). In total, the bruised Green Loans are SEK 25.8 billion, which is slightly over the total amount of green bonds proceeds, and committed green loans reaches SEK 39.6 billion (Kommuninvest, 2019).

Kommuninvest takes the advantage as a highly credible financial organization to attract investment from secure-seeking responsible investors in both Swedish and international capital markets. Kommuninvest functions like an "umbrella organization" in issuing Green Bonds, making it possible for individual local projects in different municipalities or county councils to get cost-efficient investment (Oakley, 2006).

Generally speaking, Kommuninvest adopts a "bottom-up" approach in green bond projects, which means eligible projects are financed in the following way (Kommuninvest, 2019, p.20): firstly, local projects are identified by the relevant departments in local governments; secondly, these projects get approved if they meet criteria in Kommuninvest; thirdly, Kommuninvest pre-finances approved projects; finally, relevant green bonds will be issued afterwards to continue to finance these projects.

In this way, Kommuninvest can provide more accurate and transparent information regarding eligible projects to potential investors, and Kommuninvest will be able to issue a proper volume of green bonds that do not exceed the total necessary amount for green loans disbursement (Kommuninvest, 2019). Due to the fact that eligible projects get financed from Kommuninvest first and Kommuninvest issues Green bonds afterwards, all financing processes can be seen as "refinancing" processes (Kommuninvest, 2019, p.21).

5.2 What are eligible projects?

Eligible projects are requested to meet the predetermined sustainability criteria under the Green Bonds Framework (Kommuninvest, 2018). It means that all these projects must (1) promote a "low-carbon and climate-resilient" transition, (2) be part of "systematic environmental work" in local regions, (3) be connected with to "environmental objectives or goal", and (4) contribute to climate change mitigation and adaptation or environmental management (Kommuninvest, 2019, p.14). Green Bonds Framework identified eight categories for eligible projects, which are "production and distribution of renewable energy"; "energy efficiency in energy systems"; "green building and energy efficiency"; "clean transportation"; "waste management"; "water and wastewater management"; "climate change adaptation" and "environmental management" (Kommuninvest, 2018, p.2). Green project portfolio in Kommuninvest indicates that buildings and renewable energy are the largest sectors, which account for 51% and 30% of the total disbursed amounts respectively (Kommuninvest, 2019).

In practice, local governments applying for green loans from Kommuninvest are required to supply environment-related information including (Kommuninvest, n.d.c): (1) project category according to Kommuninvest's Green Bonds Framework ; (2) main climate environmental benefits from the project; (3) Environmental Impact Assessment (EIA) and its main results; (4) relevant environmental policy in the applicant organization that addresses the project; (5) compliance with the Swedish national environmental quality objectives; (6) following-up plan for the climate and environmental effects; (7) the way and content for environmental impact reporting; (8) additional project information, if relevant and available.

5.3 Who is engaged in the processes?

Diverse stakeholders were involved in Kommuninvest's green bond sustainability experiments, in the processes of developing and reviewing Green Bonds Framework, managing proceeds from Green Bonds issuance, evaluating and selecting Green Bonds projects, and delivering Green Bonds impact reports (Figure 3).
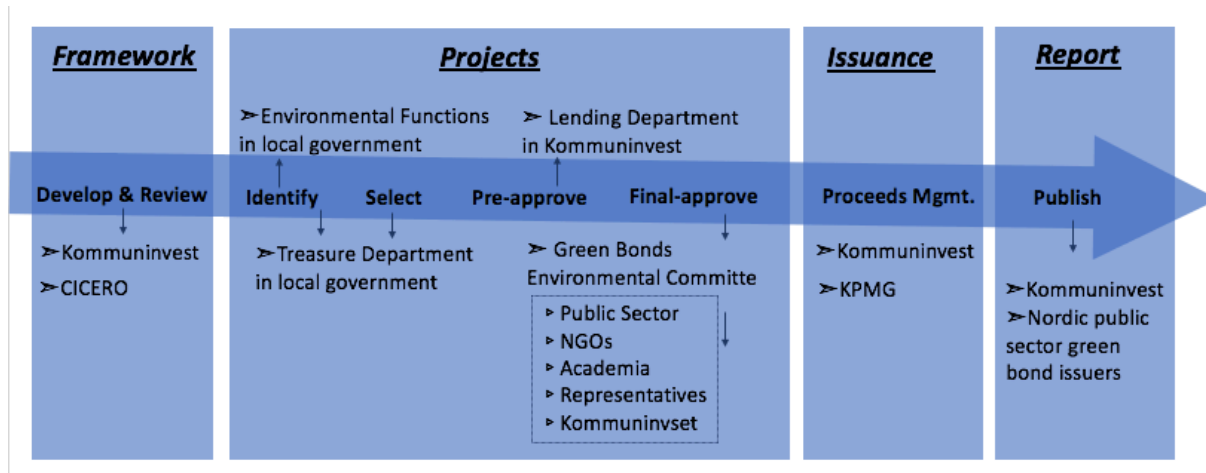
Figure 3. Stakeholders involved in green bond sustainability experiments in Kommuninvest. Created by Qian Mao, 2020, based on information from following reports: *"Green Bonds Impact Report 2018",* by Kommuninvest, 2019; *"Green Bonds Framework*", by Kommuninvest, 2018; *"Second Opinion on Kommuninvest's Green Bond Framework",* by CICERO, 2018.

Kommuninvest's green bonds framework was developed in accordance with the *Green Bond Principles* released by International Capital Market Association (ICMA), which includes four fundamental components ("Use of Proceeds, Process for Project Evaluation and Selection, Management of Proceeds and Reporting"), and use of external reviews (ICMA, 2018, p.3). This framework was reviewed by the Center for International Climate Research (CICERO), an independent non-profit research institution, and the framework was awarded as Medium Green shading in CICERO's second opinion report (CICERO, 2018). According to CICERO's definition of shades of green, Medium Green means that Green Bond projects in Kommuninvest represent steps to long-term vision of a "low-carbon and climate resilient society" but are "not quite yet there" (CICERO, 2018, p.6).

When it comes to the projects that apply for green loan from Kommuninvest, more actors are involved in the processes of identifying, selecting, and approving Green Bond Projects (Kommuninvest, 2018). Potential projects are identified and verified by the Environmental Functions in local government. Treasury Departments in local governments are responsible to select eligible projects according to Kommuninvest's instructions. The lending department in Kommuninvest will pre-approve the submitted projects on a quarterly basis. The final approval is conducted by the Green Bonds Environmental Committee, which also consists of various actors. These actors include at least two representatives from the Environmental Functions in local governments, multiple numbers of environmental specialists from public sectors, NGOs, academia and other relevant agencies, and members from Kommuninvest's management group. (Kommuninvest, 2018).

As mentioned above, Kommuninvest issues green bonds for ongoing projects. The proceeds from green bond issuances are managed according to the internal instructions in Kommuninvest but also got verified by an external auditor agency, KPMG (2017, 2018, 2019). Assurance reports from KPMG provide assurance on the management of proceeds from green bonds, and they are published on a yearly basis (Kommuninvest, 2019).

Kommuninvest publishes green bonds impact reports in accordance with the standards presented in the *Position Paper on Green Bonds Impact Reporting* developed by Nordic Public Sector Issuers (2019). This position paper is based on the outline Green Bond Principles initiated by ICMA (Kommuninvest, 2019). Kommuninvest played a leading role in developing this position paper, together with other Nordic public sector issuers (Kommuninvest, 2019). Kommuninvest's impact reports also provide the Sustainable Development Goals (SDGs) mapping, which identified nine of the SDGs addressed by Kommuninvest's Green Bonds Framework (Kommuninvset, 2019). This mapping is in accordance with the mapping reference frame provided by ICMA, and it was completed with support from other Nordic public sector issuers (Kommuninvest, 2019).

5.4 What are the environmental impacts?

According to the Green Bonds Impact Report 2018, the total annual greenhouse gas (GHG) emission reduction contributed by green bonds funded projects is approximately 662,390 tCO_2. These projects also contribute significantly to energy saving and renewable energy generation (Kommuninvest, 2019). Energy efficiency projects in Kommuninvest have saved 110.8 GWh energy, while green building projects saved 33.9 GWh energy from avoiding and reducing energy use. Besides, 3.0 TWh renewable energy is generated every year because of these projects (Kommuninvest, 2019).

The information regarding how much green loans are allocated in each category, as well as how much environmental impacts each type of project generates are also revealed in the impact report (Table 1). It indicates that renewable energy and green building projects received the largest amount of green loans from Kommuninvest, while investments on the renewable energy and energy efficiency projects have the highest impacts on CO_2 reduction as well as energy saving and production (Kommuninvest, 2019). Among SEK 25750 million total disbursed green loans, SEK 22293 million loans have CO_2 impacts. Taking the total amount of 662390 tons avoided or reduced CO_2 into calculation, it means that by average every one million SEK (equivalent to approximately USD 99,320) invested in projects in Kommuninvest has a positive impact of approximately 29.7 tonnes CO_2 reduction.

Project Category	Disbursed Green Loans (SEK mn)	Commited Green Loans (SEK mn)	Estimated annaual Energy Production or Energy Saving (MWh)	GHG Emissions Avoid or Reduced (Tonnes/year)	CO2 Reduction Impacts (Tonnes per SEK mn)
Renewable Energy	7878	11313	3032220	634446	80.5
Energy Efficiency	235	286	110845	21796	92.7
Green Building	13295	20078	33681	4915	0.4
Cleaning Transportation	730	1980	N/A	651	0.9
Waste Management	155	226	N/A	583	3.8
Water Management	3442	5844	N/A	N/A	N/A
Climate Change Adaptation	16	16	N/A	N/A	N/A
Environmental Management	0	0	0	0	N/A
Total	25751	39743	3176746	662391	N/A

Table 1. Green loans and environmental impacts of eight types of projects in Kommuninvest. Adapted from "*Green Bonds Impact Report 2018",* by Kommuninvest, 2019.

Measuring environmental impacts per SEK is meaningful in examining the efficiency of investment, although no similar data from parallel projects has been founded yet. In the long term, this measurement makes it possible to compare green bonds projects in different regions when more data is available, which contributes to providing concrete data to the investors for their decision-making. Potential challenges of this metric are also uncovered in the reporting methodology, for example "creating a false sense of quantitative rigor", which might lead to problems of recognizing some projects that have little impact according to listed measurable indicators but have significant impacts on sustainable development in other ways (Kommuninvest, 2019, p.39).

In the case of Kommuninvest, there are also many Green Bonds funded projects that have little influence on energy saving or CO2 reduction. Results of these projects have to be measured by different methods. For example, 25 projects in water and wastewater management will contribute to the constructing and upgrading of current systems, enabling the capability of providing service for equivalent to 861682 people (Kommuninvest, 2019). Similarly, the main impact of waste management lies in improving capacity of waste management. The capacity improvement of waste management is expected to be approximately 7100 tonnes per year (Kommuninvest, 2019). Other projects that in the categories of climate change adaptation and environmental management are relatively more difficult to be measured by numeric index, hence the development of qualitative measurement is of great significance and urgency. However, at the present stage, there are very few project experiences in these categories in Kommuninvest.

6 Further Analysis

This section aims to seek answers for RQ1 how the green bond sustainability experiments are undertaken, and RQ2 how green bond sustainability experiments facilitate sustainability transitions. A "four-step scheme" (Berkhout et al., 2010, p.267) in SNM framework will be utilized.

Section 5 provides the mapping of the green bond sustainability experiments in Kommuninvest, which set the first step for analysis. Built on this, RQ1 is studied through analyzing the niche development processes in green bonds sustainability experiences (section 6.1). RQ2 is studied through the investigation of relevant regimes and landscape (section 6.2) and exploring alternative pathways (section 6.3).

6.1 Analyzing green bond sustainability experiments

In the following section, green bond sustainability experiments in Kommuninvest will be analyzed with SNM framework, particularly in terms of network formation, articulation of expectations and learning process.

6.1.1 Network formation

As it is mentioned in theories, network formation refers to the process that engages relevant stakeholders and resources and builds up social networks to facilitate niche development (Berkhout et al., 2010). In this case, network formation means building a network that engages relevant stakeholders in green bond sustainability experiments.

According to results from the interview, network formation in Kommuninvest is built on the existing business network in Kommuninvest. The key stakeholders can be classified into three categories, which are: investors, clients and Kommuninvest itself. Investors of green bonds issued by Kommuninvest come from both Swedish and international financial markets, and they are, for instance: pension funds, banks and severance funds. Clients of Kommuninvest are Swedish municipalities, county councils or regions that apply green loans to fund local green projects. In Kommuninvest, network formulation is led by the Kommuninvest Green Team. It engaged Kommuninvest's employees from various departments including lending, debt management, investor relations, sustainability, communication, IT and research.

As a matter of fact, attracting investments in bonds and other securities from the capital markets and lending to Swedish local governments is core business in Kommuninvest. Hence, building a network for green bond sustainability experience in Kommuninvest is getting the existing stakeholders on board, rather than formulating a totally new network.

On the investors' side, results from content analysis and the interview indicate that Kommuninvest's established business model has the advantage of engaging investors in green bonds. It is because investors in Kommuninvest are so-called triple-A investors who are usually interested in financial products with a highly secure return. The low-risk nature of green bonds is by no doubt in line with what investors need. These investors themselves usually already have incentives in sustainable investments due to their investment mandates. So, rather than saying that Kommuninvest engage their investors in investing in green bonds, it is more appropriate to say that Kommuninvest offers an innovative and sustainable financial product to their investors, which addresses the needs for both investors and Kommuninvest. Hence, networks are established in a natural way.

On the clients' side, formation of networks takes relatively more efforts. The key challenge is to convince clients that it is beneficial to be part of the network and it is worthy to do some additional work for it. Differences between lending through green loans and traditional type loans are that green loans have requirements of investing in certain fields according to the Green Bond Framework, as well as supplying project information and reporting back annually. This extra work might lead to a consequence that clients are not willing to prioritize them, or not having capabilities to invest time and resources. Hence, the network building process means consistently engaging clients on an ongoing basis, including communicating with clients about their opportunities and possibilities and assisting them in identifying projects. In addition, Kommuninvest also offers a lower lending rate for green loans than traditional type loans that have no requirements mentioned above.

One achievement is the establishment of the Green Bonds Environment Committee, which consists of a diverse group of stakeholders from Kommuninvest, local governments, other relevant public sectors and academia. Another achievement that comes with network formation for green bond sustainability experiences is that it has facilitated the cooperation between the sustainability experts and financial experts in local governments. This cooperation means that environment functions and treasure departments in the local governments work jointly in identifying and selecting edible projects. This type of cooperation has further impacted on local governments in enabling them to take new and more ambitious steps in green investments and helping them develop climate strategies and explain towards their stakeholders.

Besides the two key stakeholders identified by Kommuninvest, this thesis also recognizes other relevant actors in the network formation. As it indicated in Figure 3, it is fair to say that external actors in the network also contribute to a certain extent in green bond sustainability experiments in Kommuninvest. These actors include, for instance, ICMA or external reviews like CICERO and KAMP. Another significant network formulation with external actors is the cooperation with other Nordic

public sectors to initiate a set of standards or recommendations for green bonds impact reporting. This network formation benefits not only the further cooperation among Nordic issuers but also leads the directions of impact reporting in market practices.

6.1.2 Articulation of expectations

Articulation of expectations refers to the process which generates expectations from discussions and negotiations among different stakeholders who have various ideas (Berkhout et al., 2010). It is an important process for niche innovation at the beginning stage because it contributes to attracting attention and resources as well as engaging new actors into the network (Berkhout et al., 2010). Articulation of expectations in this case means generating key expectations of stakeholders in the green bond network.

According to the interview, expectations of investors include the following points. Overall, they expect low-risk investments which address climate change and environmental management, which has already been mentioned in former sections. Some organization investors have environmental, social and governance (ESG) mandates, which require them to have certain environmentally or socially responsible investments. Through investing in green bonds, investors expect to add exposure to green projects, therefore align themselves with the sustainability agenda. Answers from the interview are in line with the findings of a study by Wood & Grace (2011), which argues that investors view investing green bonds as an opportunity to integrate ESG criteria to their portfolios and fulfill institutional commitments to environmental issues. Hence, it is appropriate to conclude that expectations investors are both investing a highly secure fixed-income product and creating sustainability-related positive impacts in a simple way. Just like the initial creation of the green bond concept, the expectations of investors, especially Swedish institutional investors, are driving the development of green bond sustainability experiences at the very beginning of niche development, and continuously shaping the further development.

Expectations of clients are tightly connected with the characteristics of clients themselves. As it is illustrated before, clients of Kommuninvest are Swedish local governments, who have relatively highly ambitious environmental objectives. To a certain extent, they are already committed to pathways towards sustainability transitions. Local governments are responsible for investing in local infrastructures, including residential housing, energy supply, hospitals, waste management, water management, etc. All of these mentioned above require a significant amount of investments. Considering the large amount of funding needs and relatively long-term investment cycle, local governments would expect low interest and consistent investment from Kommuninvest. In fact, Kommuninvest does offer a special incentive for the green bonds funded projects, which is two

points cheaper than traditional loans. Due to the limited resources on local projects, there is an existing expectation gap between local governments and Kommuninvest, regarding sourcing and reporting impacts of projects, which will be further elaborated in the next section.

From the perspective of Kommuninvest, as a financial organization, one basic expectation is providing suitable financial products to its clients. According to the interview, Kommuninvest discovered nascent and growing demands of green bonds among local governments, which can also be seen in cases that Swedish cities issued their own green bonds, for instance, in Gothenburg. Kommuninvest issued their first green bond in 2015, and they have continuously worked on it since then. Another more specific expectation from Kommuninvest is to increase transparency to stakeholders or investors who are interested in the information of green bond sustainability experiments. Compared with the traditional business model that Kommuninvest has no access to projects' information, the green bond funded projects are more transparent as they ask for the project information and report back on a yearly basis. When it comes to the efficiency of the projects, Kommuninvest expects that green bond funded projects would have better environmental performance. Due to the fact they have no access to the information of traditional type projects, it is difficult to compare the efficiency with available data. For a short term, Kommuninvest expects green bond sustainability experiments to have good performance in terms of financial indicators and creating positive perception of Kommuninvest in the market. For a long term, green bond sustainability experiments in Kommuninvest are expected to enable larger share of capital flows to finance climate change mitigation and adaptation and fuel the pathway to sustainability transitions.

When it comes to the expectations from local communities who are directly affected by green bond funded projects, their perspectives or opinions are not included in the designing process. Though these environmentally beneficial projects are likely to be beneficial for the common interest of local citizens, it has not come as a result of the concrete wishes of them. Fairly speaking, local knowledge, voices and expectations have not been included yet.

6.1.3 Learning process

Learning is regarded as a crucial process in sustainability experiments (Berkhout et al., 2010). Learning processes of green bond sustainability experiments are characterized by a strong focus on developing the frameworks, monitoring and evaluating performance, as well as summarizing experience.

In Kommuninvest, learning is an ongoing process. Their Green Bond Framework has been continually improved as the development of market and legalization. According to the interview, Kommuninvest is currently working on updating criteria requirements of the Green Bond Framework to focus more

on the life-cycle approach in property construction, so that it can fit better with the sustainability work in local government sectors and potentially build new networks for Kommuninvest. However, on the current stage, there is no formal strategic section or established mechanism on updating the framework on a regular basis.

The performance of green bond sustainability experiments in Kommuninvest is monitored and evaluated by both financial indicators and market indicators. The former refers to the participation rate among clients, which can be calculated through number of clients, share of total clients, increased rate of volume, share of total lending etc. The latter refers to how Kommuninvest are recognized in the market for green bond sustainability experiments. Both types of indicators show positive feedback by increasing green loans and good perception of Kommuninvest in the market.

One significant challenge or key success factor that Kommuninvest summarized is to get access to the projects. Though green bonds funded projects are required to report on a yearly basis, the reporting process is not in a certain expected format. Few clients have submitted specific project-based impact reports. Little descriptive information regarding specific projects that receive investment from green bonds is available. This challenge is recognized by the leadership in Kommuninvest in their learning process.

Learning process of green bond sustainability experiments in Swedish local governments comes as a consequence of the cooperation between green experts and financial experts in local government organizations, which has already been introduced in section 6.1.1. This cooperation enables local governments to deploy a more holistic approach in green investments and develop local climate strategies. Learning from green bond sustainability experiments also helps local governments communicate to border stakeholders including their local citizens, hence contributing to improving awareness of municipal green objectives.

6.2 Investigating relevant landscape and regimes

In light of the theoretical background of MLP in section 3.3.1, which illustrates how dominant socio-technical regimes interact with the changing landscape and emerging niche innovations, this section investigates relevant regimes and landscape in relations to the innovative niches, green bond sustainability experiments.

Landscape refers to a relatively stable external context, which sets a stage for society to develop and sustain (Rip and Kemp, 1998; Geels, 2011). Socio-technical landscape covers social, economic, political, material, technical aspects, and niches have little influence on it in a short period (Geels,

2001). In this case, elements relevant to socio-technical landscape are external factors, for instance climate change and growth paradigm.

Climate change, as elaborated in introduction section 1.1, has significant impacts on natural and human systems (Stocker et al, 2013; Field et al., 2014). Climate Change as an element of landscape puts pressure on established regimes, which affects the culture, policy, market preferences in Sweden to a great extent. Evidence can be found in green movements in Sweden and ambitious government objectives in both central and local governments. The pressure from the climate crisis is creating the "window of opportunity" (Geels, 2011, p.28), for innovative green bond sustainability experiences to develop. At the same time, other elements of landscape, for instance, growth paradigm affect the development regimes and niches in another direction. The definition of growth paradigm, according to Schmelzer (2015, p.264), is "a specific ensemble of societal, political, and academic discourses, theories, and statistical standards" that views economic growth as an imperative, desirable and limitless pathway towards development. Growth paradigm as landscape has long-term influence on the regimes, which lead to a consequence of taking pursuit of economic growth as a priority for granted. This landscape puts pressure on regimes in a way that enhances the existing practices or activities. Hence, it is likely to lead to path dependency and system lock-in of current regimes, which might hinder the development of green bond sustainability experiments.

Regimes refer to the dominant configuration in a socio-technical system (Loorbach et al, 2017), that shapes and stabilizes socio-technical systems with established practices and rules (Geels, 2004). In this case, relevant regimes can be socio-technical structures like the dominant market and user preferences, policies, culture, industry, technology, lifestyles in Sweden. The strong political support and citizen support for climate actions in Sweden leads to ambitious environmental targets, for instance, zero emission of greenhouse gas emissions by 2045 (Nordic Public Sector Issuers, 2019). These elements at regime level stimulate the development of green bond sustainability experiments via shaping expectations of key stakeholders and accelerating network formation. Results from the interview also indicate that forces from citizen, central and local governments form a "supportive ecosystem" for the green bond sustainability experiments in Kommuninvest. Market or user preference is another supportive element at regime level. To a great extent, the expectations from the institutional investors, for instance, pension funds, are the initial forces that stimulate the creation of the green bond concept. Green bond sustainability experiments align with these elements and increase internal momentum. As a consequence, possibilities of the further adjustments at established regimes occur.

6.3 Exploring pathways to sustainability transitions

Built on analysis above, this section aims to investigate potential pathways towards sustainability transitions. As it is illustrated in section 3.1, sustainability transition means a long term, multi-dimensional, and fundamental transformation process that leads towards a more sustainable society (Markard et al., 2012). Green bond sustainability experiments as the niche innovation in the finance field brings new potentials in supporting projects that tackle climate change and other environmental challenges. Issuing green bonds is a practical alternative pathway to finance green projects, even though current scale is still relatively small. Summarizing the experience from green bond sustainability experiments is essential for upscaling the green bond sustainability experiments on a global scale.

Exploring the pathways to sustainability transitions in this case means identifying key challenges of the Green bond sustainability experiments, seeking the potential solutions for existing challenges and ultimately unlocking the potentials of the Green bond sustainability experiments. Currently, green bond sustainability experiments in Kommuninvest are encountering the following challenges. Firstly, access to project information. As it is mentioned in section 6.1, projects funded by green bonds are required to report back. Kommuninvest collects the information regarding the climate and environmental impacts from self-reported forms and summarizes the total impacts for all green bonds funded projects on a yearly basis. However, in practice, few local governments are able to provide a formal report with detailed project information. As a consequence, Kommuninvest has relatively limited descriptive information regarding specific projects, in both their impact reports (Kommuninvest, 2019, 2020a) and their project by project report (Kommuninvest, 2020b). The self-reported information also makes it difficult to provide highly reliable, comparable and consistent data that enables a comprehensive analysis of parallel projects. Generally speaking, lack of access to project information can potentially affect how Kommuninvest evaluates and summarizes green bond sustainability experiments. Potential solutions to increase the accessibility to the project information might be hindered by the resource and capability limits of local governments. Besides, other available traditional financial products on capital markets might compete against the green loans with the advantage of a convenient process of lending. In face of this dilemma, further network building with a focus of cooperation between Kommuninvest and local governments is of great significance. The cooperation should address the issues of project information accessibility, maximally utilizing available resources to improve capabilities of project reporting.

Secondly, engagement of civil society. As it is mentioned in section 6.1.2, knowledge, perspectives and expectations of local citizens have not been included in the designing of green bond

sustainability experiments. Even though all green bonds funded projects are addressing certain climate or environmental targets, which seems to be in line with the benefits of the citizens. However, no available data can confirm this point. Furthermore, it is also not sure to what extent local citizens benefit from or are affected by these projects. Developing a mechanism that including voices from civil society can be helpful to guide development of green bond sustainability experiments. It could come as results of either further cooperation with local governments or other new innovative channels.

Thirdly, a formal learning process. Section 6.1.3 summarizes how Kommuninvest facilitates the learning process of green bond sustainability experiments, which points out that there is no formal and regular strategic section on reviewing and improving green bond sustainability experiments. It is understandable given that green bond sustainability experiments are at the primary stage of exploration. Developing a formal learning process will be possible when existing networks are extended, and more resources are allocated in green bond sustainability experiments.

7 Discussion

With results and analysis above, this section interprets the significance of new findings in relation to existing research, and discusses potential implications for developing countries, where huge climate finance gaps exist. This section ends up with limitations of this research and recommendations for further research.

Generally speaking, findings in this thesis bring new insights of how green bond sustainability experiments are undertaken in Sweden. An earlier research from Asian Development Bank Institute provides an overview of Nordic experience on green bonds market development and estimated potential opportunities to utilize green bonds to finance sustainability transitions in Asian countries (Nassiry, 2018). This thesis further completes the earlier research with a deeper and more detailed investigation on green bond sustainability experiments in one well-established Swedish organization. Findings from mapping and analyzing green bond sustainability experiments in Kommuninvest fill academic knowledge gaps regarding the funding processes, impact reporting, existing challenges of green bond projects etc. This thesis utilizes a "four-step scheme" (Berkhout et al., 2010, p.267) in SNM framework to analyze green bond sustainability experiments. It contributes to the knowledge generation in sustainability science, through bringing together interdisciplinary concepts, theories, and framework. Findings in this thesis also answer how Green bond sustainability experiments facilitate sustainability transitions in Sweden through investigating relevant regimes and landscape and exploring potential pathways.

Specifically, findings on investors' expectations are in line with results from earlier research conducted by Wood & Grace (2011), which argues that institutional investors' demands on both low-risk investments and fulfilling environmental commitments drive the development of green bond. Their study also suggests that issuers' abilities of issuing at large scale, engaging stakeholders for standard development, and sourcing projects are vital further development of the green bond. Through investing in Kommuninvest, an organization that issues green bonds at a relatively large scale and leads in exploring standards for impact reporting, this thesis confirms their suggestions. Findings from this thesis are consistent with another suggestion from Wood & Grace (2011), arguing that increasing accessibility for project information is of great significance.

Key implications include the following aspects. For sustainability transition, this thesis provides a concrete example on how to utilize an existing framework to analyze specific sustainability experiments at a variety of scales and levels. It draws on the experience of Verbong et al. (2010) and Rehman et al. (2010) in utilizing SNM framework for analysis and brings it to another distinct field.

For green bonds, main applications lie in providing knowledge or insights on green bonds for developing countries that have a huge shortage of finance in supporting climate and other environmental projects. It includes both practical experience from green bond sustainability experiments in Kommuninvest, in terms of business model, framework, impact reporting, stakeholder engagement, and theoretical knowledge of green bond sustainability experiments development processes. Theoretical knowledge regarding network formulation, articulation of expectations and learning process in green bond practices are advanced through testing suggestions of Wood & Grace (2011) in a detailed investigation.

However, it is worth noting that characteristics of dominant regimes and landscape in countries in the Global South might differ from that in Sweden. For instance, Sweden has relatively ambitious environmental objectives from both central local governments, while economic growth might be the priority in many countries in the Global South. Considering that there is uniquely strong support from Swedish civil society for climate actions, differences of market or user preference might be other important factors to take into consideration, when applying green bond sustainability experiments in other countries. Remarkably, as emerging market economies, especially China, accounting for increasing share of total global green bonds issuance (Climate Bonds Initiative, 2020), relevant research focus on these specific contexts is of great necessity.

One limitation of this research is inadequate insights from specific projects. Kommuninvest issues green bonds at a relatively large scale. One green bond usually supports approximately 50 projects, which are usually located in regions and have diverse project terms. With a focus of Kommuninvest as a research target in studying green bond sustainability experiments, this thesis did not obtain the adequate information at project level from available data. Hence, findings from this thesis might be more suitable to guide umbrella financial organizations similar to Kommuninvest, instead of providing direct insights to green project management. Further research at project level is recommended to fill the knowledge gaps. Conducting an investigation on project-specific green bonds or the city-based green bonds, might contribute in revealing how green bonds funded projects impact local communities.

8 Conclusion

This thesis provides new insights about how green bond sustainability experiments are undertaken in Sweden with a detailed investigation in Kommuninvest. It elaborates how green bond sustainability experiments facilitate sustainability transitions through investigating relevant regimes and landscapes and exploring potential pathways towards sustainability transitions.

The key findings of this research include the following. Firstly, through mapping green bond sustainability experiments and analyzing the niche development processes, this thesis found that networks for green bond sustainability experiments are built on the existing business networks in Kommuninvest and led by a Green Team. Green bond sustainability experiments articulate the expectations of most stakeholders, especially expectations of investors. However, the expectations of local communities, that are directly affected by green bond funded projects are not addressed. Learning processes are characterized by developing the green bond framework, monitoring and evaluating performance, as well as summarizing experience. It is an ongoing process, but no formal strategic learning process has been developed yet. Secondly, this thesis found that elements at landscape level like climate change put pressure on established regimes, creating opportunities for green bond sustainability experiences to develop, while other elements have opposite impacts, leading to the system lock-in. Market preference and "supportive ecosystem" of citizens and governments at regime level align with the green bond sustainability experiences, making it possible for further adjustments on established regimes to happen. Thirdly, key challenges for further facilitating sustainability transitions are identified, which are increasing accessibility of project information, engaging civil society, and developing a more formal learning process.

This thesis contributes to sustainability science by bridging multidisciplinary theories, concepts, framework and generating interdisciplinary knowledge regarding green bond sustainability experiments and sustainability transitions. Findings in this research advanced theoretical knowledge of green bond sustainability experiments by testing, confirming, and adding on existing research in the relevant field. In practice, this research summarized key challenges and potential solutions from green bond sustainability experiments, which might inspire developing countries in utilizing green bonds in financing local green projects, particularly in terms of business models, framework, impact reporting, stakeholder engagement.

This thesis ends up with a recommendation for further research on green bonds at project level, investigating how green bond sustainability experiments impact local communities.

9 References

Abramovitz, M. (1986). Catching up, forging ahead, and falling behind. *The Journal of Economic History*, *46*(2), 385-406.

Almeida, M., Filkova, M., Harrison, C., and Sette, P. (2019). Green Bond European Investor Survey, *Climate Bonds Initiative*, November 2019.

Barriball, K. L., & While, A. (1994). Collecting data using a semi-structured interview: a discussion paper. *Journal of Advanced Nursing-Institutional Subscription*, *19*(2), 328-335.

Berkhout, F., Angel, D., & Wieczorek, A. J. (2009). Asian development pathways and sustainable socio-technical regimes. *Technological Forecasting and Social Change*, *76*(2), 218-228.

Berkhout, F., Verbong, G., Wieczorek, A. J., Raven, R., Lebel, L., & Bai, X. (2010). Sustainability experiments in Asia: innovations shaping alternative development pathways?. *environmental science & policy, 13*(4), 261-271.

Berkhout, F., Wieczorek, A. J., & Raven, R. (2017). Avoiding environmental convergence: a possible role for sustainability experiments in latecomer countries?. *Institutions and Economies*, 367-385.

Bhattacherjee, A. (2012). Social science research: Principles, methods, and practices.

Brinkmann, S., & Kvale, S. (2005). Confronting the ethics of qualitative research. *Journal of constructivist psychology*, *18*(2), 157-181.

Buchner, B., Clark A., Falconer A., Macquarie R., Meattle C., Tolentino R., & Wetherbee C. (2019). Global landscape of climate finance 2019. *Climate Policy Initiative.* Available at: https://climatepolicyinitiative.org/publication/ global-climate-finance-2019/

CICERO. (2018). *'Second Opinion' on Kommuninvest's Green Bond Framework*. Retrieved from https://kommuninvest.se/wp-content/uploads/2018/03/Second-Opinion-Cicero.pdf

Climate Bonds Initiative. (2020). *2019 Green Bond Market Summary*. Retrieved from https://www.climatebonds.net/resources/reports/2019-green-bond-market-summary

Cook, J., Nuccitelli, D., Green, S. A., Richardson, M., Winkler, B., Painting, R., … Skuce, A. (2013). Quantifying the consensus on anthropogenic global warming in the scientific literature. *Environmental Research Letters*, *8*(2), 24024. https://doi.org/10.1088/1748-9326/8/2/024024

Cote, M., & Nightingale, A. J. (2012). Resilience thinking meets social theory: Situating social change in socio-ecological systems (SES) research. Progress in Human Geography, 36(4), 475–489. https://doi.org/10.1177/0309132511425708

Cridland, E. K., Jones, S. C., Caputi, P., & Magee, C. A. (2015). Qualitative research with families living with autism spectrum disorder: Recommendations for conducting semi-structured interviews. *Journal of Intellectual and Developmental Disability*, *40*(1), 78-91.

Ehlers, T., & Packer, F. (2017). Green bond finance and certification. *BIS Quarterly Review September*.

Elzen, B., Geels, F. W., Leeuwis, C., & Van Mierlo, B. (2011). Normative contestation in transitions 'in the making': Animal welfare concerns and system innovation in pig husbandry. *Research Policy*, *40*(2), 263-275.

Filkova, M. (2018). The Green Bond Market in the Nordics. Retrieved from https://www.climatebonds.net/files/reports/cbi-nordics-final-03b.pdf

Field, C. B., Barros, V. R., Mastrandrea, M. D., Mach, K. J., Abdrabo, M. K., Adger, N., ... & Burkett, V. R. (2014). Summary for policymakers. In *Climate change 2014: impacts, adaptation, and vulnerability. Part A: global and sectoral aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1-32). Cambridge University Press.

Fleck, J. (1994). Learning by trying: the implementation of configurational technology. *Research policy, 23*(6), 637-652.

Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Research policy*, *31*(8-9), 1257-1274.

Geels, F. W. (2004). From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory. *Research policy, 33*(6-7), 897-920.

Geels, F. W. (2005). The dynamics of transitions in socio-technical systems: a multi-level analysis of the transition pathway from horse-drawn carriages to automobiles (1860–1930). *Technology analysis & strategic management, 17*(4), 445-476.

Geels, F. W. (2011). The multi-level perspective on sustainability transitions: Responses to seven criticisms. *Environmental innovation and societal transitions*, 1(1), 24-40.

Clark, W. C., & Dickson, N. M. (2003). Sustainability science: the emerging research program. *Proceedings of the national academy of sciences*, *100*(14), 8059-8061.

Cox, R. W. (1981). Social forces, states and world orders: beyond international relations theory. *Millennium*, *10*(2), 126-155.

Green Finance Study Group. (2016). G20 green finance synthesis report. September. http://unepinquiry.org/wp-content/uploads/2016/09/Synthesis_Report_Full_EN.pdf.

Fisher, C. B., & Anushko, A. E. (2008). Research ethics in social science. *The SAGE handbook of social research methods*, 95-109.

Holling, C. S. (1973). Resilience and stability of ecological systems. *Annual review of ecology and systematics*, *4*(1), 1-23.

Hong, H., Li, F. W., & Xu, J. (2019). Climate risks and market efficiency. *Journal of Econometrics*, *208*(1), 265-281.

Hoogma, R., Kemp, R., Schot, J., & Truffer, B. (2002). *Experimenting for sustainable transport: the approach of strategic niche management*. Routledge.

Hölscher, K., Wittmayer, J. M., & Loorbach, D. (2018). Transition versus transformation: what's the difference?. *Environmental Innovation and Societal Transitions*, *27*, 1-3

ICMA. (2018). Green Bond Principles. Retrieved April 22, 2020, from https://www.icmagroup.org/green-social-and-sustainability-bonds/green-bond-principles-gbp/

Jerneck, A., Olsson, L., Ness, B., Anderberg, S., Baier, M., Clark, E., ... & Persson, J. (2011). Structuring sustainability science. *Sustainability science*, *6*(1), 69-82.

Kallio, H., Pietilä, A. M., Johnson, M., & Kangasniemi, M. (2016). Systematic methodological review: Developing a framework for a qualitative semi-structured interview guide. *Journal of advanced nursing*, *72*(12), 2954-2965.

Kates, R. W., Clark, W. C., Corell, R., Hall, J. M., Jaeger, C. C., Lowe, I., ... & Faucheux, S. (2001). Sustainability science. *Science*, *292*(5517), 641-642.

Kemp, R., Schot, J., & Hoogma, R. (1998). Regime shifts to sustainability through processes of niche formation: the approach of strategic niche management. Technology analysis & strategic management, 10(2), 175-198.

Kemp, R. (2000). Technology and Environmental Policy—Innovation effects of past policies and suggestions for improvement. *Innovation and the Environment, 1*, 35-61.

Kommuninvest. (2018). Green Bonds Framework. Retrieved April 20, 2020, from https://kommuninvest.se/wp-content/uploads/2018/03/Green-Bonds-Framework.pdf

Kommuninvest. (2019). *Green Bonds Impact Report 2018*. Retrieved from https://kommuninvest.se/wp-content/uploads/2019/04/Green-Bonds-Impact-Report-2018.pdf

Kommuninvest. (2020a). *Green Bonds Impact Report 2019*. Retrieved from https://kommuninvest.se/wp-content/uploads/2020/03/Green-Bonds-Impact-Report-Dec-2019.pdf

Kommuninvest. (2020b). Project by project reporting 2019. Retrieved May 6, 2020, from https://kommuninvest.se/green-bonds-project-by-project-reporting-dec-2019/

Kommuninvest. (2020c). *Kommuninvest i Sverige AB Annual Report 2019.* Retrieved from https://kommuninvest.se/wp-content/uploads/2020/02/KIAB_ENG_2019.pdf

Kommuninvest. (n.d.a). We are owned by our members. Retrieved April 15, 2020, from https://kommuninvest.se/en/about-us-3/organisation/

Kommuninvest. (n.d.b). Our model. Retrieved April 15, 2020, from https://kommuninvest.se/en/funding-and-funding-need/greenbonds/our-model/

Kommuninvest. (n.d.c). Ansök om grönt lån. Retrieved May 6, 2020, from https://gronalan.kommuninvest.se

KPMG. (2017). *Kommuninvest Green Bonds Assurance Report 2017*. Retrieved from https://kommuninvest.se/wp-content/uploads/2017/10/Kommuninvest-Green-Bonds-Assurance-Report-2017.pdf

KPMG. (2018). *Kommuninvest Green Bonds Assurance Report 2018*. Retrieved from https://kommuninvest.se/wp-content/uploads/2018/07/Kommuninvest-Green-Bonds-Assurance-Report-2018.pdf

KPMG. (2019). *Kommuninvest Green Bonds Assurance Report 2019*. Retrieved from https://kommuninvest.se/wp-content/uploads/2019/08/Kommuninvest-Green-Bonds-Assurance-Report-2019.pdf

Kraak, S. B. (2011). Exploring the 'public goods game' model to overcome the tragedy of the commons in fisheries management. Fish and Fisheries, 12(1), 18-33.

Krauss, S. E., Hamzah, A., Omar, Z., Suandi, T., Ismail, I. A., Zahari, M. Z., & Nor, Z. M. (2009). Preliminary investigation and interview guide development for studying how Malaysian farmers' form their mental models of farming. *The Qualitative Report*, *14*(2), 245.

Krippendorff, K. (2018). *Content analysis: An introduction to its methodology*. Sage publications.

Lant, C. L., Ruhl, J. B., & Kraft, S. E. (2008). The tragedy of ecosystem services. BioScience, 58(10), 969-974.

Loorbach, D., Frantzeskaki, N., & Avelino, F. (2017). Sustainability transitions research: transforming science and practice for societal change. *Annual Review of Environment and Resources*, 42, 599-626.

Markard, J., Raven, R., & Truffer, B. (2012). Sustainability transitions: An emerging field of research and its prospects. *Research policy*, 41(6), 955-967.

Marshall, P. A. (1992). Research ethics in applied anthropology. *IRB: Ethics and Human Research*, *14*(6), 1-5.

Mathews, J. A., & Kidney, S. (2012). Financing climate-friendly energy development through bonds. *Development Southern Africa*, *29*(2), 337-349.

Masson-Delmotte, V., Zhai, P., Pörtner, H. O., Roberts, D., Skea, J., Shukla, P. R., ... & Connors, S. (2018). IPCC, 2018: Summary for policymakers. *Global warming of*, *1*.

Morel, R., & Bordier, C. (2012). Financing the transition to a green economy: their word is their (green) bond. *Climate Brief*, *14*.

Nassiry, D. (2018). Green Bond Experience in the Nordic Countries. ADBI Working Paper 816. Tokyo: Asian Development Bank Institute. Available: https://www.adb.org/publications/green-bond-experience-nordic-countries

Nordic Public Sector Issuers. (2019). Position Paper on Green Bonds Impact Reporting. Retrieved April 22, 2020, from https://www.icmagroup.org/assets/documents/Regulatory/Green-Bonds/Resource-Centre/NPSIPositionpaper2019final-120219.pdf

O'Brien, K. (2018). Is the 1.5 C target possible? Exploring the three spheres of transformation. *Current Opinion in Environmental Sustainability*, *31*, 153-160.

Pachauri, R. K., Allen, M. R., Barros, V. R., Broome, J., Cramer, W., Christ, R., ... & Dubash, N. K. (2014). Climate change 2014: synthesis report. Contribution of Working Groups I. *II and III to the fifth assessment report of the Intergovernmental Panel on Climate Change*, *151*.

Raven, R. P. J. M. (2005). Strategic niche management for biomass: a comparative study on the experimental introduction of bioenergy technologies in the Netherlands and Denmark. Eindhoven: *Technische Universiteit Eindhoven*. https://doi.org/10.6100/IR590593

Rehman, I. H., Kar, A., Raven, R., Singh, D., Tiwari, J., Jha, R., ... & Mirza, A. (2010). Rural energy transitions in developing countries: a case of the Uttam Urja initiative in India. *environmental science & policy*, *13*(4), 303-311.

Reichelt, H. (2010). Green bonds: a model to mobilise private capital to fund climate change mitigation and adaptation projects. *The euromoney environmental finance handbook*, 1-7.

Rip, A., & Kemp, R. (1998). Technological change. *Human choice and climate change,* 2(2), 327-399.

Rotmans, J., Kemp, R., & Van Asselt, M. (2001). More evolution than revolution: transition management in public policy. *Foresight-The journal of future studies, strategic thinking and policy*, *3*(1), 15-31.

Schmelzer, M. (2015). The growth paradigm: History, hegemony, and the contested making of economic growthmanship. *Ecological Economics*, *118*, 262-271.

Schot, J., Hoogma, R., & Elzen, B. (1994). Strategies for shifting technological systems: the case of the automobile system. *Futures, 26*(10), 1060-1076.

Schot, J., & Geels, F. W. (2008). Strategic niche management and sustainable innovation journeys: theory, findings, research agenda, and policy. *Technology analysis & strategic management, 20*(5), 537-554.

Sengers, F., Wieczorek, A. J., & Raven, R. (2019). Experimenting for sustainability transitions: A systematic literature review. *Technological Forecasting and Social Change*, 145, 153-164.

Seyfang, G., & Smith, A. (2007). Grassroots innovations for sustainable development: Towards a new research and policy agenda. *Environmental politics*, *16*(4), 584-603.

Smith, A., Stirling, A., & Berkhout, F. (2005). The governance of sustainable socio-technical transitions. *Research policy*, *34*(10), 1491-1510.

Stocker, T. F., Qin, D., Plattner, G. K., Tignor, M., Allen, S. K., Boschung, J., ... & Midgley, P. M. (2013). Climate change 2013: The physical science basis. *Contribution of working group I to the fifth assessment report of the intergovernmental panel on climate change*, *1535*.

Strazicich, M. C., & List, J. A. (2003). Are CO 2 emission levels converging among industrial countries?. *Environmental and Resource Economics*, *24*(3), 263-271.

Suurs, R. A. (2009). *Motors of sustainable innovation: Towards a theory on the dynamics of technological innovation systems*. Utrecht University.

Tang, D. Y., & Zhang, Y. (2018). Do shareholders benefit from green bonds?. *Journal of Corporate Finance.*

The World Bank. (2019). 10 Years of Green Bonds: Creating the Blueprint for Sustainability Across Capital Markets. Retrieved April 14, 2020, from https://www.worldbank.org/en/news/immersive-story/2019/03/18/10-years-of-green-bonds-creating-the-blueprint-for-sustainability-across-capital-markets

UNFCCC. (2017). Bridging Climate Ambition and Finance Gaps. Retrieved April 3, 2020, from https://unfccc.int/news/bridging-climate-ambition-and-finance-gaps

Unruh, G. C. (2000). Understanding carbon lock-in. *Energy policy, 28*(12), 817-830.

Turner III, D. W. (2010). Qualitative interview design: A practical guide for novice investigators. *The qualitative report*, *15*(3), 754.

Van den Bosch, S. (2010). *Transition experiments: exploring societal changes towards sustainability*.

van den Bosch, S., & Rotmans, J. (2008). Deepening, Broadening and Scaling up: a Framework for Steering Transition Experiments.

Verbong, G., Christiaens, W., Raven, R., & Balkema, A. (2010). Strategic Niche Management in an unstable regime: Biomass gasification in India. *Environmental Science & Policy*, *13*(4), 272-281.

Vergragt, P. J., & Brown, H. S. (2007). Sustainable mobility: from technological innovation to societal learning. *Journal of Cleaner Production*, *15*(11-12), 1104-1115.

Wang, Y., & Zhang, R. (2017). China's green bond market. *Int Capital Market Features (44) Q, 1*.

Weber, M., Hoogma, R. J. F., Lane, B., & Schot, J. (1999). *Experimenting with Sustainable Transport Technologies. A workbook for Strategic Niche Management*. University of Twente.

White, M. D., & Marsh, E. E. (2006). Content analysis: A flexible methodology. *Library trends*, *55*(1), 22-45.

Whiting, L. S. (2008). Semi-structured interviews: guidance for novice researchers. *Nursing standard*, *22*(23), 35-41.

Wieczorek, A. J., Raven, R., & Berkhout, F. (2015). Transnational linkages in sustainability experiments: A typology and the case of solar photovoltaic energy in India. *Environmental Innovation and Societal Transitions*, *17*, 149-165.

Wood, D., & Grace, K. (2011). A brief note on the global green bond market. *Initiative for Responsible Investment at Harvard University*.

Wright, E. O. (2010). *Envisioning real utopias* (Vol. 98). London: Verso.

Zerbib, O. D. (2019). The effect of pro-environmental preferences on bond prices: Evidence from green bonds. *Journal of Banking & Finance*, *98*, 39-60.

Appendix List

Appendix I

Appendix I lists 16 reports and documents that are used in context analysis. They are selected from 19 identified reports and documents from Kommuninvest and external stakeholders.

	Name	Issuers	Year
1	Green Bonds Framework	Kommuninvest	2018
2	Green Bonds Impact Report 2018	Kommuninvest	2019
3	Green Bonds Impact Report 2019	Kommuninvest	2020
4	Project by project reporting 2019	Kommuninvest	2020
5	Kommuninvest i Sverige AB Annual Report 2021	Kommuninvest	2020
6	We are owned by our members	Kommuninvest	n.d.
7	Our model	Kommuninvest	n.d.
8	Ansök om grönt lån	Kommuninvest	n.d.
9	'Second Opinion' on Kommuninvest's Green Bond Framework	CICERO	2018
10	The Green Bond Market in the Nordics	CBI	2018
11	Climate Bonds Initiative	CBI	2020
12	Green Bond Principles	ICMA	2018
13	Kommuninvest Green Bonds Assurance Report 2017	KPMG	2017
14	Kommuninvest Green Bonds Assurance Report 2018	KPMG	2017
15	Kommuninvest Green Bonds Assurance Report 2019	KPMG	2017
16	Position Paper on Green Bonds Impact Reporting	Nordic Public Sector Issuers	2019

Appendix II

1 Brief Introduction:

Thank you for participating in my research. As I introduced in my email, I am writing a master thesis about green bonds and sustainability transitions. By investigating the practice in the largest green bond issuer organization in Sweden, my thesis aims to uncover how green bond sustainability experiments are undertaken in Sweden and how green bond sustainability experiments facilitate sustainability transition. Your name will not be mentioned in this thesis, if you do not want to. Your answers will be used in my thesis for providing information and facilitating analysis. Now I will start directly with my questions, and you may interrupt this session at any time.

2 Main questions and sub questions:

How are the green bond programme undertaken in Kommuninvest?

- Why did you decide to do it?

- Where does the money come from?

- Has Kommuninvest been doing similar projects before the concept of the green bond was created?

- Is the green bond linked with a specific project?

- Who could decide which project can get funded?

How did you build your network?

- Who are the main stakeholders?

- Who are the main investors?

- Why would investors be interested in it?

- Why would you clients be interested in it?

How did you attribute the expectations?

- What are the expectations of your stakeholders?

- Did you include the options for civil society?

- How did you envision your programme?

What is the learning process in this programme?

- How would you summarize your learning experience?

- Is there any mechanism of how you do it?

- How do you monitor and evaluate the programme?

How do policies or other government actions influence your programme?

- What else do you think has a significant influence on your programme?

What is the most unique part of the green bond funded projects in Kommuninvest?

What is the biggest challenge of the green bond programme in Kommuninvest?