Graduation Plan

Master of Science Architecture, Urbanism & Building Sciences

Graduation Plan: All tracks

Submit your Graduation Plan to the Board of Examiners (Examencommissie-BK@tudelft.nl), Mentors and Delegate of the Board of Examiners one week before P2 at the latest.

The graduation plan consists of at least the following data/segments:

Personal information	
Name	Daniël Brandon
Student number	
Telephone number	
Private e-mail address	

Studio	
Name / Theme	Urban Development Management: Sustainable Area Transformations
Teachers / tutors	Dr. ir. E. W.T.M. (Erwin) Heurkens Dr. ir. E. (Erwin) Mlecnik
Argumentation of choice of the studio	After completing the bachelor's and master's courses linked to urban area development with pleasure, my preference was to have Urban Development Management my main graduation theme with sustainable area transformation as a subsidiary subject. In each of the courses, but mainly during the management game course, I was tended to focus on various technical and financial tools available for energy performance and production on an urban area scale. The current energy supply is largely generated from finite sources and fossil fuels that emit greenhouse gasses (GHG's). The legal standards for energy performance for new residential buildings are becoming stricter (2020> NZEB) and the existing stock is subject to the necessary energy performance improvements. There is a trend emerging wherein the residential stock tends to be self-sufficient in various respects. From the perspective of energy, the residential stock is deemed to reduce its energy consumption and is households are sometimes even attracted to produce (renewable) energy. While there is a strong demand in residential markets, particularly in already urbanized parts of the country, there also is a growing demand for energy. The key challenge in the urban development is the energy transition towards a carbon neutral cities by 2050. I therefore see an opportunity to deepen my understanding of and propose solutions for the energy transition for existing dwellings in urban areas.

Graduation project

Title of the graduation project:	Upscaling residential heat
Subtitle of the graduation project:	Integrating district scale heat-generating facilities in urban redevelopment

1. Goal

Location:	Delft
The posed problem,	See below
research questions and	See below
design assignment in which these result.	-

Research problem

Integrating district scale heat-generating facilities in urban redevelopment requires the management of the roles concerned. Local authorities endorse efforts to implement energy policies, but face the complexity in networks of various actors, scales and disciplines (Petersen & Heurkens, 2018). For upscaling residential heat it is important to define 'who' does 'what' in the (renewable) heat supply chain and what roles exist in urban (re)development. While scholars acknowledge the existence of barriers and opportunities of upscaling residential heat to district level, little literature is found on cases where the existing built environment and infrastructure is adapted for district heating networks. This research addresses the knowledge gap on the managerial and organizational roles of public and private actors in LRECs in upscaling residential heat to a district scale.

Research goals and objectives

The main goal of the research is to gain understanding in the local approaches and efforts integrating district scale heat-generating facilities in the Netherlands. The research is intended to broaden the understanding of how public, private and civic actors collaborate in urban (re)development projects thus how management tools are used to steer on implementing district heating in the existing built environment and determine which are effective for upscaling residential heat.

The research focusses on how public efforts and private sector-led urban development approaches can bring about a local energy transition. The research is intended to clarify, gather and model the organizational and managerial roles in integrating district scale residential heat-generating facilities in the Netherlands.

Research questions

The main research question is derived from trends in energy and urban development. The emergence of LRECs seems to be a solution to stem the GHG emission, but these organisations have been little developed in upscaling residential heat to a district scale. Organizational and managerial barriers are faced by public and private actors when integrating renewable and climate neutral district heating in the existing built environment and moreover the civic society is becoming more eager to participate in energy cooperatives. Therefore the research question is as follows:

> *How do public, private and civic actors in LREC networks manage upscaling residential heat-generating facilities to district scale in the built environment in the Netherlands?*

The first research sub question concerns the roles of public actors in urban (re)development. The focus here lies on the organizational and managerial roles as defined by Heurkens & Hobma (2014). From the organizational aspects the organizational, financial and legal variables are considered. From the managerial aspects the management tools and process management variables are considered.

1. *What are the roles of public actors in urban (re)development and steering on implementing energy policies?*

In the second sub question the various 'implementation agents' of energy infrastructure and facilities at district scale are defined. The focus here lies on the organizational and managerial roles as defined by Heurkens & Hobma (2014). For private actors the organizational aspect, the organizational, financial and legal aspects are considered. From the managerial aspects the project and process management variables are considered.

2. *What are the roles of private actors in urban (re)development and implementing energy infrastructure and facilities in the built environment?*

The third sub question is to find out which to what collaboration models or partnership arrangements of public, private and civic actors in urban redevelopment are recognized in theory.

3. *What types of public, private and civic actor collaboration models are common in in urban (re)development and implementing energy infrastructure and facilities in the built environment?*

The fourth, fifth and sixth sub questions are an attempt to have an understanding of the current practices in upscaling residential heat. The empirical research is intended to define which approaches are effective for upscaling residential heat to district scale by analyzing cases that are operational. Management measures are considered 'effective' when this leads to realization of objectives (Heurkens, 2012; p107). With effective in the collaboration context is meant to what degree the collaboration led to the achievement of intended objectives.

4. *What roles of public actors are recognized in empirical research about the upscaling of residential heat-generating facilities to district scale?*

5. *What private actor roles concerning management and organization in the implementation of district scale residential heat-generating facilities (and infrastructure) in the built environment are recognized in practice?*

6. *What types of public, private and civic actor collaboration models in the upscaling of residential heat-generating facilities to district scale are recognized in practice?*

The seventh sub question is combining the results of the first six sub questions to clarify, gather and model the organizational and managerial roles in implementing renewable and climate neutral residential district heating in the Netherlands.

7. *What managerial and organizational roles and collaboration are effective in implementing district heating in the Netherlands?*

he main research question is an addition to existing research on the LRECs. It has research. The barriers and opportunities are analysed through a chosen theoretical framework to find and explain where alleviation of barriers could take place.

2. Process

Method description

In order to give an answer to the main research question the research methodology is determined. First the research approach to answer the research questions is defined followed by an the research framework on how to acquire the answers for the main and sub questions. Second the qualitative research methods and techniques are explained.

The main research question is as follows:

> *How do public, private and civic actors in LREC networks collaborate, manage and organise upscaling residential heat to a district scale in the built environment in the Netherlands?*

This question tends to answer ("how to") operation-related problems, but the research can be classified as 'empirical' since the question is knowledge-related (Barendse, Binnekamp, De Graaf, Van Gunsteren & Van Loon, 2012). The goal is to understand organizational and managerial roles in urban development (theory) but also to clarify gather and model the effective organizational and managerial roles in upscaling residential heat from practice (empirical).

2.1 Approach

An academic approach is utilized: in the introduction, literature concerning the trends in energy and urban development is utilized to formulate a research problem. The empirical part of the research is initiated according to the steps followed in an empirical research process *(Figure 2.1)* as defined by Kumar (2011).

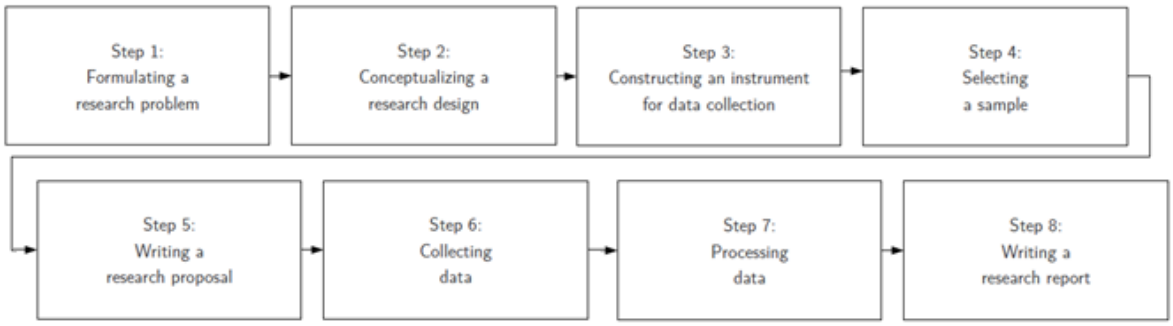

Figure 2.1 Steps of an empirical research process (Source: Kumar, R., 2011 p. 22, own edit)

The research framework of Kumar (2011) follows eight steps in chronological order.

The first step in the process has already been taken: a research problem is formulated based on the trends in urban development and energy. Besides formulating the research problem, the research aim and objectives are determined.

The second step is conceptualizing a research design **(2.2)**. The research design is discussed in the following section *(Figure 2.2)* and comprises three phases. The first phase is a literature review.

The third step is constructing an instrument for data collection **(2.3)**. For the second phase in the research, the empirical study, two cases are compared through a cross-case analysis .

In the fourth step two-level purposive sampling is applied in order to make a selection of cases and participants **(2.4)**.

2.2 Research design

There is chosen to for a research framework *(Figure 2.2)* consisting of three phases in which the research sub questions are answered.

In the first phase a literature study is performed on relevant theories to the problem. Sub question 1 until 3 are answered by naming and relating variables in urban development, network, niche management and innovation theories that influence the adoption of district scale energy-generating facilities, infrastructure adaption and adjustments to the dwellings. The conclusion of the first phase comprises a conceptual model with the relations and variables of the roles and actors.

In the second phase the conceptual model is used as an input to the empirical study where theory and practice comes together. Research sub question 4 until 6 are answered

In the third phase the synthesis takes place. In the synthesis conclusions are made based on the findings, a reflection of the process is made and shortcomings and further research is elaborated on in the discussion section.

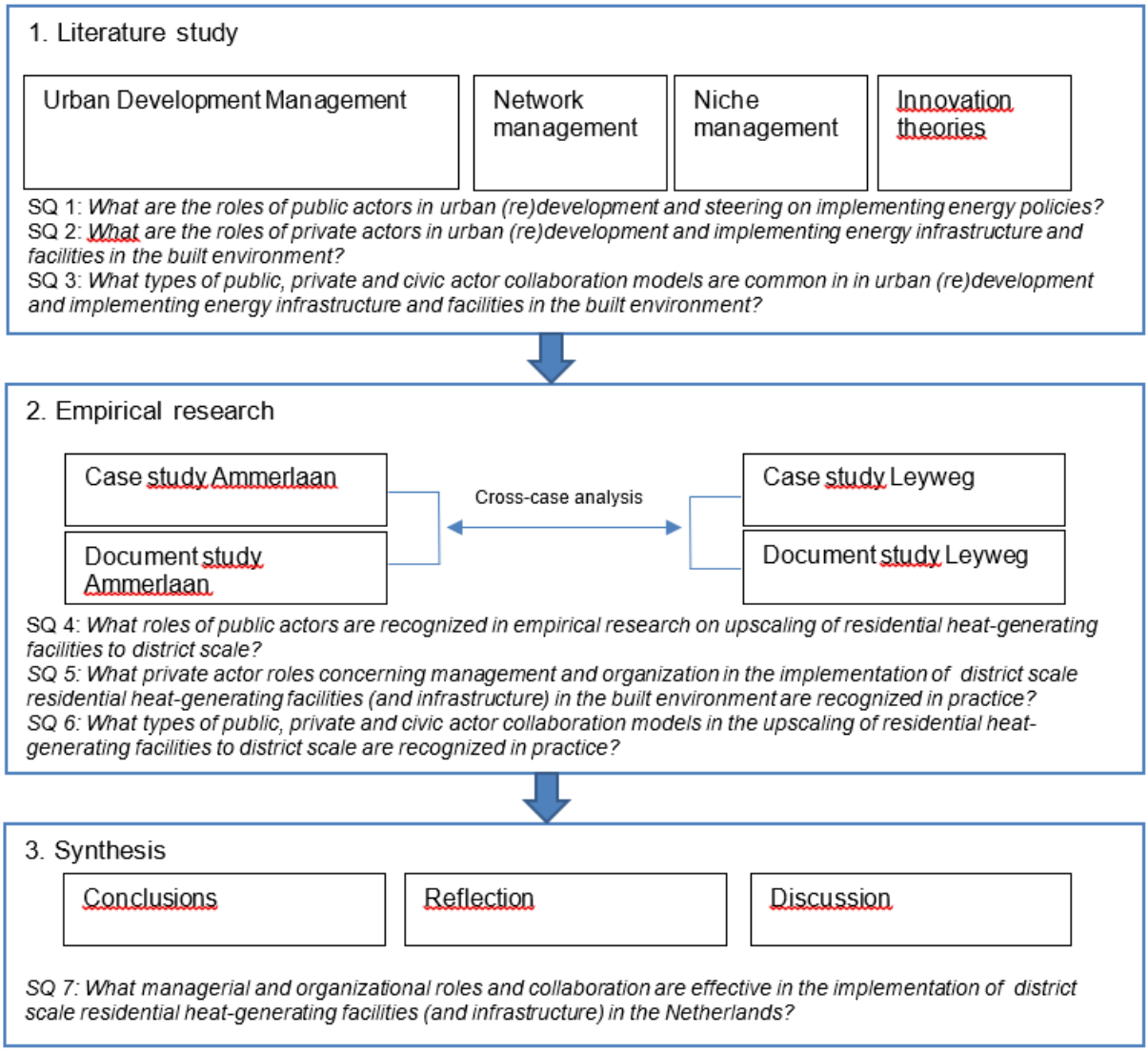

Figure 2.2 Research framework (own illustration, inspired by Heurkens, 2012; Veenhof, 2018)

2.3 Instrument for data collection

At first theory is used to form an understanding on how public actors steer in urban development, private actors manage and organize the implementation and how public, private and civic society collaborates.
Second, case study research and document study is performed on the cases. Based on two cases, Ammerlaan and Leyweg **(2.4)**, semi-structured interviews will be held, which are quantitative research methods that gather information. According to Yin (2012) the limitations of such case study research is that the results cannot generalize the outcome for the whole population. However, Yin (2012) noted that case studies are generalizable to theories.

2.4 Selection of cases

In this qualitative research purposive sampling is chosen over probability sampling: interviewing all the people participating in all energy alternatives would add a great deal to the time and cost of doing research. To deal with this problem is to employ purposive sampling (Bryman, 2012; p416) in which a selection of cases is made based on criteria. Purposive sampling is utilized in levels (Bryman, 2012, p417): in the first level the cases are sampled by context and in the seconds level sampled by participants.

2.4.1 First-level sampling

In first level sampling the following criteria are used:
1. Renewable and climate neutral: The energy that is produced must come from renewable heating sources and should not emit GHGs.

2. Scale and capacity: The heat source must be able to provide heat on a district scale and no after-heating is necessary.

3. Urban redevelopment: The integration of a district heating network is an urban redevelopment project in which infrastructure and existing dwellings were adapted. This criteria is made in order to draw lessons from adjustments to the existing built environment.

4. Competitiveness: The Leveled Cost Of Energy (LCOE) must be competitive with fossil fuel sources.

5. Project phase: The project must be operational, so to say there is already heat delivered to dwellings and used for space heating and water heating.

In order to weigh the alternatives on the aforementioned criteria a table is made *(Table 2).*

Alternative	Category		Selection criteria				
District heating			1	2	3	4	5
	Low-temperature (<70 C)	Low-temperature waste heat (data centers, greenhouses, supermarkets, etc.) Water (Sewage)	x				x
	High-temperature heat (>70 C)	Industrial waste heat	x	x		x	x
		Waste-to-energy		x		x	x
		Biomass		x		x	x
		Combined Heat Plant (CHP)		x		x	x
		Geothermal heat	x	x	x	x	x

Table 2 An overview of the heating solutions and selection criteria (Source: Energy Storage, 2018; Keutel, 2018, own edit).

The all-electric alternative is left out because this is not applicable on the district scale and the biogas alternatives are left out because the alternatives are not operational.

There is chosen for the category High-temperature heat (>70 C) because these alternatives meet the majority of the criteria and low temperature heating is not suitable for the majority of the residential stock due to energy efficiency.

Out of the fist selection geothermal heat, biomass CHP, waste-to-energy and industrial waste heat come forward. In order to select one energy source to do research on these two are compared and evaluated. According to the research IRENA (2018) the energy sources geothermal and biomass are competitive with fossil fuels when looking at the Levelled Cost of Energy. While there are cases where there are existing district heating networks on industrial waste heat (Maasvlakte Rotterdam) and Waste-to-energy (Westelijk havengebied Amsterdam), these did not became operational after adaption of existing dwellings (yet). As mentioned before, only 25% of the existing district heating networks are actually from renewable sources. Whether biomass is renewable is questioned: it contributes to depletion of natural resources and deforestation, although some of the woods chips utilized in the plant are acquired from sustainable forest management from the Foresty Commision (Staatsbosbeheer).

This leaves the selection based on context criteria to geothermal energy as alternative to household scale and building scale heat generating-facilities. But what is geothermal energy and how does it work?

In geothermal energy, hot water is extracted from the soil to heat buildings, greenhouses and industry. The deeper you drill into the earth, the higher the temperature becomes (Ammerlaan-TGI, 2018). The temperature >70 C is reached beyond a depth of 2.1 km.

In order to extract the heat from the soil, the water that is stored in sand layers at the aforementioned depth is escaping due the heat and pressure. The extraction of geothermal water is normally done using two wells connected to the surface by two doublets. The hot water is pumped up via the first well and passed through above-ground heat exchangers. The cooled water that has been used for heating buildings is pumped back into the soil and is warmed up again due the constant heat at 2.1 km and can be re-used at a later stage.

The great advantage of geothermal energy is that the source is inexhaustible and the production of heat does not rely on fossil fuels.

Figure 2.3 An image of a geothermal drilling rig during the construction. To reach the 70 C water well at depth of 2.1 km extensive drilling is required (Source: Energieoverheid, 2016).

There are actually very little geothermal projects finished and operational that fulfil the residential heat demand. Although two cases have been found to perform a case study and cross-case analysis on: Ammerlaan en Haagse Aardwarmte Leyweg. The first case was found on the website of VB-group, which is an conglomerate of various specialisms in (agricultural) technology, of which the companies operating independently, but benefiting from sharing their expertise on a regular basis (VB-group, 2018).

1. Ammerlaan

Project Description

Ammerlaan invested in a geothermal heat source in 2010. This made Ammerlaan the first floriculture company in the Netherlands with a geothermal heat source (Ammerlaan-TGI, 2018). In 2012, Ammerlaan negotiated with the municipality of Pijnacker-Nootdorp and the housing corporation Rondom Wonen about supplying 16 apartment buildings consisting of 470 apartments with geothermal heat to improve the current heating method. At the end of 2015 the project was completed (Hierverwarmt, 2018).

Figure 2.4 Geothermal plant Ammerlaan (Source: Energievastgoed, 2016)

Important stakeholders

Ammerlaan B.V.
Municipality Pijnacker-Nootdorp
Housing corporation Rondom Wonen

Status

Operational

2. Haagse Aardwarmte Leyweg (HAL)

Project Description
From 2018, the HAL will supply the district Southwest with sustainable heat from wells that are more than 2 km below ground level. The geothermal heat project is making a relaunch since the company HAL took over the two doublets that were drilled in 2010 (Energienieuws, 2017). The project is unique since it is the first inner-city geothermal plant.

Important stakeholders
Municipality of the Hague
Haagse Aardwarmte Leyweg (HAL)
Hydreco Geomec B.V. (Geomec)
Perpeetum Energy Partners B.V. (PEP)
Energiefonds Den Haag C.V. (ED)

Status
Operational

Fig. 2.5 Geothermal plant HAL (source: Energienieuws, 2017)

2.4.2 Second-level sampling
For the second level sampling, the participants (Bryman, 2012; p417) in the cases are selected based on the actor group where they belong in. Heurkens (2012) defined the three actors groups in urban governance which are going to be used as criteria in the selection of interviewees. At first the private actors who developed the project are going to be interviewed and snowball sampling will be applied (Bryman, 2012; p424). In snowball sampling the first participant can propose other participants, from the actor groups that are relevant for the research.

2.5 Administration
The semi-structured interviews are being held face-to-face, by email or by phone, depending on what the interviewee prefers. The interviews are being recorded by means of a microphone and digitally stored. Later a transcript is made out of the recorded interviews and relevant data is used in the report.
The questions in the interview should give insights and should be able to give an answer to the research main and sub questions. Measurable concepts and variables derive from the theoretical framework from literature **(3)**. The concepts from the theoretical framework will be used as input for the research questions. The concepts and variables will be ordered in an operationalization scheme to define the open questions in the semi-structured interviews.

Literature and general practical preference

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Reflection

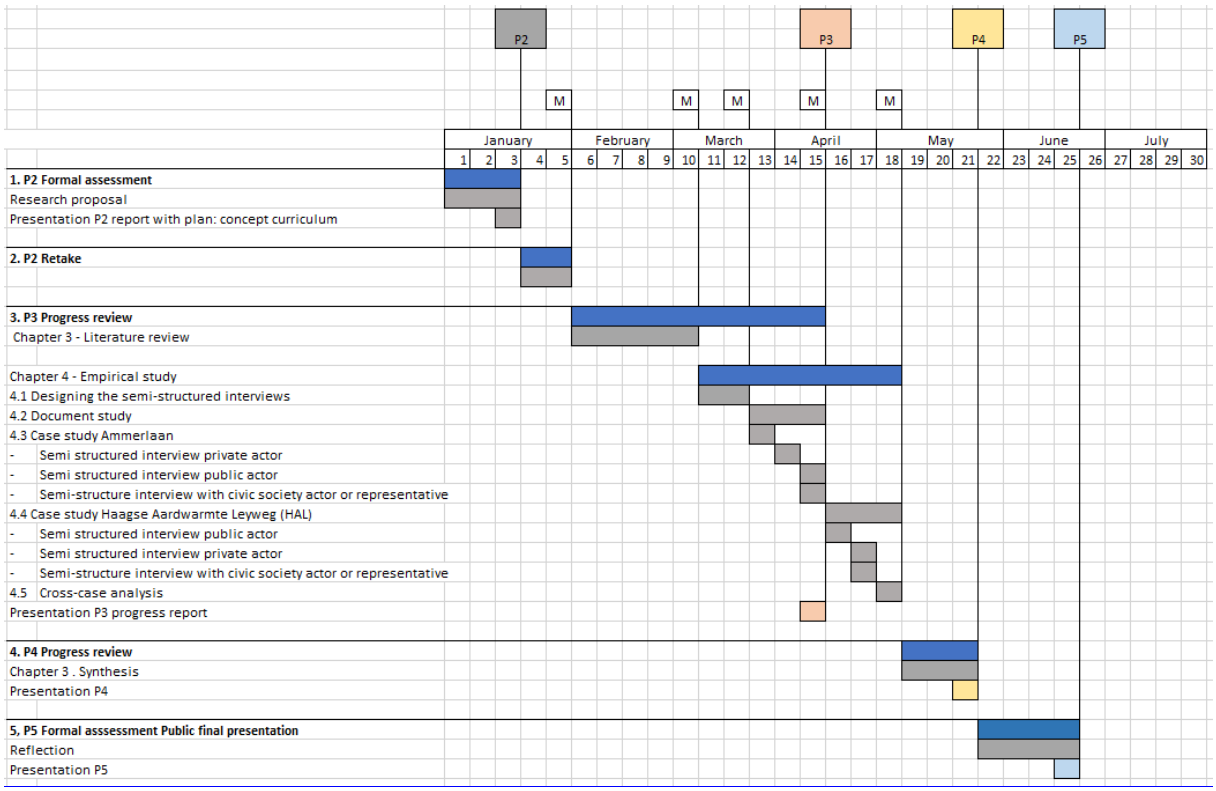
Societal and scientific relevance

Integrating district scale heat-generating facilities in urban redevelopment requires the management of the roles concerned. Local authorities endorse efforts to implement energy policies, but face the complexity in networks of various actors, scales and disciplines. While scholars acknowledge the existence of barriers and opportunities of upscaling residential heat to district level, little literature is found on cases where the existing built environment and infrastructure is adapted for district heating networks. This research addresses the knowledge gap on the managerial and organizational roles of public and private actors in LRECs in upscaling residential heat to a district scale. An analysis of the public, private and civic society roles in LREC networks can provide an understanding in the dynamic patterns of an energy transition. 'Implementing agents' such as households, have potential to participate in energy cooperatives and could represent a larger number of households, so the decision making process to implement is eased and more democratic. The intervention of intermediaries and change agents could be the missing link in the collaboration between actor groups.

For both private actors and local authorities this research contributes to effective management of upscaling residential heat-generating facilities to a district scale. Therefore this research can contribute to the pace at which the energy transition towards a larger share of renewable heat production in the Netherlands takes place.

Planning

An overall planning including important milestones is included. The P2 is delivered and contains main findings and conclusions for problem analysis, research questions, research plan, constructed instrument for data collection and the plan for a sample and case selection. In the P2 retake the a conceptual model is designed, a choice is made for the type of LREC and cases for the case study are selected based on criteria. After the P2, literature review is continued to form a concept out of theory. In the empirical part, the case studies are started and semi-structured interviews are conducted. From P3 on there is a process review of the data collected, the data aggregation is presented based on the first case. After this, the second case study is performed where after the cross-case analysis is made. After the P3 the findings are concluded. As the report approaches the P4 by the report is almost finished and final reflection is made; as stated in the graduation manual the report should be finished for 99%. The last deliverable is the P5, which is the final report with the findings of the research followed by a presentation.


P2
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1. P2 Formal assessment
Research proposal
Presentation P2 report with plan: concept curriculum
2. P2 Retake
3. P3 Progress review
Chapter 3 - Literature review
Chapter 4 - Empirical study
4.1 Designing the semi-structured interviews
4.2 Document study
4.3 Case study Ammerlaan
- Semi structured interview private actor
- Semi structured interview public actor
- Semi-structure interview with civic society actor or representative
4.4 Case study Haagse Aardwarmte Leyweg (HAL)
- Semi structured interview public actor
- Semi structured interview private actor
- Semi-structure interview with civic society actor or representative
4.5 Cross-case analysis
Presentation P3 progress report
4. P4 Progress review
Chapter 3 . Synthesis
Presentation P4
5, P5 Formal asssessment Public final presentation
Reflection
Presentation P5