UNIVERSITY OF TWENTE.

Local Renewable Energy Initiatives in the natural gas-free energy transition in the Netherlands

Obstacles, barriers and measures in niche development of
local cooperative district heating by forerunner initiatives in the province of Friesland

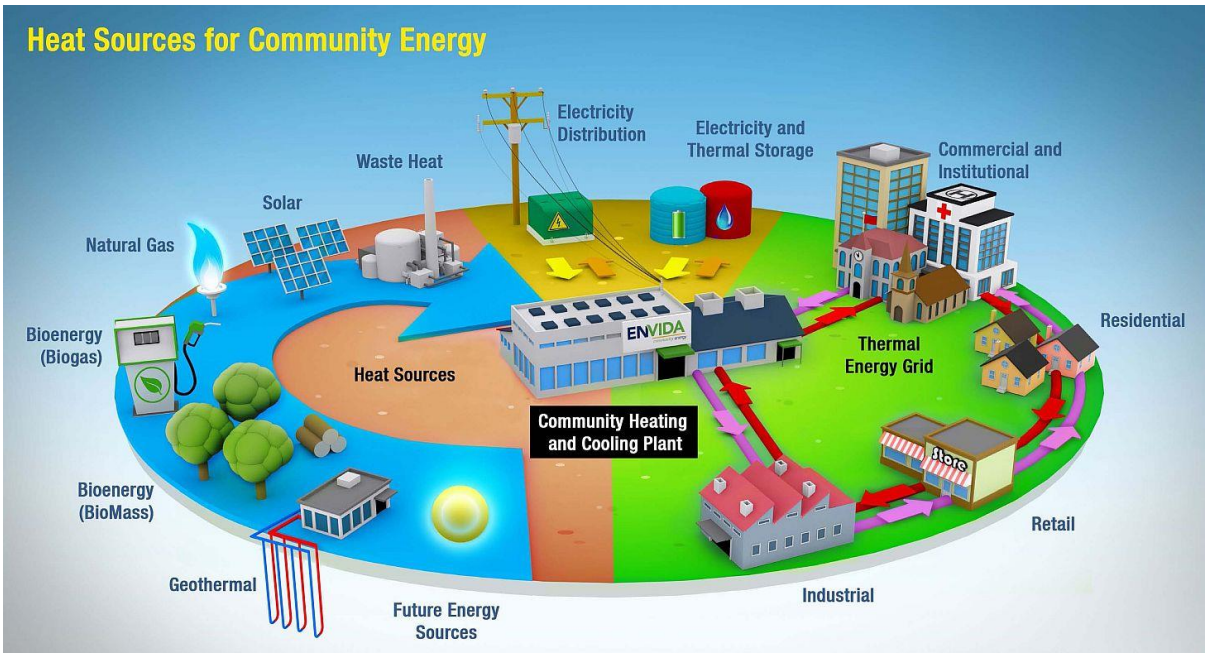

Illustration adapted from Envida (Envida Community Energy, 2017)

Master of Environmental and Energy Management (MEEM)

Master Thesis Energy Management Track

Department of Governance and Technology for Sustainability (CSTM)

Faculty of Behavioural, Management and Social sciences (BMS)

Institute for Governance Studies (IGS)

University of Twente (UT)

Date
November 17th, 2018

Author
ing. X.P.M. Klijnsma (Xantho) Student number: 2032376

UNIVERSITY OF TWENTE.

Local Renewable Energy Initiatives in the natural gas-free energy transition in the Netherlands.

Obstacles, barriers and measures in niche development of local cooperative district heating by forerunner initiatives in the province of Friesland.

Master of Environmental and Energy Management (MEEM)

Master Thesis Energy Management Track

Department of Governance and Technology for Sustainability (CSTM)

Faculty of Behavioural, Management and Social sciences (BMS)

Institute for Governance Studies (IGS)

University of Twente (UT)

Research period
April 1st till November 15th 2018

Date
November 17th, 2018

Author
ing. X.P.M. Klijnsma (Xantho) https://www.linkedin.com/in/xklijnsma/
Student number: 2032376 xantho.klijnsma@hvhl.nl

Supervisors
dr. F.H.J.M. Coenen (Frans) f.h.j.m.coenen@utwente.nl
dr. M.J. Arentsen (Maarten) m.j.arentsen@utwente.nl

Document properties

Word count	Page count	Word processor	Reference manager
39884	65	Microsoft Word 2016	Zotero 5.0.58

Keywords
Energy transition; strategic niche management; multi-level perspective; local district heating; energy cooperatives; obstacles, barriers, measures; sociotechnical niche development; heat transition; thermal energy from surface water; local renewable energy initiatives; gas regime; space heating; Friesland; Netherlands; natural gas-free, case study; biogas; green gas

Reference
Klijnsma, X. P. M. (2018). Local Renewable Energy Initiatives in the natural gas-free energy transition in the Netherlands. Obstacles, barriers and measures in niche development of local cooperative district heating by forerunner initiatives in the province of Friesland (Master Thesis). University of Twente, Leeuwarden.

Preface

During the last 15 month in the midst of my working career, I rediscovered what it feels like to be a student again. I feel privileged to be able to focus for a longer period of time on matters I am passionate about and to learn from and work together with other determined people in the area of environmental and energy management. I enjoyed the lectures, the stories, the talks and discussions with my fellow students from all over the world on environmental and sustainable issues.

To finalize my time at the Master of Environmental and Energy Management of the University of Twente, I conducted a research on two of the prominent developments in the Dutch Energy Transition, namely: the local renewable energy communities and the natural gas-free heating policy. Besides literature research I conducted interviews with an interesting variety of highly driven professional volunteers of Local Energy Initiatives and partner organizations that enable them to continue along the road to Renewable Community Energy. Many thanks to all participants and their valuable information! This Master thesis is the result of my final research project.

Hereby I express my gratitude to my wife and children for their understanding and support to be able to conduct this research project. I thank my closest colleagues who temporarily replaced me in parts of my work as a lecturer Environmental Sciences at Van Hall Larenstein University of Applied Sciences.

Finally I thank my 1st supervisor Frans Coenen for the inspiration on Strategic Niche Management, the development of my research proposal and the much appreciated feedback during the research, doctoral student Beau Warbroek for inspiration on Local Energy Initiatives and tips & tricks in this area of research and my 2nd supervisor Maarten Arentsen for the guidance in the development of my research proposal and assessing my final thesis report.

Please enjoy reading my report as much as I have enjoyed working on it!

Xantho Klijnsma

Leeuwarden, November 2018

Summary

Recent climate changes caused by anthropogenic emissions of greenhouse gases have had widespread impacts on human and natural systems. One of the main sources of enhanced greenhouse gas emissions is carbon dioxide (CO_2) as a byproduct of the use of fossil fuels in the energy production and consumption.

The Netherlands has set the target to a low-carbon energy supply in 2050 and one of the measures is to be natural gas-free. Gas is currently the dominant fossil energy source for space heating. In the energy transition centralized fossil based energy production is gradually replaced by decentralized renewable energy. New technology is needed to replace the gas-based technology used by the energy utilities. These new technologies cannot immediately compete with existing technological regimes that are characterized by lock-in and path dependence. New technologies need to evolve in protected niches to mature before they can enter mainstream markets to shift the incumbent regime.

Strategic Niche Management (SNM) is a concept that is developed as a research model and policy tool to serve the management of sustainable socio-technical innovation in niches. The assumed shared expectations, open network communication and broad learning within and surrounding the local energy initiatives ensure the right conditions for evaluative research by the SNM framework.

The conceptualization of technology and the dynamics of sociotechnical change, called Multi-Level Perspective (MLP), explains that technical change in society is mutually dependent on each other. Technical regimes are intermediaries between specific niche innovations as these are conceived, developed, and introduced, and the overall sociotechnical landscapes. These sociotechnical regimes have created a web of interdependencies that make it difficult for new technologies to be adapted into society. The multi-level perspective is considered to be the contextualization of strategic niche management.

Local Renewable Energy Initiatives are engaged in the energy transition by the development of community owned renewable energy systems in particular solar PV fields. However to replace gas as the source for heating, local renewable energy initiatives are entering into the realm of local district heating. These initiatives can create a niche to shift the regime. However niches are facing obstacles and barriers in their development. When these obstacles and barriers are identified and known in an early stage, niches can overcome these barriers and develop successfully.

Therefore this research was done with the main question: ***"How can local renewable energy initiatives create successful niches for natural gas-free district heating that contribute to the transition towards a new heating regime for existing houses?"***.

The strategy for this research is an in depth qualitative empirical case study approach. The first part of the research is based on literature combined with consultation of experts. The second part is an empirical data collection by semi-structured interviews with stakeholders part of LEI involved in the niche development of local district heating in the province of Friesland.

Based on Friesland being one of the frontrunner pilot regions for the regional energy strategy in the Netherlands, with more than 130 local sustainable initiatives and a shared third place with 53 local renewable energy initiatives and even frontrunner province with 140 connected sustainable villages, the potential for local renewable energy initiatives in Friesland for district heating was considered high. Friesland was the search area for LREI initiatives. As there is little evidence of actual development and there is no evidence of actual practices the search for local district heating cases

was focused on early development phases of initiatives and experts or intermediaries are consulted to find suitable cases.

First sub-question 1 ***"What is the existing natural gas based heating regime in the Netherlands?"*** was answered based on literature.

In the literature on the multi-level perspective (MLP) the sociotechnical regime is the meso-level between the macro-level sociotechnical landscape and micro-level technological niche. Sociotechnical regimes consist of three interlinked dimensions: actors, technology and rules. The natural gas based space heating regime of existing houses consists of actors from the Dutch State participating in the natural gas extraction, through a national transmission grid and local distribution grid, to be supplied to household consumers in combi gas boiler heating systems. The regime is path dependent as it has improved the energy efficiency along the line of gas incineration boilers and is locked-in the technology with natural gas as energy source from the gas grid. Although existing regime actors have vested interests, the rules that help stabilize the regime are changed under external influence among others to mitigate the effects of earthquakes by the gas extraction and to mitigate the effects of climate change by the emission of greenhouse gasses.

These insights are used to connect to the results of the case studies on niche innovations in district heating and the proposed structural changes in the energy system.

Next sub-question 2 ***"What are the key processes, obstacles and barriers in niche development particularly in local community district heating?"*** was answered based on literature.

The three key processes to identify and evaluate in case studies from the theory of strategic niche management (SNM) are the articulation of visions and expectations, formation of (new) actor networks and organization of learning processes. Successful niche development depends on identified aspects of all three processes. Beyond niche internal processes, the external processes at regime and landscape level are also important for niche developments to diffuse more widely as part of the multi-level perspective (MLP). Besides obstacles and barriers in relation to these key internal niche processes, niche development in local district heating initiatives can also be prevented or obstructed by aspects in the area of technology, ontology (continuity of existence), finance, legal, physical, infrastructural, management & control and cultural & social.

The key processes in niche development and the categories of obstacles and barriers together form the assessment criteria for evaluating the case studies on their niche development. Based on these assessment criteria the interview questions for involved actors have been formulated.

Subsequently two cases have been researched to answer sub-question 3 ***"How are Local Renewable Energy Initiatives developing niches in local district heating in the province of Friesland?"***.

The selected cases are: TEO Heeg and WEN biogas. These cases are currently the forerunner citizen initiatives on community renewable heat for space heating in existing residential houses. Interviews have been conducted with involved actors, such as the initiators, project coordinator, intermediary Energy Workshop, municipality and the water board Friesland.

Based on the assessment criteria in the TEO Heeg initiative, various aspects of niche development have been identified, including a vision process resulting in a village vision report, the founding of energy cooperative Duurzaam Heeg with reused statutes of another energy cooperative, a new combination of existing technologies to retrieve energy from surface water to be applied as an innovation in space heating of existing houses in the village of Heeg, for the planning phase relevant and involved actors, pro-active support by the municipality, intense support by intermediary

organization Energy Workshop and shown interest by the initiator, intermediary, municipality and water board to share knowledge on technology, finance and processes to develop the technology and to acquire participants. Although the initiative is in the planning phase and the social housing corporation is not fully involved, the development of this initiative can be considered as solid especially by the commitment of the initiator, the intermediary, the municipality and the water board displayed during the economic feasibility study and the process in the application for the Program natural gas-free neighborhoods. Based on the evidence found in this research on the identified aspects, involved actors and initiative processes in the TEO Heeg case study it can be concluded that the project is a niche in the area of local renewable energy as cooperative thermal energy from surface water to be applied in space heating of existing houses in the context of natural gas-free Netherlands. Moreover it may be considered successful in the current stage not only as a cooperative citizen initiative that is going to be described by the strategic niche intermediary Energy Workshop as a project that can be replicated elsewhere, but especially as a promising technological innovation with great energy potential that could possibly replace the gas-regime for space heating of existing houses. The energy from surface water can be considered as a primary naturally occurring source of solar energy.

For the WEN biogas initiative, as part of the integral vision of Wijnjewoude Energy Neutral 2025, also various aspects of niche development have been identified, including a vision process resulting in a shared vision website, the founding of the energy cooperative WEN, with reused statutes and added internal regulations, a new combination of existing technologies to use farm scale mono-manure-digesters to produce biogas that is transported to a central upgrade unit to produce green gas to replace natural gas for space heating of existing houses of the village of Wijnjewoude, the involved actors since the pilot status of the village are very diverse and commitment will be requested based on a detailed project plan written by current grid operator Liander and the comprehensive information sharing through the WEN website including business case documents, presentations and news items. Although the initiative is in the planning phase and the commitment of the involved actors is currently requested, the development of this initiative can be considered as solid especially by the continuous commitment of the initiator and the coordinator to engage in the Energy Park and the plans written on the energy projects and the required professional deployment. Based on the evidence found in this research on the identified aspects, involved actors and initiative processes in the WEN biogas case study it can be concluded that the project is a niche in the area of local renewable energy as cooperative biogas to green gas to be applied in space heating of existing houses in the context of natural gas-free Netherlands.

Although both cases display strong social innovation components as citizen cooperatives to provide renewable energy for their villages, they also show strong elements of technological innovations that contribute to the development of a niche in the area of local renewable energy for space heating of existing houses in the context of natural gas-free Netherlands. This niche can be considered as a new socio-technical niche that can further be studied by SNM as a policy instrument for a new governance model for local renewable district heating.

Finally based on the assessment criteria divers obstacles and barriers have been identified from the conducted interviews to answer sub-question 4 ***"What obstacles and barriers do Local Renewable Energy Initiatives in the province of Friesland face in their niche development for local district heating?"*** as well as some measures to overcome them in answer to sub-question 5 ***"How can Local Renewable Energy Initiatives in the province of Friesland overcome these obstacles and barriers?"***.

Both the initiatives TEO Heeg and WEN biogas depend on volunteers to work on the major task of becoming energy neutral villages in 2025. Although both projects focus on different technologies to

provide the village with a locally produced source of renewable energy for heating in existing houses, they show similarities and share obstacles and barriers. One of the drivers the initiatives share, is the vision process in the villages. Although the reasons slightly differ the municipalities played a role in the start of this process. The vision process resulted in a shared vision and sustainable perspective as part of the energy transition and sustainable development.

The following shared obstacles and barriers have been identified: real commitment of involved actors has to be determined to overcome obstacles in the area of financing, management and progress of the initiatives; Good examples of similar sociotechnical initiatives are limited for both initiatives to learn from and to convince villagers and actors; technological setup of the initiatives have not yet been drafted and although an economic feasibility study and a business case feasibility study have been carried out that look favorable for the initiatives, obstacles and barriers are likely to appear during realization of the plans in practice on installation and control of the technologies; continuity of the initiatives by limited time of volunteers can be overcome by engaging professionals from the involved actors while the initiative stays in control; both district heating and farm scale digesters share a historic negative image that has to be overcome besides convincing villagers on the specific technology and the cooperative collaboration to realize the initiatives; the experienced barriers in the process of recruiting members for the cooperatives are attempted to overcome by economic feasibility calculations, gradually introduction of the initiative, by free membership to try to find engaged members; both initiatives experience difficulties in involving housing corporation Elkien to make appropriate arrangements for the social inclusion of tenants in the initiatives.

In some respects the one initiative is more advanced over the other and vice versa. WEN already has a project plan with much more detail on the various parts of the project to become an energy neutral village in 2025. Duurzaam Heeg is going to draft a project plan to submit for the Program Natural gas-free neighborhoods. The actors in TEO Heeg currently show more engagement than the actors in WEN, possibly because WEN is all-encompassing and therefore difficult to show responsibility for a specific part of the plan. WEN is publically showing more activities and status updates on their website than Duurzaam Heeg, although Duurzaam Heeg seems to be in the process of starting this up for the strategy to slowly introduce the initiative to the village.

Some of the identified obstacles and barriers are specific to one of the initiatives, among others: the infrastructural adjustments in the streets of Heeg are the biggest obstacles both socially as well as financially. Measures to overcome these obstacles are to combine the digging for the district heating grid with other plans, such as the renewal of the sewage system to reduce the impact for villagers as well as sharing the costs with others; The acquisition of the former WWTP Wijnjewoude from WSF has proven to be a large obstacle for WEN the last almost two years. Specific features of the property can be reused for the Energy Park such as the grid connections and former sludge basins. Although various proposals have been reviewed, WEN does not own the property and because of this also SDE+ subsidy for the planned solar PV field was rejected.

Although the initiatives are not directly in the process of developing niches they are aware that their projects can contribute to other villages and neighborhoods in the progress towards energy neutrality or steps forward in the energy transition. Even though the obstacles and barriers these initiatives are experiencing as well as the measures they are taking to overcome them might be specific to the respective initiatives, they may certainly be used as examples and as inspiration to other initiatives especially in Friesland as they share the same support structure with rules, regulations and strategic intermediary Energy Workshop to help overcome obstacles and barriers. Moreover governmental actors such as municipalities and the water board WSF may also need to

help protect the spaces these initiatives are developing in, as the technological innovations need the opportunity to show to be viable in practice.

Based on these findings the answer to the main question of this research is:

Local renewable energy initiatives create successful niches for natural gas-free district heating by real commitment of relevant actors that have articulated their expectations and share the vision of community initiatives in the area of thermal energy from surface water or farm scale mono-manure-digesters and transparently share information on development processes and documents such as statutes, project plans and economic feasibility calculations. Initiatives in Friesland share the same support structure with strategic intermediary Energy Workshop to be able to overcome obstacles and barriers to replicate successful technological projects and with the help of changing rules by external influence to mitigate environmental impacts these accumulated projects may contribute to the transition towards a new heating regime for existing houses.

Finally it is recommended to do more research on the two forerunner initiatives in more advanced stages of development and possibly ex post to be able to analyze the full development. Meanwhile different case studies can be executed to help stimulate the learning process between initiatives in the niche of local renewable energy for space heating of existing houses in the context of natural gas-free Netherlands.

Table of Contents

List of Abbreviations 11
List of Figures and Tables 13
1 Introduction 15
2 Theoretical Framework 19
2.1 Energy transition 19
2.2 Multi-level perspective and strategic niche management 20
3 Research Design 23
3.1 Research Framework 23
3.2 Research questions 24
3.3 Definition of key concepts and demarcation 24
3.4 Case study selection 26
3.5 Research methods 26
4 Existing natural gas based heating regime 31
5 Key processes, obstacles and barriers in niche development LRDH 35
6 Local district heating niche development by LREIs 39
6.1 Case description TEO Heeg 41
6.2 Technology concept of TEO Heeg 43
6.3 Key processes niche development TEO Heeg 45
6.4 Case description WEN biogas 51
6.5 Technology concept of WEN biogas 52
6.6 Key processes niche development WEN biogas 53
6.7 Conclusions niche development LREI district heating in Friesland 58
7 Obstacles, barriers and measures in LREIs 61
7.1 Obstacles and barriers TEO Heeg 61
7.2 Measures to overcome obstacles and barriers TEO Heeg 65
7.3 Obstacles and barriers WEN biogas 70
7.4 Measures to overcome obstacles and barriers WEN biogas 75
7.5 Conclusions Obstacles, Barriers and Measures of studied cases 79
8 Discussion 81
9 Conclusions and Recommendations 83
References 87
Appendices I
Appendix I Questionnaire used for interviews of case study actors I

List of Abbreviations

ACM	Autoriteit Consument & Markt / Authority for Consumers and Markets
CO_2	Carbon dioxide
CPIs	Citizen Participation Initiatives
DH	District Heating
DSO	Distribution System Operator
EBN	EnergieBeheerNederland / Energy Management Netherlands
ECDH	Energy Cooperative Duurzaam Heeg (Sustainable Heeg)
EU	European Union
EwpF	Energiewerkplaats Fryslân / Energy Workshop Friesland
FES	Friese Energie Strategie / Frisian Energy Strategy
GIS	Geographic Information System
GTS	Gasunie Transport Services
IPCC	Intergovernmental Panel on Climate Change
IPO	Interprovinciaal Overleg / Interprovincial consultation
LDC	Local Distribution Company
LEI	Local Energy Initiative
LLCEI	Local Low-Carbon Energy Initiative
LRDH	Local Renewable District Heating
LREI	Local Renewable Energy Initiative
LREOs	Local (civil society based) Renewable Energy Organizations
LTO-Noord	Land- en Tuinbouw Organisatie Noord / North-Dutch Federation of Agriculture and Horticulture
MLP	Multi-Level Perspective
NAM	Nederlandse Aardolie Maatschappij / Dutch oil company
ODE Decentraal	Vereniging Organisatie voor Hernieuwbare Energie Decentraal / Organization for Renewable Energy Decentral
PV	Photovoltaic
RED	Renewable Energy Directive
RES	Renewable Energy Sources
RVO	Rijksdienst voor Ondernemend Nederland / Netherlands Enterprise Agency
SDE+	Stimulering Duurzame Energieproductie / Stimulation of Sustainable Energy Production
SEN	Stichting Samen Energie Neutraal / Foundation Together Energy Neutral
SNM	Strategic Niche Management
SWF	Gemeente Súdwest-Fryslân / Municipality South-West Friesland
TEO	Thermische Energie uit Oppervlaktewater / Thermal Energy from surface water
TIC	Testing, Inspection and Certification
TSO	Transmission System Operator
UK	United Kingdom
UNFCCC	United Nations Framework Convention on Climate Change
VFK	Vereniging van Nederlandse Fabrieken van Ketels voor Centrale Verwarming / Association of boiler manufactures
WEN	Wijnjewoude Energie Neutraal / Wijnjewoude Energy Neutral
Wp	Watt peek
WSF	Wetterskip Fryslân / Water board Friesland
WWTP	Waste Water Treatment Plant

List of Figures and Tables

Figure 1 Multi-level perspective on transitions starting at niche level to shift the sociotechnical regime (Frank W. Geels, 2011) 21
Figure 2 Research Framework for gas-free LREI for district heating 23
Figure 3 Conceptual research model of gas-free transition and demarcation (adapted from F. W. Geels & Schot, 2007) 24
Figure 4 Analytical framework for space-heating in houses in relation to LEI 29
Figure 5 Current natural gas regime actors in the gas chain (adapted from Correljé et al., 2003, p. 204) 32
Figure 6 Gas installation in existing houses (adapted from Habitissimo, 2018) 33
Figure 7 The three key processes of Strategic Niche Management 35
Figure 8 Niche development stages and expected processes 36
Figure 9 Reconstructed timeline of important events on energy in Heeg 43
Figure 10 TEO Heeg technology concept Thermal Energy from Surface water (adapted from IF Technology, 2018) 44
Figure 11 Actor network of TEO Heeg 48
Figure 12 Reconstructed timeline of important events on energy in Wijnjewoude 52
Figure 13 Mono-manure-digesters at dairy farms creating biogas that is centrally upgraded to green gas and injected into the existing natural gas grid (adapted from Pool, 2017) 53
Figure 14 Actor network surrounding WEN 2025 56
Figure 15 Location of the case studies in the analytical framework (adapted from Figure 4) 58

Table 1 Potential stakeholders to interview in relation to LEI 28
Table 2 Actors in the current natural gas regime with interests and connections 32
Table 3 Overview of categories of obstacles and barriers for niche development in local community district heating 38
Table 4 List of interviews conducted and used in the Case Studies 39

1 Introduction

In the IPCC Fifth assessment report of 2014 the scientists were clearly stating that: “Human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems” (Pachauri et al., 2014).

One of the main sources of enhanced greenhouse gas emissions is carbon dioxide (CO_2) as a byproduct of the use of fossil fuels in the energy production and consumption.

The first global precautionary action on climate change mitigation was The United Nations Framework Convention on Climate Change (UNFCCC) “Rio Convention” of 1992 after which the Kyoto protocol entered into force in 2005. The protocol committed its 192 Parties by setting internationally binding greenhouse gas emission reduction targets (UNFCCC, 2018a). In 2016 the Paris Agreement entered into force bringing all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries to do so (UNFCCC, 2018a). Currently 174 have ratified the agreement of 197 Parties of the Convention (UNFCCC, 2018b).

The United Nations Sustainable Development Goals focus on 17 worldwide targets, that will end poverty, inequality, injustice and climate change (“Sustainable Development Goals,” 2015). Goal number 7 concerns energy: Ensure access to affordable, reliable, sustainable and modern energy for all (United Nations, 2018).

Before the full privatization and liberalization of the energy markets in the European Union (EU) as of July 1st 2007 the public utility companies used to have a strictly regulated monopoly in their region for the production, supply, grid operation and metering of energy. One of the aims of the EU is to have one energy market with strong competition so that on the one hand the prices for consumers would decrease and on the other hand a larger variety of energy sources would be used (European Union, 2009b, 2009c). The EU also aims for secure, sustainable, competitive and affordable energy for all consumers. In the Renewable Energy Directive (RED) the production of renewables is promoted (European Union, 2009a).

The Netherlands has entered the path towards a gas-free country in 2050 (Ministry of Economic Affairs, 2017). Currently the Dutch Electricity, Gas and Heat Acts are proposed to be amended in the progress of the energy transition. One of the major changes is the removal of the natural gas connection obligation for new-built houses for small consumers which is clearing the road for other ways of heating. In 2015 almost 92% of all houses are directly or indirectly connected to the natural gas-grid and 6% is connected to a district heating system (Gerdes, Marbus, & Boelhouwer, 2016).

Consumers are switching energy suppliers regularly and consumers are organised in collectives for joint procurement for lower prices (Consumentenbond (Consumer Association), 2018). Consumers want to have a choice on where to buy energy and what (renewable) source is used to produce the energy. Consumers are also developing into so-called prosumers, since they start producing energy for example by solar PV systems (Hoppe, Graf, Warbroek, Lammers, & Lepping, 2015).

New technology is needed to replace the gas-based technology used by the energy utilities. According to Geels and Raven new technologies cannot immediately compete with existing technological regimes that are characterized by lock-in and path dependence (F. Geels & Raven, 2006). New technologies need to evolve in protected niches to mature before they can enter mainstream markets to shift the incumbent regime (Kemp, Schot, & Hoogma, 1998).

One of the niche developments are organised on a local community level in so-called Local Energy Initiatives (Hasanov & Zuidema, 2018). Most local energy initiatives are focused on affordable renewable energy in the form of solar PV systems to produce electricity (Hieropgewekt, 2018).

In a gas-free energy transition district heating utilizing diverse (renewable) heat sources is a promising technology mentioned in the Energy Agenda (Ministry of Economic Affairs, 2016).

Although district heating is put into practice in numerous cities by commercial companies in Culemborg the first local community district heating system is put into practice in the ecological district EVA-Lanxmeer in 2009 (Verschuur, 2010).

Recently various scholars have studied the obstacles and barriers the local initiatives have to cope with to gain ground on the renewable electricity market, especially solar PV systems. However limited attention is focused on the gas-free target for 2050 in a low-carbon energy society.

Local Renewable Energy Initiatives (LREI) that are focused on household heating by gas-free technologies can be considered as niches that are assumed to face similar obstacles and barriers as renewable electricity initiatives.

The Dutch province of “Fryslân” (Friesland) has a rich cooperative history also in the area of energy cooperatives featuring about 60 energy cooperatives together with more than 130 local sustainable initiatives and is stated to be a frontrunner when it comes to working from the community (Regiegroep Friese Energiestrategie, 2017). Friesland appears to be a suitable area for this research.

Strategic Niche Management (SNM) is a concept that is developed as a research model and policy tool to serve the management of sustainable socio-technical innovation in niches (Schot & Geels, 2008). The assumed shared expectations, open network communication and broad learning within and surrounding the local energy initiatives ensure the right conditions for evaluative research by the SNM framework.

Problem statement

The Netherlands has set the target to a low-carbon energy supply in 2050 and one of the measures is to be natural gas-free. Gas is currently the dominant fossil energy source for space heating. In the energy transition centralized fossil based energy production is gradually replaced by decentralized renewable energy. Local Renewable Energy Initiatives are engaged in this transition by the development of community owned renewable energy systems in particular solar PV fields.

To replace gas as the source for heating, local renewable energy initiatives are entering into the realm of local district heating. These initiatives can create a niche to shift the regime. However niches are facing obstacles and barriers in their development. When these obstacles and barriers are identified and known in an early stage, niches can overcome these barriers and develop successfully.

Research objective

The research objective is to provide insights in contemporary Local Renewable Energy Initiatives in their development of gas-free district heating niches by exploring the obstacles and barriers described in Strategic Niche Management socio-technical energy transition literature in comparison with empirical case study data collected in the Dutch province of Friesland.

Outline

This report is structured in the following way:

After this introductory Chapter 1 the Theoretical Framework in Chapter 2 elaborates on Energy Transition, Multi-level Perspective and Strategic Niche Management. In Chapter 3 the research design including the research question, sub-questions and the associated research methods will be clarified. In Chapter 4 and 5 the first two sub-questions are answered based on literature. This is followed by Chapter 6 and 7 in which the last three sub-questions are answered based on the empirical findings from interviews with actors involved with two renewable district heating initiatives. Finally in Chapter 8 the research findings will be discussed and in Chapter 9 the report concludes with the various findings answering the research questions.

2 Theoretical Framework

In this chapter the applicable theories are described to support this research project.

2.1 Energy transition

The energy transition from fossil energy sources towards renewable energy sources in The Netherlands is ongoing since the 1970s right after the Club of Rome report "Limits to Growth" (Meadows, Meadows, Randers, & Behren, 1972) and the oil crisis in 1973 (Geert Verbong, Selm, Knoppers, & Raven, 2001).

Before this period more transitions took place concerning energy, amongst others: horse-power to coal-fired steam engines, from oil-based lights to electric lights and from coal-fired to city-gas-fired cooking (Correljé, Linde, & Westerwoudt, 2003). Till 1960 the electricity and city-gas system was regionally oriented (Geert Verbong et al., 2001) and run autonomously by regional energy companies that had the informal rule to exclude the national government (G. Verbong & Geels, 2007).

The national government took a leading role in the introduction of natural gas in the 1960s by setting up a public-private cooperation between the Dutch State, Shell and Exxon to create the Gasunie with a national monopoly on natural gas exploitation (G. Verbong & Geels, 2007). Not only did this increase the national government's influence on the gas market, but later also the electricity market when gas-fired electricity plants were introduced rapidly replacing coal (Correljé et al., 2003).

By the transposition of the European Commission's liberalization directives for the internal electricity and gas markets to the national legal system from 1996 the barriers for preventing alternative suppliers to produce energy from renewable sources and for customers from changing their supplier were gradually removed (European Union, 2009b, 2009c).

In 2013 the Energy Agreement was signed by all relevant partners in the Netherlands to tackle the adopted European Union targets on reduction of greenhouse gas emissions, increase in production of renewable energy and energy saving. The energy transition towards a sustainable, reliable and affordable energy system in 2050 is the main aim of this agreement (Sociaal-Economische Raad (Social Economic Council), 2013). The Dutch Energy Agreement is a response to The United Nations Framework Convention on Climate Change (UNFCCC) "Rio Convention" of 1992 and the Kyoto protocol that entered into force in 2005. The protocol commits its 192 Parties by setting internationally binding greenhouse gas emission reduction targets (UNFCCC, 2018b).

In succession to this in 2016 the Paris Agreement entered into force bringing all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries to do so (UNFCCC, 2018b).

In response to this the Dutch Energy Agenda 2016 formulates the ambitions: 40% reduction of greenhouse gasses in 2030 compared to 1990 and will continue towards 80% or even 95% in 2050 (Ministry of Economic Affairs, 2017). In July 2018 as a result of the so-called climate tables the proposal for a Climate Agreement formulates among other things gas-free urban planning and gas-free renovation of social housing to decrease the use of natural gas in heating of houses (Ministry of Economic Affairs and Climate Policy, 2018).

The Netherlands is clearly in a transition towards a low-carbon energy society (Ministry of Economic Affairs, 2017).

However technical change in technical sectors is difficult because it is locked into dominant technological regimes that work from a generally accepted basic or dominant design framework as a starting point for improvements (Kemp et al., 1998). This is also true for the energy regimes, were the infrastructure is locked into the energy system.

2.2 Multi-level perspective and strategic niche management

Rip and Kemp (1998) developed the conceptualization of technology and the dynamics of sociotechnical change, called Multi-Level Perspective (MLP), to explain that technical change in society is mutually dependent on each other (Rip & Kemp, 1998). Technical regimes are intermediaries between specific niche innovations as these are conceived, developed, and introduced, and the overall sociotechnical landscapes. These sociotechnical regimes have created a web of interdependencies that make it difficult for new technologies to be adapted into society (Frank W. Geels & Schot, 2007; Rip & Kemp, 1998).

Kemp, Shot and Hoogma (1998) developed a perspective, called strategic niche management (SNM), on how to accelerate a transition into a new regime. The perspective consists of the creation and management of niches for promising sustainable technologies (Kemp et al., 1998). The multi-level perspective is considered to be the contextualization of strategic niche management (Schot & Geels, 2008). The theory is still being developed further (Frank W. Geels, 2011; Frank W. Geels, Schwanen, Sorrell, Jenkins, & Sovacool, 2018; Schot & Geels, 2008).

The links between niche innovations, technical regimes and the sociotechnical landscape can be depicted as three levels from bottom to top. The development over time can be depicted by a time-line from left to right. In Figure 1 this is shown.

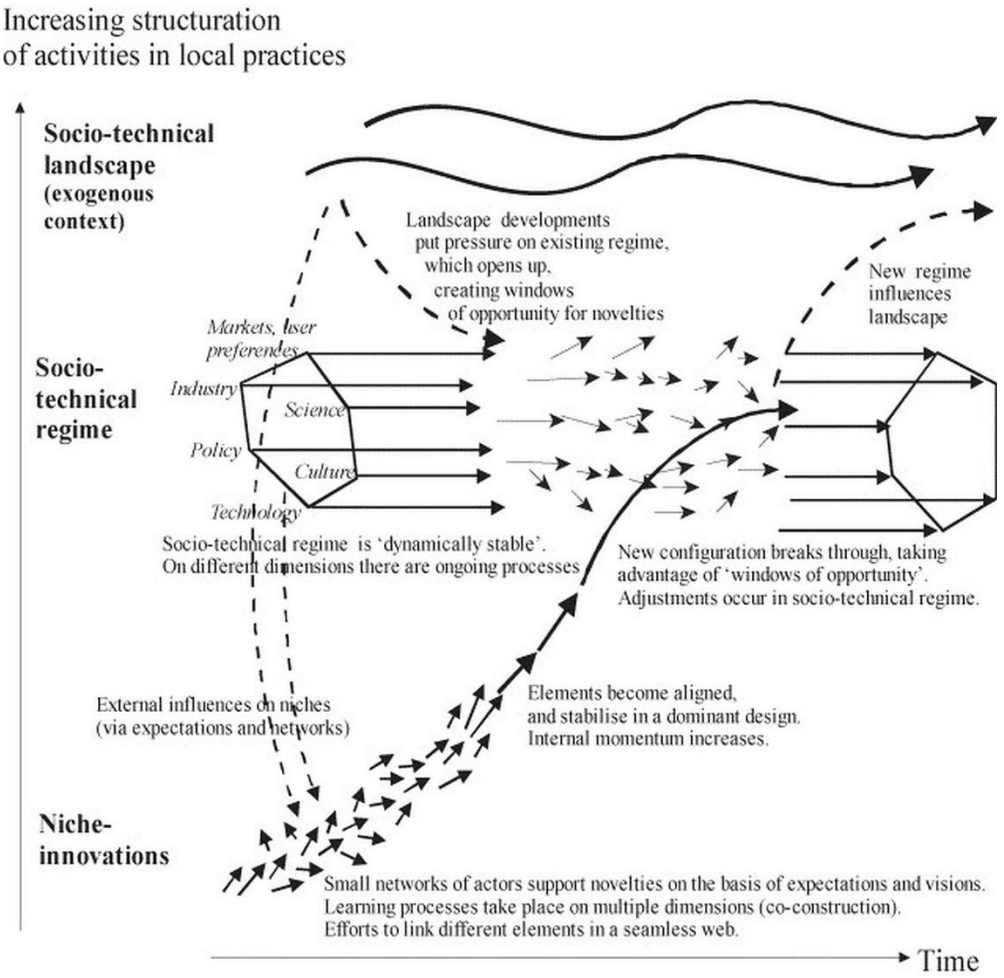

Figure 1 Multi-level perspective on transitions starting at niche level to shift the sociotechnical regime (Frank W. Geels, 2011)

In Figure 1 the niche innovations take place in the form of local projects or experiments that together can become aligned into a dominant design. When the sociotechnical regime(s) are put into pressure by landscape developments to shock the existing regimes that could be weakened creating a window of opportunity for the dominant niche design that created enough momentum.

To give an example: The oil crisis of 1973 formed the external landscape shock to create a window of opportunity for natural gas to replace the dominant coal regime in the electricity power stations (G. Verbong & Geels, 2007).

Successful niche development in this study is understood to be a combination of shared expectations; profound social networks; and learning processes involving open source information sharing; substantiated in ongoing replicated projects (Hoppe et al., 2015; Kemp et al., 1998; Seyfang, Hielscher, Hargreaves, Martiskainen, & Smith, 2014).
According to Hoppe et al. (Hoppe et al., 2015) successful niche development can influence the regime in three ways:

1. Replication of projects within the niche, bringing about changes through multiple small initiatives;
2. Constituent projects grow in scale and attract more participants;
3. Transferal of niche ideas into mainstream settings.

Most of the niche analyses found in literature are focused on single market and technological innovations by companies. In the UK Seyfang and Smith (Seyfang & Smith, 2007) started focusing on grassroot innovations, which are bottom-up civil society-led initiatives for sustainability. Concerning energy these initiatives are often developed into community-led sustainable energy projects.

Walker and Devine-Wright (Walker & Devine-Wright, 2008) refer to this as community renewable energy: a wide variety of projects where communities of place and/or interest with a high degree of involvement of local people and the outcome of the projects to be beneficial to all participants.

As described by Seyfang et al. (Seyfang et al., 2014) community energy is a diverse sector, with multiple technologies, social institutions, business models, actors and goals. These grassroots innovations include both energy generation and conservation projects. Moreover Seyfang et al. (Seyfang et al., 2014) reframe community-led initiatives for sustainability as innovative niches and conclude based on empirical exploration of UK community energy case studies that SNM can be used to analyze LREIs. They found evidence of an emerging niche forming. However attention should be given to the fact that LREIs are bottom-up and are neither strategic nor managed.

SNM originates from the perspective of evolution and selection of technology by technology actors in protected spaces created by policy makers before market introduction, however it was further developed to serve technology development in socio-technological niches particularly in socially desired innovations such as sustainability and radical novelties that face changes in multiple areas such as infrastructure, user practices and regulations (Schot & Geels, 2008).

Even though Local Energy Initiatives in the Netherland also vary greatly for example in size, financial implication or type of renewable energy source it is argued by Hoppe et al. (Hoppe et al., 2015) to be conceptually acceptable that LREIs jointly qualify as niche when they advance the sustainable energy transition and can therefore be analyzed using SNM.

3 Research Design

The research strategy for gaining insights in the nature of the research object, the Local Renewable Energy Initiatives, is to follow an in depth qualitative empirical case study approach (Verschuren, Doorewaard, & Mellion, 2010).

By studying preliminary research on obstacles and barriers in the area of strategic niche management of sustainable sociotechnical changes and consulting experts in this field a list of assessment criteria can be obtained. Based on selection criteria two comparative LREI cases are selected that are involved in local district heating. Data is collected by semi-structured interviews with the case stakeholders. The studied cases are individually assessed by the assessment criteria. The results of these analyses are compared to conclude with recommendations for successful niche creation by LREI and recommendations for further study in the field of SNM.

3.1 Research Framework

The steps that are followed to reach the research objective are put in a research framework.

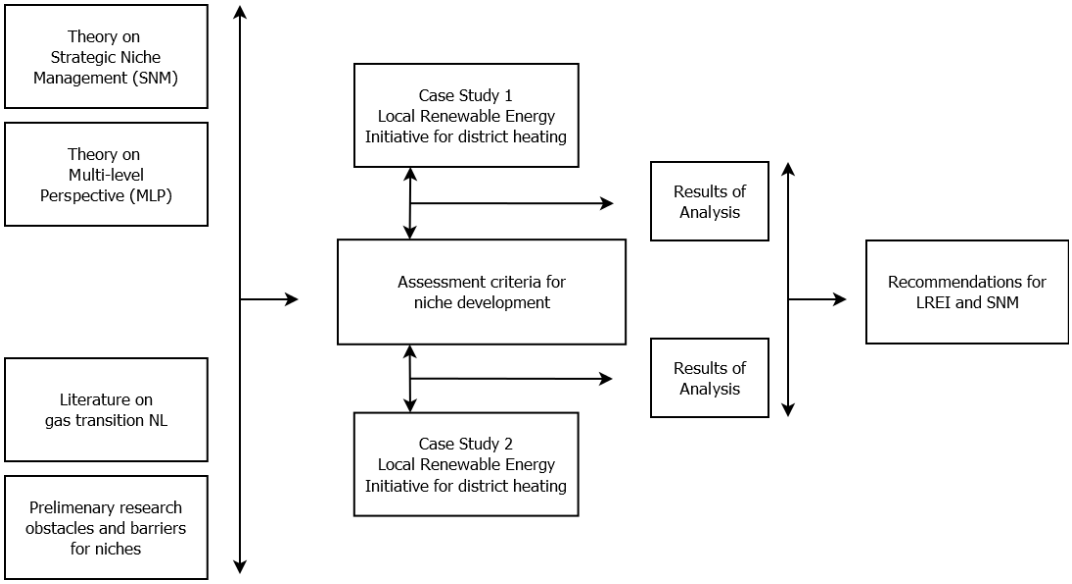

Figure 2 Research Framework for gas-free LREI for district heating

The framework in Figure 2 for this research is formulated as follows:

A study of the obstacles and barriers of niche development in the gas-free Netherlands energy transition based on consultation with experts and on relevant scientific literature, yields the assessment criteria, by means of which two Case Studies of Local Renewable Energy Initiatives for district heating in the province of Friesland will be evaluated. A confrontation of the results of the case evaluations concludes with recommendations for successful developing of niches in local district heating by Local Renewable Energy Initiatives.

3.2 Research questions

Based on the research objective, the theoretical framework and the research framework the research question if formulated.

The main question for this research is:

How can local renewable energy initiatives create successful niches for natural gas-free district heating that contribute to the transition towards a new heating regime for existing houses?

The main question is divided into the following sub-questions:

1. What is the existing natural gas based heating regime in the Netherlands?
2. What are the key processes, obstacles and barriers in niche development particularly in local community district heating?
3. How are Local Renewable Energy Initiatives developing niches in local district heating in the province of Friesland?
4. What obstacles and barriers do Local Renewable Energy Initiatives in the province of Friesland face in their niche development for local district heating?
5. How can Local Renewable Energy Initiatives in the province of Friesland overcome these obstacles and barriers?

3.3 Definition of key concepts and demarcation

The key concepts of this research can be captured in a conceptual research model.

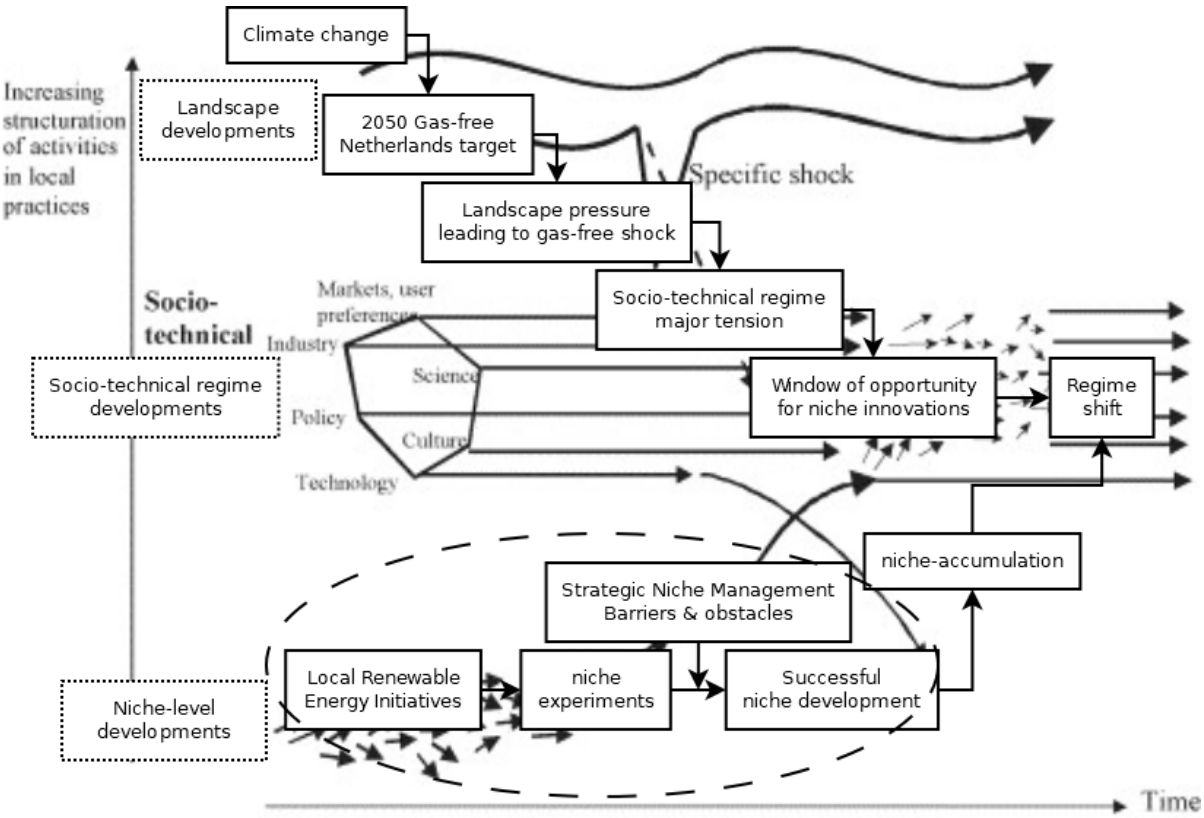

Figure 3 Conceptual research model of gas-free transition and demarcation (adapted from F. W. Geels & Schot, 2007)

In Figure 3 the technological substitution pathway for a successful sociotechnical change (Frank W. Geels & Schot, 2007) is displayed in the background. On top of this the conceptual model of

interlinking relations in the gas-free energy transition is displayed. The area of SNM where this research is situated is demarcated in the dashed area near the bottom of the figure.

The conceptual model in Figure 3 of the gas-free transition can be read as follows:

At the landscape level the global climate change challenge results in one of the measures in the Dutch gas-free 2050 target. This leads to an increase of landscape pressure that leads to a gas-free landscape shock. This shock leads to major tension on the regime level in the sociotechnical regime(s) with its stakeholders in the gas chain creating a window of opportunity for a niche innovation. At the same time on the niche level Local renewable energy initiatives start niche experiments for example in the area of district heating. The development of these niche experiments are negatively influenced by obstacles and barriers that have to be dealt with. When these obstacles and barriers are effectively handled it results in successful niche development. The accumulation of successful niche developments together form a dominant niche design that takes advantage of the window of opportunity that cause a regime shift.

Demarcation

The area of this research is demarcated around the evaluation of obstacles and barriers in two case studies of Local Renewable Energy Initiatives in their development of niche experiments in the area of district heating for existing houses in the province of Friesland.

Niches

The definition of **niches** in the SNM literature (F. Geels & Raven, 2006; Kemp et al., 1998; Schot & Geels, 2008) can be described as (Seyfang & Haxeltine, 2012):

"*a protected space where suboptimally performing experiments can develop away from regime selection pressures. Niches comprise intermediary organisations and actors, which serve as 'global carriers' of best practice, standards, institutionalized learning, and other intermediating resources such as networking and lobbying, which are informed by, and in turn inform, concrete local projects (experiments).*".

Strategic Niche Management

SNM is a concept that is developed as a research model and policy tool to serve the management of sustainable socio-technical innovation in niches (Frank W. Geels & Kemp, 2007; Kemp et al., 1998; Schot & Geels, 2008).

Case Study

The following common definition is used of a case study as a research method (Yin, 2009):

"*The essence of a case study, the central tendency among all types of case study, is that it tries to illuminate a decision or set of decisions: why they were taken, how they were implemented, and with what result.*".

Local Renewable Energy Initiative

For the purpose of this research project a **Local Renewable Energy Initiative** is understood to be an initiative in a local community and initiated by local residents that are in the process of starting or already started to produce renewable in particular heat to be used for space heating in households in the same community.

Sociotechnical landscape

A **sociotechnical landscape** is to be understood as (Rip & Kemp, 1998): "*a landscape in the literal sense, something around us that we can travel through; and in a metaphorical sense, something that we are part of, that sustains us. We will use the concept primarily at the level of societies.*".

Sociotechnical regime

A **technological regime** is to be understood as (Rip & Kemp, 1998): "*the rule-set or grammar embedded in a complex of engineering practices, production process technologies, product characteristics, skills and procedures, ways of handling relevant artifacts and persons, ways of defining problems—all of them embedded in institutions and infrastructures. Regimes are intermediaries between specific innovations as these are conceived, developed, and introduced, and overall sociotechnical landscapes.*". The regime concept has been further widened to 'socio-technical regimes', which include scientists, users, policy makers and societal groups besides engineers and firms. These social groups interact and form networks with mutual dependencies, resulting in the alignment of activities. This inter-group coordination is represented with the concept of **socio-technical regimes** (Frank W. Geels & Kemp, 2007).

3.4 Case study selection

To accelerate the energy transition 5 pilot regions in the Netherlands started developing a regional energy strategy (IPO (Interprovinciaal Overleg), 2016) in 2016. The province of Friesland was one of these frontrunner regions. In their regional strategy it is stated that about 60 energy cooperatives are active in Fryslân together with more than 130 local sustainable initiatives (Regiegroep Friese Energiestrategie, 2017). The document also states that Fryslân has a rich cooperative history also in the area of energy cooperatives. Moreover the importance of connecting the challenges for the energy transition with local and regional initiatives is emphasized in the strategy document.

According to the website of "Hier Opgewekt" (Generated Here) Friesland currently shares a third place with the province of Noord-Brabant both active with 53 local renewable energy initiatives (Hieropgewekt, 2018). Only the province of Gelderland and North-Holland have more initiatives, 54 and 58 respectively. According to the website "Netwerk Duurzame Dorpen" (Network Sustainable villages) Friesland is the frontrunner province with 140 connected villages leaving the second place to Groningen with 32 (Netwerk Duurzame Dorpen, 2018).

Based on these selection criteria the potential for local renewable energy initiatives in Friesland for district heating is considered high. Friesland is the search area for LREI initiatives.

As there is little evidence of actual development and there is no evidence of actual practices (Schwencke, 2017) the search for local district heating cases is focused on early development phases of initiatives and experts or intermediaries are consulted to find suitable cases.

3.5 Research methods

In this paragraph the methods are described by which the questions of this research are studied.

The strategy for this research is previously mentioned as an in depth qualitative empirical case study approach. The first part of the research is based on literature combined with consultation of experts. The second part is an empirical data collection by semi-structured interviews with stakeholders part of LEI involved in the niche development of local district heating in the province of Friesland.

3.5.1 Sub-question 1 – literature: existing natural gas based heating regime NL

What is the existing natural gas based heating regime in the Netherlands?

Historic developments in the gas energy transition in the Netherlands to form the current regime are drawn from literature using the three sources (Geert Verbong et al., 2001) (G. Verbong & Geels, 2007), (Correljé et al., 2003). Contemporary information is gathered by consulting online information from the Ministry of Economic Affairs and Climate Policy, the Authority for Consumers and Markets, the branch organization Network Service Netherlands (Netbeheer Nederland) and the respective stakeholders. This provides insights in the development, stakeholders and structure of the existing regime. The links between the stakeholders are depicted in a diagram.

3.5.2 Sub-question 2 – literature: processes, obstacles and barriers SNM in LC

What are the key processes, obstacles and barriers in niche development particularly in local community district heating?

From SNM research papers on the key processes, the obstacles and barriers in niche development of LREI in NL and some surrounding countries in the EU will be drafted.

The characteristics of niches in SNM are studied by a review of selected papers, including:

- Scaling up sustainable energy innovations (Naber, Raven, Kouw, & Dassen, 2017);
- The role of cooperatives in overcoming the barriers to adoption of renewable energy (Viardot, 2013);
- Disruption and low-carbon system transformation (Frank W. Geels, 2018);
- Growing Grassroots Innovations: Exploring the Role of Community-Based Initiatives in Governing Sustainable Energy Transitions (Seyfang & Haxeltine, 2012);
- The role of district heating in future renewable energy systems (H. Lund, Möller, Mathiesen, & Dyrelund, 2010);
- Local Governments Supporting Local Energy Initiatives: Lessons from the Best Practices of Saerbeck (Germany) and Lochem (The Netherlands) (Hoppe et al., 2015);
- Low carbon infrastructure investment: extending business models for sustainability (Foxon et al., 2015).

The characteristics are focused on early stages of development, since the studied case are in early phases of development.

Based on the literature an overview of key processes and a division of obstacles and barriers for niche development are given. This overview and the division displayed in a table are the assessment criteria used as input for the semi-structured interviews and to evaluate the case studies

3.5.3 Sub-question 3 – interviews: LREI niche development LDH

How are Local Renewable Energy Initiatives developing niches in local district heating in the province of Friesland?

The assessment criteria for niche development are evaluated in two comparative similar cases in the province of Friesland. First the two cases are carefully selected.

The initiatives mapped on the websites of the network organizations are reviewed: https://www.hieropgewekt.nl/, https://www.netwerkduurzamedorpen.nl/, https://www.energie-initiatief.nl/, https://www.hierverwarmt.nl/ and https://www.rescoop.nl/. In consultation with a representative of “Energiewerkplaats Fryslân” (Energy Workshop Friesland) and “Friese Milieufederatie” (Nature and Environmental Foundation) two cases are selected.

The case study method is referred to as comparative or multiple-case studies which is a variant of the single case study methodology with a different design (Yin, 2009).

As part of the triangulation process to rely on multiple sources of evidence (Yin, 2009) different stakeholders involved in the same case are interviewed with semi-structured open questions as well as (on-line) documents/information with supporting evidence are reviewed. This is also part of the validation of the findings. Other stakeholders are identified by the so-called method of snowball sampling (Verschuren et al., 2010): the stakeholder interviewed is asked to supply names with relevant stakeholders to be consulted.

Based on preliminary research (Hoppe et al., 2015; Schot & Geels, 2008) the following stakeholders in relation to LEI may be interviewed:

Table 1 Potential stakeholders to interview in relation to LEI

Function	**Point of view**
Alderman for sustainability/energy	Local government/regulations
Founder/Chair of LEI	Organization/emergence of LEI
Active community member	Member perspective
Technical person	Technical/maintenance perspective
Project leader / consultant	Process perspective
Association of cooperatives/ Energy workshop	General support network
Company supplying technology	Business case/support

The interviews are transcribed and processed in a such a way that the obtained SNM key process assessment criteria from literature are identified. Special precautions on confidentiality is taken as described in § 3.5.8. This results in an overview of key processes identified in the researched local district heating initiatives.

3.5.4 Sub-question 4 – case study: identify obstacles and barriers

What obstacles and barriers do Local Renewable Energy Initiatives in the province of Friesland face in their niche development for local district heating?

The assessment criteria of the obstacles and barriers are evaluated in two comparative similar cases in the province of Friesland. The transcriptions of the performed interview are analyzed to identify and describe actual and possible obstacles and barriers that may arise in the future.

Insights are created in the empirical situation of LEI in the Friesland case studies regarding detected obstacles and barriers.

3.5.5 Sub-question 5 - case study: measures to overcome obstacles and barriers

How can Local Renewable Energy Initiatives in the province of Friesland overcome these obstacles and barriers?

The transcriptions of the performed interview are also analyzed for measures on how detected obstacles and barriers are overcome by the LEI. Insight in the empirical situation of LEI in the Friesland cases is created to overcome obstacles and barriers in niche development.

3.5.6 Main question

The main question of this research is: *"How can local renewable energy initiatives create successful niches for natural gas-free district heating that contribute to the transition towards a new heating regime for existing houses?"*.

Based on the results of the sub-questions the main question of this research is answered. The outcome of sub-questions 3, 4 and 5 is placed in the context of the outcomes of sub-questions 1 and 2. The answer to the main question provides insights for LEI to create successful niches in natural gas-free district heating for existing houses.

3.5.7 Analytical framework for space heating in houses in relation to LEI

The analytical framework for space heating in houses in relation to LEI in Figure 4 is used to establish possible technical solutions in relation to the gas-free target.

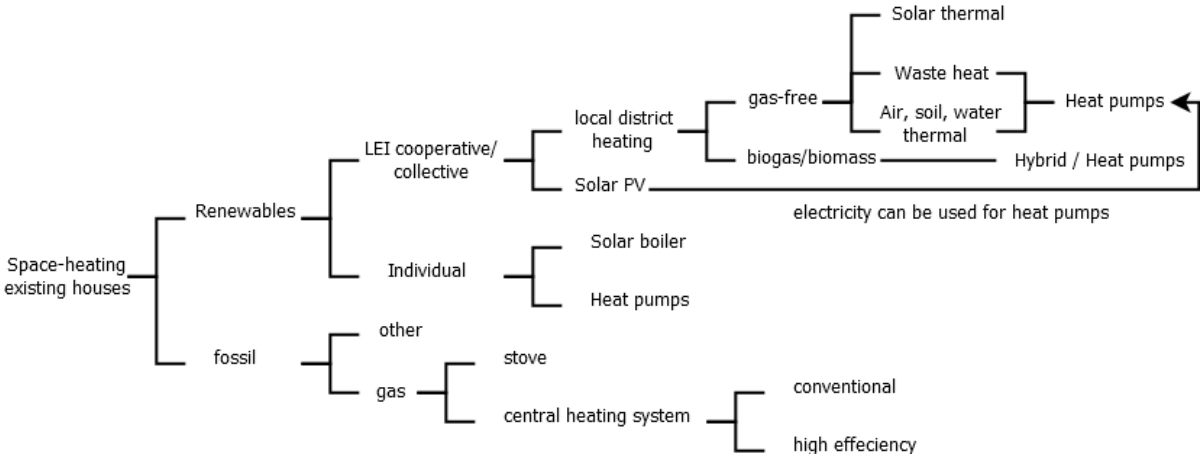

Figure 4 Analytical framework for space-heating in houses in relation to LEI

In Figure 4 a non-exhausting impression is given of the direction in which to search for Local Renewable Energy initiatives that fit the natural gas-free goal of this research. Starting from the left: the origin should be renewable instead of fossil. The initiative should involve a collective solution preferred over individual solutions. The energy transport should involve a grid where a matter other than electricity is transported. Finally the source of heat can originate from residual heat sources or can be obtained from incineration of biogas from biomass/manure digesters. The low-temperature sources often need to be upgraded to higher temperatures to be applied as space-heating in existing houses.

3.5.8 Ethical concerns

This research involves the participation of stakeholders in LEI that are interviewed. Although the information gathered is not personal, it might contain sensitive information that adversaries or other third parties can use in a way that could harm the interviewees, the organization they present or others now or in the future.

To prevent misuse of information gathered by the conducted interviews the interviews are transcribed and at the same time anonymized by using a number for the interviewee that can only be identified by the author. To provide understanding of possible harm the interviewee is informed on how the information is used in this research. A consent form is signed by the interviewee and the researcher to obtain approval.

This research has been approved by the Ethics Committee of the University of Twente on April 20th 2018 under number BCE18347.

4 Existing natural gas based heating regime

This chapter will provide insights in the recent developments and currently involved actors of the incumbent natural gas based space heating regime of existing houses in the Netherlands. The central question for this chapter is: *What is the existing natural gas based heating regime in the Netherlands?*

The insights will later be used to connect to the results of the case studies on niche innovations in district heating and the proposed structural changes in the energy system.

In the literature on the multi-level perspective (MLP) the sociotechnical regime is the meso-level between the macro-level sociotechnical landscape and micro-level technological niche (F.W. Geels, 2005), as shown in Figure 1. Sociotechnical regimes consist of three interlinked dimensions: actors, technology and rules (Frank W. Geels, 2004).

Although historic events in the gas transition are important to understand the current situation with regards to involved actors, technology and rules, for the purpose of this research the current situation will suffice to link the existing gas based heating regime to the niche developments in the case studies.

Based on Verbong et al. (Geert Verbong et al., 2001) and Correljé et al. (Correljé et al., 2003) the following description of actors can be made. In 1959 a large natural gas field near Slochteren in the province of Groningen was discovered. From then on the Maatschap (Partnership) Groningen is in control over the extraction of the fossil fuel natural gas which is entirely traded to the national transmission company Gasunie (later Gasunie Transport Services, GTS). The Dutch State, represented by the Ministry of Economic Affairs and Climate Policy, participates through EnergieBeheerNederland (EBN, Energy Management Netherlands), former known as DSM Aardgas (Dutch State Mines Natural gas), in the costs for exploration and the revenues by the production of natural gas (EBN, 2018). The NAM (Nederlandse Aardolie Maatschappij, Dutch Petroleum Company) is a joint venture of Shell and ExxonMobil for oil and gas exploration and production in the Netherlands. The Transmission System Operator (TSO) Gasunie Transport Services maintains the national transmission gas grid across the Netherlands and delivers to eight geographically separated Distribution System Operators (DSOs) (Autoriteit Consument & Markt (Authority for Consumers and Markets), 2017b). The latter are also known as Local Distribution Companies (LDCs). Since the complete liberalization of the Dutch energy market July 1st 2004 the distribution of gas through physical pipes and the supply to consumers was split to allow more competition on gas prices and freedom of choice for the consumers, in favor of renewable energy. Currently gas is supplied to retail consumers by 58 license holders that are issued and supervised by the ACM (Autoriteit Consument & Markt (Authority for Consumers and Markets), 2018b). The branch organization Netbeheer Nederland (Network Management Netherlands) shows the division of connections over TSO and the DSO's in 2016 (Netbeheer Nederland (Network management Netherlands), 2018).

In Table 2 the current actors are displayed. The Dutch State (in practice the Ministry of Economic Affairs and Climate Policy) represented by various actors has a large stake in natural gas, both on governance of the natural gas market as on the financial side of this energy source. Another aspect that is shown in the table is that GTS supplies 1,100 connections to large companies directly, the rest of the consumers is supplied through DSOs. In Figure 5 the connections between the main actors in the gas chain are displayed: from Production and Import, Trade, national Transmission by TSO GTS, regional/local Distribution by DSOs/LDC and finally Supply to the Consumers by 58 gas supply companies with a license issued by ACM.

Table 2 Actors in the current natural gas regime with interests and connections

Actors	Shareholder	Interest	Connections (2016)	Connection %
Maatschap Groningen	EBN NAM	40% 60%		
NAM (Nederlandse Aardolie Maatschappij)	Shell ExxonMobil	50% 50%		
EBN (Energie Beheer Nederland)	Dutch State	100%		
TSO: Gasunie (Transport Services / GTS)	EBN Dutch State Shell ExxonMobil	40% 10% 25% 25%	1,100	0.0%
DSOs (Distribution System Operators) / LDC (Local Distribution Companies)	Cogas Enduris Enexis Liander Rendo Stedin Westland Zebra *)	Supply to consumers through 58 license holders	140,165 190,626 2,485,126 2,256,085 104,062 1,958,462 53,646	1.9% 2.7% 34.6% 31.4% 1.4% 27.2% 0.7%
Consumers/Connections			7,189,272	100%

*) Zebra is a transport and distribution grid using Belgium gas and is not connected to the GTS grid.

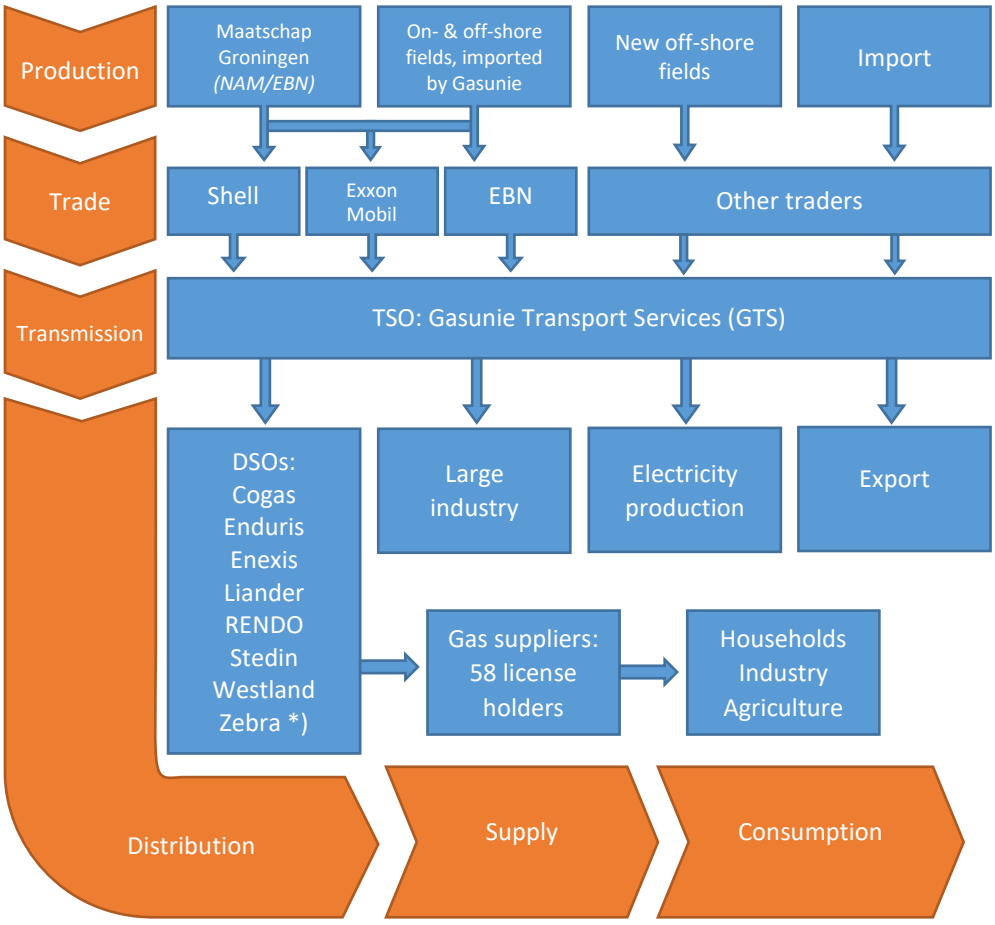

Figure 5 Current natural gas regime actors in the gas chain (adapted from Correljé et al., 2003, p. 204)

Besides the already mentioned actors, producers of gas appliances, gas connection materials and installer companies are also part of the natural gas regime. Since this research is on heating in existing houses the end of the gas chain is displayed in Figure 6.

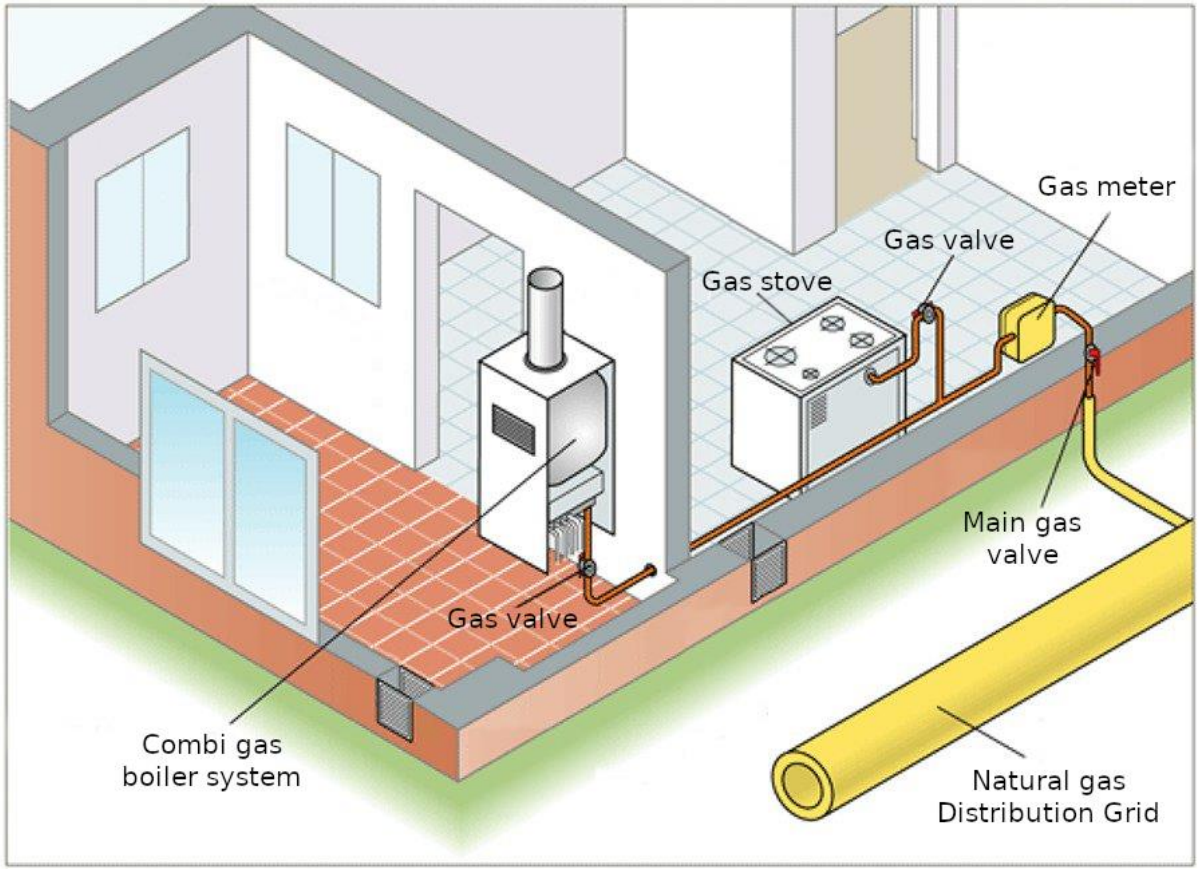

Figure 6 Gas installation in existing houses (adapted from Habitissimo, 2018)

In Figure 6 the natural gas distribution grid is branched off to the house and at the transfer point the main gas valve and the gas meter are situated (Autoriteit Consument & Markt (Authority for Consumers and Markets), 2017a). From then on the gas installation is property of the home owner. Before that the grid operator is responsible for a sound connection and the gas meter is rented from the gas supply company (Ministry of the Interior and Kingdom Relation, 2000). Since the liberalization of the energy market a separate metering company will register the meter readings for charging of the supplied gas and the transport of the gas. The supply company sends one bill to the consumer and passes on the transport fee to the DSOs.

The natural gas technical installation in existing houses consists mostly of a gas stove or cooker and a combi gas boiler that incinerates the gas to produce hot tap water and hot water for the central heating system with radiators or underfloor heating. The description of technical details of all technology in the system from extraction, blending, pressurizing, measuring, odorizing, reducing in pressure, using yellow colored pipes and finally incineration is beyond the aim of this research, however it is important to notice the specialization and critical specifications that are required to keep the system gas tight and safe.

The rules that guide the activities of actors in the natural gas regime for space heating of existing houses can be divided into formal, normative and cognitive rules (G. Verbong & Geels, 2007). Part of the formal rules are contained in standards, in the case of natural gas the Gastec Quality Assurance quality mark is issued to products that are safe to use in the gas system by Kiwa the supplier of

Testing, Inspection and Certification (TIC) services (Kiwa, 2018a). Especially for the Dutch heating industry a voluntary certification Kiwa brand called Gaskeur (Gas label) for energy efficient heating was created in 1994 together with the VFK (Vereniging van Nederlandse Fabrieken van Ketels voor Centrale Verwarming, Association of boiler manufactures) (Kiwa, 2018b). Besides these standards the Dutch Gas Act and Decrees by Authority for Consumers and Markets protects among others residential gas consumers from getting involuntarily disconnected and until recently to get connected to the local distribution grid (Ministry of the Interior and Kingdom Relation, 2000). Since July 1st 2018 the gas connection obligation of distribution service operators was lifted for new houses and for certain other circumstances to stimulate other forms of heating, preferably renewable heating (Ministry of the Interior and Kingdom Relation, 2018c). Exemptions to this new rule are maintained by ACM in a gas register (Autoriteit Consument & Markt (Authority for Consumers and Markets), 2018a). Moreover the Ministry of Economic Affairs and Climate Policy is currently changing the Electricity and Gas Acts into the Act Progress Energy Transition, among other things in order to respond to the earthquakes caused by the natural gas extraction in the province of Groningen and to reduce the emission of greenhouse gasses as a result of using fossil fuels and to create more possibilities for renewable energy production. Besides these former rules also cognitive rules such as belief systems, problem agenda's, guiding principles and search heuristics of employees exist and also normative rules such as role relationships and behavioral norms in social groups such as households ensure that the current regime is stabilized (G. Verbong & Geels, 2007).

Existing sociotechnical regimes are characterized by path dependence and lock-in (G. Verbong & Geels, 2007). The path dependency and technology lock-in of the current natural gas heating regime can simply be illustrated by the fact that approximately 82% of the households in the Netherlands in 2015 is using a natural gas powered central heating system (Gerdes et al., 2016). Only 6.3 % of all households is natural gas free, as the rest is heated indirectly by a natural gas source.

Alternatives exist in the area of wood (pellet) stoves connected to the central heating system, electric heat pumps (ground-based or air-based) and district heating grids using various sources of heat. However the incumbent actors, especially grid operators have vested interest because of long-term investments in gas infrastructure. Boiler companies and equipment producers have invested in machines and in technical complementarities between components. Besides these technical dependencies, the installer companies have developed routines to provide good service. Moreover the consumer at the household level is used to the familiar natural gas powered central heating system with ease of use and proven comfort.

To conclude: the natural gas based space heating regime of existing houses with actors from the Dutch State participating in the natural gas extraction, through a national transmission grid and local distribution grid, to be supplied to household consumers in combi gas boiler heating systems is path dependent with improved energy efficiency along the line of gas incineration boilers and is locked-in to the technology in connection with natural gas as the energy source. Although existing regime actors have vested interests, the rules that help stabilize the regime are changed under external influence among others to mitigate the effects of earthquakes by the gas extraction and to mitigate the effects of climate change by the emission of greenhouse gasses.

5 Key processes, obstacles and barriers in niche development LRDH

This chapter aims to provide an answer to sub-question 2: *What are the key processes, obstacles and barriers in niche development particularly in local community district heating?*

Based on literature work of Kemp, Schot and Hoogma on the theory of strategic niche management (SNM) successful niche development depends on three key processes (Kemp et al., 1998):

1. management of expectations and visions;
2. formation of (new) actor networks;
3. organization of learning processes.

These three niche internal processes are fundamental to evaluate niche development of sustainable technology innovations and may be used to create appropriate policies with favorable conditions for sustainable niche experiments (Schot & Geels, 2008).

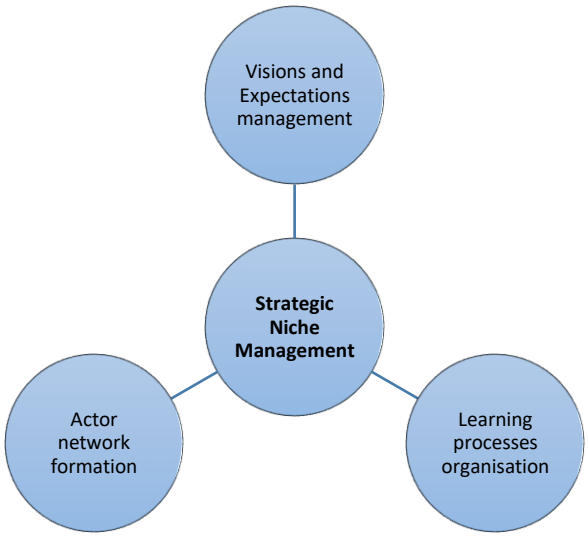

Figure 7 The three key processes of Strategic Niche Management

In Figure 7 the three key processes in Strategic Niche Management are displayed. Although the processes can be regarded separately, they display a certain dependency.

Schot and Geels consider expectations to be crucial for niche development because they provide direction to learning processes, attract attention and legitimate protection and nurturing of the experiment (Schot & Geels, 2008). Moreover they consider building a relevant actor network important in order to support the new technology, to facilitate interactions between the actors and to provide the necessary resources (money, persons and expertise). Lastly they acknowledge the importance of learning processes on multiple aspects including the technology itself, design, market, users, culture, symbolics, infrastructure, maintenance, industry, production, regulation, policy and the social and environmental implications. Learning from other experiments is also considered important.

According to Kemp et al. barriers are to be found in any of these key processes or in one area causing barriers in another area preventing the development of niche experiments (Kemp et al., 1998). Barriers in relation to insufficiently articulation of visions and expectations can result in uncertainty and perceptions both involving the technology itself and the social impacts of the new technology. Other barriers might appear when too many actors with vested interests in other technologies are involved in the experiments trying to slow down the development. Local government and other public authorities can help create new networks with actors and protected

spaces in which the new technology can function as desired. Barriers in the previous mentioned areas might also cause barriers in the organization of learning processes.

In a recent paper Naber et al. developed indicators for the niche internal processes to value them and provide an indication of strength, quality and profoundness (Naber et al., 2017). They provide insights in an assessment method to evaluate the upscaling of sustainable energy innovations which they applied to smart grid experiments. Although the assessment method can be used to assess niche internal processes in local renewable district heating initiatives, it basically serves as an interpretative instrument to compare patterns across cases especially regarding upscaling. However some aspects of the interview questions are relevant to provide insights in the niche internal processes in local renewable district heating initiatives and can therefore be used as inspiration.

Besides niche internal processes, the external processes at regime and landscape level are also important for niche developments to diffuse more widely as part of the multi-level perspective (Schot & Geels, 2008). Naber et al. describe some of these external processes as patterns of upscaling and diffusion (Naber et al., 2017). First the growth in size of an experiment by an increasing number of participants or involved actors, second the replication of the main concept of an experiment in another location or context, third the accumulation of experiments facilitated by intermediary organizations and finally the transformation of the regime shaped by influential experiments.

Various scholars describe different processes in different stages of niche development from the emergence of Local Renewable Energy Organizations (LREOs) (F. P. Boon & Dieperink, 2014), the inception of grassroot innovations (Seyfang & Smith, 2007), the maintenance of Community-based Initiatives (CBIs) (Becker, Franke, & Gläsel, 2017), the effective niche protection by shielding, nurturing and empowering (Smith & Raven, 2012), niche develop phases creation, maintenance and phasing out (W. P. C. Boon, Moors, & Meijer, 2014) and finally to become the dominant design, the market niche and reconfigure the regime (Frank W. Geels, 2004, 2018).

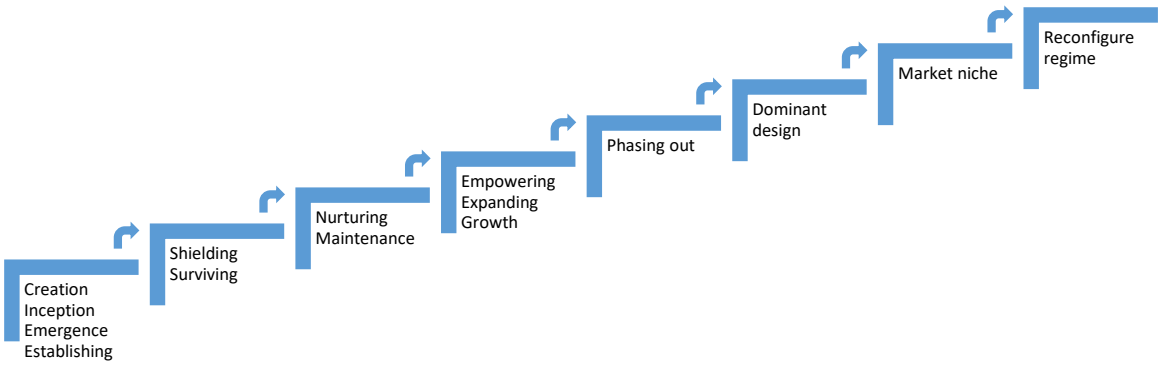

Figure 8 Niche development stages and expected processes

In Figure 8 different stages of niche development with expected processes are displayed in an ascending order similar to the MLP niche innovation level of Figure 1. By determining the phase of an experiment, initiative or project being researched, the expected processes can be discovered and both internal and external aspects of these processes can be identified and analyzed.

Based on case studies in local low carbon energy initiatives in the Netherlands (Hoppe et al., 2015) the role of public leadership by public officials in their interaction with the local actors, regional and national professional networks should not be underestimated in the local energy transitions. Communities are considered as key arenas of transforming policies into actions, especially where local governments put great efforts into developing and applying renewable energy strategies

(Petersen, 2018). Moreover mutual trust between local government and representatives of the local communities, but also among community members is often mentioned in SNM literature (Hermans, van Apeldoorn, Stuiver, & Kok, 2013; Hoppe et al., 2015; Naber et al., 2017; Walker, Devine-Wright, Hunter, High, & Evans, 2010).

The literature on the obstacles and barriers in niche development in local communities in the context of this research can roughly be divided into three categories:

1. Obstacles and barriers in the establishing phase of local community initiatives or projects;
2. Obstacles and barriers in adopting of community Renewable Energy;
3. Obstacles and barriers in the scaling up of local initiatives.

Seyfang and Smith categorize the challenges of grassroot innovations in the United Kingdom into two forms: to simply survive or to grow, diffuse and challenge mainstream systems, named Intrinsic Challenges and Diffusion Challenges (Seyfang & Smith, 2007). Intrinsic Challenges are understood to be in the establishing phase of an initiative and in the surviving phase to keep going. In their experience government support funding for community renewables are rarely responding to recipients needs and initiatives often spend most of their time to survive and consequently fail to develop robustness and resilience. Challenges can be found in funding cuts, key people leaving, turnover of volunteers, burnout of activists, shifts in government policy and lack of formally documented institutional learning. Besides the barriers, the initiatives can also struggle to obtain appropriate sustainable technologies.

The obstacles and barriers in adopting community Renewable Energy can be divided into technological, ontological, social, financial, legal and physical hindrances and cooperatives play an important role in overcoming these barriers (Viardot, 2013). Furthermore it is noted that social acceptance of distributed energy infrastructures is based on co-ownership and awareness of local benefits (von Wirth, Gislason, & Seidl, 2018). Especially since there are numerous technologies for district heating (Kooij et al., 2018; Henrik Lund, 2010) with varying factors on physical or infrastructural impacts (Foxon et al., 2015; Henrik Lund et al., 2014; Petersen, 2018).

Within the literature on niches, intermediaries are identified as playing an important role in helping niches to develop and become more robust (F. Geels & Deuten, 2006; Hoppe et al., 2015), however not all grassroots innovations want to grow and diffuse (Hargreaves, Hielscher, Seyfang, & Smith, 2013).

Ruggiero, Martiskainen and Onkila suggest that in the Finnish context, different projects in socio-technical niches have different interests in forming strategic niches (Ruggiero, Martiskainen, & Onkila, 2018). The cost-reduction projects and the technical expertise projects showed little evidence of interest in expanding. However the system change projects showed strong evidence of networking and learning between projects and had a clear aim to expand the initiatives. Barriers mentioned are in the nature of energy market regulation, social convincing people, bureaucracy of obtaining authorization to raise capital, technical issues and profitability.

Socio-technical niches are protected spaces by definition and can develop into market niches to be applied in specific markets (Weber, 1999). The market niche is subject to regular market rules and can therefore encounter obstacles and barriers that are known to other more common technologies.

Seyfang and Smith (Seyfang & Smith, 2007) elaborate more on the Diffusion Challenges at higher levels – within incumbent regimes and overarching socio-economic processes, however these challenges and possible barriers are outside the demarcation of this research.

In literature numerous obstacles and barriers are mentioned on a diversity of aspects, varying in size, concerning different development phases and dealing with various topics within renewable energy niches and within other socio-technical niches. Although a number of them could be relevant to this research, the majority is less relevant in relation to the phase the initiatives on renewable heat are currently in in the Netherlands (Schwencke, 2017). Therefore it is decided to use categories of obstacles and barriers that can be used for gathering information from case studies almost independent of the phase of development of the initiative.

These categories are displayed in Table 3 together with non-exhaustive indicative aspects.

Table 3 Overview of categories of obstacles and barriers for niche development in local community district heating

Category	**Aspects**
Technological	Efficiency, technical knowledge, installer, manufacturer
Ontological (continuity of existence)	Establishing, surviving, growing, volunteer, intermediary
Financial	Funding, professionals, (local) benefits, actors, members
Legal (law and regulations)	Local government, bureaucracy, permits
Physical	Impacts in surroundings or in houses
Infrastructural	Existing or change in grids, capacity, storage
Management/Control	Maintenance, administration, co-ownership
Cultural/Social	Cooperatives, members, cohesion, acceptance, structures, traditions

To conclude this chapter, the key processes to identify and evaluate in case studies from strategic niche management are aspects of: articulation of visions and expectations, formation of (new) actor networks and organization of learning processes. Besides obstacles and barriers in relation to these key internal niche processes, niche development in local district heating initiatives can also be prevented or obstructed by aspects in the area of technology, ontology (continuity of existence), finance, legal, physical, infrastructural, management & control and cultural & social.

The key processes in niche development and the categories of obstacles and barriers together form the assessment criteria for evaluating the studied cases on their niche development. Based on these assessment criteria the interview questions for involved actors of Appendix I have been formulated.

6 Local district heating niche development by LREIs

This chapter aims to provide an answer to sub-question 3: *How are Local Renewable Energy Initiatives developing niches in local district heating in the province of Friesland?*

In this chapter the two cases researched are described, analyzed against the assessment criteria for niche development described in Chapter 5 and finally compared to conclude on their successfulness.

Based on the initiatives presented on the local initiative websites ("Het Energie Initiatief (The Energy Initiative)," 2018; "HIERopgewekt (Generated Here)," 2018; "HIERverwarmt (Heated Here)," 2018), in the Local Energy Monitor(Schwencke, 2017) and in consultation with experts from Vereniging Organisatie voor Hernieuwbare Energie Decentraal (ODE Decentraal, Organization for Renewable Energy Decentral), Friese Milieu Federatie (Nature and environmental Federation Friesland), Natuur en Milieu Federatie Groningen (Nature and environmental Federation Groningen) and de Energiewerkplaats Fryslân (EnergyWorkshop Friesland) the most promising initiatives were selected.

The selected cases are: TEO Heeg and WEN biogas. These cases are currently the forerunner citizen initiatives on community renewable heat for space heating in existing residential housing.

In this research the following interviews have been conducted:

Table 4 List of interviews conducted and used in the Case Studies

No	Role/Relation	Inititiative	Part of vision/plan	Date
XK1	Initiator	TEO Heeg	Duurzaam Heeg	28-6-2018
XK2	Initiator	TEO Heeg	Duurzaam Heeg	5-7-2018
XK3	Intermediary	TEO Heeg, WEN biogas	Energiewerkplaats Fryslân	5-7-2018
XK4	Intermediary	TEO Heeg, WEN biogas	Energiewerkplaats Fryslân	9-7-2018
XK5	Partner	TEO Heeg	Gemeente Súdwest-Fryslân	17-7-2018
XK6	Partner	TEO Heeg, WEN biogas	Wetterskip Fryslân	19-7-2018
XK7	Initiator	WEN biogas	WEN 2025	7-8-2018
XK8	Coordinator	WEN biogas	WEN 2025	15-8-2018

Intermediary organizations play an important role in the robust development of niches (F. Geels & Deuten, 2006; Seyfang et al., 2014; Warbroek & Hoppe, 2017). In the province of Friesland the Energiewerkplaats Fryslân (Energy Workshop Friesland) is the intermediary network organization that aims to support local renewable energy initiatives by sharing information, giving advice and stimulating innovations to speed up the energy transition (Energy Workshop Friesland, 2018). The Energy Workshop was initiated by the Province of Friesland as a joint program with Foundation Doarpswork and the Frisian Environmental Federation about 5 years ago. Later the umbrella cooperative Us Koöperaasje (Our Cooperative) joined the partnership and became more active in supporting local energy cooperatives. The support consists basically of vision development, energy saving and energy production for civic collectives. According to the intermediary the most attention goes to the vision development and energy production, because energy saving projects are more difficult to organize collectively.

From the interviews XK3 and XK4 it became clear that the Energy Workshop received the assignment from the Province of Friesland to **describe and develop collective energy concepts that can be replicated especially three renewable heat concepts**. These concepts are based on practices of initiatives the Energy Workshop is involved in. The concepts will be used to develop (calculation) models and project plans that can be used by other initiatives to successfully setup, develop and

realize renewable heat projects. **This can be considered as a strategic activity that stimulates niche development.** According to the intermediary these models and project plans are ready developed for LREI involved with solar PV systems. Many local initiatives are developing small or large projects with PV and according to the initiator almost all and definitely the large projects **started with the vision process**. The example given is the village of Garyp that successfully developed a solar PV field of about six hectares that started generating in January 2017 and received the first quality mark MienskipsEnergie in April 2018 (Energy Cooperative Garyp, 2017; Mienskipsenergie, 2018b). Based on experience of various of these PV projects the Energy Workshop distilled a mental model on how to organize these processes in steps: village vision is solar PV, preferably collectively, search for a location, enter the permit trajectory, research feasibility, finance it, build it and finally it is realized.

The municipality Tytsjerksteradiel together with energy cooperative Garyp, association Village Interest and association of entrepreneurs submitted a plan and received 5.5 million euro from the Ministry of the Interior and Kingdom Relation to be a pilot that can be learned from in becoming a natural gas-free existing neighborhood within a few years (EKGaryp (Energy Cooperative Garyp), 2018; Ministry of the Interior and Kingdom Relation, 2018d). According to the intermediary the village of Garyp was already planning to work collectively on energy saving and the village is very good in project management. According to the intermediary it is because Garyp has already shown to be a collective that can realize projects, they have become a partner that the municipality takes more seriously than a random group of citizens.

According the intermediary from his experience municipalities are struggling with the role of an energy cooperative as sort of a representative of citizens, if they have no prior experience. The intermediary calls this democratic legitimacy and mandate to act on behalf of a collective group of citizens. The consent by the majority of citizens is needed for the initiator to assign the democratic mandate to himself in order to make collective decisions to progress faster. According to the intermediary, if the initiator does not have the mandate, then he is only organizing his own opposition.

According to the intermediary the vision process enables the success of long term projects, such as local renewable energy initiatives, because the vision is the mutual starting point that will not be questioned later. As this has become a generally accepted idea, the Energy Workshop is developing a larger project with Netwerk Duurzame Dorpen (Network Sustainable Villages) in order to support more villages in the vision process.

Although the Energy Workshop not only helps villages in their renewable energy initiatives, also neighborhoods are helped, but in Friesland there are more villages than neighborhoods and according to the intermediary villages progress faster, because of the stronger social cohesion in villages compared to neighborhoods.

Currently the Energy Workshop notices an increasing pressure on neighborhoods to develop socially supported projects for collective heating and the intermediary expects this to increase even more the coming year, so their focus is on these projects for the replicable concepts as a neighborhood approach.

The intermediary considers it to be more difficult to start the joint process to get off the gas as efficiently as possible and to choose new solutions than deciding where to put a solar PV field next to the village.

According to the intermediary the national government could choose to copy the framework of Denmark with a national campaign to collectively switch from natural gas to collective heating, but when the government decides not to this, a lot of pilot projects are needed to build up experiences.

The Energy Workshop promotes the use of the so-called Principles of Raerd that are laid down in the quality mark Mienskipsenergie (Community Energy). These principles are in short: the community, a village or a neighborhood, decides and the majority accepts the project, the energy type is local renewable energy that the community wants, and the energy is locally used and the community benefits (Mienskipsenergie, 2018a).

From experience the intermediary explains that the government should provide for an honest process in a way that choices are made not based by commercial parties on financial optimum, they should be based on trying to include everyone in such a way as to reach a societal optimum. Examples are given: for instance every house has a drinking water connection, even if the house is very remote; the costs for the remote house are relatively higher than a connection in a street with a lot of houses. If you look at the total project, the marginal costs for connecting the remote house are higher, but the costs for the street with a lot of houses are very low. Another example is cable or optical fiber installation: if you let a commercial company decide on who to connect, they will look at the most connections with lowest cost and the remote places are outside their project circle. If the government want access to high speed internet they also want the remote houses to be included and compared to the total of the whole job the costs are low. If the core of a village is already connected by a commercial company and the government later decides to connect the remote places the costs are much higher and payed with public money. Sometimes a different technology or other solution is more efficient for the remote groups, such as water tanks and wireless internet.

The intermediary compares the current transition off the natural gas with the way the national government organised that everybody got connected to the gas grid. If the government would have let the individual consumers decide, it would have cost a lot more money to get connected later. In the natural gas transition the government propagated the advantages of gas over coal and that everybody would be connected and the city gas appliances were adopted for natural gas on a discounted tariff. That way the societal optimum was reached over the economic optimum and almost everyone was connected economically efficient. For really remote houses they may have proposed gas tank based solutions.

6.1 Case description TEO Heeg

Based on the interviews XK1 through XK6 the following reconstruction of TEO Heeg is made.

The 2011 merger municipality South-West Friesland (SWF, “Súdwest-Fryslân”) requested a Village Vision from Local Interest Heeg. In a process, assisted by professionals, of more than a year a real sustainable Village Vision (Plaatselijk Belang Heeg (Local Interest Heeg), 2013) was created that is supported by the whole village. Based on the vision Duurzaam Heeg (Sustainable Heeg) a number of working groups, mostly called vision groups, were created to be concerned with different parts of the vision, including energy. The board members of Local Interest Heeg all took one of the groups under their wings to keep in contact. As such, the initiator joined the energy vision group. The energy group consists of five persons that support sustainability well.

At a given moment they knew a lot of money was involved and the expectation was that more money was going to be involved. So they needed a legal entity. The Energy Workshop was asked by Local Interest Heeg to explain how an energy cooperative works. As Local Interest Heeg considered a cooperative to be a suitable entity, they founded the Coöperatie Duurzaam Heeg (Cooperative

Sustainable Heeg) in 2014 ("Statuten Coöperatie Duurzaam Heeg U.A. (Statutes of the Cooperative Sustainable Heeg Excluded Liability)," 2014). Which is currently specific for the purpose of the energy group and therefore mostly called Energie Coöperatie Duurzaam Heeg (ECDH, Energy Cooperative Sustainable Heeg). The initiator of the heat initiative TEO Heeg became and still is treasurer of the ECDH.

The idea for TEO (Thermische Energie uit Oppervlaktewater, Thermal Energy from Surface water) originates from a meeting with Wetterskip Fryslân (WSF, Water board Friesland) during information sessions of the Friese Energie Strategie (FES, Frisian Energy Strategy). The ECDH and WSF talked about the water sport association of Heeg that had a system to retrieve energy from surface water. After about a year the cooperative was invited by WSF on a field trip to Wageningen and Arnhem where the company IF Technology operates a number of systems for Thermal Energy from Surface water. When the initiator saw the technology he was immediately charmed and wanted to use it in Heeg. The installer from Heeg that made a similar system at the water sport association of Heeg also saw improvements for their system. The efficiency increase compared to a standard heat pump is very interesting to the initiator. The IF Technology systems were not connection to a heating grid at that time.

After the initial idea right after the summer of 2017, the initiator asked the municipality to organize a project group with the necessary partners and to invite them for a meeting as the municipality has short connections to actors in their region.

In the next board meeting the board of the cooperative reacted very positively to the action of involving the municipality to start a projectgroep for TEO Heeg. After a few months in the general meeting of the cooperative the general idea was explained to the members. They supported the idea straight away and wanted continuation. After that it was introduced to Duurzaam Heeg and discussed with the other vision groups. At that time the board of Local Interest Heeg was very inactive according to the initiator and there was no contact, so they were not involved. Currently since a few months there is a new board of Local Interest Heeg and the initiator had a meeting with them on July 5th to explain TEO Heeg. The chairman was already positive when he had spoken to him and the rest of the board is curious to what the idea entails.

The energy cooperative started a Postcoderoos project (Postcode Rose Regulation) in 2017. According to the Energy Workshop they are the first in Friesland (Energy Workshop Friesland, 2016). Most participants have a number of participations of 300 Wp. In total usually one less than their current electricity demand. The reason is that when you produce more than your own consumption, you will not receive a compensation. That way they built in a little safety margin. The energy tax for your own electricity consumption can be deducted in the year after the year of production.

The idea of the energy cooperative is to keep the energy flow and money flow locally. Citizens can be clients of Energie van Ons (Energy from us) that supplies the energy that is produced by the cooperative. Therefor a second so-called generate cooperative Opwek 1 (Generate 1) was formed for participants in the Postcode Rose project to use PV panels on the roof of a large company. These participants are also members of ECDH and clients of Energie van Ons and the ECDH receives 35 euro per year for every client they introduce. Currently ECDH receives about 700 euro's every 3 months for Opwek 1 (Generate 1). The second postcode project Opwek 2 (Generate 2) is set up and the generate cooperative is founded, but it stagnates. After a year and a half not even half of the participations are sold. The project was announced in the village newspaper, on the website and a week before an information evening they distributed flyers, but only five citizens showed up and one person registered. The cause is unknown, but the phenomenon occurs at many cooperatives

according to the initiator. It can also be the other way around that the first project is slow and the second is full in no-time. Probably because more involvement is created.

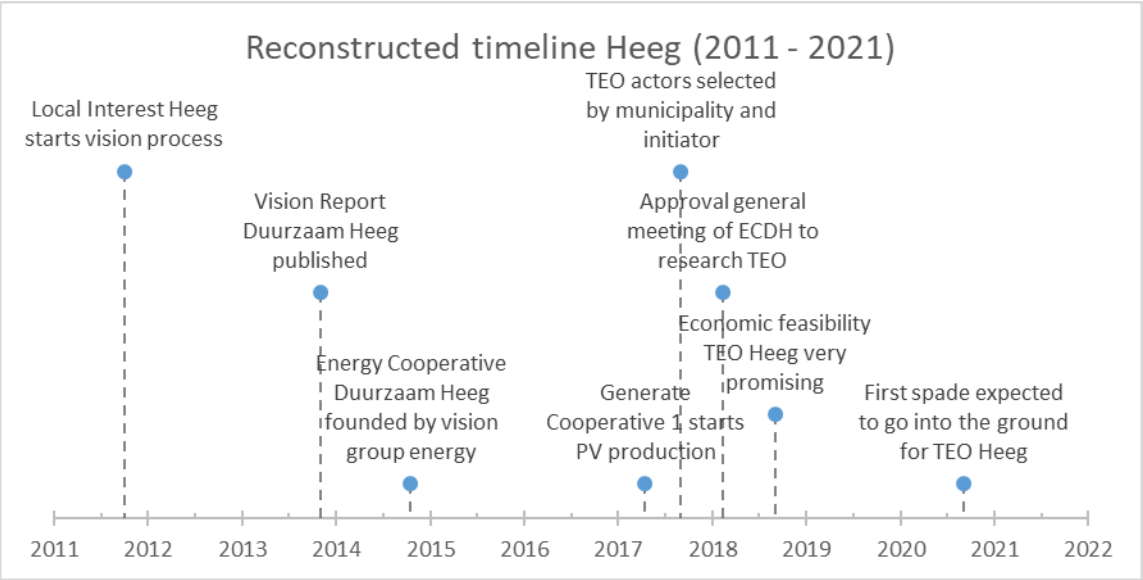

Figure 9 Reconstructed timeline of important events on energy in Heeg

In Figure 9 the timeline of important events as part of the energy transition in Heeg and the initiative TEO Heeg are reconstructed. The timeline shows about 2,5 years between the founding of the Energy cooperative Duurzaam Heeg and the start of the electricity production by Generate 1. The initiator estimates about the same amount of time between the promising economic feasibility of TEO Heeg and the actual start of the physical activities in the streets of Heeg. The overall vision of Heeg Energy Neutral in 2025 is not displayed for reasons of clarity of the timeline.

6.2 Technology concept of TEO Heeg

The technology proposed for TEO Heeg consists of a standard Heat and Cold Storage in conjunction with an extra system that uses a heat exchanger to retrieve thermal energy during the summer from the surface water of a nice wide waterway with a good flow through the village. Next to the source a piece of municipality owned property can possibly be used for the technical area of the system and it can even be build underground beneath the existing paved surface. The thermal energy of the inlet surface water is retrieved and the energy is pumped into the Heat Well of the system. The surface water is decreased with 5 to 6 °C and discharged 100 meters further along the waterway. The Heat and Cold wells are drilled some distance apart into soil layers at a depth of approximately 150 meters. The storage temperature in the soil should not stress the area too much and it is net kept at zero. According to IF Technology at least 80% of the energy stored can be retrieved. The recommended system is an open system that needs less drilling than a closed system. Furthermore it will be a medium temperature system with temperatures between 40 and 70 °C, whereby 70 °C is only needed during cold periods. The rest of the year the temperature of the system is dependent on the outdoor temperature. The goal is to include 90% of the Heeg citizens housing and the industrial zone is mostly excluded in this initiative, because of the extra distances and limited additional heating for the mainly used production halls. Although the aim is also to improve the houses with insulation to decrease the heat demand, the system is planned to have on over-capacity of 10 to 15%. All the houses need to be connected to the source by a local district heating grid that is going to have the most impact besides the fact that people have to switch from gas cookers to induction plates. The expected changes in the houses are limited to removing the gas connection,

gas meter and gas boiler together with the installation of a connection unit with heat meter to the district heating grid. There will be no energy conversion from one source to the other, but only a transfer of heat from the outdoor grid to the indoor radiator system that can probably remain the same. For the induction cooker a direct power line from the fuse box is needed and possibly some new pans. All technology is on the market and works properly. TEO Heeg will join it all together in one system.

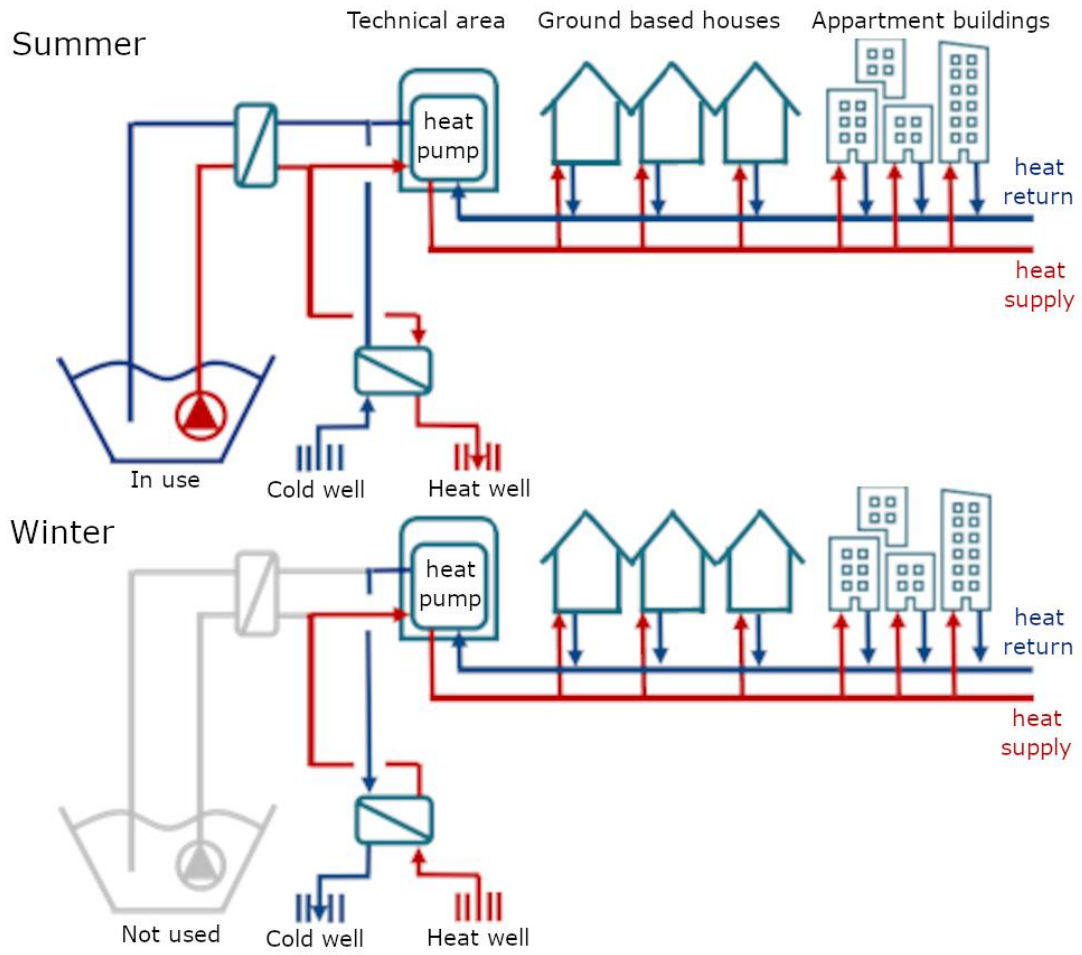

Figure 10 TEO Heeg technology concept Thermal Energy from Surface water (adapted from IF Technology, 2018)

In Figure 10 the concept of TEO Heeg technology is displayed. At the top side during the summer the heat from the surface water is extracted and mostly stored into the Heat well. During winter time (bottom half) the surface water part of the system is not used, because the heat from the Heat well is retrieved and used in the houses. During the summer the heat demand is low and in winter time it is high. The system could also be used for cooling. The energy from surface water can be considered as a primary naturally occurring source of solar energy.

Compared to the current natural gas regime described in Chapter 4 the existing gas infrastructure can be removed to be replaced by a district heating grid to connect the heat source to the houses. Although the specific technology needs to be chosen, it is expected that the houses will receive a connection unit with heat exchanger and heat meter to transfer heat from the grid to the existing radiator system and can possibly also supply hot water. The natural gas cooking equipment will be replaced by electric induction cookers with a direct power connection to the fuse box.

6.3 Key processes niche development TEO Heeg

Based on the interviews XK1 through XK6 the following aspects of the niche internal key processes in of TEO Heeg have been identified.

6.3.1 Visions and Expectations management

The vision/goal of the energy cooperative is to make Heeg Energy Neutral in 2025. According to the Statutes the main purpose of the cooperative is on the one hand to reduce energy use in Heeg plus close surroundings and on the other to produce renewable energy for the purpose of its members ("Statuten Coöperatie Duurzaam Heeg U.A. (Statutes of the Cooperative Sustainable Heeg Excluded Liability)," 2014).

A sub-target is to use financial means for Heeg. So far this has not been done. The financial resources are saved and used for their own projects, such as developing an energy monitor tool that keeps track of all individual PV systems in Heeg. The purpose is to create involvement of all citizens in Heeg by showing what is currently happening.

The vision of TEO Heeg is 90% of Heeg off the gas. Ultimately even more. The outskirts are difficult, but this first initiative aims for 90% gas reduction. Within 2 to 3 years the first spade should go into the ground according to the initiator.

Although the initiator was involved in the PV projects, he currently is more into the heat transition. His expectation is that it will yield a lot more renewable energy compared to the PV projects. He also expects a lot more district heating grids to be developed in the Netherlands. The energy cooperative wants these grids to be cooperative district heating.

The cooperative part of this initiative will greatly help the acceptance of this change. According to the initiator the current large energy companies are further away, hardly reachable, cumbersome, slowing progress down and decisions are being forced upon their clients. Decisions are not made together. In a cooperative together you can decide.

The expectations of the actors currently involved in TEO Heeg are not explicit, although they share the same goal and have been selected based on their possible facilitative role in this initiative. If necessary the Energy Workshop tries to connect actors in discussions. In the case of TEO Heeg it is not necessary as the municipality has taken on this role.

According to the intermediary the approach of the initiative is quite unique, as the energy cooperative want TEO Heeg to be researched; the municipality considers it interesting and pushes it forward in a way that on a provincial level the research is financially supported; the Energy Workshop provides support; and also WSF support the idea because they realize they need to play a role as the water quality guard in these pilots. The intermediary calls TEO Heeg to be a triple pilot: firstly the technology of Thermal Energy from surface water, secondly the demand from the perspective of inhabitants and not a project developer or owner of the heat and thirdly the collectivity of how to organize, develop and finance this collectively.

TEO Heeg is very interesting to the Energy Workshop, because TEO and a local district heating grid is a new development and very challenging as a lot of things still need to be researched to even know what questions need to be answered.

The initiator changed his house into an energy neutral home by installing a PV system, removing the gas infrastructure and using an electric boiler as heating system more than 10 years ago. Therefore the initiative is not for the benefit of the initiator, but for the village of Heeg.

The Energy Workshop is involved in TEO Heeg based on their general role of supporting local initiatives, among other things: providing knowledge, providing access to their netwerk, help to formulate questions to communicate better with other actors, help think about business cases, plans and financing issues. The initiator is in the lead and gives tasks to the intermediary, not the other way around. As the standard mode of operation of the Energy Workshop is open source in such a way that it can be replicated by other initiatives. According to the intermediary it is nice to organize something somewhere, but it is even nicer to distill knowledge, experience, models and structures to apply them elsewhere. The open source knowledge should be available for the energy transition. These are usually solid standard documents that can be used for energy collectives. The way forward according to the Energy Workshop is to use the principles of MienskipsEnergie also for heat transitions such as TEO Heeg.

The municipality Súdwest-Fryslân is showing ambition and concrete targets on sustainable development in the coalition agreement for the period 2018-2022 (Gemeente Súdwest-Fryslân (Municipality South-West Friesland), 2017) and especially in the agenda for sustainable development (Gemeente Súdwest-Fryslân (Municipality South-West Friesland), 2018). The vision is among other things, as many villages/cities energy neutral in 2030 and climate neutral in 2050. According to the strategic consultant of the municipality the amount of employees on sustainable development changed from 1 to 12 since the beginning of this year.

Because of the vision energy neutral villages, the municipality wants to include all inhabitants in the initiative, but realizes that people should decide to participate on a voluntary basis. Moreover the municipality want the first villages and cores to be sustainable in 2020 and therefore the TEO Heeg initiative should be part of a plan to become sustainable. The village has this ambition, only about five years later.

The municipality considers TEO Heeg at this moment not as a pilot, as that would involve a practical exercise. Currently the meetings are considered as an internal and good discussion with direct stakeholders on this preliminary study as the municipality calls it. The municipality expects a whole different setting when the actual realization in Heeg is put into practice. The alderman will have a saying depending on the role of the municipality, but it is expected that there will be political aspects.

The water board Friesland WSF is working towards an energy neutral organization in 2025 and towards climate neutrality in 2030. WSF notices an increasing demand from third-parties to use their assets to generate renewable energy, as is the case for TEO.

According to WSF the actors currently involved in TEO Heeg have the notion that together they can contribute to the social interest of change towards a renewable energy system.

Although the expectations are not explicitly pronounced, during introduction at meetings and field trips various conversations contribute to understanding the other actors and trust is being build.

6.3.2 Actor network formation

The actors in the TEO Heeg initiative currently are: The energy cooperative Duurzaam Heeg (ECDH), Wetterskip Fryslân (WSF), Energy Workshop Friesland (EwpF), municipality of Southwest-Friesland (SWF) and housing corporation Elkien.

The actors were selected jointly by the municipality and the initiator from the beginning just after the summer of 2017. Right from the beginning the initiator said to form a do-group instead of a talk-group. The interaction between the actors is very good, according to the initiator, because they

respond quickly and new meetings are scheduled in a reasonably short term. Especially the municipality seems to be very willing. The meetings are always jointly up till now. They had about five meetings together.

The municipality is currently represented by three employees. The initial employee of sustainable development was promptly replaced by the strategic consultant sustainability when he had to go on sick leave. The other employees are involved with renewable energy and infrastructure. Also the alderman for sustainable development visited Heeg to discuss the possibility to push Heeg forward as a pilot in the Program natural gas-free neighborhoods.

The Energy Workshop helps TEO Heeg with access to their network, by sharing information and standard documents and general advise demand-driven. The intermediary generally visits a village or a neighborhood as the first contact person when the Energy Workshop is asked for help on energy production initiatives and involves others at the moment specific financial or technical information is required. In the case of Heeg, the initiator asked the Energy Workshop to help them with TEO.

According to the intermediary the TEO Heeg initiative is just at the beginning and among other things the questions and tasks have to be formulated, a project plan has to be drawn up and communication has to be provided with the inhabitants. The intermediary considers the Energy Workshop not as a partner in TEO Heeg, but as a supporter that is quite involved because the project is new and interesting to be described as concept on how to organize collective heat that can be replicated.

The initiator asked the intermediary for help and because the initiative is new, there is no scenario written down on how to go forward, so they mutually work together to see what the initiator can do and how the intermediary can complement.

According to the intermediary the WSF is proactively participating and the municipality of SWF is engaged in this initiative almost un-municipality-like. Sometimes municipalities are so-called stribbling along and eventually volunteers are bogged down in the bureaucracy of the municipality. The municipality is currently really helping forward this initiative. Elkien does not see its task in Heeg, but might well see this in Sneek.

The municipality, informed by the Energy Workshop, pushed the initiative forward at the Province of Friesland pointing to the social aspects of TEO Heeg by which it became one of the projects that could get their economic feasibility calculated by ROM3D financed by the Province. Furthermore the municipality facilitates the initiative by providing conference rooms and information about infrastructure and houses.

WSF is currently involved in TEO Heeg with the coordinator sustainability. A new function has been created to manage the assets of WSF to be used by third-parties to generate renewable energy. The asset manager will take over the involvement of WSF in TEO Heeg.

WSF is a governmental organization and the main tasks are: safe, sufficient and clean surface water for Friesland. Besides the water quantity, the water quality is a very important aspect that the water board is bound to maintain by law (Ministry of the Interior and Kingdom Relation, 2018b).

Figure 11 Actor network of TEO Heeg

In Figure 11 the actors of the TEO Heeg initiative are displayed, situated as an initiative of one of the vision groups of Duurzaam Heeg. There is a strong relation between the actors in this specific initiative therefore they are closely connected in the figure. TEO Heeg is an initiative of the energy vision group. The other vision groups include amongst others: waste, village garden and mobile transmission tower ("Duurzaam Heeg (Sustainable Heeg)," 2018a).

Now that the economic feasibility calculations are promising the next stage is to discuss the report and to make arrangements with the actors on who is doing what and why. The tasks will be delineated and the expectations of all the parties will be put forward. The initiator will discuss the report in the energy cooperative and the board needs to comment on this.

6.3.3 Learning processes organization

The vision group energy of Duurzaam Heeg used the Statutes of the energy cooperative Woudsend as a basis for their own cooperative to be founded. In the preliminary stage these parties spoke a lot about the vision of the cooperative. The initiator stresses the need for a good vision and sound Statutes for the cooperative, because they are the basis for their shared direction. The majority of Duurzaam Heeg wanted to just do activities and they did, but the vision and statutes were always on the agenda of the energy group. A sub-group took on this task under chairmanship of the initiator. The whole preparation for the cooperative took about 2,5 years.

The vision groups of Duurzaam Heeg work closely together, share information and support each other.

The energy monitor tool is developed with other cooperatives in mind. They can create their own environment in the system to be able to show what is going on in their village and maybe show totals.

The energy cooperative organized several energy fairs and can advise on energy saving measures and subsidies. In close cooperation the local soccer club was advised on a PV system, a sports club subsidy for renewable energy was requested and the whole PV system was bought and without

profit delivered. The members of the club placed the PV panels on the roof and the village installer connected the system in the fuse box. All the work by the energy cooperative was done pro-deo. The knowledge and experience of the (board) members of the cooperative was used.

The Energy Workshop Friesland plays an important role as an intermediary for shared knowledge and network. They pointed into the direction of the economic feasibility study of 20 test locations in the four Northern Provinces of which TEO Heeg became one. Moreover they referred to the Business case calculation model from Denmark for cooperative district heating that is made available by ODE Decentraal and needs to be translated to the Dutch situation. About 70% of the houses in Denmark are heated by district heating. The gas prices are higher so they already have a business case for a longer time. As the gas prices are going to rise in the Netherlands it will also become economically feasible here.

The Energy Workshop regards TEO Heeg as a pilot project for cooperative heat to be learned from and to be described in a project plan as a ready-made concept to be applied in more areas of Friesland and possibly beyond.

According to the intermediary though there is a certain logic to how to convince inhabitants, the technical feasibility, the financial feasibility including a business case together with organizing of the acceptance process of inhabitants should all be worked on simultaneously.

The initiator gathered information about the technology from the excursions, through internet searches and from the engineers of IF Technology. The initiator went to IF Technology separately and two specialists came to Heeg to see the area and agreed that TEO is technically very well possible in Heeg. They even gave a presentation to the current actors of TEO Heeg. Now they are a bit out of the picture because of the pilot project of the Province that already made arrangements with ROM3D.

Furthermore the idea for the strategy to bring information slowly about this initiative to the village was discussed with the Energy Workshop and another person from the village. The idea is to slowly warm up the villagers, so that it will not overtake them. The economic calculations are important to generate as soon as possible, because the first question villagers will ask is: ”What will it cost?”.

The municipality provided information to ROM3D for the economic feasibility calculation of TEO Heeg and based on their solid questions expects a good feasibility report, but does not know the exact assignment the Province of Friesland has given to the researchers.

The Energy Workshop is going to gather information, experiences and knowledge based on the TEO Heeg project and provide it to others as concepts that can be replicated on a Creative Commons Non-commercial basis, because that is the essence of their organization.

The municipality is interested in facilitating pilots in their own municipality for sustainable energy innovations, but it is also known that the Ministry of the Interior and Kingdom Relation started a learning process as part of the Program natural gas-free neighborhoods (Ministry of the Interior and Kingdom Relation, 2018d). So the experiences are build up in certain municipalities and can be used for other similar projects in another municipalities. TEO is potentially a very interesting technology for Friesland, as it is a water-rich province. In the first-phase GIS analysis of the northern provinces Heeg did stand out as a promising area for TEO based not particularly on technical aspects, but mainly for the social aspects as support by the energy cooperative and social housing corporation (Rienks, Stoffelen, Marquering, & Boogaard, 2018).

The project should give insights in the potential of TEO, the financial implications and the challenges that remain for other types of energy production according to the municipality.

WSF already knows that no additional policy is needed to manage their assets for the purpose of energy generation by third-parties. They may need to respond to certain request with provisions, restrictions or regulations, because of potential negative effects on the quality of surface water in case of TEO. They may prefer social initiatives over project developers, because of their social responsibility, but WSF realizes to need both types to be able to reach an energy neutral Friesland in 2050.

Halfway July of this year there was another excursion set up bij WSF for members of the Dutch Union of Water boards to visit three projects in Friesland, one of which is the TEO system at the water sports association in Heeg. That system is a closed piping system filled with water that recovers heat through a heat exchanger. During the excursion another TEO system currently build in Balk was also visited. That system is a closed piping system that runs through the surface water and is filled with a cooling fluid based on glycol. According to WSF it is unknown what the effects are when glycol accidentally seeps into the surface water because of a breech in the pipes. This will probably be researched by STOWA (Foundation for Applied Water Research) on behalf of the Union of Water boards. The initiator of TEO Heeg, the intermediary from Energy Workshop, an installation company, the Province of Friesland and the municipality of Leeuwarden all went along on the excursion together with WSF and members of the Union of Water boards to learn from TEO systems.

The Union of Water boards together with Rijkswaterstaat (part of the Dutch Ministry of Infrastructure and Water Management) and STOWA organized a so-called TEO festival in June of this year to exchange knowledge internally, but also potential consumers of TEO were invited, among others: municipalities, installer companies and project developers. Documents on the potentials of Aqua thermal energy including TEO are publically available on the website of the Union of Water boards (Unie van Waterschappen (Union of Water boards), 2018).

6.4 Case description WEN biogas

Based on the interviews XK3, XK4, XK6 through XK8 the following reconstruction of WEN biogas is made.

The Municipality Opsterland was searching for a village for a long term sustainability project. The challenge was to become an energy neutral village within 10 years. Active villagers involved Local Interest Wijnjewoude and after an inspiring presentation by Foundation Together Energy Neutral (Stichting Samen Energie Neutraal, SEN) on 23rd of October 2014, the village agreed to take on this challenge ("Historie Coöperatie Wijnjewoude Energie Neutraal (History Cooperative Wijnjewoude Energy Neutral)," 2018; "Wijnjewoude energieneutraal (Wijnjewoude energy neutral)," 2018). A core group was formed with representatives of Local Interest, SEN, Municipality Opsterland and work groups Cooperative, Finance, Farmers and Communication. The initiative by Local Interest Wijnjewoude was immediately labeled Wijnjewoude Energie Neutraal (WEN, Wijnjewoude Energy Neutral).

The current chairman of the board of the energy cooperative WEN volunteered when he retired. He is an experienced manager in the health care sector and has a reputation in cooperative organizational change. The work group Cooperative prepared the statutes based on statutes from other villages ("Wijnjewoude Newsletter 'Step by step' June 2015," 2015).

Meanwhile during so-called Energy mix meetings organized by the Province, the combination of types of energy production was discussed. On November 12th 2015 the mix with solar PV on roofs of big companies, heat pipes for heating of water and mono-manure-digesters was selected by 40 villagers ("Wijnjewoude Newsletter 'Step by step' December 2015," 2015).

In the same week the energy cooperative WEN was founded by Local Interest Wijnjewoude on 16th of November 2015 ("Statuten Coöperatie Wijnjewoude Energie Neutraal U.A. (Statutes of the Cooperative Wijnjewoude Energy Neutral Excluded Liability)," 2015).

Also as a result from the Energy mix meetings the location of the Waste water treatment plant (WWTP) of WSF in Wijnjewoude was considered as an interesting location for the production of biogas from sewage sludge. WEN consulted WSF about this idea, but the decision was already made in 2014 to close down the WWTP (Wetterskip Fryslân (WSF, Water board Friesland), 2015). The idea grew that this location once abandoned could become a very suitable location for the production of renewable energy and storage of energy as well as reusing the infrastructure. When the WWTP was officially closed down, WEN send a project plan to WSF to acquire the location and to turn the former WWTP into an Energy Park (Cooperative Wijnjewoude Energy Neutral, 2016). The demolition of the location was postponed, but WEN is still not owner. This topic will be discussed as one of the obstacles in Paragraph 7.3.

The pilot status of Wijnjewoude as a village in transition towards energy neutrality in 10 years is recognized on different levels: municipality, province and even on national level. During a conference on sustainability day 10th of October 2017 WEN became strategic pilot in the Frisian Energy Strategy based on their integral vision on how to become an energy neutral village in an agricultural area. Therefore various actors are involved: villagers, a dairy farmer, WSF, housing corporation Elkien, municipality Opsterland, Energy Workshop Friesland, Province of Friesland, LTO-Noord (Land- en Tuinbouw Organisatie Noord, North-Dutch Federation of Agriculture and Horticulture), electricity grid operator Liander, Gasunie, Netherlands Enterprise Agency (Rijksdienst voor Ondernemend Nederland, RVO) and the Ministry of Economic Affairs and Climate Policy.

Even though these actors are willing to contribute and various meetings were held, WEN realized that the challenge is very demanding for a group of volunteers and asked for substantial use of professionals from these actors or money to hire professionals. A stalemate situation arose when the actors refused to deliver resources when there was no project plan. Finally before the summer of 2018 actor Liander proposed to write a plan and wrote the project plan “Wijnjewoude Energie Neutraal 2025 - Van gedacht beleid naar gedaan beleid” (Wijnjewoude Energy Neutral 2025 - From thought policy to done policy) under supervision of WEN including all major topics: private individuals/companies energy measures, Social Housing, large PV electricity production and Biogas / Green gas / digestion (Sprang, Nellen, Pos, Pluis, & Geurds, 2018). The expected professional resources required for these topics together with overall project management and communication amounts to 15,9 fte (full-time equivalent) till 2025. WEN is currently in the process of asking commitment from the individual actors to deliver part of the required resources.

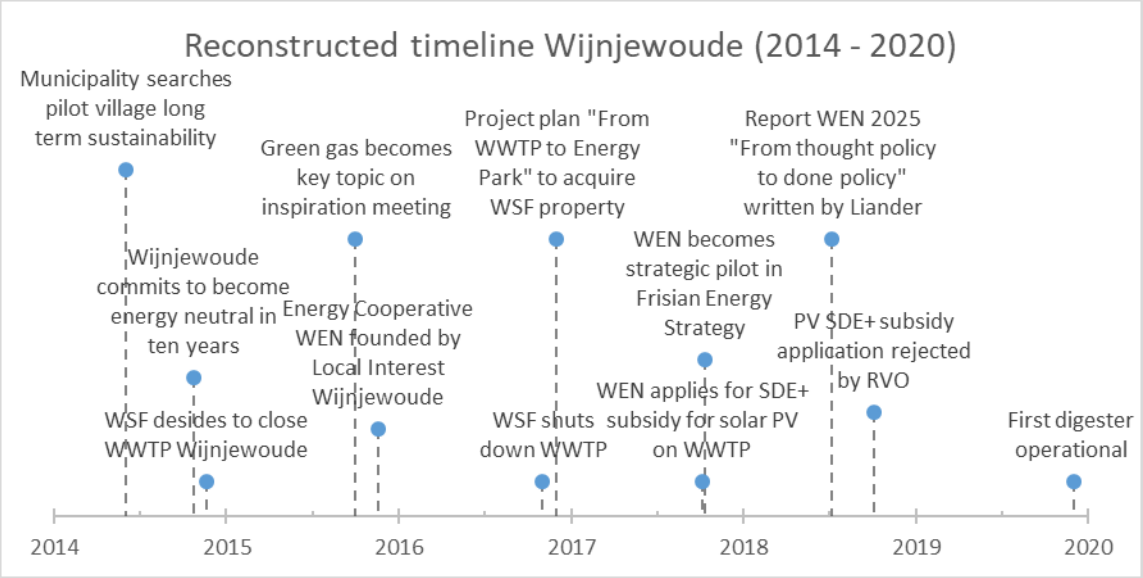

Figure 12 Reconstructed timeline of important events on energy in Wijnjewoude

In Figure 12 the timeline of important events as part of the energy transition in Wijnjewoude and the initiative WEN biogas are reconstructed. The timeline shows that the negotiations to acquire the former WWTP property from WSF are ongoing for almost two years. In the three years since the energy cooperative was founded the first production of renewable energy has not started because SDE+ subsidy was rejected because the former WWTP property is not owned by WEN. Based on the project plan within about a year and a half the operation of the first mono-manure-digester is projected. The overall vision of Wijnjewoude Energy Neutral in 2025 is not displayed for reasons of clarity of the timeline.

6.5 Technology concept of WEN biogas

During the energy mix meetings, even before the start of the energy cooperative, WEN biogas from manure of local dairy farms became a key topic. The idea arose to involve dairy farmers to produce biogas from manure by so-called mono-manure-digesters. WEN is convinced that off the gas is not realistic for everyone and also a destruction of capital. Based on a feasibility study by DLV Consultancy for a local farmer the business case for one farm was only feasible with large amounts of SDE subsidy (Bas, 2016). The option that included a Combined Heat and Power plant (CHP) is

interesting because of lower investment costs, but the efficiency of a small scale CHP is also low. The option with an upgrade unit to convert biogas into green gas was most interesting, but the investment cost of such an upgrade unit is relatively high for a farmer. In Figure 13 the current idea is displayed: a central upgrade unit on the Energy Park Wijnjewoude that is fed with biogas from five manure digesters at local dairy farms. The upgraded gas called green gas has the same properties as natural gas and can be injected into the existing natural gas grid to be used by consumers in their existing heating system and cooking equipment.

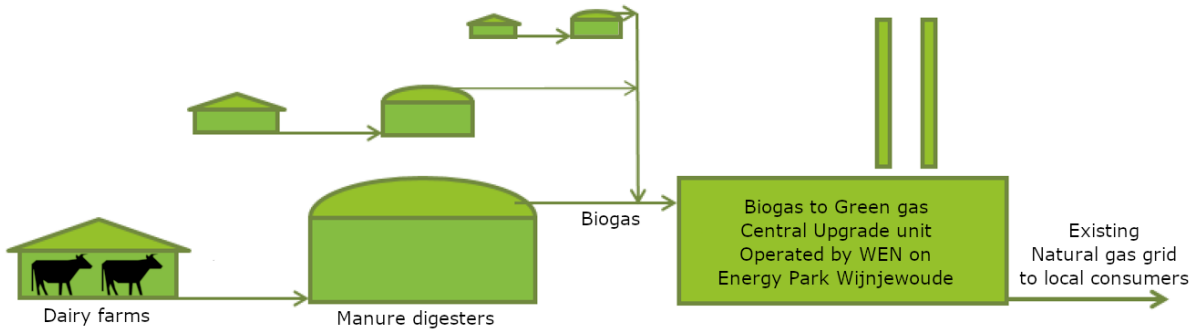

Figure 13 Mono-manure-digesters at dairy farms creating biogas that is centrally upgraded to green gas and injected into the existing natural gas grid (adapted from Pool, 2017)

The currently proposed location of the Energy Park is the former WWTP of WSF close to the village of Wijnjewoude. Besides the upgrade of biogas to green gas, the location will be assigned three more functions: electricity production by a solar PV field, electricity storage in batteries and also knowledge/research center. The idea is to use the current infrastructure: electricity grid connection for the PV production, the existing natural gas grid to feed in the green gas and the former waste water basins as storage locations for the batteries.

Compared to the current natural gas regime described in Chapter 4 the existing gas infrastructure can remain as the green gas will be injected in the distribution grid near the village so that the actual gas is physically used in the region besides the certificate of origin to virtually guarantee local use. Although the biogas is has a different origin and different composition compared to natural gas, the upgrade unit will change the composition in a way that the calorific value is within the Wobbe index and the gas will also be odorized for fast human detection. All natural gas equipment in the houses will continue to function properly with green gas.

6.6 Key processes niche development WEN biogas

Based on the interviews XK3, XK4, XK6 through XK8 the following aspects of the niche internal key processes in of TEO Heeg have been identified.

6.6.1 Visions and Expectations management

The vision/goal of the energy cooperative is to make Wijnjewoude Energy Neutral in 2025. According to the Statues the main purpose of the cooperative is on the one hand to make the living environment more sustainable by decreasing the energy use in the area of Wijnjewoude and on the other hand produce renewable energy individually, but especially together ("Statuten Coöperatie Wijnjewoude Energie Neutraal U.A. (Statutes of the Cooperative Wijnjewoude Energy Neutral Excluded Liability)," 2015).

A sub-target is to invest any profits into local/regional jointly sustainable and/or social projects. Currently this is done by gathered subsidies for home improvements and education for two unemployed members.

WEN is convinced that off the gas is not realistic for everyone and it is also considered a destruction of capital. They are also convinced to do different projects parallel to reach their target.

The initiator and the coordinator (or driving forces) are working closely together on the integral vision of WEN as well as on parts of the vision, such as the biogas to green gas part on the Energy Park. In the vision of WEN it is almost impossible to take it step by step, basically there is no time and all activities are more or less connected and interdependent. In fact it is a chosen strategy to handle more projects at once.

In addition to the joint projects some villagers are already off the gas, as they installed heat pumps. Currently 8 villagers are off the gas and on a total of about 800 houses that is 1%, which can be called high for a small village in Friesland according to the initiator.

The vision for WEN biogas is to produce 1 million m^3 of green gas in 2025 by 15 local farmers that generate biogas by farm scale mono-manure-digesters which is upgraded in 3 centrally located upgrade unit (Sprang et al., 2018). This makes the village self-sufficient on gas based on reduction of the current 1,8 million m^3 use of natural gas by energy savings and part of the village switching to heat pumps.

The role of the involved actors currently is mostly to stimulate and facilitate the initiative WEN, but the initiator asks continually what that concretely entails. Currently the steering group meetings are facilitated, but the initiator compares these meetings with an agricultural setting in which experts discuss on how to improve the efficiency of harvesting, while the farmer has no money to buy seeds. According to the initiator this is similar to the WEN situation, in which the actors discuss a lot on different possibilities, but WEN still has not acquired a location for the Energy Park.

According to the initiator the expectations of the different actors is probably not sufficiently pronounced, as the Province and the municipality claim that WEN increasingly expects too much. However there is a shared vision of the village of Wijnjewoude to become energy neutral.

It appears that the actor WSF and WEN are in opposing positions as the expectations towards the location are different. WEN would like to acquire the location to realize the Energy Park with solar PV, biogas upgrade units and in the future electric energy storage. WSF would normally demolish a former WWTP, clean up if necessary, sell it as a piece of land and remove all connections to that location. Although new proposals are put forward and conditions are exchanged the location is untouched for almost two years.

The Energy Workshop considers WEN to be more difficult to progress, because it is an all-encompassing initiative that tackles many issues at the same time. The initiator expects that in the near future many more municipalities will go into this direction. The energy transition is a big challenge, so what to do?

The advantage is that a broad coalition is involved in Wijnjewoude, so the discussions are very broad according to the intermediary. The disadvantage is that with so many actors in the same meeting it is difficult as a project to progress, according to the intermediary.

The Energy Workshop is currently not equipped to support the WEN biogas project well enough as the questions are very diverse and various partners need to help support the integrated initiative.

This is inherent to the phase the project is in and the Energy Workshop realizes that the support has to be organized better for these type of initiatives.

6.6.2 Actor network formation

The pilot status of Wijnjewoude as a village in transition towards energy neutrality in 10 years provides that various actors are currently involved, especially since the process of the sector table Energy & Agro of the Frisian Energy Strategy: villagers, a dairy farmer, WSF, housing corporation Elkien, municipality Opsterland, Energy Workshop Friesland, Province of Friesland, LTO-Noord, electricity grid operator Liander, Gasunie, Netherlands Enterprise Agency (Rijksdienst voor Ondernemend Nederland, RVO) and the Ministry of Economic Affairs and Climate Policy.

It all started with some active villagers, the Local Interest Wijnjewoude, the municipality Opsterland and support from SEN. Because of the WWTP location WSF became involved as well as a local farmer that had its business case for biogas calculated by DLV Consultancy. Energy Workshop Friesland was involved as they generally support energy cooperatives. LTO-Noord, Province of Friesland, Liander, RVO and the Ministry of Economic Affairs and Climate Policy became involved during the Frisian Energy Strategy process (FES). The municipality Opsterland push WEN forward as a pilot for the sector table Energy & Agro. In the process towards presentation of the Frisian Energy Strategy these actors met about 5 to 6 times organized by Berenschot and about 2 times afterwards organized by WEN. Elkien became involved because of the social housing and finally Gasunie became involved at first for their interest in hybrid heat pumps, that use gas in cold periods besides electricity, but later also for the biogas to green gas initiative. Gasunie already mentioned to be willing to provide a project leader for the biogas part. WEN is currently in the process of asking commitment from the individual actors to deliver a part of the required resources. After these individual meetings WEN is going to set a meeting with all committed actors to make arrangements to go forward. WEN expects more commitment of the actors by the individual meetings preliminary to a joint meeting.

From the beginning of WEN numerous actors have been consulted on financial or technical options, but these actors have been dropped mostly because the revenue models of these companies are too dominant. Especially for this reason WEN does prefer not to work with consultancy companies. According to the initiator WEN wants to work together preferably cooperatively with people that are dedicated, expert in their field, share the same goals and earn a normal salary.

The involved farmer had its business case calculated, but apart from information meetings with other farmers, currently no effort is put into involving more farmers because of the progress of the project.

As the vision of Wijnjewoude Energy Neutral 2025 is mostly tackled as an integral process of interrelated activities by various actors that still need to commit to parts of the project, the actor network currently can best be displays as a circle surrounding WEN 2025.

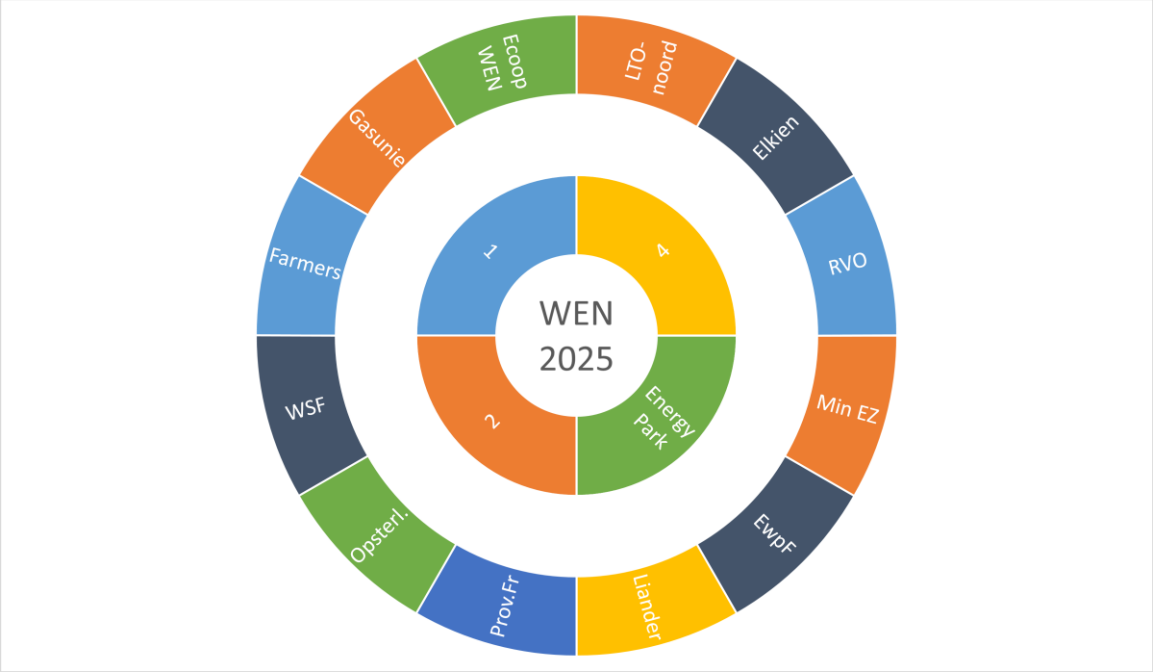

Figure 14 Actor network surrounding WEN 2025

In Figure 14 the current actors involved in the vision WEN 2025 are displayed. One of the projects of the energy cooperative is the Energy Park including the WEN biogas initiative. Although some connections could be made between some actors and the initiative, the energy cooperative currently is unsure about the commitment of the actors to one or more projects. There is a weak relation between the actors and this specific initiative therefore they are not connected in the figure.

One of the other projects in WEN 2025 is energy measures for individual households and companies (Sprang et al., 2018). The organization Buurkracht is going to supervise the workgroup that will involve the neighborhood associations to help villagers with individual energy saving measures and energy generation.

During the period when the report WEN 2025 was written and the period the actors were asked for commitment, according to the intermediary WEN did not want interference by the Energy Workshop.

As the initiator became involved during the period prior to the founding of the cooperative, the coordinator became member of the cooperative in December 2016 and was asked by the board based on his affinity with sustainability and the energy transition.

6.6.3 Learning processes organization

The last eight years or so, according to the initiator, the energy demand decreased and the production of renewable energy improved not by concrete real measures, but shear by motivation and attention. The percentage of renewables is about 10% which is considered high in comparison to other villages in the municipality of Opsterland. It is not that this village has more environmentally friendly citizens, but mainly because there is much attention. It all starts with a pioneer and a few others gather around. Half of the board of the energy cooperative WEN, so 3 members, are off the gas. The initiator claims the board of volunteers of the cooperative to be involved in pioneering.

As mentioned before actor Liander wrote a project plan under supervision of WEN on the currently proposed topics and especially on the resources it requires from professionals to obtain the goals

between now and the year 2025. The actor Netherlands Enterprise Agency (Rijksdienst voor Ondernemend Nederland, RVO) co-read the report. The initiator considers the report to be unique, because it really shows what it means for a village to be off the natural gas and to be energy neutral.

Information meetings have been organised for local farmers to inform them about the possibilities of mono-manure-digestion on their farm in relation to the energy vision of Wijnjewoude. The local farmer from Wijnjewoude that had its business case calculated as well as the consultant from a similar project in Noord-Deurningen were involved in the information sharing. The planning is to invite farmers from Noord-Deurningen to tell their story to farmers in the surroundings of Wijnjewoude about their biogas from mono-manure-digesters. According to the coordinator the Province is also in the process of organizing a masterclass on this topic. The idea is to invite farmers from the area of Wijnjewoude to join this masterclass.

The initiator also mentions to have had contact with Jumpstart, a project run by dairy cooperative FrieslandCampina, that involves farmers to produce biogas with farm scale mono-manure-digesters. According to the initiator the contact eventually broke off based on disagreement about allowing the by WEN proposed addition of 5% glycerin to the digesters. The initiators also mentioned that the first Jumpstart farmer in Hinnaard recently quit working with the manure-digester, because in practice the installation is more difficult to manage and less efficient as projected (Bouhuijzen, 2018).

The initiator expects it to be a long-term matter before the change to cooperative collaboration will become reality, that it sometime takes a few failures before is succeeds and that the first initiatives, the pioneers might sometimes break down.

On the website of WEN (WEN, 2018) a lot of information is shared, such as the biogas business case for the mono-manure-digester, the project plan for acquiring the WWTP, the project plan for the professional resources needed to realize WEN and also various events and newspaper articles. The initiator claims it is not really a conscious strategy, but they realize they need to show what is being done, what is realized, but also to learn from others and show these examples as an inspiration to the village.

The coordinator is besides his WEN activities involved in the Frisian umbrella cooperative Ús Koöperaasje (Our cooperative) as a team member that supports all member energy cooperatives in Friesland in their development mainly with information and standard documents.

The project plan is shared with all involved actors. The actual situation on the technology of the projected digesters is done by public domain internet searches and to keep up to date by the news. Moreover the involved farmer is active on various online forums and shares important information.

6.7 Conclusions niche development LREI district heating in Friesland

As described in the previous paragraphs on the TEO Heeg initiative, various aspects of niche development have been identified, including a vision process resulting in a village vision report, the founding of energy cooperative Duurzaam Heeg with reused statutes of another energy cooperative, a new combination of existing technologies to retrieve energy from surface water to be applied as an innovation in space heating of existing houses in the village of Heeg, for the planning phase relevant and involved actors, pro-active support by the municipality, intense support by intermediary organization Energy Workshop and shown interest by the initiator, intermediary, municipality and water board to share knowledge on technology, finance and processes to develop the technology and to acquire participants. Although the initiative is in the planning phase and the social housing corporation is not fully involved, the development of this initiative can be considered as solid especially by the commitment of the initiator, the intermediary, the municipality and the water board displayed during the economic feasibility study and the process in the application for the Program natural gas-free neighborhoods.

Based on the evidence found in this research on the identified aspects, involved actors and initiative processes in the TEO Heeg case study it can be concluded that the project is a niche in the area of local renewable energy as cooperative thermal energy from surface water to be applied in space heating of existing houses in the context of natural gas-free Netherlands. Moreover it may be considered successful in the current stage not only as a cooperative citizen initiative that is going to be described by the strategic niche intermediary Energy Workshop as a project that can be replicated elsewhere, but especially as a promising technological innovation with great energy potential that could possibly replace the gas-regime for space heating of existing houses. The energy from surface water can be considered as a primary naturally occurring source of solar energy. The place of TEO Heeg in the analytical framework is shown in Figure 15.

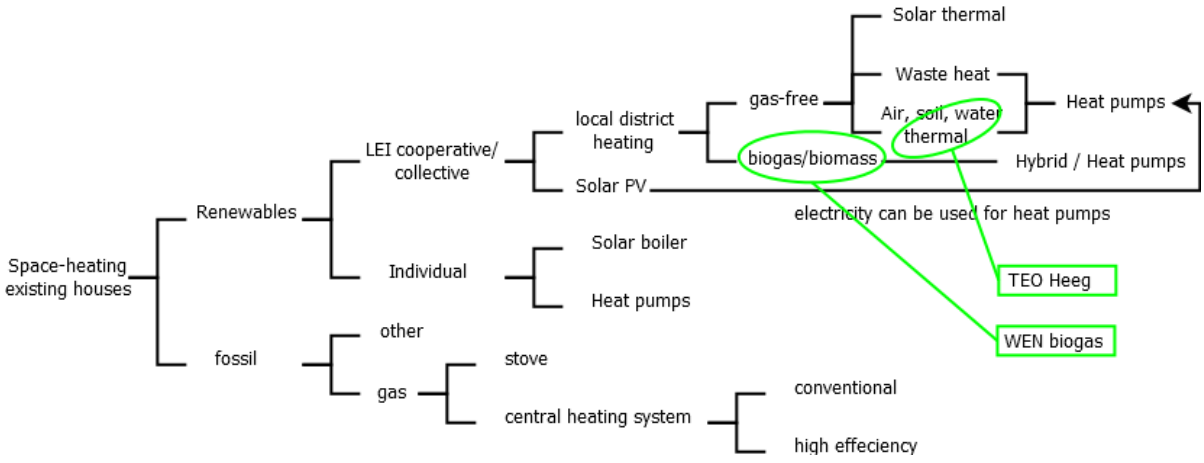

Figure 15 Location of the case studies in the analytical framework (adapted from Figure 4)

For the WEN biogas initiative, as part of the integral vision of Wijnjewoude Energy Neutral 2025, various aspects of niche development have been identified, including a vision process resulting in a shared vision website, the founding of the energy cooperative WEN, with reused statutes and added internal regulations, a new combination of existing technologies to use farm scale mono-manure-digesters to produce biogas that is transported to a central upgrade unit to produce green gas to replace natural gas for space heating of existing houses of the village of Wijnjewoude, the involved actors since the pilot status of the village are very diverse and commitment will be requested based

on a detailed project plan written by current grid operator Liander and the comprehensive information sharing through the WEN website including business case documents, presentations and news items. Although the initiative is in the planning phase and the commitment of the involved actors is currently requested, the development of this initiative can be considered as solid especially by the continuous commitment of the initiator and the coordinator to engage in the Energy Park and the plans written on the energy projects and the required professional deployment.

Based on the evidence found in this research on the identified aspects, involved actors and initiative processes in the WEN biogas case study it can be concluded that the project is a niche in the area of local renewable energy as cooperative biogas to green gas to be applied in space heating of existing houses in the context natural gas-free Netherlands. The place of WEN biogas in the analytical framework is shown in Figure 15.

Although both cases display strong social innovation components as citizen cooperatives to provide renewable energy to their villages, they also show strong elements of technological innovations that contribute to the development of a niche in the area of local renewable energy for space heating of existing houses in the context of natural gas-free Netherlands. This niche can be considered as a new socio-technical niche that can further be studied by SNM as a policy instrument for a new governance model for local renewable district heating.

7 Obstacles, barriers and measures in LREIs

This chapter aims to provide an answer to sub-questions 4: "*What obstacles and barriers do Local Renewable Energy Initiatives in the province of Friesland face in their niche development for local district heating?"* and 5: *"How can Local Renewable Energy Initiatives in the province of Friesland overcome these obstacles and barriers?".*

In this chapter the obstacles, barriers and measures from the two cases researched in this study are described, analyzed and classified according to the categories gathered from literature of Chapter 5.

7.1 Obstacles and barriers TEO Heeg

The initiative TEO Heeg is a project in the planning phase of a new potential source of energy from surface water. The following obstacles and barriers have been identified in this research.

Technological

The initiator does neither experience technological obstacles or barriers nor expects technological obstacles though all technical components have not been combined into one system, they are proven technology separately. However in his experience the installation sector is very reluctant, because many installer companies have not connected heat pumps although the technology exists for many years. This might be an obstacle once the project enters the phase in which installers are attracted to install the system and connect the consumers to the district heating grid in Heeg.

Although the lack of having large heat consumers cannot be counted as an obstacle or barrier, however it would be a driver, because these large consumers also account for a large part of the revenues. The industry in Heeg mainly consists of production halls that require only a little additional heating. The large heat consumers of Heeg are potentially the apartment complex for elderly care that is renewed just before the idea for TEO was born and the second complex that is currently build with an individual heat pump.

The surface water in Friesland is maintained by the water board WSF. WSF acknowledges the potential for TEO, however they neither consider the heat recovery from surface water nor the distribution as their task. Although there are ideas on the energy chain from the surface water source to the households, the system still has to be realized. TEO Heeg is the first project in Friesland of its kind and according to the intermediary there are currently no appealing examples in the Netherlands to show how collective renewable heat can be organized so not being able to compare to other projects might be considered as a barrier or at least a challenge for TEO Heeg.

The temperature of the surface water is one of the parameters of the water quality that is maintained by WSF, however the thermal energy is not owned by the water board according to the coordinator. It can be compared to fish swimming in the surface water that are part of the ecosystem and therefore influence the water quality, but the fish are also not owned by WSF. WSF want to keep track on all activities that can influence the water quality such as contaminants. If the contaminants cause an adverse effect on the water quality, it may also disrupt the ecological stability. The heat recovery or discharge and also cold recovery or discharge to the surface water can also disrupt the ecological stability. TEO is influencing the temperature of the surface water and the effects on the water system have to be controlled. Currently there are standards for the water quality, but not all the values are currently known. According to the WSF cooling water discharges in Friesland are only incidentally allowed above a temperature value of 30°C. Other values such as heat recovery have to be researched, before values can be determined. This might be an obstacle to TEO

Heeg, because WSF may allow the installation based on current values and expected impact, in the future the system could be rejected on newly determined values for heat recovery from surface water.

Another obstacle that might rise depending on the TEO system usage, involves water discharges during winter periods. Both the inflow and outflow of a heat exchanger system could cause a constant whirl in the surface water preventing ice to be formed on the surface. Especially in the route of the Eleven cities tour for ice skating the use of systems that cause swirls in the water will not be allowed according to WSF. Although Heeg is not on but near the Eleven cities tour, the obstacle can also rise on surface water that is generally use in winter time for ice skating.

Ontological (continuity of existence)

The connection between the vision groups of Duurzaam Heeg and Local Interest Heeg has reduced over the years. The former chair of the board of Local Interest Heeg is part of the energy vision group and maintained mutual contact. According to the initiator the subsequent board did not consider it as important to stay in contact with Duurzaam Heeg. The current board is almost completely renewed, including new residents. This might become an obstacle when participants for the initiative TEO Heeg are recruited as both parties represent a part of the villagers of Heeg and their support for the initiative might convince villagers to become participants.

The initiator does all the work for the energy cooperative voluntarily and does not have time to tackle all problems by visiting the actors separately. On average the initiator spends at least 8 hours per week. The other members of the board currently spend a few hours per week to a few hours per month, but it varies in time. Especially the housing corporation Elkien appears to find it difficult to be as involved with the initiative as the other actors since they missed a few meetings. It might be that the initiative at this stage is too far from their core activity or it could be connected with their current central contracts with maintenance companies that they do not want to take the lead in making a statement on preparing their houses to be connected to the heating grid once the system is in place. This might become an obstacle in the area of continuation but especially socially, because they own around 150 houses in the proposed area of Heeg that could contribute financially to the initiative and the tenants could profit equally as private home owners not creating a social gap.

The coordinator sustainability of the water board WSF will soon be changed by the new asset manager. Although the asset manager is already introduced during the excursion to the TEO Heeg actors, the relation with the actors of the initiative has to be rebuild. It could become a barrier to regain trust, but it could also be a driver, because the asset manager will be coordinating various projects for WSF and structures will be setup to facilitate projects such as TEO Heeg.

Financial

The financial feasibility is calculated by ROM3D, but the initiator does not know the indicators and costs that are used, because the assignment was given by the Province. It was stressed to use future gas prices, because otherwise it would not be a fair comparison. Another criterion the initiator explicitly asked for was the system to be energy neutral. So the required energy also needs to be renewable energy preferably locally generated. Although the first calculations by ROM3D on the financial feasibility are promising according to the initiator, recalculations need to be carried out with different parameters. If the costs for the recalculations are not paid by the Province, this is considered an obstacle to the initiator.

One of the main reasons to start the energy cooperative was to keep the money spend on energy locally in Heeg and not to the current sometimes foreign energy suppliers and grid operators (Elzinga, 2014). The preconception on these companies to be too much semi-government, cumbersome and expensive may lead to not involving them. This might become an obstacle as the municipality, the water board as well as the intermediary consider these companies to be able to contribute to the initiative by either knowledge on the technology of heating grids, on liability or even financially.

The infrastructural works from the source to every house will be the biggest cost. Moreover not a great deal of commercial parties are currently involved in this technology and they might be cautious about pricing. This could become an obstacles in the financing phase of the project as it might be difficult to attract companies to can carry out the work for a realistic price.

Legal

Although the initiator has not looked into the law and regulations, it is known that they at least need a permit for their open source system. The municipality is not yet consulted about this. Although currently no obstacles have been identified, it is important to keep legal aspects in view and make necessary arrangements before irreversible or costly activities are carried out.

Physical/Infrastructural

The infrastructural adjustments are the biggest obstacles for TEO Heeg. Every house of the participating households need to be connected to the central heat source by piping in the streets of Heeg. If the renewal of the sewage system could be combined with the construction of a local district heating grid it would be very favorable. Although the municipality is currently gathering data on the renewal of the sewage system, it is already known that hardly any sewage renovations are planned in Heeg. Moreover there are currently no housing renovations planned by the housing corporation Elkien in Heeg that could be combined with adjustments in the houses. Although the physical activities themselves are not the real obstacle as there is often dug, they might become an obstacle for the acceptance and support of the project if the villagers are not convinced about the necessity of these adjustments.

Management/Control

The energy cooperative wants to stay in control over TEO Heeg, because they have the involvement of the citizens of Heeg and want to help them. According to the initiator it is a problem that the municipality is not used to work together with citizens. They are used to run their projects themselves. This might become an obstacle in the future because they might prefer to take over TEO Heeg, because it is a fairly large joint project.

Although the energy cooperative wants to stay in control and prefer not to involve large companies, they asked the municipality to submit the initiative TEO Heeg as a pilot in the Program natural gas-free neighborhoods. The municipality is willing to submit TEO Heeg as a pilot, based on the requirements of the Program, the municipality needs to be the submitter and it is required that besides the local inhabitants, also stakeholders such as social housing corporation Elkien and the local energy distribution company Liander should be involved and the stakeholders should support the project. It is expected that the process to realize the project will involve general practices from the municipality, such as a steering group or project group. Again this might become an obstacle in the future for the energy cooperative to stay in control, but the Program might as well be a driver in the process of realization of the project.

The impact on the environment of the TEO infrastructure in the surface water, in the heat and cold wells in the soil, as well the heating grid in the ground have to be taken into account and may become an obstacle if it requires additional costs.

Social/Cultural

The most important obstacles of the whole project according to the initiator is the social acceptance and how to introduce this idea to the citizens of Heeg. The social aspect is the most difficult one, because a lot of people are reluctant about most changes and totally not into sustainability according to the initiator and is furthermore convinced that all other aspects can be dealt with one way or the other. Moreover the distribution companies that laid down the existing district heating grids in some urban neighborhoods in the past have created a negative image according to the intermediary due to among other things issues with pricing. This negative image might be an obstacle for TEO Heeg, because they do not only have to convince villagers by the beneficial aspects of their sustainable initiative, but they may have to overcome negative attitudes toward district heating.

The intermediary explains that although in Denmark collective district heating grids have been developed for almost 100 years and similar to Friesland there is a lot of agriculture and villages, the culture and historic collective awareness towards cooperative heat is very different. The history of these cooperatives provide the rich examples including technology, financing and consumption that are needed to persuade everyone. The historic cooperative examples in the Netherlands are agricultural and economically driven. There are no examples for heat cooperatives, accept the Thermo Bello project in the eco-neighborhood EVA-Lanxmeer in Culemborg (Thermo Bello, 2018; Verschuur, 2010). Although this might not really be considered as a barrier, examples can generally be used to give a genuine idea on the impact of the change, but it also helps to convince inhabitants that it can be done.

The potential members of the new TEO cooperative have to be recruited. Both the initiator and the municipality want to include all inhabitants in the initiative, but they realizes that people should decide to participate on a voluntary basis. The acceptance is expected to grow in phases and depending on how the project is going to be financed the minimal participation has to be reached in order to continue. The second phase of participants will definitely pay more to get connected according to the initiator, because of additional digging and extension of the system. Since the fact that all members of the cooperative decide together it should not be too large. The involvement with the area of living is very important for a cooperative. The initiative in Heeg could have about 900 to 1000 members (houses) which is an appropriate size according to the initiator as the villagers recognize each other. On the one hand the recruitment of participants is a barrier especially if the target is set high, on the other the way the initiative is to be presented to the citizens and how people might be prepared for TEO Heeg will be the first obstacle that has to be tackled. However the cooperation between Duurzaam Heeg and the foundation Plaatselijk Belang Heeg (Local Interest Heeg) needs to be restored first to be able to work together on this.

The initiative is not expected to effect in a lot of adjustments in the houses. However the most resistance according to the initiator is to be expected switching from a gas cooker to an induction plate. This may involve the need to learn to cook in a different way. Besides this the citizens will as a member of the cooperative also become co-owner of the energy grid. They might fear the idea. These social barriers have to be addressed in order to convince the villagers and not to become a barrier for the whole project.

Currently very little information about TEO in Heeg is publicly available. Once the initiative enters the next stage in which the inhabitants of Heeg will be involved, communication will play an important role. The municipality considers communication as an important role for the municipality together with other actors. The municipality wants to start a process with sufficient communication from the moment that they are going for the pilot in the National Program natural gas-free in which among other thing measuring the support by the population in Heeg. Moreover the communication with the involved partners will also change, because the real commitment of the partners will be required. Both the initiator and intermediary are well aware of the delicacy of the introduction of the idea to the village. Although this might not be a difficult barrier to overcome, it might become an obstacle when the communication by the various actors is not properly managed.

7.2 Measures to overcome obstacles and barriers TEO Heeg

Measures to overcome the identified obstacles and barriers in TEO Heeg are described in this paragraph along with some drivers for the initiative.

Technological

Large heat consumers make it easier to realize the project. There was talk of a new large supermarket being built, that is possibly interested to participate. Moreover the apartment complexes are large heat consumers that might be connected in maybe 15 years when their current heating system is to be renewed.

For the municipality it is obvious to involve Elkien with the rental houses besides privately owned houses for the social inclusion of the citizens. They also want to involve the current distribution grid operator Liander to oversee the consequences in the changes to the existing gas and electricity grid.

The surface water temperature in Friesland is rising in summer according to WSF. A recovery of heat during summer from surface water that is subsequently stored in a heat well in the soil, has a positive effect on the temperature of the surface water and can therefore be beneficial to the ecosystem and the quality of the surface water.

Heat recovery in wintertime by a closed piping system will be beneficial to the forming of ice as the surface water is cooled and swirls are prevented by the closed system.

These technological aspects can be taken into account in the process of designing and dimensioning of the TEO Heeg system.

Ontological (continuity of existence)

According to WSF first you have to find each other, then to like each other and to trust each other to take the next step. In TEO Heeg all current actors except Elkien met during an excursion on TEO in Wageningen, they had about 5 meetings with good energy and good progress, so they started trusting each other. For the continuation of the initiative WSF suggests to draft a letter of intent with agreements on the process and also to write up a project plan with agreements on parts of that plan with the involved actors. WSF expects that the project plan and the letter of intent can create commitment at Elkien to become really involved. The municipality is expected to also play a role in involving stakeholders such as Elkien and Liander in the process towards application for the Program Natural gas-free neighborhoods. Moreover a financial statement by Elkien to have the intention to prepare their houses in Heeg to be connected to the heating grid could help overcome the financial side of the initiative as well as not generating a gap between societal groups.

The goal of the energy cooperative is to make this initiative into a separate TEO cooperative. That is a step to create a real entity for the current initiative that really just exists in the minds of the involved actors. When the cooperative is founded members can be recruited and administered.

According to WSF the current process with the calculation of the economic feasibility can be parallel to the process of letter of intent and project plan, because the project can still continue based on the mutual willingness to contribute to the vision of Duurzaam Heeg. The willingness to be sustainable is a factor that is not a standard part of business case calculations.

The initiator tries to think things through, but realizes that not everything can be thought of in advance. The general idea is: to set the target, then take it step by step and if you run into things try to come up with good solutions that could mean to turn left or right or sometimes even back, it is going to be an experience.

Financial

The economic feasibility is calculated by ROM3D. This consultancy company has done previous research for the four Northern Provinces and is now paid by the provinces to do economic feasibility studies for 20 test locations of which Heeg is one. It is an advantage for Heeg to be at the forefront as the Province of Friesland is paying the study. In follow-up projects these calculations may need pre-financing, because local initiatives may not be able to afford this. Once the technology is embraced, banks will probably step in to finance TEO projects.

In an email on 30th of August 2018 the initiator stated that the results from the economic feasibility study was very favorable. Additional calculations will be made with some other parameters, but it is expected to be favorable as well. Based on this result the municipality is going to apply for a government contribution for the TEO project of Heeg. The program is called “Proeftuin aardgasvrije wijken” (Testing ground for natural gas-free neighborhoods) for 90 projects with each at least 500 houses per project (Ministry of the Interior and Kingdom Relation, 2018d).

The intermediary explains the advantage of a municipality involved in the financing of a project such as TEO Heeg, because the government may be willing to lend money for a societal project with an interest rate of 1% whereas a commercial project developer need for instance 15%. In the first case it is much easier to finance a large project. Besides this the municipality can move the renewal of the sewage system forward or backward and pre-finance the digging.

The initiator currently has the approach that the total investment costs for the local district heating will have to be covered by the connection cost of the participants and that way it can be depreciated in 20 to 25 years.

The gas prices are expected to rise of about 50-60% within a few years according to the initiator, which is favorable for the development of this initiative. The price level for the participants is going to be kept on the same level as current or future gas prices so that it will not cost more than the current gas infrastructure and gas prices.

WSF proposed to the actors to draft a letter of intent to commit to the project and to assign employees and money to the project. WSF has about 10 to 15 thousand euro for a so-called icon project on Thermal energy. This money can be used to do some additional research or to draft a business model for TEO Heeg.

Legal

The Statutes of the energy cooperative Duurzaam Heeg were based on the ones of energy cooperative Woudsend mainly because of the legal structure of the document as they were already notarized.

If the current law and regulations do not allow this TEO form of renewable energy to be put into practice, the municipal council may need to adjust their previous established municipal regulations.

Physical/Infrastructural

The municipality is gathering planning data on the renewal of the sewage system, gas grid and similar activities. It can be favorable to TEO Heeg when digging can be combined with other projects as the nuisance for the inhabitants will be less and the costs may be shared over the projects.

Management/Control

In the TEO Heeg meetings a second project in Sneek was also discussed as it basically involves the same actors and the same technology. The housing corporation Elkien was asked to take the lead in the Sneek project, because the renewal of houses of Elkien are planned within a few years with the possibility to adapt TEO. It could be an advantage to the TEO Heeg actors to be involved in a similar project to share experiences.

The municipality considers as their main role to be facilitating, stimulating and coordinating, but in the gas-free neighborhoods they have a pronounced pulling role, because of the national goal to be a natural gas-free country with a shared responsibility over provinces and municipalities.

The financial administration of the customers of the new cooperative has been thought over a little by the initiator and discussed with the Energy Workshop. The both consider it ideal if EnergyVanOns would take care of this, because they already have the administrative system in place.

If the energy cooperative Duurzaam Heeg wants to stay in control over TEO Heeg, good agreements have to be made with the municipality if the initiative is going to apply for the government contribution Natural gas-free neighborhoods in the course of 2019, because the submitter of the plan has to be the municipality and all stakeholders need to be involved and need to support the plan. It is expected that the municipality will draw activities toward their organization, because they will feel the responsibility for the process during the writing up of the plan and probably beyond.

Social/Cultural

Duurzaam Heeg (Sustainable Heeg) is a partnership of a large group of citizens of Heeg that shows real engagement with sustainability by their voluntary actions as part of one of the vision groups and participation in the energy cooperative and as clients of EnergieVanOns. According to the initiator these citizens are personally convinced that something has to be done and their life vision is sustainable development. Recently ideas are formed to make Duurzaam Heeg a legal entity either a foundation or a cooperative. This might give more structure to this partnership and could help in restoring the relation with Local Interest Heeg. Duurzaam Heeg already explained the history of the vision to the new members of the new board of Local Interest Heeg. According to the initiator both groups of active villagers will be needed to convince as many fellow citizens to become participants of TEO Heeg. The initiator of TEO Heeg also stresses the involvement of local residents in the vision process to be the basis on which all following actions are build. This could be the key element for sustainable development in other areas.

The vision group waste developed a project to reduce residual household waste. Their project was so successful in Heeg that is was adopted by various municipalities. Even in four other villages in Friesland the reduction was not as large as in Heeg. The process and result of the village vision Duurzaam Heeg probably created more involvement amongst the residents.

In the Netherlands there are different heating grids, some are success stories, others less successful. In Denmark about 64% of the heating demand is understood to be supplied by local district heating generally cooperatives. The intermediary uses appealing examples to show to volunteers of energy cooperatives so that they know they are not on their own. As there are currently hardly any heat cooperatives in the Netherlands, examples from Denmark might be used to convince villagers.

According to the intermediary the initiator received the mandate of the energy cooperative by asking permission to research TEO as an interesting solution for the current heat transition. This mandate is necessary to take the next steps. The intermediary also claims a certain degree of consent in the village of Heeg is needed for this initiative to succeed. So the villagers need to voluntarily agree to the proposal of TEO Heeg. According to the intermediary convincing villagers can be done by for instance calculations, the consent is more difficult because it among others involves trust over a longer period of time.

A group of citizens is going to be formed for the issue on how to introduce the initiative to the village. Meanwhile the initiator mentions the general idea of the initiative on various occasions to gauge the reactions and get confirmation that they support the whole idea of the energy cooperative. In February of this year the initiator asked approval at the general meeting of the cooperative to research alternatives for the fact that at some point the village is going to be disconnected from the gas grid. The approval was given by the members and the board at that meeting. The strategy is to introduce the initiative together with Local Interest Heeg, because together with Duurzaam Heeg they have more support together. These two local actors can create more involvement amongst villagers, especially social commitment. The different vision groups of Duurzaam Heeg already have various ideas on how to collectively bring it to the village. The whole idea is really supported by Duurzaam Heeg. The slow introduction is currently visible by a news item on the Duurzaam Heeg website about the potential of thermal energy from water (Duurzaam Heeg (Sustainable Heeg), 2018b).

According to the initiator the municipality should not be involved in raising participation amongst the villagers, because the citizens might get the idea that the project is being forced upon them. The municipality also considers energy cooperatives to play a major role in involving residents because the energy cooperatives have experience in gathering support for their own plan. The fact that the municipality is involved and supports the TEO Heeg initiative might convince consumers to change.

To stimulate the inhabitants of Heeg the municipality suggests to use financial incentives for various target groups to not enlarge the social gap, so create opportunities for everyone to improve their house and energy situation. These incentives should not only come from the municipality, but also form other parties, because the municipality cannot decide on all target groups. The social commitment of the tenants can be created by Duurzaam Heeg if Elkien delivers the financial commitment to the initiative.

If the initiative is successful according to the initiator participants only need to purchase a new set of pans and an induction plate. Even the costs for the pans and cooking plates can be kept as low as possible by a collective arrangement with a manufacturer or a wholesaler. Moreover cooking

workshops can be given by various parties that have experience with induction or a famous chef can give cooking demonstrations at the local food fair.

Finally an energy game that visualizes the tasks to become an energy neutral village and the changes that need to be taken to reach that goal can be useful to convince people.

Remarks on TEO Heeg

There is a tension between the role and involvement of the municipality and the survival of the initiative. Although the initiator forged the TEO Heeg coalition together with the municipality, asked them to use their power to influence Elkien to commit and is going to apply for a subsidy in which the municipality needs to play a major role, the energy cooperative will withdraw if the municipality takes over the project.

7.3 Obstacles and barriers WEN biogas

The initiative WEN biogas is a project in the planning phase and part of the integral plan Wijnjewoude Energy Neutral 2025. The following obstacles and barriers have been identified in this research.

General

The acquisition of the former WWTP Wijnjewoude from WSF has proven to be a large obstacle for the last almost two years. The original decision made by WSF in 2014 was to shut down the plant, to demolish all infrastructure, to clean up possible contamination beneath the sewage basins and sell the property as building ground or agricultural land. Approximately 400 thousand euro was put in the budget for the demolition and cleanup (Wetterskip Fryslân (WSF, Water board Friesland), 2015) and the sale would revenue 30 to 40 thousand euro after cleanup. WEN stated that it would not be very sustainable to demolish everything as the infrastructure might well be used for the purpose of the energy cooperative. By the end of 2016 the plant was closed down and WEN was asked to write a project plan for their Energy Park plans with the location (Cooperative Wijnjewoude Energy Neutral, 2016). As the water board is also engaged with sustainable development they considered it a nice gesture to offer the property to a civil society organization as WEN instead of executing their standard procedure: demolish, clean and sell. Working together at that location was not an option for WSF, because their interest was to get rid of the location as it was definitely put out of operation.

WSF acknowledges the potential of the location with facilities for WEN, especially the grid connections. The board of WSF decided to offer the property for sale to WEN for 30 thousand euro. According to WSF to offer the location free of charge was not an option because of legal advice on favoring one organization over another. According to WEN a valuation of the property in current condition showed a negative value, however after demolition and possibly cleaning the property was valued for 37 thousand euro. There were mixed feelings about this offer, because WSF considered it to be a reduced price and WEN responded not to be able to accept the risk of possible future cleanup costs. According to WSF they also proposed to WEN to just start and when the Energy Park is not built in three years WSF will demolish and clean up the area then. This offer was also refused by WEN, because they considered the risk too high.

The property can also be viewed as two almost equal halves: one part with the infrastructures and one part with trees that were planted by WSF some time ago because they had no use for that piece of the property. The current proposal by WSF is to offer the half with trees to WEN and to put the other half with the buildings and other infrastructure on public sale. If the property is not sold it will be demolished and cleaned to be sold as land. Before the 1st of August of this year WEN had to state if they wanted to make use of the right of first buyer for half of the property with the trees. WEN made it clear to WSF that they want to make use of their right of first buy under the condition that they receive SDE+ subsidy to put a solar PV field on that location and that the electricity infrastructure is included.

The negotiations with WSF have been going on for almost two years now and WEN is still not owner of part of the former WWTP. The location is highly suitable for the renewable energy purposes of WEN, but the Energy Park can also be located elsewhere. From the point of view of WSF the demolition and cleanup of the former WWTP Wijnjewoude is postponed because WEN would like to acquire the location. According to the initiator WSF does not experience the resistance WEN experiences by institutions such as WSF. The result according to the initiator is most likely that the location cannot be obtained by WEN with existing infrastructure.

Technological

The Energy Park will be assigned four functions: upgrade of biogas to green gas, electricity production by a solar PV field, electricity storage in batteries and knowledge/research center.

The biggest technological barrier according to the initiator is the feasibility of the business case for biogas. The calculated business case for the one farmer is positive, but only when the upgrade unit for biogas to green gas is shared by five farmers. This is currently an obstacle, because those farmers have not come yet to make the solid business case with five farm scale mono-manure-digesters and one biogas to green gas upgrade unit on the Energy Park.

The general ideas on the biogas to green gas still have to be drawn up in more detail such as specific installation types. Moreover it is still unknown whether more farmers actually want to be involved in this initiative. Besides these the actual technology of mono-manure-digesters is uncertain as there are limited examples in the Netherlands. The initiator claims that the business cases in surrounding counties such as Germany and Belgium is different because of subsidy structures and the installations do not need as much production time to be profitable as the claimed 92% in the Netherlands. The initiators also mentioned that the first Jumpstart farmer in Hinnaard recently quit working with the manure-digester, because in practice the installation is more difficult to manage and less efficient as projected (Bouhuijzen, 2018). Experiences are also exchanged with the farmers and consultants of the manure-digesters and biogas piping to nearby industry in Noord Deurningen (Sustainable Noord Deurningen, 2017). Although the specific digester technology is not yet selected and the idea is to add the currently maximum allowed 5% glycerin to boost production, the efficiency of mono-manure-digesters is generally low and in practice difficult to handle. As WSF is installing sewage sludge digesters on some of their WWTP to produce biogas they consider the biogas to green gas as a good initiative for WEN on the former WWTP location. It might become an obstacle for WEN in the future, to select the appropriate installations, to help the farmers to run the digesters as efficiently as possible and to receive a proper flow of biogas for the upgrade to green gas.

In the vision of WEN electricity storage of electricity from renewable sources, such as solar PV panels, is necessary to absorb seasonal fluctuations between production and consumption. Therefore their ambition is to have a test setup of batteries on the Energy Park. Various actors, including Gasunie and the Ministry of Economic Affairs and Climate Policy discourage this, because it is too complex. This might become an obstacle for WEN in the process of Wijnjewoude toward energy neutrality.

Ontological (continuity of existence)

The board of the energy cooperative WEN and the active members are all volunteers. The initiator mentions the amount of time involved is substantial. Two active members were temporary unemployed and could put more time in the cooperative. Now that one of them is employed again, less lime can be spent on the activities for the cooperative. The fact that the energy cooperative is run by volunteers that have limited time could jeopardize the progress of initiatives and also the continuity of the cooperative. This obstacle is already identified by WEN, because they know they need more professionals to progress faster to be able to reach their goal of energy neutral village in 2025.

The initiator mentions the need to publicly show some real results otherwise the continuity of WEN could be jeopardized. Although limited progress is made on the generation of renewable energy, the cooperative shows a lot of activities on their website including reports, presentations and news

items. Although the limited progress can hardly be counted as a separate barrier, the lack of substantial renewable energy production might jeopardize the continuity of the energy cooperative in the future.

Another obstacle WEN has to deal with is the distrust farmers have against digesters from the time that co-digesters were popular. These digesters use at least 50% manure and almost 50% co-products. Those farmers lost their business case when prices of co-products became unaffordable. Farmers lost a lot of money because of this, so according to the initiators WEN experiences a healthy and realistic distrust among farmers towards digesters. Moreover digesters are known to cause odor nuisance and according to the initiator some villagers are not yet explicit on this issue, probably because the locations of the digesters at the farmers are still unknown. The continuation of the biogas to green gas initiative might become an obstacle if the technology is not stable, the associated business case is not interesting for the individual farmer and the villagers do oppose against the installations.

Financial

WEN successfully gathered subsidy from the Iepen Mienskipsfûns to improve livability in Wijnjewoude from the Province of Friesland of about 22 thousand euro in total which was spent on larger projects. Since not all projects continued as planned, part of the subsidy is not spend. WEN is currently facing corporation tax because of this. According to the initiator Fiscality is considered a barrier as it is rather complex for a cooperative of volunteers.

The purchase of the former WWTP location or part of the location is dependent on the acquisition of SDE+ subsidy for the solar PV field. If the property is purchased for 30 thousand euro a revenue model is needed right from the start according to WEN. This would be different is the property was given for free or for the symbolic amount of 1 euro. WEN applied for SDE+ subsidy in the last round of 2017, but it was rejected at first based on the fact that the subsidy decision is based on 15 years and the temporary spatial planning permit is only for 10 years. Therefore RVO claims the project is not economically feasible. According to WEN many SDE+ subsidies were granted for projects based on temporary spatial planning permits and based on ruling of the Council of State RVO has to allow temporary spatial planning permits, because the installation can produce for the remaining five years on another location. Although WEN went into appeal, a news item in the regional newsletter SA! of October 3rd 2018 states that the SDE+ subsidy now officially has been rejected by RVO based on the fact that WEN currently is not the owner of the property (Waninge, 2018). This really is an obstacle for WEN, because their solar PV business case was based on an SDE+ compensation and the renewable electricity production cannot currently start.

The project plan WEN 2025 describes the various projects and resources that are needed to become an energy neutral village. According to the initiators it is expected that a number of projects of the plan will probably yield a positive business case whereupon investors are willing to pre-invest. However some projects will ultimately only cost money, such as program management and energy savings investments for houses. Moreover the involved governmental organizations such as the municipality, the Province and the water board WSF are alert on illegal State aid to cooperatives such as WEN. This may become an obstacle, because the lack of financial resources for program management and energy saving measures might cause a stagnation or slow progress of the renewable energy transition process of WEN.

Legal

WEN asked the legal department of WSF to write up a concept purchase contract. In the document it is stated that WEN should be aware that the location used to be a WWTP that could have caused environmental impact, i.e. pollution, and since they are unable to detect pollution underneath the sludge basins, that risk lies with the purchaser. The energy cooperative cannot bear this burden according to the initiator as they do not have the financial reserves. So they did not agree to these terms but instead proposed to get the property together with half of the 400 thousand euro that was put in the budget by WSF. Later WEN was offered the right of first purchase by WSF for half of the property with trees. WEN stated to want to make use of that right and asked WSF again for a concept purchase contract for that part of the property on the condition of SDE+ and including the electricity grid connection. Although the legal department of WSF was put to work on multiple occasions, it is an obstacle that WEN has limited legal knowledge causing the requirement of the current grid connection for WEN on that location not to be included in the contract yet.

WEN applied for SDE+ subsidy for the solar PV field on part of the former WWTP location awaiting acquisition of the property. WEN needs a spatial planning permit from the municipality to be able to apply for subsidy. According to WEN the municipality claims to need a change in the zoning plan to be able to issue a spatial planning permit. Finally when the temporary spatial planning permit was issued the Province nevertheless appealed because the area covered with trees is now classified as nature. The current situation is that the municipality issued the temporary spatial planning permit but the Province is still in appeal. If WEN still wants to acquire the concerning piece of property with tree, this might become an obstacle if the solar PV field cannot be installed.

Physical/Infrastructural

Besides the aforementioned obstacles concerning the acquisition of the former WWTP another physical barrier mentioned by the initiator deals with the security of the installation against vandalism and theft. Although this is currently not a barrier now, it will have to be dealt with once the solar PV field is installed or other part of the plan are realized.

Another combined physical and financial barrier mentioned by the initiator is connected to the heat pumps for the villagers that individually want to get off the gas. The removal of the gas infrastructure by the gas distribution grid operator Liander will cost 600 euro for every disconnection from the gas grid. Although this can be considered a barrier for individuals, it might become a barrier for WEN as it is one of the energy measures they promote to villagers.

Management/Control

The initiator is retired and as chairman of the board of the energy cooperative spends on average about 16 hours per week. The coordinator is involved since 2017 and as coordinator of the Energy Park spends on average about 8 hours per week, sometimes more. He currently is unemployed, so when he gets a job again it will be much less. He claims he could easily work between 40 to 60 hours per week for the cooperative, but it is unpaid. The member involved with communication spends about 8 hours per week and the rest of the board about 2 hours per week. This might become an obstacle for the progress of the project or the management of the cooperative in the future if members of WEN cannot spend enough time, because all the work for the energy cooperative is voluntarily and unpaid.

Besides the meetings with employees from the involved actors there are periodically steering group meetings in which board members of the involved parties gather to discuss pilot project WEN.

Before the project plan WEN 2025 was drafted one of the steering group member from LTO-Noord was pushed forward by the Province to become project leader of WEN biogas paid by the Province. Although WEN would rather select a project leader based on described competences, they agreed. Unfortunately the project leader got another job and according to the initiator a successor from LTO-Noord was not supplied, because of financial reasons. WSF recognizes the needed professionalism to run a large project such as WEN and would like to see the Province to help on this both financially and knowledge wise. Helping by supervising to make the right choices would be suitable according to WSF, although the Province is also searching what to do. As mentioned before this obstacle is already identified by WEN, because they know they need more professionals to progress faster to be able to reach their goal of energy neutral village in 2025.

Social/Cultural

About two years ago the social housing corporation Elkien was asked by WEN to become involved in the energy neutral vision as the actor has about 160 houses in Wijnjewoude and WEN wants to include all villagers. According to the initiator Elkien considered Wijnjewoude as a shrinking village not based on number of villagers or tenants, but based on internal strategic sessions. All property was labeled to be either focus villages, core villages or shrinking villages. The latter meaning Elkien wants to sell all property in time. WEN saw this as an opportunity especially if the corporation could provide some resources to implement energy saving measures. Because of changes in board members of Elkien and project/asset managers the new board decided on a new strategy: slowly pullback from Wijnjewoude. WEN still wants to invest possibly together with Elkien, but to set up a meeting is troublesome. This might become an obstacle for the social inclusion of tenants in WEN if no appropriate arrangements can be made with Elkien.

During member meetings of the energy cooperative sometimes members state that they like all the nice stories according to the initiator, but they want real results, such as a solar PV field. Although this obstacle is already mentioned under the continuation of the project, it is also a social obstacle because the members of the cooperation really want to change their energy situation.

The energy cooperative WEN want all villagers to become a member and therefore membership is free. At the same time WEN is aiming for active citizens that want to be actively involved in WEN. Although the potential lack of volunteers is already mentioned under the continuation, it is also a social barrier because WEN on the short-term needs active members to contribute to the realization of the project and on the long-term all villagers to become members for reaching the energy neutral village goal.

The aim for the WEN website besides showing what is done and realized, was according to the initiator also for the purpose of sharing information by villagers and participation of villagers in communities of interest. The online collaboration has unfortunately not really succeeded. Some members just wanted WEN to select the best construction contractor for instance, whereas the idea was that villagers involved with energy would actively collaborate with other villagers and companies as partners to reach sustainable solutions for their own needs. This is currently considered a barrier for creating community supported solutions, however it might become an obstacle if villagers do not become actively engaged in the energy transition in Wijnjewoude.

7.4 Measures to overcome obstacles and barriers WEN biogas

Measures to overcome the identified obstacles and barriers in WEN biogas are described in this paragraph along with some drivers for WEN to become an energy neutral village in 2025.

Technological

To involve and commit farmers to the WEN biogas project, according to the initiator WEN needs an experienced project leader that does home visits and example calculations. The intermediary also admits currently not to be able to make rough calculations for mono-manure-digesters. Another aspect mentioned by the initiator to be helpful to realize the biogas project is a strong claim by the government for the need for a different type of heating in existing houses.

Even though storage of renewable electricity production is part of the vision of WEN because it is considered to be necessary to absorb seasonal fluctuations in a sustainable energy system, it will not be worked on (Sprang et al., 2018). The seasonal fluctuations will have to be balanced in a different way.

Ontological (continuity of existence)

The initiator and coordinator speak and act on behalf of the energy cooperative WEN and discuss the general strategy toward the involved actors. Even though they might experience resistance sometimes, they try to stay constructive. That way WEN tries to engage actors. Continually the strategy is discussed internally when an issue arises.

The resistance WEN experiences from involved actors according to the initiator is discussed during meetings they had together. First the strategy during these meetings was to personally address the actors in their role in the project and in their organization. However during one of the steering group meetings in the presence of a process supervisor the WEN chairman was pointed on his critical comments that removed positive energy from the meeting. The new strategy according to the initiator is on the one hand confirm that the actors share the same vision, but on the other ask for understanding on how it is for initiators. WEN not only wants to think and talk about ideas, they want to put ideas on energy neutrality into practice in Wijnjewoude. WEN also shows this by the subtitle of the project plan WEN 2025: ‘From thought policy to done policy’ (Sprang et al., 2018).

WEN has a list of about 28 dairy farmers in the surroundings of Wijnjewoude that might become involved in the biogas to green gas initiative. These farms vary in size, in this case the amount of cows that produce manure is relevant. Looking at a business case for an individual farm a minimal amount of cattle would be required, but in the combination of larger and smaller farms more farms could have a business case for jointly upgrading to green gas.

The initiator claim that the total amount of work and required expertise to reach the energy neutral target in 2025 can hardly be expected from a group of local volunteers and asked for real commitment from the involved actors. In order to support the demand for substantial professional help, a project plan was written by actor Liander under supervision of WEN (Sprang et al., 2018). The expected professional resources required amounts to 15,9 fte (full-time equivalent) till 2025. WEN is currently in the process of asking commitment from the individual actors to deliver part of the required resources. Moreover WEN is convinced to have to work on some projects in parallel in order to reach their ambitious goal.

Financial

WEN has the idea to second specific civil servants of the Province of Friesland and the municipality Opsterland together with employees of the involved companies to Wijnjewoude in order to works closely together on the projects in the village itself. The initiator calls this 'new professionalism'. In his vision 'Old professionalism' is that the professional explaining to be right and 'New professionalism' is that the professional puts all his knowledge and skills at the service of what the customer, in this case the citizen, wants to realize. The latter is to collaborate cooperatively, which is the goal for WEN with its involved actors. This might be one of the measures to involve professionals that help the project to progress and is financially supported by the involved actors. Especially the project parts of the WEN 2025 plan that will not return on investment might be contributed in this way in the interests of society as a whole.

The costs involved in infrastructure such as a heavy grid connection for the solar PV field and connection to an injection location of the gas grid can be minimized if existing infrastructure can be reused as is currently planned for the former WWTP location.

Now that the SDE+ subsidy has been rejected by RVO the energy cooperative will need to discuss the situation internally on the acquisition of the former WWTP. Currently there is no prospect of revenues from the business case of the projected 1 hectare solar PV field that can contributed to opportunity to buy the property. The search for an alternative location for the solar PV field could be a measure to overcome this obstacle.

Legal

A so-called "kruimelregeling" (crumbs regulation) exists to provide a temporary permit for 10 years if the proposed project generally is in line with the planning of the municipality and not very substantial (Ministry of the Interior and Kingdom Relation, 2018a). The municipality is projecting one hundred hectares of solar PV park also in the area of Wijnjewoude, so according to the initiator that could not be a barrier. WEN put a lot of pressure on the local council in order to get the temporary permit. The province of Friesland also had to agree. They did after some pressure. Finally this was realized right through the official resistance according to the initiator. To receive a final permit according to the coordinator it takes at least 1.5 years due to public consultation periods. Even though WEN managed to take this measure to overcome the permit barrier, the Province eventually appealed the temporary permit. Although WEN did some research on compensation of nature for their plans of the solar PV field, they would rather not build on nature and therefore to overcome this obstacle the solar PV field might be planned elsewhere.

Physical/Infrastructural

Currently the Energy Park Wijnjewoude is planned at the former WWTP location of WSF. Even though the location is very suitable for different projects WEN is currently working on, the project will continue elsewhere independent of the acquisition of this location.

Management/Control

WEN tries to manage all interests as good as possible and tries to mitigate or solve problems that occur as soon as possible. As long as no professionals are involved in the projects of WEN 2025, the volunteers will work on them. The initiator and coordinator together are involved in the overall project management and WEN biogas. The coordinator is also involved as coordinator of the Energy Park. Other board members of the cooperative are involved in other parts of the plan. When

professionals take over, the idea is that the WEN volunteers take a step back in a way that they remain in control.

As stated in the project plan, WEN wants professional independent project leaders, certainly for the biogas to green gas project, in order to manage the whole project, to identify opportunities and to draw up what is needed to realize the plan. The initiator mentions that this could well be someone from the Gasunie, LTO-Noord or another agriculture related company.

The year plan of the energy cooperative will also be structured around the overall project management and the different projects in the plan in such a way that it will be clear who will take the lead and who will take a step back. By doing proper project management, the expectation of the coordinator is that the progress will be less jerky as it currently is.

Ultimately WEN wants to operate the whole Energy Park in-house by members of the energy cooperative. According to the coordinator maintenance will probably be done together with commercial preferably local parties.

Social/Cultural

WEN wants to include tenants of the social houses of housing corporation Elkien as they want to include all villagers in the vision of energy neutrality. However most of the energy measure are focused on private home owners. A measure to overcome this obstacle is to negotiate with Elkien on gradually taking over the houses including proposed energy measures.

The coordinator and another active member of the energy cooperation were unemployed at a certain moment. WEN is using their resources to pay for education of these members to become an energy consultant. This has succeeded for the active member. Although this measure might have a negative influence on the amount of time these active members spend on WEN, the initiator considers this as an important part of the social side of sustainability.

According to the WEN website the current number of members of the cooperative is 190 families. The initiator claims the approximate number of villagers is 2000 living in approximately 800 houses. One of the measures to recruit more members is to keep the membership currently free of charge. For WEN this is one way to identify members that might potentially actively support the cooperative.

At the moment WEN starts producing green gas, it will be distributed through the existing gas grid virtually tracked and traded by a Guarantee of Origin. The current approach of WEN is to sell the produced renewable electricity and green gas to EnergieVanOns. As many inhabitants of Wijnjewoude as possible would become client of EnergieVanOns to use the locally produced renewable energy. EnergieVanOns will pay a contribution of €75 per year for every client that consumes both renewable electricity and green gas for the benefit of the village.

Remarks on WEN biogas

The challenge of becoming energy neutral within 10 years is easier said than done. The volunteers of the energy cooperative WEN put in a lot of time and effort to keep the attention of actors involved in their pilot village. One of the actors, network operator Liander, drew up a project plan under supervision of WEN on how much professional time is needed for all different topics in the aim to reach energy neutrality in 2025. This plan is a realization of what it really entails to go for an ambition to become energy neutral for a village of 800 houses and approximately 2000 inhabitants.

The approach of WEN is that the ideas need to come from the local community and the community should stay in control while professionals tackle the projects in a faster way, with an expert approach and more realistic than volunteers can do from the local community.

There is a tension between the possibility to acquire the tree area of the former WWTP location and the condition that the sale should include the current electricity grid connection, because the connection is on the other half of the property where the buildings are situated. Currently the part with the buildings is on public sale and potential buyer would possibly require an electricity grid connection as well.

7.5 Conclusions Obstacles, Barriers and Measures of studied cases

Divers obstacles and barriers have been identified as well as some measures to overcome them.

Both the initiatives TEO Heeg and WEN biogas depend on volunteers to work on the major task of becoming energy neutral villages in 2025. Although both projects focus on different technologies to provide the village with a locally produced source of renewable energy for heating in existing houses, they show similarities and share obstacles and barriers.

One of the drivers the initiatives share which was also mentioned by the intermediary of the Energy Workshop, is the vision process in the villages. Although the reasons slightly differ the municipalities played a role in the start of this process. The vision process resulted in a shared vision and sustainable perspective as part of the energy transition and sustainable development.

Apart from similar drivers the initiatives share among others the following obstacles and barriers:

1. The real commitment of involved actors has to be determined to overcome obstacles in the area of financing, management and progress of the initiatives;
2. Good examples of similar socio-technical initiatives are limited for both initiatives to learn from and to convince villagers and actors that it can be done and what the prospect in practice might look like;
3. The technological setup of the initiatives have not yet been drafted and although an economic feasibility study and a business case feasibility study have been carried out that is favorable for the initiatives, obstacles and barriers are likely to appear during realization of the plans in practice on installation and control of the technologies;
4. The continuity of the initiatives currently depends on the time volunteers are available to work and make progress. This obstacle is inherent to the organization of local community energy cooperatives and the measure to overcome this is to engage professionals from the involved actors or paid by the involved actors in the interest of society as a whole. Both initiatives are careful to stay in control over their initiative;
5. Both district heating and farm scale digesters share a historic negative image that has to be overcome besides convincing villagers on the specific technology and the cooperative collaboration to realize the initiatives;
6. Both initiatives experience barriers in the process of recruiting members for the cooperatives. TEO Heeg first wanted to have calculations on the economic feasibility to gradually introduce the initiative to the villagers and although WEN has free membership and their cooperative grows gradually, they need members to become engaged;
7. The social housing corporation Elkien owns approximately 150 houses in both villages. Although the circumstances are different, both initiatives experience difficulties in involving Elkien or make appropriate arrangements for the social inclusion of tenants in the initiatives.

In some respects the one initiative is more advanced over the other and vice versa. WEN already has a project plan with much more detail on the various parts of the project to become an energy neutral village in 2025. Duurzaam Heeg is going to draft a project plan to submit for the Program Natural gas-free neighborhoods. The actors in TEO Heeg currently show more engagement than the actors in WEN, possibly because WEN is all-encompassing and therefore difficult to show responsibility for a specific part of the plan. WEN is publically showing more activities and status updates on their website than Duurzaam Heeg, although Duurzaam Heeg seems to be in the process of starting this up for the strategy to slowly introduce the initiative to the village.

Some of the identified obstacles and barriers are specific to one of the initiatives, among others:

1. The infrastructural adjustments in the streets of Heeg are the biggest obstacles both socially as well as financially. Measures to overcome these obstacles are to combine the digging for the district heating grid with other plans, such as the renewal of the sewage system to reduce the impact for villagers as well as sharing the costs with others;
2. The acquisition of the former WWTP Wijnjewoude from WSF has proven to be a large obstacle for WEN the last almost two years. Specific features of the property can be reused for the Energy Park such as the grid connections and former sludge basins. Although various proposals have been reviewed, WEN does not own the property and because of this also SDE+ subsidy for the planned solar PV field was rejected.

Although the initiatives are not directly in the process of developing niches they are aware that their projects can contribute to other villages and neighborhoods in the progress towards energy neutrality or steps forward in the energy transition. Even though the obstacles and barriers these initiatives are experiencing as well as the measures they are taking to overcome them might be specific to the respective initiatives, they may certainly be used as examples and as inspiration to other initiatives especially in Friesland as they share the same support structure with rules, regulations and strategic intermediary Energy Workshop to help overcome obstacles and barriers. Moreover governmental actors such as municipalities and the water board WSF may also need to help protect the spaces these initiatives are developing in, as the technological innovations need the opportunity to show to be viable in practice.

8 Discussion

In this chapter the research conducted and the possibility for limited conclusions based on the two cases is discussed.

The two reconstructed, described and analyzed cases are the most advanced initiatives in the area of natural gas-free local community district heating in Friesland organized by cooperatives of citizens of two villages, however they are only still in the planning phase of development. Therefore only niche processes, obstacles, barriers and measures in the early stage of niche development could be studied.

The two studied cases in district heating are both located in the same province. Although the cases are forerunner initiatives in Friesland, during network meetings of ODE Decentraal, REScoop Plus and HierOpgewekt it became clear that a number of interesting cooperative heat initiatives in other provinces are also developed. However the initiatives in Friesland share the same support structure with rules, regulations and strategic intermediary Energy Workshop, new initiatives can therefore learn from close examples and benefit from existing and experienced support to create more solid niches.

In the case of TEO Heeg all relevant involved actors have been interviewed except for housing corporation Elkien. This interview is not held because less involvement was shown to the initiative in Heeg and probably only the expectations of Elkien towards the initiative could have been added to the reconstruction.

In the case of WEN biogas the two main actors from the initiative have been interviewed and two of the other involved actors. Although an attempt was undertaken to interview the municipality, all other mentioned actors have not been interviewed. The initiator and the coordinator were at the crucial point of requesting commitment based on the project plan WEN 2025 by visiting all involved actors separately. Before real commitment was gathered by the initiators, interviews for this research would possibly have caused some disturbance. Although the initiators did not object, probably only the expectations would become more clear and the identified obstacles and barriers with regards to the commitment of professionals would have been confirmed as well as the shared vision toward an Energy Neutral village. However to conduct the interviews after real commitment was gathered, would have added to the findings of measures to overcome some of the obstacles and barriers for professional support. Moreover actors that would leave the initiatives could help identify additional obstacles and barriers.

Coincidentally the intermediary lives in Heeg. During the interviews the independence of the intermediary has been questioned and although the intermediary displayed much interest in the TEO Heeg case, it was confirmed that his role in not different in this initiatives than in other initiatives and since both the initiator and the intermediary are already off the gas grid in that respect they do not have personal interests.

The potential for thermal energy from surface water is considerable in the water-rich province of Friesland. The same applies to biogas from mono-manure-digesters, as Friesland is a rural area with numerous dairy farms. Although the infrastructural changes in the case of TEO are expected to resort in a bigger societal impact than biogas to green gas in the existing natural gas grid, the energy from surface water can be considered as a primary naturally occurring source of solar energy that keeps the energy chain short and is potentially more solid than biological processes in the chain of feedstock, dairy cattle, manure and biogas. However the technological innovations in biogas are

limited that could be beneficial to the extent to which this case could be replicated over the TEO case.

Although the studied cases display evidence on niche development of local renewable space heating for existing houses that could become a dominant niche to shift the natural gas regime, it may be considered that the formal rule change by the natural gas-free target in the Netherlands may not only be a shock to the existing natural gas regime to create an opportunity for niche innovations, it may change the regime directly as the fossil energy source natural gas will be considered as an obsolete technology that is going to be banned for the purpose of space heating in houses.

The dilemma of villages becoming energy neutral and the national task to become gas-free was touched by the strategic consultant of the municipality of SWF. If all villages and neighborhoods would become energy neutral, still a lot more energy has to be produced to run the country. Possibly not all regions of the Netherlands can reach targets of energy neutrality, so it can be expected that in the regional energy strategies a larger contribution to the national task is to be included. In the case of energy neutral villages in the context of a rural area such as Friesland it could mean that villages have to become net energy producers.

Another aspect that was mentioned in the interviews was the Frisian region and culture that shapes the situation of dependency on each other to make things happen also in the energy transition. Even though cultural aspects were also mentioned with regards to Denmark cooperative district heating, in this research no arguments have been identified to support findings based on aspects of the Frisian culture.

Finally all interviews have been conducted and transcribed in Dutch and although the interviews are carefully interpreted, some details may have been lost in translation or errors could have been introduced to this English written research report.

9 Conclusions and Recommendations

The main question of this research is: *"How can local renewable energy initiatives create successful niches for natural gas-free district heating that contribute to the transition towards a new heating regime for existing houses?*

First in answer to sub-question 1 the natural gas based space heating regime of existing houses is described. In the literature on the multi-level perspective (MLP) the sociotechnical regime is the meso-level between the macro-level sociotechnical landscape and micro-level technological niche. Sociotechnical regimes consist of three interlinked dimensions: actors, technology and rules. The natural gas based space heating regime of existing houses consists of actors from the Dutch State participating in the natural gas extraction, through a national transmission grid and local distribution grid, to be supplied to household consumers in combi gas boiler heating systems. The regime is path dependent as it has improved the energy efficiency along the line of gas incineration boilers and is locked-in the technology with natural gas as energy source from the gas grid. Although existing regime actors have vested interests, the rules that help stabilize the regime are changed under external influence among others to mitigate the effects of earthquakes by the gas extraction and to mitigate the effects of climate change by the emission of greenhouse gasses.

These insights are used to connect to the results of the case studies on niche innovations in district heating and the proposed structural changes in the energy system.

Next the key processes, obstacles and barriers in niche development in local district heating are described based on literature in answer to sub-question 2. The three key processes to identify and evaluate in case studies from the theory of strategic niche management (SNM) are the articulation of visions and expectations, formation of (new) actor networks and organization of learning processes. Successful niche development depends on identified aspects of all three processes. Beyond niche internal processes, the external processes at regime and landscape level are also important for niche developments to diffuse more widely as part of the multi-level perspective (MLP). Besides obstacles and barriers in relation to these key internal niche processes, niche development in local district heating initiatives can also be prevented or obstructed by aspects in the area of technology, ontology (continuity of existence), finance, legal, physical, infrastructural, management & control and cultural & social.

The key processes in niche development and the categories of obstacles and barriers together form the assessment criteria for evaluating the case studies on their niche development. Based on these assessment criteria the interview questions for involved actors have been formulated.

Subsequently two cases have been researched on how these local renewable energy initiatives are developing niches in local district heating in the province of Friesland in answer to sub-question 3. The selected cases are: TEO Heeg and WEN biogas. These cases are currently the forerunner citizen initiatives on community renewable heat for space heating in existing residential houses. Interviews have been conducted with involved actors.

Based on the assessment criteria in the TEO Heeg initiative, various aspects of niche development have been identified, including a vision process resulting in a village vision report, the founding of energy cooperative Duurzaam Heeg with reused statutes of another energy cooperative, a new combination of existing technologies to retrieve energy from surface water to be applied as an innovation in space heating of existing houses in the village of Heeg, for the planning phase relevant and involved actors, pro-active support by the municipality, intense support by intermediary

organization Energy Workshop and shown interest by the initiator, intermediary, municipality and water board to share knowledge on technology, finance and processes to develop the technology and to acquire participants. Although the initiative is in the planning phase and the social housing corporation is not fully involved, the development of this initiative can be considered as solid especially by the commitment of the initiator, the intermediary, the municipality and the water board displayed during the economic feasibility study and the process in the application for the Program natural gas-free neighborhoods. Based on the evidence found in this research on the identified aspects, involved actors and initiative processes in the TEO Heeg case study it can be concluded that the project is a niche in the area of local renewable energy as cooperative thermal energy from surface water to be applied in space heating of existing houses in the context of natural gas-free Netherlands. Moreover it may be considered successful in the current stage not only as a cooperative citizen initiative that is going to be described by the strategic niche intermediary Energy Workshop as a project that can be replicated elsewhere, but especially as a promising technological innovation with great energy potential that could possibly replace the gas-regime for space heating of existing houses. The energy from surface water can be considered as a primary naturally occurring source of solar energy.

For the WEN biogas initiative, as part of the integral vision of Wijnjewoude Energy Neutral 2025, also various aspects of niche development have been identified, including a vision process resulting in a shared vision website, the founding of the energy cooperative WEN, with reused statutes and added internal regulations, a new combination of existing technologies to use farm scale mono-manure-digesters to produce biogas that is transported to a central upgrade unit to produce green gas to replace natural gas for space heating of existing houses of the village of Wijnjewoude, the involved actors since the pilot status of the village are very diverse and commitment will be requested based on a detailed project plan written by current grid operator Liander and the comprehensive information sharing through the WEN website including business case documents, presentations and news items. Although the initiative is in the planning phase and the commitment of the involved actors is currently requested, the development of this initiative can be considered as solid especially by the continuous commitment of the initiator and the coordinator to engage in the Energy Park and the plans written on the energy projects and the required professional deployment. Based on the evidence found in this research on the identified aspects, involved actors and initiative processes in the WEN biogas case study it can be concluded that the project is a niche in the area of local renewable energy as cooperative biogas to green gas to be applied in space heating of existing houses in the context of natural gas-free Netherlands.

Although both cases display strong social innovation components as citizen cooperatives to provide renewable energy for their villages, they also show strong elements of technological innovations that contribute to the development of a niche in the area of local renewable energy for space heating of existing houses in the context of natural gas-free Netherlands. This niche can be considered as a new socio-technical niche that can further be studied by SNM as a policy instrument for a new governance model for local renewable district heating.

Finally based on the assessment criteria divers obstacles and barriers have been identified to answer sub-question 4 as well as some measures to overcome them in answer to sub-question 5. Both the initiatives TEO Heeg and WEN biogas depend on volunteers to work on the major task of becoming energy neutral villages in 2025. Although both projects focus on different technologies to provide the village with a locally produced source of renewable energy for heating in existing houses, they show similarities and share obstacles and barriers. One of the drivers the initiatives share, is the vision process in the villages. Although the reasons slightly differ the municipalities played a role in

the start of this process. The vision process resulted in a shared vision and sustainable perspective as part of the energy transition and sustainable development.

The following shared obstacles and barriers have been identified: real commitment of involved actors has to be determined to overcome obstacles in the area of financing, management and progress of the initiatives; Good examples of similar sociotechnical initiatives are limited for both initiatives to learn from and to convince villagers and actors; technological setup of the initiatives have not yet been drafted and although an economic feasibility study and a business case feasibility study have been carried out that look favorable for the initiatives, obstacles and barriers are likely to appear during realization of the plans in practice on installation and control of the technologies; continuity of the initiatives by limited time of volunteers can be overcome by engaging professionals from the involved actors while the initiative stays in control; both district heating and farm scale digesters share a historic negative image that has to be overcome besides convincing villagers on the specific technology and the cooperative collaboration to realize the initiatives; the experienced barriers in the process of recruiting members for the cooperatives are attempted to overcome by economic feasibility calculations, gradually introduction of the initiative, by free membership to try to find engaged members; both initiatives experience difficulties in involving housing corporation Elkien to make appropriate arrangements for the social inclusion of tenants in the initiatives.

In some respects the one initiative is more advanced over the other and vice versa. WEN already has a project plan with much more detail on the various parts of the project to become an energy neutral village in 2025. Duurzaam Heeg is going to draft a project plan to submit for the Program Natural gas-free neighborhoods. The actors in TEO Heeg currently show more engagement than the actors in WEN, possibly because WEN is all-encompassing and therefore difficult to show responsibility for a specific part of the plan. WEN is publically showing more activities and status updates on their website than Duurzaam Heeg, although Duurzaam Heeg seems to be in the process of starting this up for the strategy to slowly introduce the initiative to the village.

Some of the identified obstacles and barriers are specific to one of the initiatives, among others: the infrastructural adjustments in the streets of Heeg are the biggest obstacles both socially as well as financially. Measures to overcome these obstacles are to combine the digging for the district heating grid with other plans, such as the renewal of the sewage system to reduce the impact for villagers as well as sharing the costs with others; The acquisition of the former WWTP Wijnjewoude from WSF has proven to be a large obstacle for WEN the last almost two years. Specific features of the property can be reused for the Energy Park such as the grid connections and former sludge basins. Although various proposals have been reviewed, WEN does not own the property and because of this also SDE+ subsidy for the planned solar PV field was rejected.

Although the initiatives are not directly in the process of developing niches they are aware that their projects can contribute to other villages and neighborhoods in the progress towards energy neutrality or steps forward in the energy transition. Even though the obstacles and barriers these initiatives are experiencing as well as the measures they are taking to overcome them might be specific to the respective initiatives, they may certainly be used as examples and as inspiration to other initiatives especially in Friesland as they share the same support structure with rules, regulations and strategic intermediary Energy Workshop to help overcome obstacles and barriers. Moreover governmental actors such as municipalities and the water board WSF may also need to help protect the spaces these initiatives are developing in, as the technological innovations need the opportunity to show to be viable in practice.

Based on the findings the answer to the main question of this research is:

Local renewable energy initiatives create successful niches for natural gas-free district heating by real commitment of relevant actors that have articulated their expectations and share the vision of community initiatives in the area of thermal energy from surface water or farm scale mono-manure-digesters and transparently share information on development processes and documents such as statutes, project plans and economic feasibility calculations. Initiatives in Friesland share the same support structure with strategic intermediary Energy Workshop to be able to overcome obstacles and barriers to replicate successful technological projects and with the help of changing rules by external influence to mitigate environmental impacts these accumulated projects may contribute to the transition towards a new heating regime for existing houses.

Finally it is recommended to do more research on the two forerunner initiatives in more advanced stages of development and possibly ex post to be able to analyze the full development. Meanwhile different case studies can be executed to help stimulate the learning process between initiatives in the niche of local renewable energy for space heating of existing houses in the context of natural gas-free Netherlands.

References

Autoriteit Consument & Markt (Authority for Consumers and Markets). Gas Act Decree on transfer point of gas connections to the distribution grid (2017). Retrieved from https://zoek.officielebekendmakingen.nl/stcrt-2017-56338.html

Autoriteit Consument & Markt (Authority for Consumers and Markets). (2017b, May 17). Incentive regulation of the gas and electricity networks in the Netherlands. Retrieved from https://www.acm.nl/en/publications/publication/17231/Incentive-regulation-of-the-gas-and-electricity-networks

Autoriteit Consument & Markt (Authority for Consumers and Markets). (2018a). Gasregister. Retrieved September 20, 2018, from https://www.acm.nl/nl/onderwerpen/energie/netbeheerders/gasaansluitplicht/gasregister

Autoriteit Consument & Markt (Authority for Consumers and Markets). (2018b). Vergunninghouders gas (License holders gas). Retrieved September 21, 2018, from https://www.acm.nl/nl/onderwerpen/energie/energiebedrijven/vergunningen/vergunninghouders-gas

Bas, A. van der. (2016, October 10). Feasibility study micro digestion and manure processing. DLV Consultancy. Retrieved from https://www.wen.frl/wp-content/uploads/2016/12/onderzoeksrapport-mestvergisting.pdf

Becker, S. L., Franke, F., & Gläsel, A. (2017). Regime pressures and organizational forms of community-based sustainability initiatives. *Environmental Innovation and Societal Transitions*. https://doi.org/10.1016/j.eist.2017.10.004

Boon, F. P., & Dieperink, C. (2014). Local civil society based renewable energy organisations in the Netherlands: Exploring the factors that stimulate their emergence and development. *Energy Policy*, *69*, 297–307. https://doi.org/10.1016/j.enpol.2014.01.046

Boon, W. P. C., Moors, E. H. M., & Meijer, A. J. (2014). Exploring dynamics and strategies of niche protection. *Research Policy*, *43*(4), 792–803. https://doi.org/10.1016/j.respol.2014.01.005

Bouhuijzen, L. (2018, June 30). Eerste Jumpstartboer wil stoppen met monovergister (First Jumpstart farmer want to quit with the mono-digester). Retrieved October 26, 2018, from https://www.melkvee.nl/artikel/83129-eerste-jumpstartboer-wil-stoppen-met-monovergister/

Consumentenbond (Consumer Association). (2018). Energiecollectief: Bespaar tot €200 op je rekening | Consumentenbond. Retrieved April 1, 2018, from https://www.consumentenbond.nl/energie-vergelijken/vergelijker/energiecollectief

Cooperative Wijnjewoude Energy Neutral. (2016, December). Project plan Energy Park WEN - Tolleane Wijnjewoude - From Wastewater treatment to Energy Park. Retrieved from https://www.wen.frl/rioolzuiveringslocatie/

Correljé, A. F., Linde, J. G. van der, & Westerwoudt, T. (2003). *Natural gas in the Netherlands: from cooperation to competition?* Amsterdam-Zuidoost: Oranje-Nassau Groep.

Duurzaam Heeg (Sustainable Heeg). (2018a). Retrieved October 2, 2018, from http://duurzaamheeg.nl/

Duurzaam Heeg (Sustainable Heeg). (2018b, October 22). Potentie thermische energie uit water groter dan gedacht (Potential thermal energy from water higher than expected). Retrieved October 25, 2018, from https://duurzaamheeg.nl/potentie-thermische-energie-uit-water-groter-dan-gedacht/

EBN. (2018). About EBN. Retrieved November 7, 2018, from https://www.ebn.nl/en/about-ebn/

EKGaryp (Energy Cooperative Garyp). (2018, October). EKGaryp - Natural gas-free Garyp. Retrieved October 22, 2018, from https://ekgaryp.nl/index.php

Elzinga, J. (2014, November 10). Energiecoöperatie opgericht in Heeg (Energy cooperative Heeg founded). Retrieved October 25, 2018, from http://uskooperaasje.nl/energiecooperatie-opgericht-in-heeg/

Energy Cooperative Garyp. (2017, January). EKGaryp (Energy Cooperative Garyp). Retrieved October 21, 2018, from https://ekgaryp.nl/nieuws

Energy Workshop Friesland. (2016). Heeg als eerste Friese dorp aan de slag met Postcoderoos – Energiewerkplaats. Retrieved October 9, 2018, from http://energiewerkplaats.frl/?p=486

Energy Workshop Friesland. (2018). Wat doet Energiewerkplaats Fryslân (What does the Energy Workshop Friesland). Retrieved October 21, 2018, from http://energiewerkplaats.frl/?page_id=203

Envida Community Energy. (2017). Heat Sources for Community Energy. Retrieved March 11, 2018, from http://www.envida.ca/en/developingsustainableenergy/howdistrictenergyworks.asp

European Union. (2009a). Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.

European Union. (2009b). Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC, 39.

European Union. (2009c). Directive 2009/73/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in natural gas and repealing Directive 2003/55/EC, 43.

Foxon, T. J., Bale, C. S. E., Busch, J., Bush, R., Hall, S., & Roelich, K. (2015). Low carbon infrastructure investment: extending business models for sustainability. *Infrastructure Complexity*, *2*(1). https://doi.org/10.1186/s40551-015-0009-4

Geels, F., & Deuten, J. J. (2006). Local and global dynamics in technological development: a socio-cognitive perspective on knowledge flows and lessons from reinforced concrete. *Science and Public Policy*, *33*(4), 265–275. https://doi.org/10.3152/147154306781778984

Geels, F., & Raven, R. (2006). Non-linearity and Expectations in Niche-Development Trajectories: Ups and Downs in Dutch Biogas Development (1973–2003). *Technology Analysis & Strategic Management*, *18*(3–4), 375–392. https://doi.org/10.1080/09537320600777143

Geels, Frank W. (2004). From sectoral systems of innovation to socio-technical systems. *Research Policy*, *33*(6–7), 897–920. https://doi.org/10.1016/j.respol.2004.01.015

Geels, Frank W. (2011). The multi-level perspective on sustainability transitions: Responses to seven criticisms. *Environmental Innovation and Societal Transitions*, *1*(1), 24–40. https://doi.org/10.1016/j.eist.2011.02.002

Geels, Frank W. (2018). Disruption and low-carbon system transformation: Progress and new challenges in socio-technical transitions research and the Multi-Level Perspective. *Energy Research & Social Science*, *37*, 224–231. https://doi.org/10.1016/j.erss.2017.10.010

Geels, Frank W., & Kemp, R. (2007). Dynamics in socio-technical systems: Typology of change processes and contrasting case studies. *Technology in Society*, *29*(4), 441–455. https://doi.org/10.1016/j.techsoc.2007.08.009

Geels, Frank W., & Schot, J. (2007). Typology of sociotechnical transition pathways. *Research Policy*, *36*(3), 399–417. https://doi.org/10.1016/j.respol.2007.01.003

Geels, Frank W., Schwanen, T., Sorrell, S., Jenkins, K., & Sovacool, B. K. (2018). Reducing energy demand through low carbon innovation: A sociotechnical transitions perspective and thirteen research debates. *Energy Research & Social Science*, *40*, 23–35. https://doi.org/10.1016/j.erss.2017.11.003

Geels, F.W. (2005). Processes and patterns in transitions and system innovations: Refining the co-evolutionary multi-level perspective. *Technological Forecasting and Social Change*, *72*(6), 681–696. https://doi.org/10.1016/j.techfore.2004.08.014

Gemeente Súdwest-Fryslân (Municipality South-West Friesland). (2017, December 29). Coalitieakkoord SWF ontwikkelt en verduurzaamt 2018-2022 (Coalition agreement SFW development and sustainable 2018-2022).

Gemeente Súdwest-Fryslân (Municipality South-West Friesland). (2018, July 12). Agenda Duurzame Ontwikkeling 2018-2022 (Agenda Sustainable Development 2018-2022).

Gerdes, J., Marbus, S., & Boelhouwer, M. (2016, September 13). Energietrends / Energy trends 2016. ECN, Energie-Nederland, Netbeheer Nederland. Retrieved from http://www.ecn.nl/publications/ECN-O--16-031

Habitissimo. (2018). Drawing of gas installation at home. Retrieved November 7, 2018, from https://fotos.habitissimo.es/foto/grafico-de-instalacion-de-gas-en-vivienda_706626

Hargreaves, T., Hielscher, S., Seyfang, G., & Smith, A. (2013). Grassroots innovations in community energy: The role of intermediaries in niche development. *Global Environmental Change*, *23*(5), 868–880. https://doi.org/10.1016/j.gloenvcha.2013.02.008

Hasanov, M., & Zuidema, C. (2018). The transformative power of self-organization: Towards a conceptual framework for understanding local energy initiatives in The Netherlands. *Energy Research & Social Science*, *37*, 85–93. https://doi.org/10.1016/j.erss.2017.09.038

Hermans, F., van Apeldoorn, D., Stuiver, M., & Kok, K. (2013). Niches and networks: Explaining network evolution through niche formation processes. *Research Policy*, *42*(3), 613–623. https://doi.org/10.1016/j.respol.2012.10.004

Het Energie Initiatief (The Energy Initiative). (2018). Retrieved October 2, 2018, from https://www.energie-initiatief.nl/

Hieropgewekt. (2018, March 31). Lokale Duurzame Energie-initiatieven. Retrieved March 31, 2018, from https://www.hieropgewekt.nl/initiatieven

HIERopgewekt (Generated Here). (2018). Retrieved October 2, 2018, from https://www.hieropgewekt.nl/

HIERverwarmt (Heated Here). (2018). Retrieved October 2, 2018, from https://www.hierverwarmt.nl/kaart

Historie Coöperatie Wijnjewoude Energie Neutraal (History Cooperative Wijnjewoude Energy Neutral). (2018). Retrieved October 14, 2018, from https://www.wen.frl/onze-historie/

Hoppe, T., Graf, A., Warbroek, B., Lammers, I., & Lepping, I. (2015). Local Governments Supporting Local Energy Initiatives: Lessons from the Best Practices of Saerbeck (Germany) and Lochem (The Netherlands). *Sustainability*, *7*(2), 1900–1931. https://doi.org/10.3390/su7021900

IF Technology. (2018, March 12). Thermische Energie uit Oppervlaktewater - Business case Genderdal. Retrieved from http://m.stowa.nl/Upload/onderzoek_projecten/Thermische%20energie%20uit%20oppervla

ktewater/Thermische%20Energie%20uit%20Oppervlaktewater%20-%20Business%20case%20Genderdal%20-%20Definitief%201.pdf

IPO (Interprovinciaal Overleg). (2016, June 22). IPO : Regio's maken werk van energiedoelen. Retrieved March 31, 2018, from http://www.ipo.nl/publicaties/regios-maken-werk-van-energiedoelen

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. https://doi.org/10.1080/09537329808524310

Kiwa. (2018a). Kiwa at a glance. Retrieved November 7, 2018, from https://www.kiwa.com/en/about-kiwa/

Kiwa. (2018b). Kiwa Gaskeur. Retrieved November 7, 2018, from https://www.kiwa.com/en/service/gaskeur/

Kooij, H.-J., Oteman, M., Veenman, S., Sperling, K., Magnusson, D., Palm, J., & Hvelplund, F. (2018). Between grassroots and treetops: Community power and institutional dependence in the renewable energy sector in Denmark, Sweden and the Netherlands. *Energy Research & Social Science*, *37*, 52–64. https://doi.org/10.1016/j.erss.2017.09.019

Lund, H., Möller, B., Mathiesen, B. V., & Dyrelund, A. (2010). The role of district heating in future renewable energy systems. *Energy*, *35*(3), 1381–1390. https://doi.org/10.1016/j.energy.2009.11.023

Lund, Henrik. (2010). The implementation of renewable energy systems. Lessons learned from the Danish case. *Energy*, *35*(10), 4003–4009. https://doi.org/10.1016/j.energy.2010.01.036

Lund, Henrik, Hvelplund, F., Østergaard, P., Möller, B., Mathiesen, B. V., Connolly, D., & Andersen, A. N. (2014). Analysis. In *Renewable Energy Systems* (pp. 131–184). Elsevier. https://doi.org/10.1016/B978-0-12-410423-5.00006-7

Meadows, D. H., Meadows, D. L., Randers, J., & Behren, W. W. (1972). *The Limits to Growth: A Report for the Club of Rome's Project on the Predicament of Mankind*. New York: Universe Books.

Mienskipsenergie. (2018a). Principes van Raerd - Mienskipsenergie (Principles of Raerd - Community Energy). Retrieved October 5, 2018, from http://mienskipsenergie.frl/principes-van-raerd/

Mienskipsenergie. (2018b, April 26). Press release MienskipsEnergie - Garyp. Retrieved October 22, 2018, from http://mienskipsenergie.frl/persbericht-mienskipsenergie/

Ministry of Economic Affairs. (2016). *Energieagenda – Naar een CO2-arme energievoorziening*.

Ministry of Economic Affairs. (2017). *Energy Agenda: Towards a low-carbon energy supply*.

Ministry of Economic Affairs and Climate Policy. (2018). *Proposal for a Climate Agreement*. https://www.klimaatakkoord.nl/actueel/nieuws/2018/07/10/eerste-belangrijke-stap-naar-klimaatakkoord

Ministry of the Interior and Kingdom Relation. Gaswet (Gas Act) (2000). Retrieved from https://wetten.overheid.nl/BWBR0011440/2018-07-28

Ministry of the Interior and Kingdom Relation. Besluit omgevingsrecht (Decree Environmental Licensing Act), § Appendix II (2018). Retrieved from https://wetten.overheid.nl/BWBR0027464/2018-07-28#BijlageII

Ministry of the Interior and Kingdom Relation. Dutch Water Act (2018). Retrieved from https://wetten.overheid.nl/BWBR0025458/2018-07-01

Ministry of the Interior and Kingdom Relation. Wijzigingswet Elektriciteitswet 1998 en Gaswet (voortgang energietransitie) / Amendment of the Electricity Act 1998 and of the Gas Act (progress energy transition) (2018). Retrieved from https://wetten.overheid.nl/BWBR0040852/2018-07-01

Ministry of the Interior and Kingdom Relation. (2018d, May 31). Programma aardgasvrije wijken (Program natural gas-free neighborhoods). Retrieved October 9, 2018, from https://www.rijksoverheid.nl/onderwerpen/aardgasvrije-wijken

Naber, R., Raven, R., Kouw, M., & Dassen, T. (2017). Scaling up sustainable energy innovations. *Energy Policy*, *110*, 342–354. https://doi.org/10.1016/j.enpol.2017.07.056

Netbeheer Nederland (Network management Netherlands). (2018). Energie in Cijfers (Energy in numbers). Retrieved September 21, 2018, from https://energiecijfers.info/hoofdstuk-1/

Netwerk Duurzame Dorpen. (2018, March 31). Netwerk Duurzame Dorpen. Retrieved March 31, 2018, from https://www.netwerkduurzamedorpen.nl/

Pachauri, R. K., Allen, M. R., Barros, V. R., Broome, J., Cramer, W., Christ, R., … others. (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*. IPCC.

Petersen, J.-P. (2018). The application of municipal renewable energy policies at community level in Denmark: A taxonomy of implementation challenges. *Sustainable Cities and Society*, *38*, 205–218. https://doi.org/10.1016/j.scs.2017.12.029

Plaatselijk Belang Heeg (Local Interest Heeg). (2013). *Dream fan in doarp, Visie van Heeg 2013 - 2025 (Dream of a village, Vision of Heeg 2013-2025)*. Retrieved from http://www.plaatselijkbelangheeg.nl/duurzaam-heeg/visieboek/

Pool, M. (2017, February). *Mono-mestvergisting*. Retrieved from https://www.wen.frl/wp-content/uploads/2016/11/presentatie-mono-vergisting.pdf

Regiegroep Friese Energiestrategie, F. (2017, October). Friese Energistrategie - De bouwstenen. Retrieved from http://frieseenergiestrategie.nl/

Rienks, W., Stoffelen, G., Marquering, M., & Boogaard, L. van den. (2018, March 16). Energy from surface water - Phase 1 GIS Analysis - Potential for Friesland, Groningen, Drenthe and Overijssel. ROM3D. Retrieved from http://www.rom3d.nl/wp-content/uploads/2018/06/fase-1-GIS-analyse-eindrapportage.pdf

Rip, A., & Kemp, R. (1998). Technological change. In S. Rayner & E. L. Malone (Eds.), *Human choice and climate change. Vol. II, Resources and Technology* (pp. 327–399). Battelle Press.

Ruggiero, S., Martiskainen, M., & Onkila, T. (2018). Understanding the scaling-up of community energy niches through strategic niche management theory: Insights from Finland. *Journal of Cleaner Production*, *170*, 581–590. https://doi.org/10.1016/j.jclepro.2017.09.144

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. https://doi.org/10.1080/09537320802292651

Schwencke, A. (2017). *Lokale energiemonitor 2017 (Local Energy Monitor)*.

Seyfang, G., & Haxeltine, A. (2012). Growing Grassroots Innovations: Exploring the Role of Community-Based Initiatives in Governing Sustainable Energy Transitions. *Environment and Planning C: Government and Policy*, *30*(3), 381–400. https://doi.org/10.1068/c10222

Seyfang, G., Hielscher, S., Hargreaves, T., Martiskainen, M., & Smith, A. (2014). A grassroots sustainable energy niche? Reflections on community energy in the UK. *Environmental Innovation and Societal Transitions*, *13*, 21–44. https://doi.org/10.1016/j.eist.2014.04.004

Seyfang, G., & Smith, A. (2007). Grassroots innovations for sustainable development: Towards a new research and policy agenda. *Environmental Politics*, *16*(4), 584–603. https://doi.org/10.1080/09644010701419121

Smith, A., & Raven, R. (2012). What is protective space? Reconsidering niches in transitions to sustainability. *Research Policy*, *41*(6), 1025–1036. https://doi.org/10.1016/j.respol.2011.12.012

Sociaal-Economische Raad (Social Economic Council). (2013). Energieakkoord voor duurzame groei. *Report From: Http://Www.Energieakkoordser.Nl/*, (September), 1–146.

Sprang, A. van, Nellen, S., Pos, P., Pluis, J., & Geurds, M. (2018, July 6). Wijnjewoude Energie Neutraal 2025 - Van gedacht beleid naar gedaan beleid (Wijnjewoude Energy Neutral 2025 - From thought policy to done policy). Retrieved from https://www.wen.frl/wp-content/uploads/2018/08/Wijnjewoude-Energie-Neutraal-2025-van-gedacht-beleid-naar-gedaan-beleid.pdf

Statuten Coöperatie Duurzaam Heeg U.A. (Statutes of the Cooperative Sustainable Heeg Excluded Liability). (2014, October 16).

Statuten Coöperatie Wijnjewoude Energie Neutraal U.A. (Statutes of the Cooperative Wijnjewoude Energy Neutral Excluded Liability). (2015, November 17).

Sustainable Development Goals: Werelddoelen voor duurzame ontwikkeling - Ontwikkelingssamenwerking - Rijksoverheid.nl. (2015, December 17). Retrieved January 19, 2018, from https://www.rijksoverheid.nl/onderwerpen/ontwikkelingssamenwerking/internationale-afspraken-ontwikkelingssamenwerking/global-goals-werelddoelen-voor-duurzame-ontwikkeling

Sustainable Noord Deurningen. (2017, July 31). Start aanleg uniek biogasnetwerk in Noord Deurningen (Start construction of unique biogas network in Noord Deurningen). Retrieved October 17, 2018, from http://duurzaam-nd.nl/nieuws/369/start-aanleg-uniek-biogasnetwerk-in-noord-deurningen

Thermo Bello. (2018). Thermo Bello. Retrieved October 25, 2018, from http://www.thermobello.nl/

UNFCCC. (2018a). UNFCCC eHandbook. Retrieved January 26, 2018, from http://bigpicture.unfccc.int/

UNFCCC. (2018b). UNFCCC Paris Agreement - Status of Ratification. Retrieved January 26, 2018, from http://unfccc.int/paris_agreement/items/9444.php

Unie van Waterschappen (Union of Water boards). (2018). Thermische energie (Thermal energy). Retrieved November 14, 2018, from https://www.uvw.nl/thema/duurzaamheid/thermische-energie/

United Nations. (2018). UN SDG - 7 Energy. Retrieved January 27, 2018, from http://www.un.org/sustainabledevelopment/energy/

Verbong, G., & Geels, F. (2007). The ongoing energy transition: lessons from a socio-technical, multi-level analysis of the Dutch electricity system (1960–2004). *Energy Policy*, *35*. https://doi.org/10.1016/j.enpol.2006.02.010

Verbong, Geert, Selm, A. V., Knoppers, R., & Raven, R. (2001). *Een kwestie van lange adem: de geschiedenis van duurzame energie in Nederland*. Uitgeverij Æneas BV.

Verschuren, P., Doorewaard, H., & Mellion, M. J. (2010). *Designing a research project* (2nd ed. / rev. and ed. by M.J. Mellion). The Hague: Eleven International Pub.

Verschuur, G. (2010). *Thermo Bello: energie voor de wijk: nieuwe nuts in de praktijk*. Utrecht: InnovatieNetwerk.

Viardot, E. (2013). The role of cooperatives in overcoming the barriers to adoption of renewable energy. *Energy Policy*, *63*, 756–764. https://doi.org/10.1016/j.enpol.2013.08.034

von Wirth, T., Gislason, L., & Seidl, R. (2018). Distributed energy systems on a neighborhood scale: Reviewing drivers of and barriers to social acceptance. *Renewable and Sustainable Energy Reviews*, *82*, 2618–2628. https://doi.org/10.1016/j.rser.2017.09.086

Walker, G., & Devine-Wright, P. (2008). Community renewable energy: What should it mean? *Energy Policy*, *36*(2), 497–500. https://doi.org/10.1016/j.enpol.2007.10.019

Walker, G., Devine-Wright, P., Hunter, S., High, H., & Evans, B. (2010). Trust and community: Exploring the meanings, contexts and dynamics of community renewable energy. *Energy Policy*, *38*(6), 2655–2663. https://doi.org/10.1016/j.enpol.2009.05.055

Waninge, A. (2018, October 3). WEN stuit op grillige wetgeving (WEN encounters erratic legislation). *SA! Media ISSUU*, p. 3.

Warbroek, B., & Hoppe, T. (2017). Modes of Governing and Policy of Local and Regional Governments Supporting Local Low-Carbon Energy Initiatives; Exploring the Cases of the Dutch Regions of Overijssel and Fryslân. *Sustainability*, *9*(1), 75. https://doi.org/10.3390/su9010075

Weber, M. (1999). *Experimenting with sustainable transport innovations: a workbook for strategic niche management*. Enschede: Universiteit Twente.

WEN. (2018). Coöperatie Wijnjewoude Energie Neutraal (Cooperative Wijnjewoude Energy Neutral). Retrieved October 2, 2018, from https://www.wen.frl/

Wetterskip Fryslân (WSF, Water board Friesland). (2015, September 30). Meerjarenperspectief 2016 - 2020 (Long-term perspective 2016 - 2020). Retrieved from https://www.wetterskipfryslan.nl/documenten/organisatie/

Wijnjewoude energieneutraal (Wijnjewoude energy neutral). (2018). Retrieved October 12, 2018, from https://wijnjewoude.net/energieneutraal/

Wijnjewoude Newsletter “Step by step” December 2015. (2015, December 7). Retrieved October 14, 2018, from https://wijnjewoude.net/2015/12/nieuwsbrief-stap-voor-stap-december-2015/

Wijnjewoude Newsletter “Step by step” June 2015. (2015, June). Retrieved October 14, 2018, from https://wijnjewoude.net/wen-het-nieuws/wen-stap-voor-stap/

Yin, R. K. (2009). *Case study research: design and methods* (4th ed). Los Angeles, Calif: Sage Publications.

Appendices

Appendix I Questionnaire used for interviews of case study actors

As a Master student Environmental and Energy Management at the University of Twente, I am conducting research in the area of Local Renewable Energy Initiatives working on district heating.

The research objective is to provide insights in contemporary Local Renewable Energy Initiatives in their development of gas-free district heating niches by exploring the obstacles and barriers described in Strategic Niche Management socio-technical energy transition literature in comparison with empirical Case Study data collected in the Dutch province of Friesland. This region particularly because of the rich cooperative history and many energy initiatives.

I would like to interview you on the development of the heating initiative of Heeg/Wijnjewoude.

How did you get involved with the cooperative?

Can you explain the emergence of the cooperative?

How is the cooperative currently organized concerning the board, working groups and members?

What is the goal/vision of the cooperative?

Which projects were set up by the cooperative and which projects are implemented?

In which projects are you involved and in which role?

What obstacles or barriers did you encounter in project x, y and z?

How did you overcome these obstacles and barriers?

[Now concerning the heating initiative. You have indicated to be busy with TEO Heeg/WEN biogas]

What exactly is your role in the heating initiative?

What is the goal/vision of the heating initiative?

What are the current plans or what does the project entail?

[Actor network]

Which parties/persons are involved in this initiative/project?

Have parties also dropped out? Which? Why?

What is the role of the involved parties/persons?

How is the interaction between these parties?

What obstacles or barriers have you encountered in this heating project?

[Ask the following areas explicitly and individually]

Are there obstacles in the area of: technology, continuity of existence, financially, law and regulations, physical, infrastructural, management/control, cultural/social?

How have these obstacles or barriers been overcome?

Are there enough resources available, among others time and money?

How much time do you spend and do other members spend on this project?

How much money is available/needed and what are the sources?

[Management of expectations / visions]

What were your expectations at the beginning of this initiative?

Have your expectations changed in the course of time?

How have the expectations of the involved parties been expressed?

What are the expectations of the involved parties?

Has a common expectation been created within the project parties?

What experiences are the expectations based on?

How are the expectations substantiated?

[Learning processes organization]

What are the learning objectives of the project?

In what way has knowledge been gathered for the project?

What are the prejudices regarding the heating initiative?

How is the knowledge exchange organized internally and how externally?

What are the plans / steps to further develop this project?

Do you have any suggestions on persons or initiatives to consult to get more information?

Name/Address/Reason/What kind of information/How to contact?

Actions/Agreements

☐ Signed informed consent form in duplicate!

Thank you very much for your valuable information. You can send additional information to:
x.p.m.klijnsma@student.utwente.nl