The use of 'Local Practical Knowledge' in Sustainable Energy Systems

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Master Thesis

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Acknowledgement

During my master program Science and Innovation Management I got to know about the development of new energy systems which were more capable of coping with renewable energy generation. This triggered my attention while it seemed to be a complex innovation process with lots of stakeholders involved. This master thesis came into being when I read some articles from my supervisor Alexander Peine on technological configurations and the need for certain 'local practical knowledge' in the implementation process. I wondered how residential users were involvement in the development of those new energy systems, and that is when the idea for this master thesis became born.

It was my aim to combine my master thesis with a graduate internship at a company in order to gain some experience in the working field and to make my research valuable not only for the academic world but for the real world as well. I was therefore very pleased to be welcomed by the distribution system operator Alliander at the division Asset Innovation Management. I have had a wonderful time at the office while my colleagues involved me in all kinds of events and activities which provided me with a great inside look into the company. Besides, my colleagues were very helpful by thinking along when I got stuck and they provided necessary information on the various projects in the field of sustainable energy systems. Thanks to all of my Alliander colleagues.

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Summary

Power industries, across the world, are preparing for the energy transition towards renewable energy generation. These developments have an enormous impact on the current electricity grids. An increasing electricity demand requires an infrastructure with a bigger capacity, and decentralized energy generation requires the electric grid to support energy flows in two directions. Currently, large scale generation of renewable energy causes problems in balancing energy demand and supply throughout the grid while renewable energy sources such as the sun and the wind are not always available. (AgentschapNL, 2011[1,2]) The power industry has to adapt the energy supply system and redefine how energy should be generated, distributed and used, in order to coop with the challenges of the energy transition (KEMA, 2011). In rethinking the technological and institutional process, the role of the user will have to be redefined. Residential energy users will, in the future, fulfil an additional role as energy producer more frequently; so called 'prosumers' (Top Team Energy, 2011). Residential users will also become increasingly important because they are one of the stakeholders necessary to accomplish the local energy matching of demand and supply (Top Team Energy, 2011). Residents have to adjust their energy consumption behaviour and become flexible in consuming energy at times there is enough energy supply.

Given the historical traditions of residential users not being aware of their energy consumption, and the industry lacking the involvement of residential users; a successful energy transition asks for more focus on residential users. In order to do so, this research will investigate how various projects regarding new sustainable energy systems, cope with *user-involvement* and explore if stakeholders rethink the input and role of residential users.

The concept of 'local practical knowledge' is used in this thesis as a sensitizing concept throughout the exploration process. This concept originates from a theory of Fleck (1993, 1994) on technological configurations. The concept refers to very specific user requirements, related to the usability and value (meaning) of the system, which the technological system should meet in order to be implemented successfully.

The main goal of this master thesis is to investigate the acquisition (specification and selection) and adoption of sustainable energy systems in a local setting, and explore to what extent the perspective of the local user concerning value and usability of the system, is taken into account. This research therefore answers the following research question:

How is 'local practical knowledge' being used, to shape the architecture of sustainable energy systems in pilots initiated by organizations, and projects initiated by citizens in the Netherlands?

Both pilot projects by organizations and local initiatives by citizens are investigated while they can provide valuable insight in how users are involved and what 'local practical knowledge' means in a household setting. Such citizens' initiatives have, most probably, more easily access to knowledge about the user-environment. Strategies for gathering user-knowledge and the role of user-knowledge in the acquisition and adoption process may therefore differ in projects initiated by citizens compared to pilots initiated by organizations.

The answer on the research question is found by answering the following two sub questions:

1. *How are the users and their perspective represented in a specific local setting in the various phases of the development process; specification, selection, implementation and adoption?*
2. *How have, the various projects, dealt with user-knowledge in the development process of sustainable energy systems in the Netherlands?*

This research is executed by collecting qualitative data by means of semi-structured interviews at three local initiatives ('Morgen Groene energie', 'Duurzaam Hoonhorst' and 'Wetering Duurzaam') and two pilot projects by organisations ('PowerMatching city Hoogkerk', 'Smart Power system Ulft').

This interview data was complemented with additional secondary data sources and subsequently analysed by means of various coding methods. The analysis comprised an iterative process of data collection, data reduction, data comparison and conclusions drawing/verifying. After all data was collected, the researcher moved only among the data reduction, data comparison and conclusions drawing for the final part of the research.

User-representation

From the analysis it became clear that users are represented in different ways in various projects. At *local initiatives*, users are mainly represented by themselves and their own opinions. They participate actively in the specification and selection phase of the development process by expressing their wants and needs in a direct or indirect manner. Users at local initiatives are not represented in the implementation and adoption phase. From the analysis it became clear that the systems applied at local initiatives could better be categorised as a general system than a configurational system. One of the advantages of a general system is that it can be implemented relatively easily. Involvement of users or representatives in the implementation and adoption phase is not required for such systems to be implemented successfully.

Within the *projects initiated by organisations*, users are represented in different ways. At the specification and selection phase, users are represented mainly by assumptions based on the ideas of the design organisation. This pattern is in line with an *indirect representation* described by Peine and Herrmann (2012). In the implementation and adoption phase several, differences between the projects are identified. During the implementation and adoption phase of 'PowerMatching city Hoogkerk' the organisation started to involve users into the further development process of the system. Users could express their opinion and requirements at three-monthly meetings, brainstorm sessions, surveys and by participating in a special design group. The user-feedback was translated into specific technological requirements by experts from various fields. This pattern is in line with the notion of *direct participation* described by Peine and Herrmann (2012).

In the project 'Smart Power System Ulft' the development process has yet reached the implementation phase. Although not everything is working smoothly the organisation has not yet started to involve residents in the implementation process. At the moment it seems like the problems are mainly of a technological nature and are expected to be solved without specialised knowledge on user-requirements.

Processing user-knowledge

Within *local initiatives* user-knowledge is solely dealt within the specification and selection phase. Sometimes an advisor, from within the residents or externally, is appointed to help with the specification and selection of the system based on the user-requirements. User-knowledge in these local initiatives is knowledge related to *residents' motives* to acquire a sustainable energy system. Motives that emerged from the interviews were: saving money, contributing to a more sustainable living environment, or contributing to the liveability of the village. These motives have influenced the selection process for a specific sustainable energy system. However, during the further development process of implementation and adoption no user-knowledge has been used.

The *projects initiated by organisations* dealt with user-knowledge in different ways. Within 'Smart Power System Ulft' the organisation assumed that people should adapt their energy consumption in order to reach energy neutrality. The organisation therefore choose to add a monitoring device to the system and included ICT technologies related to measuring and modelling of energy flows. Generation and consumption flows are now easily perceptible and the system is very practical and simple in use.

The organisation of 'PowerMatching city Hoogkerk' dealt with user-knowledge in a more extensive manner. The organisation started involving users in the implementation phase by gathering user-knowledge during meetings with all residents, brainstorm sessions and surveys. A special 'design group' provided user-knowledge as well, while this closely involved group of residents gave feedback during the various steps in the development process and served as a sounding board. The gathering of user-knowledge was one step in the *iterative* development process which consists of: gathering feedback from users, expert analysis, product development and again back to the residents for testing. The expert analysis is a challenging part since it requires experts to *translate* the user-feedback into technological requirements. The organisation has coped with this challenge by appointing a doctoral student to investigate the user-side. She has the skills to gather the right data from the residents. This data was complemented with external inputs from other researchers within the network of the doctoral student, and input from various producers involved in the project. The role of the PhD student in the project 'PowerMatching city Hoogkerk' is in line with the notion of facilitator (Vennix, 1998). The facilitator should create conditions that facilitate an open dialogue, where diffusion of knowledge between actors becomes possible and where processes of learning emerge. The appointed student does facilitate an open dialogue between organisation and residents, by acquiring appropriate user-feedback and translating it into specific user-requirements.

Drawing back on the performed analyses it can be concluded that 'local practical knowledge' can take various forms and does not always shape the architecture of the system to the same extend.

In local initiatives, 'local practical knowledge' only consists of knowledge about the goals the users wants to reach. These local goals from users in combination with the technological possibilities in the specific setting, determines how the system is going to look like. Hence, 'local practical knowledge' is being used in a manner which does not strike with the views as stated by Fleck (1994) and Peine (2009), since it is not used in the implementation process and does not result in the creation of certain amount of novelty in the technology.
In pilots by organisations 'local practical knowledge' consists of knowledge about local system goals from the organisation and specific user-requirements. Knowledge regarding user-requirements is a combination of knowledge about: the usability of the system, and the user goals that create additional value for residents. By aligning both the generic component knowledge and the local practical knowledge, a viable system comes into being. These results underpin the statement of Fleck (1994) that successful implementation is reached by combining both generic technology knowledge and local practical knowledge.

Content

1 Introduction

1.1 Background

The need and use for electric energy has grown since the first electrical applications became available at the beginning of the 19th century and will continue to increase (EIA, 2011; OECD, 1999). This growing demand on electricity is caused by the continuous development of nations which are getting wealthier and create accordingly a growing demand for (electric) mobility and increased use of electrical appliances (EIA, 2011; ExxonMobile, 2007).
In 2009, eighty percent of the energy consumption was harvested out of fossil sources (Globalisation101, 2012). These fossil fuels have an enormous impact on our natural environment and our health (EPA, 2007[1,2,3]; WHO, 2009). Besides, fossil energy sources will be less available in the future due to a lack of economic feasibility of the remaining energy sources (Lako & Kets, 2005). For these matters, governments, increasingly focus on new sources of renewable energies in order to decrease CO_2 emissions and second focus on new energy efficient systems. (ECN, 2009) New housing estates become more energy efficient since they are better isolated. Houses will generate, on a more frequent basis, their own energy trough solar panels, micro-cogeneration devices (micro-CHP), heat pump, solar collectors and wind energy turbines in residential areas.

The shift from energy generation on central locations from fossil sources towards energy generation on decentralized locations from renewable sources, is called the energy transition. Power industries, across the world, are preparing for this energy transition while these developments have an enormous impact on the current electricity grids. The impact is twofold. An increasing electricity demand requires an infrastructure with a bigger capacity, and decentralized energy generation requires the electric grid to support energy flows in two directions. The current electricity grid does not suit these requirements. Large scale generation of renewable energy causes problems in balancing energy demand and supply throughout the grid while renewable energy sources such as the sun and the wind are not always available. Besides, the injection of renewable energy at many different locations cause fluctuations in mains voltage. (AgentschapNL, 2011[1,2]) In order to continue to guarantee continuous energy supplies in the future, electrical utility companies will have to adapt their energy supply system and redefine how energy should be generated, distributed and used (KEMA, 2011).

1.2 Problem definition

Historically, residential users fulfil a passive role in the energy industry. It is a conservative industry with little development in how electricity is generated and supplied for many years. Instead, the power industry has focussed on developing a reliable electricity grid and energy supply which is approximately always available. The continuous availability of energy makes, however, that residential users consume energy differently than the consumption of other goods and services. Research indicates that residential consumers are not at all aware of their energy consumption and that the decision making process of purchasing energy differs from that of other goods and services (Yamamoto et al., 2008). Yamamoto et al. (2008) state that when people purchase energy, they do not maximize value within their budget constraints, as they do with other goods and services. This is caused by the fact that people do not consume electricity directly. People consume energy in a more indirect manner through the various appliances in their homes. Moreover, the consumer is confronted with different payment systems of public facilities (Yamamoto et al., 2008). In the Netherlands, end-users get their electricity bill only once a year, which leads to unawareness about the energy efficiency and costs of the services of the various appliances delivered to users.

As mentioned in the previous paragraph, the power industry has to adapt the energy supply system and redefine how energy should be generated, distributed and used, in order to cope with the challenges of the energy transition (KEMA, 2011). However, besides rethinking the technological and institutional process, also the role of the user has to be redefined. Residential energy users will, in the future, fulfil an additional role as energy producer more frequently; so called 'prosumers' (Top Team Energy, 2011). Residential users will also become increasingly important while they are one of the stakeholders necessary to accomplish the local energy matching of demand and supply (Top Team Energy, 2011). Residents have to adjust their energy consumption behaviour and become flexible in consuming energy at times there is enough energy supply.
Given the historical traditions, to succeed the energy transition asks for more focus on residential users.

Currently the power industry is developing strongly to respond to future trends. The introduction of 'smart grids' is a possible solution to cope with the future challenges of two directional energy flows and unbalanced demand and supply of renewable energy. A smart grid is an energy network which is designed to support energy flows in two directions and uses Information & Communication Technologies (ICT) to regulate supply and demand in a more intelligent, efficient and reliable manner (Beard, 2010; Smart grids, 2011).Distribution system operators, power companies and research institutions such as TNO and KEMA, undertake all kinds of research activities and pilot projects in order to develop the smart grid system further and find a way to implement this technology successfully. A smart grid system can be separated in three layers, the service layer, the virtual infrastructure and the physical infrastructure (figure 1). The *physical infrastructure* is related to all components that facilitate the generation, transport and distribution of energy. The layer of *virtual infrastructure* contains a layer of interfaces (ICT technology) which makes that change in the service layer does not negatively impact the physical infrastructure and vice versa (Top team Energy, 2011 p.25). The *service layer* can be characterised as the place where businesses and consumers can choose for various products and services in the following areas: influencing behaviour, intelligent appliances, energy management, load balancing and demand side management, energy storage and power conversion, and services (Top team Energy, 2011 p.22). It has to be noted that some of these areas are at the moment further developed than others.
Pilot projects by energy companies relate to all of these three layers, but project objectives were, so far, highly focused upon technological innovation; various technical feasibility challenges.

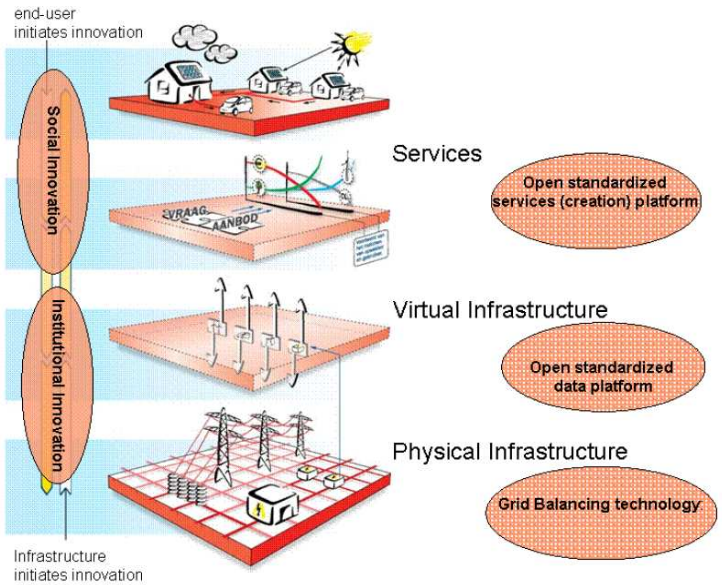

Figure 1: Three layers of a smart grid (Top team Energy, 2011)

As mentioned above, not only technological innovation is needed to cope with the challenges of the energy transition, the social aspect has to be redefined as well. The challenge of social innovation is here to get end-users actively involved in the energy transition; "the end user perspective, should be reflected in the technical design of a smart grid; in creating smart energy services" (Top team Energy, 2011, pg. 29). Social innovation is therefore mainly related to service layer of the smart grid. The aim of this thesis is to provide a contribution to the aforementioned gap by focussing on the social innovation aspect. In order to do so, this research will investigate how various projects cope with *user-involvement* and explore if stakeholders rethink the input and role of residential users (hereafter "users").

In order to so, the concept 'local practical knowledge' in used in this thesis as a sensitizing concept trough out the exploration process. 'Local practical knowledge' is a concept which originates from a theory of Fleck (1993, 1994) on technological configurations. Fleck states that *'local practical knowledge'* is essential for a successful implementation of configurational technologies. A technological configuration is a system which comprises of various sub-systems to obtain additional goals (Fleck, 1994). In this sense, the smart grid systems the power industry is developing, can be considered as configurations.
The essence of 'local practical knowledge' here refers to the fact that the configuration should meet very specific user requirements (Fleck 1993, 1994). What kind of requirements is not specifically defined in Fleck's studies (1993, 1994) although he refers to knowledge regarding: organisational working patterns, routines and skills of the employees whom make use of the configurations. Different from Fleck (1994) who investigated the implementation of configurations in an organisational context, this research aims at investigating the implementation of various sustainable energy systems in *private household settings*. Not much is known about 'local practical knowledge' in this different setting and how this type of knowledge shapes technology. In order to investigate this, the researcher assumes that 'local practical knowledge' is, in line with Fleck's definition, knowledge related to the 'usability' and 'value' (meaning) of the system.

Although Fleck's theory of 'configurational technologies' and the practical knowledge involved, intersects with other social studies of technology (SST), there is an important difference. SST focuses on the construction of generic technologies; "the way in which the activities of specific groups of technologists are turned into generally accepted and used artefacts" (McLaughlin et al. 1999). Fleck on the other hand, focuses on the *enactment* of a technology in a particular (local) setting. In this way the theory of technological configurations also intersects with the strand of domestication research (Silverstone et al., 1992; Silverstone & Haddon, 1996). It is this latter focus, of the enactment of a technology in a local (household) setting that will be applied in this research. By investigating the *acquisition* (specification and selection) and *adoption* of sustainable energy systems it can be revealed, if, and how local peculiarities influence the ***'usability'*** and ***'value'*** (meaning) of the system. McLaughlin et al. (1999) refer to a process of *relocation* where "..the form and purpose of technology are, to a greater or lesser extent, renegotiated locally.." (pg.51) . Usability refers to how the system fits the daily life and routines of the users and how easy they can use the system. Value refers to the degree to which the systems' functionality matches with the purpose the users want to use it for.

The identification of such user-requirements may, however, also be a challenging process. Hyysalo (2003) describes in his study that predicting the use of a technology is not easy. Conventional quantitative market research does not fit new complex technologies since users cannot imagine their wants and needs in advance. Their user-preferences become clear and develop over time while making actual use of the technology; they are not given for a certain technology (Hyysalo, 2003). Given this research, pilot projects seem to be essential to identify, the 'usability' and 'value' of new energy systems, and possible adjustments based on user-requirements.

1.3 Research question

With regard to the above mentioned problem that the energy transition requires changes in the conventional role and involvement of users, this research will additionally take into account local initiatives of citizens. Throughout the country citizens unite to execute various sustainable energy projects in their environment in order to facilitate the energy transition for their fellow citizens. Most of these projects aim at generating renewable energy locally. Although these projects differ in complexity from the smart grid related pilot projects initiated by organisation, they can provide valuable insight in how users are involved and what 'local practical knowledge' means in a household setting. Such citizens' initiatives have, most probably, more easily access to knowledge about the user-environment. Strategies for gathering user-knowledge and the role of user-knowledge in the acquisition and adoption process may therefore differ in projects initiated by citizens compared to pilots initiated by organizations. This research will therefore investigate both pilot projects initiated by organisations and projects initiated by citizens.
Since this research focuses on the social innovation part of the energy transition in the Netherlands, more specific the changing role and involvement of residential users, only pilot projects that are related to the service layer of the smart grid (figure 1) are included. Though this layer refers to both businesses and residential users, only projects in a household setting are taken into account.

The main goal of this master thesis is to investigate the acquisition (specification and selection) and adoption of sustainable energy systems in a local setting, and explore to what extent the perspective of the local user concerning value and usability of the system, is taken into account. This research therefore answers the following research question:

> *How is 'local practical knowledge' being used, to shape the architecture of sustainable energy systems in pilots initiated by organizations, and projects initiated by citizens in the Netherlands?*

'Local practical knowledge' is considered as knowledge with regard to the ***usability*** and ***value*** (meaning) of the system for residential-users, but also information about *environmental conditions* can be relevant. Knowledge about the *usability* can contain information about user-routines, social practice and operational requirements. Knowledge regarding the *value* of the system can contain information about the functionality and activities it is used for, the lifestyle of users and their social identity.
The answer on the research question is found by answering the following sub questions:

1. How are the users and their perspective represented in a specific local setting in the various phases of the development process; specification, selection, implementation and adoption?
2. How have, the various projects, dealt with user-knowledge in the development process of sustainable energy systems in the Netherlands?

The first sub-question investigates how the users and their perspective are represented when organizations and residential-energy users initiate projects regarding sustainable energy systems. As noted above, this can, among others, be knowledge about the usability and value of a sustainable energy system and environmental conditions.
The second sub-question investigates how the projects under study, deal with the user-knowledge. This sub-question aims to reveal the interaction process between the behaviour of users and technology which thereby creates further understanding of the concept 'local practical knowledge'. This second question relates to a statement made by McLaughlin et al. (1999) that "emerging technology can mean different things to different people but, on the other hand, the range of possible meaning is framed by the qualities and features designed into the technology." (pg. 42) In

line with the concept 'local practical knowledge' this statement implies a mutual interaction between users and producers.

2 Theory

This Chapter elaborates further on the theory of technological configurations (Fleck (1993, 1994; Peine, 2009) and academic literature on user-involvement. The theory chapter starts with an elaboration on the theory of technological configurations in section 2.1, by discussing the main characteristics and special features according to the literature. Section 2.2 briefly reviews the various approaches known in the literature on user-involvement in design processes, and discusses where the theory of technological configurations fits in. Section 2.3 elaborates further on the concepts 'usability' and 'value'. Section 2.4 then discusses the relevant literature on user-involvement and identifies the literary gap this research aims to fill.

2.1 Technological configurations

A configuration is a technological system that is build up from a varying range of components, sometimes consisting of full systems as well. What components and arrangement of components a technological system comprises of, is not determined beforehand. There is *no generic identity*. The architecture of the system can only be defined when the requirements of a specific application become known. The way the system-components are arranged thus depends on the location where it is implemented and therefore on *local contingencies* and specific user requirements. A configuration is a technical system for which no dominant design occurs.
The various components which the system comprises are technologies on its own with a separate value and functionality and also an individual design space and market structure. How advanced the various components are developed may vary though. By combining the various components into a system, additional value and functionality arise. (Fleck, 1994; Peine, 2009)
In configurational technologies two kinds of knowledge can be distinguished: component knowledge and architectural knowledge. Component knowledge is all knowledge related to the form and function of the various individual components. Architectural knowledge is knowledge with regard to the form and function of the overall system, i.e. the connection between the various components and the creation of additional system functionalities. A certain looseness can thus be found in the architectural knowledge, which determines the shape and function of the overall system. (Fleck, 1994; Peine, 2009)

Due to this looseness, innovation occurs during the implementation process while a certain amount of novelty is created. (Fleck, 1994; Peine, 2009) This is different from other, more simple, technologies where implementation means only plugging into a power supply and executing some additional settings where after the technology is ready to use.
According to James Fleck (1993, 1994) successful implementation of configurations needs both generic technology knowledge and local practical knowledge. The development of working configurations can be seen as a process of *'learning by trying'* where there is a certain amount of struggle to get the system to work. (Fleck, 1994). The functionality of the system has to be *re-defined* every time the configuration get implemented and therefore modifications have to be made to the arrangement of the components. So innovation occurs when various forms of knowledge (component knowledge, architectural knowledge and local practical knowledge) come together and have to be aligned (Peine, 2009).
Local practical knowledge is input from the user about specific user-requirements. This is often tacit knowledge which is embodied in the users' daily life; day-to-day activities and routines, but also user-skills. To acquire user-knowledge, close cooperation between users and generic technology suppliers is needed, which is a challenging approach. (Fleck, 1994) Communication problems between supplier and user, and unfamiliarity with the eventual working of the system, may cause problems during implementation (Fleck, 1994).

The development of configurations is also different. Where generic systems are developed by means of a process of innovation and subsequently diffusion, configurations are developed by means of a process of innovation and diffusion which occur at the same time. This process is known as '*innofusion'* which means that the technology will not stabilize into one dominant design which diffuses widespread, but the technological configuration can stabilize into a subset of dominant arrangements (Fleck, 1994). So the implementation process of configurations is not a linear process but an iterative process where interaction, development, consideration alternate each other.(Fleck, 1994)
When configurations are aimed at the consumer market, a clear definition of the consumers' added value of the system level is required. Without proper value propositions, the investment costs cannot be justified and will not attract potential users (Peine, 2009). This is an additional need for aligning generic knowledge with local practical knowledge. The success of creating both a *feasible* and *viable* solution depends on the success of strategies to derive user-knowledge and on the amount of openness of the system to create various solutions (Peine, 2009).

It should, however, be noticed that generic system and configurations are theoretical ideals, in real life, systems can also be anything in between these two ideal forms (Fleck, 1993).

2.2 Involving users in design processes; various approaches

In the innovation literature *user-involvement* in technological design processes is a widely studied topic which is characterised by three main strands: user innovation, Science and Technology studies (STS) and domestication research (Peine, Herrmann, 2012). User-involvement in this research relates to the latter two strands. Science and Technology studies explores how users are involved along the development of a technical object, with special focus on the construction and imagination of users and use (Akrich, 1992; Woolgar, 1991). Domestication research concentrates on how technologies are embedded in a local context, more specific ; into the local practices of residential users (Silverstone et al., 1992; Silverstone & Haddon, 1996).
By focussing on the peculiarities of a local setting, Flecks' theory of 'configuration technologies' (1994) intersects with domestication research. Fleck has, however, only investigated configurations in a organisational setting. Besides, the theory lacks insight on how users are involved in the development process of configurations, and how the interaction between users and producers looks like.
This research combines both strands of STS and domestication research by exploring how residential users are involved in the development process of sustainable energy systems, and how technology and residential users mutually shape each other.

2.3 Knowledge related to the local embedding of technology

As mentioned in the previous section, Fleck (1994) focuses on the enactment of a configuration in a particular local setting. McLaughlin et al. (1999) refers similarly to a process of *relocation* where "..the form and purpose of technology are, to a greater or lesser extent, renegotiated locally.." (pg.51) . Essential in this process is to take 'local practical knowledge' into account. In line with Fleck's definition, 'local practical knowledge' is assumed to be knowledge related to the 'usability' and 'value' (meaning) of the system. This is underpinned by McLaughlin et al.'s (1994) statement that the form and function of technology evolve.
As discussed in the introduction, 'local practical knowledge' is therefore used in this thesis as a sensitizing concept trough out the exploration process. Usability refers to how the system fits the daily life and routines of the users and how easy they can use the system. In line with this definition, McLaughlin et al. (1999) provide criteria for usability:

- *"Confidence*: Users have confidence both in their capability to use the system and in the system itself.
- *Control:* Users have control over the operation of the system, particularly of the information fed into the system.
- *Speed*: The system can be used quickly.
- *Ease of user*: The system is easy to use.
- *Understanding*: Users understand the logic of the system and what it does with the data they input." (McLaughlin et al., 1999, pg.173)

Value refers to the degree to which the systems' functionality matches with the purpose the users want to use it for. McLaughlin et al. (1999) state about utility value in an organizational setting that:

- " Systems do not achieve utility when they simply meet pre-existing user needs. Utility and user needs develop together over time.
- Users construct utility opportunities in their organizational setting.
- The impetus to find utility opportunities is encouraged by particular organizational contexts.
- Different users will have different utility values." (pg.180)

Although McLaughlin et al. (1999) investigated an organizational setting, these aspects could nevertheless also by true for users in a residential setting.

2.4 User-involvement

From both Fleck (1994) and McLaughlin et al. (1999) it becomes clear that knowledge regarding the usability and value of the technology is essential for a successful implementation of the technology. It is, however, not specified how such knowledge should be gathered and what sort of interactions this requires between users and producers.

Traditionally, design and development processes are a main issue in technology studies. Unlike the theories of Fleck (1994) and McLaughlin et al. (1999), most of those studies do not ascribe an active role to consumers in the development process (Stewart & Williams, 2005). Stewart and Williams (2005) state that "the design of the artefact is a more or less simple reflection of the values and priorities of designers and developers" (pg. 196). Although this view is nowadays revised , Stewart and Williams (2005) argue that this historic perspective is still visible in the prevailing analyses of social shaping of technology and constructivists. In contrast to these traditional strands who stress a rather 'linear' model of innovation, the theories of Fleck (1994) and McLaughlin et al. (1999) refer to more 'interactive' model of innovation with a more user-centred perspective.
The main challenge of such more user-centred perspective is the identification of user-requirements, while these evolve over time and get influences by the development of new technical capabilities and practices (Stewart & Williams, 2005). This is in line with research by Hyysalo (2003) who states that predicting the use of technology is not easy and requires pilot projects for highly complex technologies . Conventional (marketing) research methods consider user-needs as given for a certain technology. Hyysalo (2003) states that such quantitative market research does not fit new complex technologies since users cannot imagine their wants and needs in advance. Their user-preferences become clear and develop over time while making actual use of the technology. The user thus goes through a learning process while using the technology. This process is in the literature referred to as 'disembodied learning' (Rosenberg, 1982). However, literature also relates to disembodied learning when 'learning about use' (Peine, Herrmann, 2012). Such as producers who aim at constructing the future use of a technology into the design by generating use knowledge about the intended future user of the technology. This generated use knowledge can, however, vary substantially from the actual use-environment (Peine, Herrmann, 2012). Peine and Hermann (2012) have provided an

overview of the various strategies innovators apply to represent the user into the design process by tapping into various sources of use knowledge:

I. Non-representation; The user is not represented or involved in the design process. This strategy is also known as the "I-methodology" (Akrich, 1995), while designers refer to their own imagination and preferences to infer use knowledge, sometimes supplied by general perceptions on users and use circulating in the professional network. There is no systematic analysis of the users and use.
II. Implicit representation; Implicit representation implies that earlier experiences in the field and technical traditions form the basis for certain images of use. However, users and use are not represented in a deliberate manner.
III. Indirect representation; User-knowledge is based on the expertise of experts on users and use in general. Design teams may involve experts such as interest groups who look after the interests of users. This type of knowledge is generalized knowledge which does not represent the users and use within a specific innovation project.
IV. Direct representation; Experts are mediating between manufacturers and real users. Use knowledge is gathered by empirical analysis of the users and use of the technology is a specific project. Various forms of marketing research comprise this strategy.
V. Co-creation; Users become actively involved and are not solely consulted in an oblique manner through, for instance, surveys. The users are directly involved and cooperate with the design team to shape the technology.
VI. Domestication or learning by using; As mentioned above, users develop user-requirements in time. Domestication research suggests therefore that a certain amount of use knowledge is created relating the meaning and function of the technology. Peine and Herrmann (2012) state, however, that this source of use knowledge is "most detached from actual design modifications" (pg.9).

Fleck's (1994) theory on configurations implies that various forms of use knowledge are involved in the development of configurations. While the first four strategies of representation may be applied in the initial development of a configuration, the last three strategies may become of increasing importance in the implementation process of configurations. Fleck (1994) describes the implementation process as a process of 'learning by trying' where there is a certain amount of struggle to get the system to work. It is in this process of learning by trying that the inclusion 'local practical knowledge' is essential. The type of use knowledge described under 'VI' is highly related to the 'local practical knowledge' described by Fleck (1994) and Peine (2009). As mentioned above, the main challenge is to gather this tacit type of use knowledge and incorporate it into the technology by making actual design modifications. This research aims at contributing to the literature by exploring subsequently the gathering process of tacit use knowledge from residential users and how this knowledge is processed into specific design modifications.

3 Research Methodology

The research methodology describes the methods and techniques used in this master thesis, and justifies why certain choices are made to investigate how knowledge from residential energy users contributed to the development process of sustainable energy systems. Section 3.1 describes the research design applied in this thesis and section 3.2 elaborates further on the case selection, the techniques used for data collection and analysis.

3.1 Research Design

In practicing academic research, two distinct starting points can be chosen. A theoretical research starts from abstract imagination and aims at elaborating existing theory and enters the debate with other researchers. Empirical research has the real world as starting point and aims at understanding and explaining a specific empirical situation, to generate new scientific knowledge as well. (Cooper & Schindler, 2006) This research aims at acquiring data on how knowledge from residential energy users contributes to the development process of sustainable energy systems. This includes knowledge about the interaction process between users and producers and how users give meaning to the technology. The researcher attempts to gain overview of the object under study, and the *empiric world* in therefore used as a starting point to study the innovation process of sustainable energy systems.

Although user-involvement is investigated extensively, the theory of configurational technologies and the notion of 'local practical knowledge is not. As discussed in the theory chapter, not much is known about the gathering of tacit use knowledge from residential users and how this knowledge is processed into specific design modifications. Also the topic of research, sustainable energy systems, is a fairly new phenomenon which is still in its infancy of development. An *exploratory research* is here particularly useful since it enables the researcher to learn and provide new insights in the context under study and additional insight in the theory of configurational technologies.

The explorative character of this master thesis is also reflected in the research questions. The main research question has an explorative nature since it aims at gathering insight in the role of 'local practical knowledge' in the decision-making process of local energy users and organizations (like distribution network operators), for implementing a certain sustainable energy system. The explorative nature is also reflected by the sub questions. The first sub-question explores how the users and their perspective are represented; what kind of knowledge is taken into account, is it collected explicitly, and if so, at what phase of the project. The second sub-question explores how the various projects deal with this user-knowledge; it reveals what interaction is present between the behaviour of users and technology; how they mutually shape each other.

Because of the strong explorative nature of the questions this research addresses, and the underdeveloped theoretical- and research topics at stake, a qualitative research method is appropriate. Qualitative research is still in strong development and is characterised by a range of different schools including symbolic interactionism, phenomenology, ethnography and organisational research (Miles & Huberman, 1994; Wester, 1995). The common ground of these schools is that people construct reality based on the meaning they give to objects (Blumer, 1969). Another important feature of qualitative research is that it has an open research design. The analytical framework is not fixed beforehand because the relation between concepts and collected data is open in advance. The researcher approaches reality with an open mind and fits the indentified patterns with theory in later phases of the research. The analysis is executed by a continues cycle of reflection, observation, analysis and reflection. (Wester, 1995)

A *multiple case study strategy* is selected as an appropriate strategy for this research, while it allows exploring the role of 'local practical knowledge' (phenomena under study) in the development process of various sustainable energy systems. The development process is thus the unit of analysis. It will in this research include the decision making process (specification and selection) for a specific system but also the actual implementation and adoption of the system. It is, however, hard to give an exact definition of the beginning and end point of this process. Most preferably would be to do research about the role of 'local practical knowledge' over a big time span. But since sustainable energy systems are fairly new technologies, there is a lack of projects which already run for a long period of time. The exact definition regarding the beginning and end point of the development process (unit of analysis) will therefore depend on time span of the cases under study. One criterion for case-selection is therefore the current lifetime of the project. This will be explained in more detail in the next paragraph.

3.2 Research Method

This paragraph describes the operational research design. It gives a brief overview of the cases and how they are selected. It describes how the data has been collected and which procedures for observation and analysis have been applied. The researcher further elaborates on the quality of the analysis by describing which precautions haven been taken into account to guarantee the quality of research data and scientific analysis.

3.2.1 Case Selection

This research investigates the user involvement in the development process of local sustainable energy systems. The development of such systems is in its infancy, and at this moment development takes place in the form of pilot projects initiated by organizations (inter alia, distribution network operators and energy consultant companies) or local projects initiated by citizens. Although the technical systems implemented at citizens' initiatives are less complex than the technical systems implemented by organization, both types of projects are included in this research. This while such citizens' initiatives have, most probably, more easily access to knowledge about the user-environment. Strategies for gathering user-knowledge and the role of user-knowledge in the acquisition and adoption process may therefore differ between the two types of projects, which created additional insight.

Through the graduate internship of the researcher at Liander, she was able to gather information about a major part of the pilot projects and local initiatives in the Netherlands. Information from the Liander network was extended by information from Agentschap NL on smart grid projects (AgentschapNL, 2011[3]) and information on citizens' initiatives from the p-nuts awards book (Westendorp, 2011) and the internet. From this overview of both local citizens' initiatives and organizational pilots, the researcher started selecting cases based on the following criteria:

- Projects which are in an advanced stage of development, by prefer technical systems which are already implemented, are chosen over other less developed projects.
- Sustainable energy systems which consist of a combination of different technologies, (like, PV-panels, micro-cogeneration devices, smart meters, demand-response technologies, feedback systems, white-goods and electric cars), are chosen over more simple systems. This to approach the concept of technological configurations as much as possible.

By means of these criteria, five cases were selected. Two cases are pilot projects initiated by organizations: 'PowerMatching city Hoogkerk' and 'Smart Power System Ulft. The three other cases are local initiatives: 'Morgen Groene energie', 'Duurzaam Hoonhorst' and 'Wetering Duurzaam'.

'Wetering Duurzaam' is selected as an additional case. It deviates from the other cases while the sustainable energy system is not yet implemented in this project. Nevertheless the project is selected while this local initiative pursues the ambitious goal of making their neighbourhood energy neutral by developing an sustainable energy system with various technologies. The project is very interesting from an user-involvement point of view while they are searching for the optimal local solution by means of a true bottom-up process.
A brief description is now provided on the various cases. Starting with the pilot projects initiated by organizations followed by the local initiatives by citizens.

PowerMatching city Hoogkerk
As KEMA describes it: "PowerMatching City is a living lab Smart Grid demonstration in the Netherlands consisting of 25 interconnected households" (Bliek et al., 2011, p.1). These 25 houses are provided with micro-CHP devices, hybrid heat pumps, smart meters, PV-panels, electrical vehicles and smart household appliances. The project is initiated by cooperation between TNO, HUMIQ, Essent and KEMA. The first meeting for the project was in 2009 and the sustainable energy system was implemented in 2010. (Bliek et al., 2011)

Smart Power system Ulft
'Smart Power system Ulft' is a new housing estate with energy neutral houses in order by Wonion which is a housing corporation. The goal was to develop 39 social houses with costs comparable to normal houses. Energy neutrality is reached due to a combination of isolation and sustainable energy technology for generation. The technical solution consists of solar panels on the roof, a ventilation air heat pump, a solar water heating device and a monitoring system. The first residents entered the new houses in January 2012, but at the time of this research not all 39 houses are delivered yet.

Morgen Groene Energie
'Morgen Groene Energie' is a local energy cooperation in the village Nuenen. The aim of the cooperation is to deliver affordable sustainable energy, generated within their own village. The cooperation currently executes projects for sustainable energy generation but since this is not yet sufficient, the difference is delivered by Greenchoice.

Duurzaam Hoonhorst
'Duurzaam Hoonhorst' is an association which attempts to sustain and increase *liveability* in the small village of Hoonhorst. In order to increase liveability, projects are focuses on three main topics: *supporting social services* like a school, library and sports associations; *supporting the local economy*; and *supporting elderly* in making their life more easily. Projects for generating green energy serve as a means to obtain the above mentioned goals.
It needs a special notation that 'Duurzaam Hoonhorst' has won a subsidy of 1.5 million euro to executed sustainable projects.

Wetering Duurzaam
'Wetering Duurzaam' is a neighbourhood association in the Wetering neighbourhood of Amsterdam. Neighbours are joining hands in order to make their neighbourhood more sustainable. Although plans initially did not only focus on sustainable energy but on sustainability in a much broader sense, they are now mainly focussing in sustainable energy. The association is elaborating plans to make their neighbourhood, or at least 20 houses, energy neutral. The aim for energy neutrality is chosen since they applied for a subsidy which aims at this goal.

3.2.2 Data collection

In order to get insight in the development process of sustainable energy systems in the various projects, interviews has been carried out with key-people involved in these projects. Key-people were identified by questioning people in the Liander network about the projects' informants. Interviews are an appropriate method to collect data for qualitative interpretive studies, since interviews can be used to capture the ideas of participants about the various aspects and thought about the subject under study (Cooper & Schindler, 2006).
The interviews made use of semi-structured questions to obtain an in-depth exploration of particular topics and experiences. Semi-structured means that the questions leave enough space for exploring various other interesting aspects that come up during the interview. The researcher asked the participants to describe their experience with the technology and the development process in general, and attempted to steer the participants towards a reflection of their experiences.

The interviews took generally about one hour and happened to be at the home or office of the respondents. Nine interviews have been executed which all have been recorded and transcribed. Three interviews at the project 'PowerMatching city Hoogkerk', three at the project 'Smart Power system Ulft', and one at each of the three local initiatives. The local initiatives turned out to be rather small projects with only one key-person. One interview with the key person seemed therefore sufficient while extra interviews would, most probably, not generate any new data on the overall process and the corresponding procedures.
The interview data was complemented with six additional transcripts of interviews with participants of the project 'PowerMatching city Hoogkerk'. These transcripts were provided by the project organisation. Besides, interviews data was complemented with other documents from multiple sources like websites, press publications and articles from the project organisation. In this way *data triangulation* can be reached (Yin, 2003). *Reliability* is created by both applying data triangulation and recording all interviews.

As mentioned in the introduction, this research uses the concept 'local practical knowledge' (Fleck, 1993, 1994; Peine, 2009) as a sensitizing concept (Blumer, 1954) and provides directions along where to look. The concept gives direction when exploring the development process of sustainable energy systems. It is therefore not unfortunate that the concept of 'local practical knowledge' is not very definite defined. Blumer (1954) states, that sensitizing concepts can be improved and refined by testing them in different contexts. Wester (1995) also states that using a concept in a 'sensitizing' manner means that the concept, both the empirical and general part, should be investigated in various settings (Wester, 1995, pg.29). The sensitizing concept is however not a reflection of the direct perceptual experience, it is a line suggestion along where to look when collecting and analysing data (Wester, 1995).
While collecting data, 'local practical knowledge' will in first instance be interpreted as knowledge about 'usability' (user-routines, social practice and operational requirements) and knowledge regarding the 'value' (information about the functionality and activities it is used for, the lifestyle of users and their social identity). This notion of 'local practical knowledge' guided the interviews by its reflection in the interview topics. Interview topics are used to structure the interviews in a flexible way. These topic were:

- Description of the technical system and its goals
- Expectations of both organisation and users
- Involvement of users in the development process and implementation
- Motivation of users to get involved
- Expected and actual use of the system
- Problems during implementation

Although described separately, data collection and data analysis were interrelated processes in order not to miss any valuable information. After having collected the first data, this data is analysed and valuable input is taken along into the next interviews. The interpretation of 'local practical knowledge' is in this way adjusted along the way while the meaning of the concept becomes clear in the new context.

3.2.3 Data analysis

Different from quantitative research, qualitative research has not a fixed research design beforehand but becomes constructed along the research process (Wester, 1995). Especially in case-study research there are no common procedures for analysis, it is rather a combination of different techniques (Wester, 1995, pg. 117). This paragraph describes which techniques are used in this research to analyze the data.

As described above, qualitative interviews are the main source of data in this research. Although this is an appropriate method, it does bring about some challenges in analyzing it. Transcribed interviews bring about an enormous amount of paperwork which is experienced as a barrier for the data analysis. To cope with the barrier, the transcripts are systemized around various categories based on *open coding* (Corbin et al., 1990) which is similar to the notion of initial coding by Charmaz (2006). With this method the data is broken up in pieces such as, actions, events and interactions that take place in the development process of sustainable energy systems. Each transcript goes through a first phase of *data reduction* while coding, because clear irrelevant data is not coded. A second phase of data reduction takes place when similar codes of one transcript are summarized into one category. The transcript is in this way summarized in various categories. These interview summaries are manageable in the further analysis process and can be found in Appendix A. Secondary documented data is analyzed by means of open coding as well. All data is coded by making use of the software program Nvivo9. This helped the researcher to keep overview of the codes while coding different parts and sources of text. In this program codes can easily be adjusted or grouped together. Text with similar codes can also be grouped together which makes analysis better manageable while searching for similarities and differences in codes between different pieces of data.

Creating overview between the various pieces of data is even more important when executing the second step in the analysis process, axial coding. Axial coding is the process in which the categories developed in the initial coding process are intensively analyzed (Strauss & Corbin, 1998). The axial coding process comprised the following steps. First, the categories within the various data sources of each project were compared and main similarities and differences were identified. Data was reduced by excluding categories that not seemed to be relevant to answer the research question after all. Subsequently, deliberate case descriptions are constructed around three themes by merging similar categories from various data sources. This last data reduction made it possible to compare and analyze the various cases further around five themes, as is described in chapter 5.

However, as described in the previous paragraph, data collection and data analysis were interrelated processes. After every new collection of data, the new data was instantly be analysed and compared with the earlier data collected (constant comparison). The researcher followed an iterative process of data collection, data reduction, data comparison and conclusions drawing/verifying. After all data was collected, the researcher moved only among the data reduction, data comparison and conclusions drawing/verification for the final part of the research.

4 Results

In this chapter, a comprehensive description is given for each case under study. The three local initiatives will be discussed as one case when results are similar. If results differ between the three cases this is described. This approach is applied since the data of these local initiatives is one-sided. The case are described around three main themes. The theme 'technical solution' describes the sustainable energy system and the main objectives of the project. The second theme is 'the representation of users' which describes how users are represented in the various cases. 'Systems' value for users' is the third theme and describes how users value the system.

4.1. PowerMatching city Hoogkerk

4.1.1 Technical Solution

PowerMatching city Hoogkerk is a where a Smart Grid is created. The organisation involves KEMA, ECN and HumiQ, and 25 households are participating in the living lab. These households consist of various family compositions and various types of houses in the neighbourhood Hoogkerk.
Half of the homes is provided with a micro combined heat and power device (micro-CHP).The other half is provided with hybrid heat pumps. In addition to these technologies, the sustainable energy system furthermore comprises a windmill, a gas turbine, 350 m^2 of solar panels and two electric cars, which are all connected. The system uses ICT, such as the PowerMatching algorithm, to match energy supply and demand in the network. Some household have additional smart appliances in their house. These smart appliances are washing machines and dishwashers that are connected to the energy system. Through the connection they can communicate with the PowerMatcher. The PowerMatcher, which is an energy management system, controls both the energy generation devices and the smart appliances. A signal is sent to the smart appliances when it is the best moment is to turn on, depending on the amount of energy demand and supply in the network. .

The main objective of the project is to develop a market and coordination mechanism in which sustainable energy get priority, but where all stakeholders interest are represented as well. Furthermore, they aim to make it independent of the connected appliances. They also choose to let the system work and act fully automatic based on distributed intelligence, but it should not influence the comfort of people. The main objective of the project was, however, to demonstrate that a smart grid system could work in real life.

The above description of the system is the reflection of the organisation. The residents (participants of the project), proved to have deviating expectations about the system.
From another expert, who got involved in the project later on, it became clear that the project at first mainly focused on technology. Realising peak-shaving was the most important. Peak shaving means that they try to level out the peak load on the grid, which is created by great energy demands, by distribution energy demand more evenly during the day. The users' interest is only represented by creating a very minimalistic online user-portal which visualizes energy data on supply and demand. And users get a fixed financial compensation for the energy exchange on the virtual market.
One of the residents stated that KEMA told them that the system could contribute to energy savings since users should become more aware of their energy consumption behaviour. This is reflected in the fact that most residents expect to save energy with the project. Furthermore a lot of residents expected to have more insight in their energy consumption and how their energy consumption relates to results of the whole network. Some residents expressed that they would like to participate more actively. They would like to get (more) means to optimize their energy consumption.

For most residents it has now, afters about 2.5 years, become clear they are participating in an innovative project which aims at using energy more efficiently during the day, not in a project which aims at saving energy.

4.1.2 The representation of users

The initial idea's about the system was to design a system were, among other things, the various stakeholders' interests are represented. This resulted in a system where the users are represented by making sure the comfort of people will not be influenced and that the residents get a better price for their energy because of the dynamic pricing system. After the start they also decided to give residents some insight in their consumed and generated energy flow by means of an online portal, but the development of this portal was really a sideline.
So in general the organisation thought about the users a bit, but the real goal was to make the peak shaving technology work in real time. This is reflected in the fact that the dynamic prising system still does not work properly and users are still, after 2 years, getting a fixed financial reward, which is not based on their consumption behaviour. The choice between micro-CHP or a heat pump was made by KEMA based on the specific situation of the household; magnitude of the energy demand and house specifications like isolation and floor heating. So for the initial system as installed in the beginning of the project, users were only represented by the imagination by the project developers. The fact that the organisation had not a special focus on residents may also be reflected in the fact that there seems to be a gap in expectations between residents and reality, in what the system could bring them.

At the start, a doctoral student of the Hanze hogeschool joined the project. She is executing research on the interaction between technology and users and therefore this field got, from then on, more attention in the project.
From October 2009 on, resident meetings were organised every three months. In general, the main goal of these meetings was to inform people about the state of the project and to gather feedback from the residents. In October 2009 when the project had just started, the organisation collected data on user-needs by executing a brainstorm session under residents. This data has been analysed and gave them insight in the values, goals and behaviour of the residents.
Thereafter they sat-up a portal design group were residents took place in. This group met four times in 9 months to think about the further development of the user-portal. Experts first reviewed the current portal before they met with the design group to discuss the usability of the portal. The analysis of this input resulted in the formulation of user-profiles. Based on this information and an investigation of competitor products, they design a concept version of a user interface. This version is reviewed by external experts which resulted in a second concept. Thereafter the experts designed some use-cases and learned about the use context within the households. This resulted in the development of a diary which was then tested within the design group of residents. During this test they determined how to continue and the experts developed persona which were then again tested at the design group. The design group worked with the persona which gave more insight about future needs. They then organised a new round of gathering user-feedback by setting out a questionnaire to all participants in the project. Based on these results the experts designed a diary on the website.
So data in gathered from the real users and this data is than analysed and interpreted by various experts. And although the raw data may not always contain very clear user requirements, the experts translate the data into specific user requirements, which is then tested again within the design group. Data gathering and testing were arranged at several moments during the project, since users develop their needs in time and don't have a clear vision about their wants and needs right away, according to the organisation.

According to the project leader the development of a more advanced user portal is important since people have a limited flexibility in changing their energy behaviour. The advanced portal will be more valuable to the residents since it has more functionality and gives greater insight in the amount of energy saved, and it visualises the effect of their energy behaviour more clear. In this way residents can validate their investment in the system. The project leader things that visualising the effect will result in residents who are more aware and will consider other sustainable measures more easy.
The researcher states that the further development of the portal is necessary to reach both the goals of residents and organisation. This makes the system more valuable for the residents. She also thinks that not taking into account the user-side can result in negative effects like more energy consumption.

During the project, Kema also started to develop a proposition for smart appliance. In this process they also involved end-users in the process. This has been done by testing their ideas under the residents, who turned out to be very positive about the ideas. Something they didn't quite expected at KEMA.

Other system adjustments which will be achieved at the start of the next phase of the project are a replacement of the thermostat. Residents had big issues with the thermostat since it wasn't programmable. Though the thermostat had enough functionality to let the system work in the most optimal way, people felt different about it. Since the thermostat could only be put on the lower standby function for 7 hours, many people came at home in a cold house. Their alternative was to leave the thermostat high, but this didn't fell good either. So the usability of the thermostat was underperforming. Based on the feedback from residents they decided to replace the current thermostat for one with more functionality.

4.1.3 Systems' value for users

Most residents expected to participate in energy savings project. So, most people expected to save energy and thus money. A few people were participating since the project was a nice opportunity to add something to a better and more sustainable world. A few others participated since they were interested in technology and wanted to know more about it. But from the residents reactions it also became clear that some people decide to participate since they had to buy a new boiler anyway, so this was a nice lucrative possibility. They state that the normal investment for such a system would be to big with not enough benefits.
In general people would like to have more insight in their own energy behaviour and the corresponding effect. Further, they would like to have tools to act more themselves and influence the effect of their behaviour. Some interviewees mention they would like to get an advice about when it is the best time to use energy. Is it for instance better to take a shower in the morning or somewhere in the evening?
It is also striking that a lot of people don't know how the whole system works exactly. They do not always understand why their heat pump or micro-CHP turns on at very odd moments. Some people stated that they feel as if the system is not yet smart and they think the system could offer a lot more functionalities which could make it even more efficient.

At the moment the system is very much running in the background without people to notice anything about it. Most people didn't save any energy yet and they are not yet paid off based on their energy behaviour. The user-portal is not perceived as valuable as well since it provides too little information.
So residents mention they have the feeling they are contributing to a better planet although they don't have real facts to underpin these feelings. But most people mention that they are still enthusiastic and have faith in the organisation that the system will be improved in the next phase of the project. This is mainly because the organisation involved the residents in the process.

4.2. Smart Power system Ulft

4.2.1 Technical Solution

Smart Power system Ulft is a new housing estate for energy neutral houses in order by Wonion which is a housing corporation. The goal was to develop 61 energy neutral houses which do not costs much more than normal houses. 39 of the 61 houses are social housing. At the moment, only the 39 social houses are built since the other houses are not yet sold. Energy neutral in this case means that the houses generate about as much energy as the residents of the house demand for. This is measured over the year.
Besides all the newness of sustainable technologies the procurement- and development process was also highly innovative. Wonion asked different consortia to act in a competition in order to further develop various possible solutions for energy neutral houses. This has to be done in multidisciplinary teams. They valued the concepts based on the maintenance plan, energy concept, sustainability and quality. Due to good cooperation between various disciplines, the run time was much shorter than traditional new housing estate projects.
Five consortia applied for the contest and the consortia of installer Klein Poelhuis and builder Klomps won the procurement. Besides these two firms, the consortia contained an architect, two advice agencies and a care specialist.

The energy concept requires the houses to be energy neutral but the comfort level of people should be maintained at all times. Tenants are not paying for building related costs like heating, ventilation, cooling and lightning, but they have to pay for using-costs of televisions or ovens inter alia.

Energy neutrality is reached due to a combination of very good isolation and sustainable energy technology for generation. The technical solution consists of solar panels on the roof, a ventilation air heat pump, a solar water heating device and a monitoring system. The monitoring system is the In Home System (IHS) of Liandon which can visualise energy flows in the house real time. The energy flows the system can visualise are electricity, gas, water and heat. IHS visualises the generated energy and consumption of the ten different electricity groups in the houses on a display which is located in the corridor. This display is an addition to the IHS system since Wonion required that the residents should be able to see their energy consumption at all times, so not by the internet.
IHS is connected to both a smart meter and the Powerrouter. The powerrouter is a convertor and smart steering system which decides if the generated energy by the solar panels should be used in the house or if it should be delivered back to the grid.

Furthermore residents are encouraged to buy very energy friendly appliances with an energy label A or AA. They encourage people by offering them a gif voucher of €300 which they can only spend on appliances with energy label A or AA.

4.2.2 The representation of users

The current residents of the houses are not represented by themselves in the development of the energy system. One reason is that the project consists of new housing estate and more precisely of social housings, it was therefore not yet clear during the building process who would go renting these houses. Another reason may be that Wonion was also experimenting with a new procurement and development process for new housing estate. Due to this system the project was developed and built very quickly, much quicker than during traditional building projects.
The organisation, however, did think about the users. Especially in relation to what they wanted to achieve, energy neutrality, and what was needed to achieve this goal. This consortium won the

procurement since they included a monitoring system in the energy concept. The project leader of installer Klein Poelhuis mentioned that this is very important since people really have to live towards energy neutrality. Although they are living in a energy neutral house it is still possible to use a lot of energy and get a high energy bill. So people have to become aware of their energy consumption if they would like to reach energy neutrality. Therefore Wonion required that residents should be able to see their energy consumption at all times. Not by the internet since this is less easy to access. Besides total energy consumption the IHS system visualises the energy consumption per group. And since the houses have ten groups it is possible to get fairly good insight in the appliance which cause high energy consumption. IHS further visualizes the generated energy flows as well, which can be graphically showed next to the graphic consumption flows. This gives a clear view of the net energy consumption right away and should encourage people to take action right away. So could it also be noticed if old appliances have shortcomings which make them using more energy.
Furthermore people can set the system easily on sleep modus or away modus with one finger tap on the display. The system than adjusts on the new situation and uses the least possible energy for a certain comfort level corresponding to the various modes.
What also contributes to low energy consumption is the dying plateau which is included in every house. At the back of the house they created a so called winter garden which is a building extension made of glass were temperatures are rising very quickly. In this part of the house they situated a laundry drying place which makes a laundry dryer superfluous.

So what the developers did is looking at what functionalities residents should have available to help them in living an energy neutral life. Besides the above mentioned technical functionalities, they also thought about which services could help them even more. At the completion of the house, residents get a very clear explanation about the system; how it works and how they should- and shouldn't use it. After they moved in, they even get three months of human support where they can get advice on their energy behaviour based on the results of the IHS system.

Unfortunately, the monitoring system is not yet working completely after the first people moved in six months ago. This is due to technological problems in fine-tuning all the systems and making them work together. Therefore the display does not provide the insight in consumed and generated energy. People can only see their energy- consumption and generation by looking at the smart meter, but this is not a very easy way to get information. Due to this lack of a working system residents cannot give any feedback on the monitoring system yet. The only feedback they gave is that they find it very comfortable to live in these houses.
In the future the organisation plans to actively gather user-feedback, but how and when this is going to be planned is not clear yet.

For the monitoring system IHS Liandon did some research about user requirements, but this was general market research within another group of people. They executed research to find out what people's perception was about the energy steering functions of IHS. This research made clear that people are a bit reluctant against such functions. Because of these results and the fact that are already some players in the market who focus on energy management systems, they decided to skip the steering functions of IHS. Next year, when people are living in their houses for around 12 months, Liandon wants to gather some user-feedback from the residents in this project, but there are no concrete plans about how and when this data will be gathered. Adjustments and further development of IHS based on this feedback are realistic options.

4.2.3 Systems' value for users

According to the experts the system is valuable for residents since they can constantly check their energy consumption in real time. This gives them the possibility to act upon their own energy

consumption in order to create financial benefit. Furthermore the display is easy accessible and easy to use. But the thing remains that people have to create the eventual value themselves since they have to become aware of their energy usage and adjust their consumption patterns in order to receive the financial benefit. The system is valuable since it helps them to reach this financial benefit.
Furthermore, the houses are very comfortable since there is no draught within these houses.

The residents who were interviewed stated that they find the houses very comfortable and that they already consumed a lot less energy. Their energy bill will be about 1/6 of what it was before they moved to this house. They think this is very valuable. The fact that this heating system is less flexible to fluctuate temperature since it is a low temperature heating system, is no problem to them. They found their own way to fluctuate temperature if they want to. Since the winter garden is heating up very quickly when there is only little sun, this part of the house is generally much warmer than the rest of the house. So if they are sitting in their living room in the evening and they want to increase temperature, they open the door towards the winter garden. The living room then gets heated up with one or two degrees very easily.
Furthermore they find the system easy to operate with the different modes. In general they live in the same way as they did in their previous house. They only adjusted (the use of) some appliances. They for instance don't use a dryer or dish washer anymore and they replaced their refrigerator and cooking device for a label AA version. Insight in the energy flows of the house is still limiting because a lack of internet. So they haven't experienced the monitoring system quite well. This may have some additional impact on their energy behaviour in the future.
A valuable additional functionality would be to turn the lights on and off at distance according to the interviewee.

4.3. Local initiatives in Nuenen, Hoonhorst and Amsterdam

4.3.1 Technical Solution

In general it is seen that local initiatives are constructing systems which aim at the generation of renewable energy. These systems do not consist of technologies which can intelligently steer energy flows. This has to do with the big investments that are needed to add some intelligence and make the system work more efficiently. Local initiatives lack the capital investments to do so and are already struggling to get good business cases for the generation of sustainable energy. This is due to the fact that those technologies are still very expensive and payback times are long.
Due to this lack of investment capital there is also a general tendency that there are a lot of local initiatives but most initiatives haven't executed any projects yet. Most initiatives remain quite long in the stage of talking and generating ideas.
For this research I investigated three local initiates. Two of which already have executed some projects ('Morgen Groene Energie' and 'Duurzaam Hoonhorst') and one which is still in its idea phase (Wetering Duurzaam). Despite its early development phase, Wetering Duurzaam is interesting since they really apply a bottom-up approach.

<u>Morgen Groene Energie – Nuenen</u>
Morgen Groene Energie is a local energy cooperation which has as an ultimate goal to deliver locally generated green energy to their members. Although the cooperation has not reached its first anniversary yet, they really seem to have a hands-on mentality. One of the objectives of the cooperation is to get the mass public to move to a green energy supplier. The cooperation thinks this is only possible if generation green energy becomes *healthy business* where people can benefit from. So when ideas for a new local project arise, they will always search for a good business case. And although they only exist for less than one year they already executed some projects.

At the moment they are executing a project for placing seven hydroelectric stations in the Dommel, which is a small nearby river. Some watermills already have a hydroelectric turbine others will get one in the nearby future. A project the organisation already executed was a purchase project on solar panels. They help their members by giving them advice on what kinds of solar energy system fits best in their specific situation. Since they buy the solar panels collectively and by organising the installation of all these panels very efficiently, they got a really good price. Since this first project was so successful, they are already planning a second one. Furthermore they are busy planning two other solar panel projects, one aims at placing solar panels on a primary school and the second project aims at placing solar panels on a shopping centre.

<u>Duurzaam Hoonhorst – Hoonhorst</u>

'Duurzaam Hoonhorst' is an association which has as main goal to sustain and increase *liveability* in the small village of Hoonhorst. In order to increase liveability projects are focuses on three main topics: *supporting social services* like a school, library, sports associations, church and out-of-school care for children; *supporting the local economy* and local entrepreneurs; and *supporting elderly* in making their live more easily. Projects for generating green energy are thus a means to obtain the above mentioned goals. More specific, to support social services and to support local economy.
It needs a special notation that 'Duurzaam Hoonhorst' has won a subsidy of 1.5 million euro, which makes that they have less financial barriers to overcome when executing projects.
The projects they already executed are a project to purchase and install solar panels on individual houses and a project to isolate individual houses. The solar panel project also contains a rental track for people who cannot afford to buy their own solar panels. Besides this, they also have some project ideas which are at an advanced stage. They are for instance planning to use the heat which is generated in a local composting business. This heat will be used to dry wood, to heat the building of the local composting business and to initiate the bio fermentation process at local farmers.
Furthermore they are planning a project for pruning waste. Villagers can bring their pruning waste to the local composting business for free and this firm will than transform the prune waste into highly energetic wooden chips. These wooden chips will then be used as an energy source to heat the buildings of social services.
As already mentioned above, they are also planning a project to turn manure from local farmers into biogas by means of bio fermentation.
From these projects it can be seen that Duurzaam Hoonhorst is really looking for technical solutions that make use of the local possibilities and resources as much as possible.

<u>Wetering Duurzaam – Amsterdam</u>

Wetering Duurzaam is a neighbourhood association in the Wetering neighbourhood of Amsterdam. Neighbours are joining hands in order to make their neighbourhood more sustainable. Although plans initially did not only focus on sustainable energy but on sustainability in a much broader sense, they are now mainly focussing in sustainable energy. This was mainly because the sustainable energy market is very active, and there was a lot of interest in this aspect from people in the neighbourhood.
They are now making plans to get their neighbourhood, or at least 20 houses, energy neutral. The aim for energy neutrality is chosen since they applied for a subsidy which aims at this goal. The solution will most probably be a combination of individual and collective measures. Individual measures alone will not be sufficient due to the small space town houses generally have. They aim at monthly costs that are about the same as the current energy costs. Future increases in energy prices may be included though. Furthermore they are thinking of an action plan where people can choose to execute one or more steps towards energy neutrality, and set additional steps a few years later.

4.3.2 The representation of users

Local initiates are interesting since they are set up by individuals with certain goals. Power relations are, generally, evenly distributed and all people involved in an initiative can give their input on what they want and what the added value of the system should be. It is therefore interesting to see how residents are represented in the various local initiatives.

<u>Morgen Groene Energie – Nuenen</u>
Morgen Groene Energie aims at representing the big mass of people who are not green minded and shouldn't move to another energy supplier that quickly. They are representing them by thinking that these people need a financial benefit to change to green energy.
They are, as cooperation themselves also a representation of the village people. In the board of the cooperation, people of different age groups are represented; for instance elderly and young people. These representatives will bring ideas back in their own environment to discuss them. Like elderly who want to do something with green energy but are afraid they will not reach the time the investment pays itself back. They are trying to find something on this issue; for instance as a gift for children or grandchildren. So idea's are first 'tested' within their own target group and specific issues are taken into account.
In general all members influence the cooperation and its activities by expressing themselves on the plenary meetings.
In the purchasing project of solar panels, the cooperation acts as an *independent advisor* by means of volunteers. In this way residents get help by making decisions in the field of sustainable energy. This is needed since the field is new and very unstructured. The cooperation tries to make the best deal for everyone based on their individual requirements. People are then advised about the best deal, but can always deviate from it. Every project has its own taskforce consisting of volunteers, some with more background knowledge than others.

<u>Duurzaam Hoonhorst – Hoonhorst</u>
The user perspective is very well represented in the objective of Duuzaam Hoonhorst. The cooperation started with the goal to do something about the worries within residents that the village may become unliveable in the future.
But also in individual projects the users are well represented. They executed 'Energy Performance Advises' (EPA) for the individual houses which was followed up by a questionnaire under these households. In order to determine what the current situation of the houses is and what people want. Do they already have a clear opinion about how they want to generate energy for instance? Or do they like to have more information first, in the form of an advice or talk.
The combination of EPA advises and feedback on user-requirements by means of the questionnaire was the starting point. Based on these results they started organising projects.
For the solar panels everyone of the core team specialised in various types of solar panels and convertors. They made a choice for a standard system based on this specialised knowledge since the organisation thinks people will lost themselves in the various possibilities and will, due to this, drop out of the project. So they decided to do a collective procurement and people could apply for one system; one convertor and installation package. In this way they achieved a very good price. They choose an installer who had a local business but they also took into account possible risks.
So they choose to make it easy for villages by offering one package of good quality with guarantees and installation. Duurzaam Hoonhorst did the control during installation.
In case of the manure fermentation, they sat down with all stakeholders, plus an external expert, to make a plan which is beneficial to all stakeholders. All stakeholders were also involved when developing the plans for a heating grid which runs on woodchips. Here they also included external experts like a group of students, a technical advisor and an architects office.
Wind energy is not beloved by the villagers due to landscape pollution, so they are not planning to do any projects with this kind of energy, although Timo himself is very positive about wind energy since this can make this village energy neutral.

So the projects that were focused on the villagers like the solar panels and the house isolation were initiated due to a user-need expressed by the villagers. But the choice for a specific interpretation of the system was not based on large-scale user input. This was done by the core team of Duurzaam Hoonhorst who did some studies about the possibilities and made a choice based on their own perspective and the objectives of the cooperation. But since the core team themselves are also villagers, they are their representatives.
The projects which are not specifically focused on the villagers like the heat grid which generated heat from wood chips and the manure project, both came into being by meetings with all stakeholders and some experts. The project had to be profitable for all stakeholders, otherwise they would not continue.

<u>Wetering Duurzaam – Amsterdam</u>
The initiator of 'Wetering Duurzaam' strongly feels that people's perspective should be heard and taking into account seriously. This is done by organising many meetings for residents in the neighbourhood and providing them with enough information. In their search for a technical solution to become energy neutral, some residents of the neighbourhood with knowledge on this topic are representing the neighbourhood and executing a control function. A sounding board of 3 people from the neighbourhood and 3 or 4 external experts reflect on the plans of the external advisers. Users are thus very much represented by themselves since they are making choices by themselves based on the information that is provided to them.

The choice for a search towards an energy neutral solution arose as follows:
During the first meeting they discussed various topics in the field of sustainability. Energy was one of the topics and this study group met again quickly after the first meeting. It than became clear that sustainable energy is such a specialised field, that the residents themselves got no further. They needed some specialised knowledge. When looking out for help, the core team got into the world of sustainable energy, which is already a very active and dynamic market. This is also when the possibility to apply for subsidy came by. Due to these events sustainable energy became the main focus of the project at this moment. The subsidy requires the project to aim at energy neutrality. But if it cannot be reached, it isn't a problem. They want to user the subsidy for further steps in investigation and creating plans.
In their way to look for the best opportunity for a heating system and electricity system, the core team first executed a lot of orienting talks with experts and advisers. But they found out quickly that they wouldn't be able to reach energy neutrality by means of individual measures. For the residual energy demand they have to look for collective measures. They also aim at getting the energy costs around the same level as people have today.
In order to get people involved in and support the plans, Maartje beliefs in supplying people with the right information. Furthermore she beliefs that people should get the possibility to make the step when they are ready for it (for instance when their old boiler has to be replaced). So she aims at making a action plan with various steps they can undertake.

4.3.3 Systems' value for users

<u>'Morgen Groene Energie'</u> is the only official energy cooperation of the local initiates and this is reflected in the value the technology offers to its members. The value is mainly the financial benefit they can obtain when joining this cooperation. They offer green energy against a very good price which is highly competitive with grey energy. In general, people would also think it is a valuable side-effect that it is better for the environment to generate energy by renewable sources, but this is probably not the main reason to shift energy supplier.

The main value of the applied system of 'Duurzaam Hoonhorst' is the fact that it supports and maintains the liveability of the village. This is a worry which is widely felt by villagers. Since the energy system support social services and the local economy, the system is valuable to a lot of people, although sometimes indirectly.
There are, however, also some direct benefits of the system which creates value for the villagers. Like the solar panels which generate financial benefit since the cooperation gave the participants their paid VAT back. They also arranged that people with less money to spend, could rent solar panels. People who rent the panels get a financial benefit as well, since they only pay 80% of the normal kWh price of grey energy.

At the initiative 'Wetering Duurzaam' there isn't a system yet. But it may be interesting to outline the motives of people to participate in the project. According to the initiator of the association the main reason for people to participate is not the potential money savings but the fact that they are making a contribution to sustainability. Most people find this important. Another aspect which is mentioned is fact that people like to get to know their neighbours and met new nice people.
The green motivation is reflected in people's reaction on the research results for collective generation of heat by a consulting agency. This agency proposed that a large wood stove would be the best option. But people reacted reluctant against this proposal since they don't think this is a real sustainable option.

5 Analysis

In the above chapter, results are provided on the various technical systems, the way the user is represented in those systems and what the user finds valuable about it. This chapter seeks to provide a more in depth analyses on how the several patterns in user-knowledge fit in the concept 'local practical knowledge' and how the process of learning between producers and end-users takes place.
From the data several patterns on user-knowledge and configurations are deduced. Before providing the in depth analysis in section 5.5, these several patterns are discussed.
Section 5.1 provides an analyses of the various strategies that are used by actors to find user-knowledge. Section 5.2 discusses what the various actors think is important in user-knowledge. The various idea's user have about the system will be determined in section 5.3. If and how sustainable energy systems fits the theoretical concept of configurations will be discussed in section 5.4.

5.1 Strategies used by actors to find user-knowledge

When analysing the projects initiated by organisations it can be seen that these projects at first are very focussed on getting the basic technology working. In these projects intelligent ICT technologies are applied to optimize the system, mostly by measure and control technologies. It may be due to the newness and complexity of these technologies that these projects at first do not pay much attention to the user-side. In both projects, PowerMatching city Hoogkerk as well as Smart Power system Ulft, the actors were not focused on finding and gathering explicit user knowledge as input for the initial development of the system. But it is not the case that they did not think about the user-perspective at all during the development of the system, it is only in a very minor way. Ideas about what the users want and need are mainly based on the actor's own imagination which is sometimes inspired by some general market research. According to Peine and Herrmann (2012) this type of representation can be categorized as an *indirect representation*. In this type of representation user-knowledge is based on the expertise of experts on users and use in general. But the results also point toward an *implicit* type of representation (Peine & Herrmann, 2012), although in a minor way. Implicit representation implies that earlier experiences in the field and technical traditions form the basis for certain images of use. The long tradition of consuming energy in an unconscious way and the odd purchasing and billing system of energy (Yamomoto et al., 2008) play a part in the way the user is represented by the organisations. This points towards an implicit representation although the organisations also thought about the users and use in a more conscious way, which points more towards an indirect representation. Therefore, the hypothesis could be taken that it most likely will be a mixture of the two forms.

The strategy of PowerMatching city changes when entering the implementation phase of the project. With the commencement the project implementation a researcher of Hanze hogeschool joint the project. Hence, the user-side gained in attention. By means of 3 monthly meetings with the residents they noticed that many residents experienced that the system was not exactly what they expected. In order to gain understanding what these residents wanted, needed and expected, the organisation set up several meetings. The thoughts and experiences of users were explored during brainstorm sessions, qualitative interviews with households and surveys. Likewise, the organisation set up a design group of residents who where more actively involved in the further development of the system. According to the theory of Peine and Herrmann (2012) this type of representation can be characterised as '*direct representation'* and tends towards *'co-creation'.* Users become actively involved and are not solely consulted in an indirect manner through surveys. Although their involvement is very extensive it is not exactly a matter of '*co-creation'* (Peine & Herrmann, 2012), since the use-information is always mediated.

The development strategy was an *iterative process* in which data gathering, expert analysis, product development and testing by residents, alternated. This development strategy will be discussed in more detail in paragraph §5.5.

When analysing the local initiatives it can be concluded that there are some differences in the applied strategies. In general, all make use of user-knowledge since these initiatives are started by individuals themselves. However, there are some differences in the intensity of involvement between the various local initiatives. The overview developed by Peine and Herrmann (2012), quoted in the above, is not fully applicable to the results of local initiatives. User-knowledge is not used by manufacturers or organisations to shape the design of technologies. It is only used by residents in the specification and selection phase to decide what type of sustainable energy technologies they could best acquire.

Duurzaam Hoonhorst applied a more directed strategy by choosing to execute EPA which advises to identify technological possibilities, and applied a survey to investigate what the villagers wanted. There are, however, no frequently organised meetings with the villagers. Once a week the 'office' is open for questions and consultations. Though they are represented at all kinds of village-events, 'Duurzaam Hoonhorst' does not organises meetings for the villagers to express their opinions as compared to Hoogkerk. This strategy has common grounds with *direct representation* described by Peine and Herrmann (2012) in the sense that user-requirements are explored in the context of a specific project and the fact that the specific users serve as a source for the user-knowledge.
'Wetering Duurzaam' is a group of people whom execute initiatives together, for that is 'a for residents, by residents' strategy. They frequently have official (in)formal meetings, where all neighbours are invited and were they can express themselves. It doesn't matter if you are in the core team, the working groups or only present at the meetings, everyone can express their opinions and they are heard evenly. An important characteristic is that everybody is equal.
Although 'Morgen Groene Energie' is a cooperative organisation it at the same time is an official energy supplier. This is reflected in their strategy to find user-knowledge, which is a bit more of a top-down approach than a bottom-up approach. Ideas are generally formed within the board of the cooperation before being *sounded out in their environment*. They also find user knowledge by means of the *general assembly*.

5.2 The importance of user-knowledge, according to the various actors

As discussed in the above paragraph, not all actors are evenly active in finding user-knowledge. The ratio for this may be found in the fact that not all actors have a very clear opinion on why they find user-knowledge important and what they are looking for. Two projects do have a clear opinion on this; these are 'PowerMatching city Hoogkerk' and 'Wetering Duurzaam'.

Various actors in the project <u>'PowerMatching city Hoogkerk'</u> state that it is because of the active involvement during the project that all participants remain interested and active in the project. Although they have had a lot of problems and the system was not that valuable to everyone during the first phase, people have faith that the next phase of the project will be better. The actors are of the opinion that it is important to get insight in what people want and need to create a system which is valuable to them and fulfils their expectations. This is especially related to product and services for residents which make use of the intelligent infrastructure. However, the organisation also mentions that residents cannot be used as a source for all user-knowledge. Design issues that are related to privacy and security issues or market structure, for instance, are too specialised to request residents about their opinion. For these issues special interest groups like 'bits of freedom' should represent the user.
Hence, user-knowledge is important to *create acceptance* under residential users since the initial system was now mainly developed to achieve a societal goal (large-scale renewable energy

generation), according to the actors. Without adapting the system according to user-requirements, the system will not get enough value for residents to adopt and accept the system. The actors are furthermore of the opinion that taking the user-side into account can *avoid negative effects* in the consumption behaviour of residential users; more specific compared with some kind of rebound effect. Therefore, the organisation remains of the opinion that it is of great importance to understand what effect the technology has on people.

Within the project 'Wetering Duurzaam' the initiator has a clear view on the need for involving users in the process and gathering user-knowledge. Sustainability is for the actor a holistic concept, which not only has to do with technology or the effects of using technology, but focuses on balancing. Therefore the organisational process is of great importance as well. In applying a bottom-up approach trust becomes very essential when creating sustainability. In order to get trust, insight must be gained in balancing- power ratios, capital distribution and ownership. Hence, people must have the feeling that their voice in being heard in a serious manner in order to gain sustainability.

Ulft in its project 'Smart Power System' expresses the view that the opinions of users are important. However, at the same time they approach it as communication in one direction. They are very much aware of the fact that they need the user to change their energy consumption in order to reach energy neutrality. And in order to make users change their behaviour they believe *good and clear communication* is the manner to reach this. Communication about how the system works and what the various causes and effects of residential behaviour are, are believed to be very important. The organisation has therefore chosen a monitoring system to support the awareness of people. In other words, they actually state that *creating awareness results in a change in consumption behaviour*. If this is really the case should be proved in time since the implementation phase has just been started and no results on the actual effect of the system could be collected yet.
For the other projects, 'Morgen Groene Energie' and **'**Duurzaam Hoonhorst' no clear opinion on the specific importance of user-knowledge can be deduced from the results.

5.3 How users value a sustainable energy system

In general, results shows that residential users feel like the system should serve as a means to reach individual goals. However, no clear structure can be found in the types of goals of local initiatives and organisation-initiated projects. In most cases users do value the system based on various aspects or goals. System-value is thus created by *the possibilities the system offers* to provide a contribution to various individual goals. One goal which is present in most initiatives is the goal to save money. This seems to become more important when people make an investment, especially when this is a significant one. Other aspects residents mention is that they like to contribute to a better environment. Their comfort increased due to the system in their homes. And residents are very interested in these new technologies. What is striking is that residents who participate in the project 'PowerMatching city Hoogkerk', with a more 'intelligent' system and a longer lifespan, came up with more ideas about what they think about the system and how it could become more valuable to them. These ideas are both related to functionality and usability. They would like, for instance, to have more insight in their energy behaviour and the corresponding effect. At the same time they would also like to have more possibilities to influence their behaviour in order to influence the effects. Some residents stated that they would like to get an advice from the system on how to deal with energy in an efficient low cost manner. Such like, when it is the best moment of the day to take a shower.
Hence, it seems like a more 'intelligent' system, in combination with a longer lifespan of the project, provides more possibilities for residents to create system value. This is in line with the statement made by McLaughlin et al. (1991) that "…the range of possible meaning is frames by the qualities and features designed into the technology." (pg. 42) In addition, it is also in line with the statement

of Hyysalo (2003) that user-needs are not a given fact when dealing with complex technologies, and that users cannot imagine their wants and needs in advance. User-preferences develop over time. It has to be stressed that sustainable energy systems are in its early development and keep developing over time. Therefore it is highly recommendable to gain more knowledge on these theoretical statements by performing additional research

5.4 The configurational nature of Sustainable energy systems

Given the fact sustainable energy systems are real systems, they may have, to a greater or lesser extend, a configurational nature. This paragraph provides a determination about how sustainable energy systems fit in the notion of configurations.

From the results two types of sustainable energy systems can be distinguished. Systems which are focused on generating sustainable energy (hereafter "type A"), and systems which focus on intelligent steering of renewable energy flows (hereafter "type B"). These latter systems make use of ICT, mainly measure and control technologies, to optimize the system and obtain additional goals. This part of the analysis determines how these two types of systems fit the notion of configurations to a greater or lesser extent.
Type A systems are focused on generating sustainable energy. These systems make use of technologies that generate sustainable electricity (like solar panels, wind turbines, hydro turbines), and systems that generate sustainable heat (like heat pumps and micro-CHP), or a combination of these two. It can be derived from the results that type A systems are applied in local initiatives as investigated in this research. Although some projects apply various sub-systems that complement each other, like solar panels, a heat pump and a solar water heating system, these systems are not connected to each other. The choice for these sub-systems does, however, depend on the specific location. The amount of energy consumption and the specific housing situation determine which sub-systems fits the specific situation best. Although the various sub-systems can create value to people, the sub-systems are *not connected* and therefore *no additional value* is created for the users. Architectural knowledge is inapplicable in these systems. Type A systems can therefore be considered more as a variety of individual generic systems than one configuration.

From the analysis of type B systems it became clear that these system have a more configurational nature than type A systems. In type B systems the various sub-systems are connected by means of ICT which makes that one can use energy in a more efficient manner and obtain additional goals. The choice for the various components and the way they are connected depends on the requirements of the specific application. The case 'PowerMatching city Hoogkerk' is an example of a type B system which becomes tailor made to the specific location. It comprises various components like heat pumps, mirco-CHP devices, solar panels and white goods which all have their own separate design space with corresponding component knowledge. The necessary knowledge on several different components can be found around the specialised suppliers of the various components. These components are connected to each other by means of ICT in order to make them smart and obtain additional goals like peak shaving, making use of energy more efficiently and creating awareness in energy consumption. ICT has its own architectural knowledge which makes that the system works in a certain way. The functioning of the system highly depends on the required additional goals namely; peak shaving, more efficient energy use and more conscious energy consumption. But since the whole system is implemented at the residential homes of people in the neighbourhood Hoogkerk, a successful implementation, according to the theory (Peine, 2009) and project actors, also dependents on specific user-requirements in order to create a valid system with appropriate value propositions for the residents. A more in depth analyses on 'local practical knowledge' in this new context, will be discussed in paragraph 5.5.

The applied system in the project 'Smart Power System Ulft' also makes use of ICT to link the various components hence making the system intelligent, which makes it a type B system. The intelligent functionalities of the system are, however, less extensive compared to the project in Hoogkerk. Where the project in Hoogkerk connects technologies for generation of electricity, heat, warm water and smart appliances, the project in Ulft only connects technologies for generation of electricity, heat and warm water. In addition, the requirements for the specific configuration where less complex. The organisation in Hoogkerk aimed to achieve peak shaving, more efficient use of energy and creating awareness on energy consumption. The organisation in Ulft, however, solely focuses to create insight in, and awareness on energy consumption. These differences make the system of 'Smart Power System Ulft' less complex than the system of 'PowerMatching city Hoogkerk'.
Taken from a more theoretical approach (Fleck, 1994; Peine, 2009) this implies that the system is therefore less dependent on local practical knowledge. A more in depth analyses is provided in the next paragraph.

Drawing back on the above analyses and the results from this research it can be concluded that type A systems are more of a generic system than a configuration technology. In accordance with (Fleck, 1994; Peine, 2009) this implies that implementation of these systems is simpler and therefore easier. This is underpinned by the results of the local initiatives where implementation itself is less complicated. However, organisational and financial issues beforehand are the biggest challenges. A successful installation of the system at these local initiatives depends on component knowledge and sometimes some additional environmental knowledge, which can be gathered quite easy since the user is not interacting with the system or actively using it.
The type B systems which are applied by organisations, have a more configurational nature. This implies a more complex implementation process which requires extra effort, more specific in the field of learning between users and producers. (Fleck, 1994; Peine, 2009)
In the next paragraph a more in depth analysis is made on the implementation process of these 'intelligent' sustainable energy systems.

5.5 View on Local practical knowledge in the context of Sustainable energy systems

This paragraph provides insight in what the scope of 'local practical knowledge' is in the context of sustainable energy systems. Secondly, this paragraph will determine how the process of learning between producers and end-users takes place.

The theoretical concept of 'local practical knowledge' refers to knowledge which is related to user-requirements but can, however, not be determined easily without delving into the daily life of residential users. When comparing the two type B systems, it can be noticed that the project 'PowerMatching city Hoogkerk' is really making an effort to delve into daily life of the residential users and hence take the wishes of the residential into account. Although the project 'PowerMatching city Hoogkerk' at first did not involve the views of residential, the project in second instance did take a turn. The organisation in the project 'Smart Power System Ulft' did not make an extensive effort to gather special user input to develop the system. The organisation in Ulft made use of their own imagination on how the user and their way of living when will be decisive in how the system should work. Besides, the supplier of the monitoring system made use of some general market research results. The project is currently running for half a year. Although the system is not working completely, residents seem quite satisfied with the system. There are some issues on making the whole system interoperable. However, the future will have to prove if these problems can be solved and if the system can obtain the additional value it is designed for. From my perspective at first sight, the choices made by the organisation and the strategies applied to obtain user-knowledge could work efficient in practice. The overall goal was to build houses where people could live in an energy neutral manner. The organisation has chosen to connect the various components in a system in order to *give insight and create awareness* about energy supply and energy consumption. According to the organisation, this is required, because *people slightly have to change their energy behaviour* if they want to live in an energy neutral manner. In this way the system's functionality is defined on the basis of specific requirements of this application, which is in line with the point of views of Fleck (1994) and Peine (2009). They state that the functionality of the system has to be redefined at every implementation. Modifications to the arrangement have to be made based on the requirements of the specific application (Fleck, 1994; Peine, 2009). It has to be stressed that the organisation did not delve into the lives of the residents in order to define user-requirements. 'Local practical knowledge' in this project consists mainly of *local contingencies* and to a lesser extent of user-requirements. If the presumption of the organisation is correct and if awareness will really changes people's behaviour will have to be proven in practice. Moreover, the functionality of the system as a whole and whether the system creates the level of awareness sought remains unknown and will be proven over time. It has to be noted that 'Smart Power System Ulft' is not one of a great configurational nature thereby not requiring great knowledge on the use of user-knowledge.

In the project **'**PowerMatching city Hoogkerk' the focus, at first¸ was aimed at aligning component knowledge and architectural knowledge. Although it was already very difficult to align component knowledge with architectural knowledge, they also noticed that this approach did not create enough user acceptance by the residents. There were not enough proper value propositions to fulfil people's needs and construct acceptation within the residents group. This is in line with the theory of Peine (2009) in which is stated that configurations aimed at the consumer market require a system that is both *feasible* as well as *viable* in order to attract potential users. Hence, the organisation started to gather user-knowledge by investigating how users experienced the technology. They gathered data on what the opinion of the residents was about the system, if their expectations are fulfilled and which adjustments to the system could add value to them. From this data gathering it turned out that the residents did not liked the system's thermostat since the functionalities made their daily life less comfortable. They also preferred to have more insight in their energy consumption and how their energy consumption relates to results of the whole network. In addition the residential expressed their wish to participate more actively in the system and hence having more possibilities to act and influence their own energy behaviour, for instance by getting advise on when it is the best time to take a shower. Therefore the organisation decided to delve into the lives of the residents and gathered data on, among others, the fitting of system in their daily routines and the match between user-skills and usability of the system. This is in line with the theory that states that 'local practical knowledge' is tacit knowledge which is embodied in users' daily lives and activities as well as user-skills (Fleck, 1994; Peine, 2009). In addition, data was gathered on the value of the system for people; what they expected and how more value could be created. This is knowledge which is more related to the viability of the system which is mentioned by Peine (2009) to be important for configurations aimed at the consumer market. The project organisation states that they will act upon these feedbacks and that they are busy making adjustments to the system which will be applied in the next phase. Aligning this user-knowledge with the rest of the technological knowledge will most probably increase user acceptance. This is underpinned by many residents in the project who state that they remain positive about the project, despite of the many problems. They have faith that their input is processed and will result in better system in the next phase.

Having determined that 'local practical knowledge' has indeed been used in the context of intelligent sustainable energy systems, a closer look should be taken at the **process of learning** between organisation and residential users.

The organisation of 'PowerMatching city Hoogkerk' learned about the users by means of an iterative process of data gathering from users, expert analysis, product development and again back to the residents for testing. Especially the expert analysis is a challenging part since it requires experts to *translate* the user-feedback into technological requirements (Peine, 2007, 2009). The organisation has coped with this challenge by appointing a researcher who is executing her doctoral research within the project. She has the skills to gather the right data from the residents. Furthermore she is a more independent person within the project which may have resulted in greater feelings of trust and confidence within the residents. From the other cases it can be seen that residents are generally suspicious towards organisations. It has to be stressed that drawing back on gathering data from users, the project 'PowerMatching city Hoogkerk' experienced that residents are very cooperative and willing to add value to the project. Furthermore, the organisation dealt with the challenging process of processing user-feedback into technological requirements by gathering external input from other researchers within the network of the doctoral student, and gathering input from various producers.

This process of learning between organisation and residential users has similarities with the concept of third-order-learning by Boonstra (2000). This type of learning applies to third-order-changes, where process of learning and creation merge into an interactive process of actors (Boonstra, 2000, pg. 27). Intrinsic to third-order-changes are problems which have a vague and complex nature and come with a lot of uncertainty. The perspective of third-order-changes implies that ligatures should be created and processes should be supported where actors shape the innovative process together. The main focus is that feedback processes should become visible and that processes of acting, reflecting and learning should start. The notion of third-order-learning can be complementary to the notion of l*earning by trying* (Fleck, 1994), a concept which is originally connected to configurational systems. Fleck states that this type of learning is applicable to complex and systemic technologies that have a challenging implementation process since it is hard to make the system operable. A certain amount of novelty and innovation takes place when organisations struggle and try to make the system work. The notion of third-order-learning gives more insight in this process of 'struggle to make it work' by proposing that these complex problems call for a different approach. Boonstra (2000) states, that the process of learning and creation merge into an interactive process of actors. According to Boonstra (2000), the leader of the innovative process plays a special role in this type of learning. This leader should create conditions that facilitate an open dialogue where diffusion of knowledge between actors becomes possible and where processes of learning emerge. (Boonstra, 2000) This is in line with the notion of a *facilitator* by Vennix (1998) who states that this person should have the following behavioural characteristics: "one should be honest, and should have good communicative-, expression- and listening skills, and should be able to create an open communication climate.." (Boonstra, 2000, pg.29). Third-order-learning is about recognising and rethinking certain initial assumptions and patterns of action (Boonstra, 2000, pg. 30) to solve non-routine problems and create some novelty.

Drawing back on the above, the independent researcher in the project of 'PowerMatching city Hoogkerk' seems to fulfil this role of an independent facilitator between organisation and producers on the one hand, and residents on the other hand.
The organisation has chosen an *iterative process* since they are of the opinion that user-requirements develop over time. This is in line with the statement of Hyysalo (2003) that users cannot imagine their wants and needs in advance and that user-preferences develop over time. This phenomenon also intersects with *learning at an individual level* described by Buchanan & Huczynski (2004). They state that learning is about acquiring new knowledge, behaviours, skills, values, preferences and understanding, while the acquiring process goes through individual reflection and re-evaluation of knowledge and experience. This process of learning at an individual level (Buchanan & Huczynski, 2004) can be specified in more detail as a process of *learning by using* (von Hippel & Tyre, 1995; Rosenberg, 1982). Learning by using is a type of learning that may occur when there is a mismatch between product functionality and usability, and the actual use of the technology in a specific environment (Peine, 2007). This mismatch reveals itself in 'PowerMatching city Hoogkerk' by

residents who feel the system does not fulfil their expectations on both functionality and usability aspects.

Conclusion
Henceforth, within the various households, residents go through a process of learning as they gain experience in using the various technologies. This learning process results in the development of additional or changing wants and needs under residents. Further research is needed to investigate how the process of learning unfolds exactly.
The organisation gathered data by using a combination of quantitative- and qualitative methods; general meetings, brainstorm sessions, qualitative interviews and surveys. The meetings provided a substantive contribution to the *users' learning process* since the organisation gave, *inter alia*, information about the system in those meetings which gave the residents a short introduction on how the system evolves every time

It can be noticed that 'PowerMatching city Hoogkerk' is the only project which both uses qualitative and quantitative methods to gather user-knowledge. Furthermore, it uses the most extended methods to delve into people's daily lives. It has to be noted that this method requires the biggest effort to translate this user-feedback into technological adjustments. This is most probably due to the fact that they appointed a specialist to execute this process who has her own motives to approach the development process in this particular way. By having chosen this way of working, the organisation may tried not to lack in obtaining sufficient user-knowledge from the residents. As stated in the above, this is quite challenging job which requires some advanced capabilities to gather- and translate user-feedback into specific technological requirements.

In sum, the results on the various projects support the theory of configurational technologies (Fleck, 1993, 1994; Peine, 2009) in the sense that the amount of effort and local practical knowledge required depends on the degree to which the system can be classified as configurational. Systems which have a less configurational character may need less effort and may include enough user-knowledge by working with indirect or implicit representatives for gathering user-knowledge.

6 Conclusion

This research started with the aim to explore the social development side of new sustainable energy systems. The theory of configuration technologies (Fleck, 1993, 1994; Peine, 2009), and more specific the notion of 'local practical knowledge', served as a guide to explore this development process. In this way insight is gained on the innovation process of sustainable energy systems and a contribution in made to the academic literature on user-involvement and the notion of 'local practical knowledge'. The two sub questions will serve as a backbone to answer the main research question at the end of this chapter.

First sub question: How are the users and their perspective represented in a specific local setting in the various phases of the development process; specification, selection, implementation and adoption?

Users are represented in different ways in various projects. At *local initiatives*, users are mainly represented by themselves and their own opinions. They participate actively in the specification and selection phase of the development process by expressing their wants and needs in a direct or indirect manner. Users at local initiatives are not represented in the implementation and adoption phase. From the analysis it became clear that the systems applied at local initiatives could better be categorised as a general system than a configurational system. One of the advantages of a general system is that it can be implemented relatively easily. Involvement of users or representatives in the implementation and adoption phase is not required for such systems to be implemented successfully.
Within the *projects initiated by organisations*, users are represented in different manners. At the specification and selection phase users are represented mainly by assumptions based on the body of thought of the design organisation. Sometimes these assumptions are guided by some general market research. This pattern is in line with an *indirect representation* described by Peine and Herrmann (2012). When analysing the implementation and adoption phase several differences between the different projects are identified. During the implementation and adoption phase of 'PowerMatching city Hoogkerk' the organisation started to involve users into the further development process of the system. The system kept on developing further based on newly gained technological- and user knowledge. Hence, users were in these latter two phases represented by themselves. They could express their opinion and requirements at three-monthly meetings, brainstorm sessions, surveys and by participating in a special design group. The user-feedback is translated into specific technological requirements by experts from various fields. This pattern is in line with the notion of *direct participation* described by Peine and Herrmann (2012).
In the project 'Smart Power System Ulft' the development process has yet reached the implementation phase. Although not everything is working smoothly the organisation has not yet started to involve residents in the implementation process. At the moment it seems like the problems are mainly of a technological nature and are expected to be solved without specialised knowledge on user-requirements.

Second sub question: How have, the various projects, dealt with user-knowledge in the development process of sustainable energy systems in the Netherlands?

Within *local initiatives* user-knowledge is solely dealt within the specification and selection phase. Sometimes an advisor, from within the residents or externally, is appointed to help with the specification and selection of the system based on the user-requirements. User-knowledge in these local initiatives is knowledge related to *residents' motives* to acquire a sustainable energy system. Motives that emerged from the interviews were: saving money, contributing to a more sustainable

living environment, or contributing to the liveability of the village. These motives have influenced the selection process for a specific sustainable energy system. However, during the further development process of implementation and adoption no user-knowledge has been used.
The *projects initiated by organisations* dealt with user-knowledge in different ways. Within 'Smart Power System Ulft' the organisation assumed that people have to adapt their energy consumption in order to reach energy neutrality. To help them adapt their behaviour the organisation has added a monitoring device to the system and included ICT technologies related to measuring and modelling of energy flows. Generation and consumption flows are now easily perceptible and the system is very practical and simple in use. It has to be stressed that since the implementation phase has not yet been finished, these aspects can still change.
The organisation of 'PowerMatching city Hoogkerk' dealt with user-knowledge in a different, more extensive, manner. The organisation started involving users in the implementation phase by gathering user-knowledge during meetings with all residents, brainstorm sessions and surveys. The special 'design group' provided user-knowledge as well, while this closely involved group of residents gave feedback during the various steps in the development process and served as a sounding board. The gathering of user-knowledge was one step in the *iterative* development process which consists of: gathering feedback from users, expert analysis, product development and again back to the residents for testing. The expert analysis is a challenging part since it requires experts to *translate* the user-feedback into technological requirements. The organisation has coped with this challenge by appointing a doctoral student to investigate the user-side. She has the skills to gather the right data from the residents. This data was complemented with external inputs from other researchers within the network of the doctoral student, and input from various producers involved in the project. This learning process is in line with the theory of Boonstra (2000) on third-order-changes and third-order-learning. Intrinsic to third-order-changes are problems which have a vague and complex nature and that come with uncertainty. Process of learning and creation merge into an interactive process of actors (Boonstra, 2000, pg. 27). The main focus is that feedback processes should become visible and that processes of acting, reflecting and learning should start. The role of the PhD student in the project 'PowerMatching city Hoogkerk' is in line with the notion of facilitator (Vennix, 1998). The facilitator should create conditions that facilitate an open dialogue, where diffusion of knowledge between actors becomes possible and where processes of learning emerge. The appointed student here fulfils, inter alia, the role of facilitator. She facilitates an open dialogue between organisation and producers on the one hand, and residents on the other, by acquiring appropriate user-feedback and translating it into specific user-requirements.

The main research question:
How is 'local practical knowledge' being used, to shape the architecture of sustainable energy systems in pilots initiated by organizations, and projects initiated by citizens in the Netherlands?

In local initiatives the 'local practical knowledge' only consists of knowledge about the goals the users wants to reach. These local goals from users in combination with the technological possibilities in the specific setting, determines how the system is going to look like. A viable systems comes into being by selecting those technologies that are both technological feasible and contribute to the local goals of the residents. Therefore, generic components knowledge has to be aligned with knowledge about local goals in order to select a viable system. Thereby 'local practical knowledge' is being used in a manner which does not strike with the views as stated by Fleck (1993, 1994) and Peine (2009), since it is not used in the implementation process and does not result in the creation of a certain amount of novelty in the technology.
In the pilots initiated by organisations 'local practical knowledge' consists of knowledge about local system goals from the organisation and specific user-requirements. Knowledge about user-requirements is a combination of knowledge about the usability of the system and knowledge about user goals that create additional value for residents. By aligning both the generic component

knowledge and the local practical knowledge, a viable system comes into being. These results underpin the theory of Fleck (1993, 1994) on configurational technologies and his statement that successful implementation is reached by combining both generic technology knowledge and local practical knowledge (Fleck, 1993).

Drawing back on the performed analyses it can be concluded that 'local practical knowledge' can take various forms and does not always shape the architecture of the system to the same extend.

7 Discussion

As mentioned in the introduction, the aim of this master thesis is to contribute to the notion of 'local practical knowledge' and the learning process between users and producers that are needed to gain this tacit user-knowledge. Another purpose of this master thesis is to get more insight in the innovation process of sustainable energy systems. In the discussion the researcher reflects upon both these theoretical and practical contributions. In section 7.1 the researcher reflects on the contributions to the scientific literature and suggestions for further research are proposed. Section 7.2 elaborates the findings of this master thesis to the practice of innovation management. The discussion will finish with a reflection on the research process, evaluating upon the actions and decisions made during the research project in section 7.3.

7.1 Theoretical implications

The field of sustainable energy systems is clearly a very dynamic field which is still developing. At the moment the field can be named diverse since various kinds of systems occur. The systems range from a very simple generic nature till an extraordinary configurational nature for systems that are made 'smart' by connecting various systems by measure- and control technologies.
This master thesis has explored the configurational nature of these sustainable energy systems further and came up with some new insights on how 'local practical knowledge' is gathered and how interaction happens to occur between organisations (producers) and residential users.
The cases on 'smart' sustainable energy systems illustrated that 'local practical knowledge' is knowledge about both goals from the organisation and residents, and knowledge about the usability of the system in the daily lives of residents. This differs from the theoretical description of 'local practical knowledge' by Fleck (1993, 1994) and Peine (2009), since the knowledge they refer to is only related to one type of users. However, in the case of 'PowerMatching city Hoogkerk' the system provided additional value for both distribution system operators and residents. Hence, knowledge about the use of the system in both these two types of use-environments in included. The essence of the concept 'local practical knowledge' is, however, not changed.
This master thesis has also created insight in the processes of interaction and learning between organisation and residents. At the case 'PowerMatching city Hoogkerk' user-knowledge was gathered by means of various qualitative and quantitative methods such as interviews, surveys and brainstorm sessions. The organisation applied an iterative process where the following steps are repeated: gathering feedback from users, expert analysis, product development and again back to the residents for testing. This process reflects *learning by trying*; the struggle to get the system to work as expressed by Fleck (1994). It is in this process that a certain amount of novelty is created. This master thesis has made a contribution to the notion of *learning by trying* by determining how this struggle looks like; the iterative process of gathering feedback from users, expert analysis, product development and again back to the residents for testing. From the results it also became clear that the researcher appointed to the project played an essential role in this process. These observed phenomena are in line with the notion of third-order-learning that is needed in third-order-changes, as described by Boonstra (2000). This additional literature recognises the essential role of a facilitator (Boonstra, 2000; Vennix, 1998) who should create conditions that facilitate an open dialogue where diffusion of knowledge between actors becomes possible and where processes of learning emerge. The facilitator should have the following behavioural characteristics: "one should be honest, and should have good communicative-, expression- and listening skills, and should be able to create an open communication climate.." (Boonstra, 2000, pg.29). The independent researcher in the project of 'PowerMatching city Hoogkerk' seems to have these characteristics and recognises certain initial assumptions and patterns of action where she steers towards rethinking to solve non-routine problems and create some novelty, which is in line with the notion of third-order-learning (Boonstra, 2000, pg. 30).

Although this master thesis created some new insights in the theory of configurations, this thesis also provides various opportunities for further research. Sustainable energy systems are still in a nascent phase of development which creates an exciting research agenda especially in the field of innovation. It is for instance very interesting to investigate how sustainable energy systems develop in the future, will the configurational nature gain in strength or not. And if so, how do these configurations stabilize in time?

The theory on configurations faces some interesting possibilities for further research as well. As this research only investigated two cases with a configurational nature, one of which was still in an early phase of implementation, generalisations on the findings of this master thesis cannot be given. Further research is needed towards the acquirement of user-knowledge by actors and the learning process between residential users and organisations. This is needed to identify whether the findings in this master thesis are widely applicable.

Additional insight should also be gathered on the process of embedding certain user-knowledge in the design of the configuration. Which knowledge is included and which knowledge is not? This master thesis was not able to provide this insight while the development of sustainable energy configurations is not yet far enough advanced.

7.2 Practical implications

The findings of this master thesis have also potential for managers in the field of innovation and project managers of sustainable energy systems. Managers need to acquaint themselves with the phenomenon of configurations and the subsequent challenges in the implementation process of such systems. They should notice that the acquirement of specific user-knowledge gets more important as the system gains in configurational nature. Extra attention should be paid to the process of translating user-feedback into specific user-requirements and aligning this knowledge with technological knowledge. They should also be aware of the fact that users develop their wants and needs in time when it concerns complex systems.

Managers should consciously think about a capable person to facilitate the innovation process, someone who can also mediate between residential users and producers and who can rethink conventional processes.

Residential users are in general suspicious towards organisations and will not be very willing to cooperate and be open about their thoughts and feelings. As illustrated by the results, appointing an independent researcher with proper capabilities can be a possible manner to deal with this challenge. It is important in this process that residents feel heard and that their perspective is taken along and reflected in the development of the technology.

Since pilot projects with sustainable energy systems are long-term and capital intensive projects, it is important for managers to draw upon the experiences of path finding projects that have already begun to explore this odd implementation process of configurations.

7.3 Limitations

This master thesis has applied a qualitative method where conclusions are drawn from the results through an iterative process of reflection, observation and analysis. Ideally such method applies *theoretical sampling* which means that important findings from the results are brought back into new data to adjust these findings and ground them into a broad field of data. Unfortunately the researcher was not able to apply theoretical sampling in this master thesis since the investigated cases turned out to be fairly different in nature and new similar cases could not be found. This is probably due to the newness of the 'smart' sustainable energy field and the large timespan inherent to the development of such projects. The consequence is that the interesting new findings brought about in this master thesis could not yet be generalised into theory. If the field of 'smart' sustainable energy systems continues to develop, further research should be done to verify these findings and ground them into theory.

The researcher has chosen to include local projects initiated by citizens in this master thesis while these projects might have provided additional insight in the way users are represented in the developments process, how user-knowledge was gathered and how this knowledge is processed. Contrary to what was expected, these cases did not provide very exiting results regarding the ways citizens were involved in the projects and the development of the technical systems. This is, most probably, due to the fact that they lack the technological expertise and use experience to clearly define what they want and need. And more important these projects lack the financial resources and organization structure to implement more complex systems. However, these cases did provide some interesting insights on how user-acceptance can be reached. From the local initiatives it became clear that citizens are suspicious of organizations and therefore they want to make their own choices as much as possible. Their perspective should truly be heard and taken seriously.

From the results is became clear that projects related to sustainable energy systems take a long time, generally a few years, to develop and get successfully implemented. During this process a lot of things happen, also in connection with the users. It turned out to be very challenging to gather data on this whole process at only one moment in time. Ideally this type of research should be executed over a longer period time in close connection with the development of the various projects. In this way the researcher can observe processes of development and learning, instead of depending on the memory of respondents. Observations provide much more natural material which leaves less room for bias. By interviewing respondents about their actions, expectations and feelings at one moment in time about the whole process, may create biased data since it is hard to determine if their story at this moment fits the reality at a certain moment in time.

This master thesis was a huge learning process for the researcher who has gained a lot in experience in doing qualitative research. Gaining experience is extremely important in qualitative research since the validation and reliability of results depend highly on the skills and experience of the researcher. Despite the learning process during this master thesis, the researcher was inexperienced and faced some challenges in grasping the enormous amount of textual data and deducing some meaningful theoretical findings from it.

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Appendix A: Interview summaries

Interview with the Project leader of PowerMatching City Hoogkerk

In the person of Frits Bliek (KEMA) on 20th April 2012

<u>General reflection on the interview</u>

Duration:	+/- 1 hour
Location:	At the KEMA department Arnhem, in a quiet meeting room
Motive to cooperate:	Agreed right away to cooperate in my research. He states that all project data is open for everyone who can make a contribution to it. As my research could probable give a contribution he was glad to give his full cooperation.
Small matters:	At the time of the interview, I had already done the interviews with Manon Vlamings and Wim Timmerman. At first, the interview with Frits was planed ahead of the interviews with Manon and Wim, but Frits's secretary postponed the meeting.

Course of the interview:
Since the interview was executed in a meeting room, the interview passed in a calm and pleasant way. Though I had the feeling that Frits was somewhat more reserved in his openness about the project than, for instance, Manon was. This can be since he was talking with me as an employee of KEMA, but it can also be because of his Physical background since he was telling about the project very succinctly and factually.

<u>Most coded</u>
Objectives project, Creating support and involvement, Problems, Communication with users, Use of user knowledge, Smart grid solution, Representation users

Objectives project:
Creating a sustainable energy landscape for they year 2030 focused on small users. Special focus should be on the changing position/function of the owner.
Furthermore, the project should coop with peak loads in order to avoid endless expansions of grid capacity. And end-users should be able to, eventually, get access to the market. They should use and supply energy from/to the grid when they require it, in order to create an optimal usage of the appliances in the network. Since the systems and appliances which are used, are more or less stand alones which are commercially available, the biggest challenge of the project is to get all the different parts working together.
Furthermore, the system should be appliance-independent and it should be able to make the free supply of energy possible while constraining grid expansions. Another objective is that the system should work fully automatic based on distributed intelligence and should not influence the comfort of people.
In the 1st phase of the project the mean goal was to demonstrate that such a system could work.
In the 2nd phase of the project the focus will be more on the end-users. Increasing the interaction by creating financial triggers for end-users. Focus will be on the development of interfaces and user-services.

Creating support and involvement:
For the project in Hoogkerk they used a small financial trigger. People had to pay €1000 at the start of they project but they also received a montly financial contribution which gives them a net profit.

In general people's consideration can be ranked as follows: people find comfort of the system the most important, then costs and on the third place they rank sustainability.
Furthermore, Frits states, that it is important to get the details right. If there are some small things people dislike these things can become continuous issues. This has also to do with having influence on the choice. If people have no choice they find that annoying.
Frits states, that there is a limited flexibility in change of people's behaviour. Promised energy savings have to be reached and made **visual** for the residents. If they can see the **effect** they will probably consider other

sustainable measures. In this way a portal is perceived as very valuable for residents.
You have to get insight in the requirements of the end-users. For instance, end-users want to validate their investment which has consequences for the development of the system (portal). Furthermore, you have to explain very well how the system works and that it makes decisions in their advance. You really have to inspire their confidence.

Problems
There are some technical problems. The actions of the system on behalf of the residents are not accounted for. So the (financial) effect is not visible.
Problems with smart appliances like washing machines and dishwashers, this is due to problems with power line communication between the appliances and the system. The communication is disturbed by interference from the environment.
Furthermore, there aroused some problems during the installation of the various technologies. These were due to a lack of combined action between the technologies. They faced that installers had some difficulties since the technology was too complex.
But there where also problems due to local peculiarities which the system was not calculated for. And problems with the thermostat since the system thermostat has less functionality than users where used to, though this is not effecting their comfort in living. The problem was probably creating due to user-routines and a lack of influence of choosing the functionalities of the system.
Another problem was a gap in expectation. KEMA was expecting a substantial change in user-behaviour, which seemed to be only limited. This may be due to a lack of awareness of user-requirements which should be taken along in the system design.

Communication with users
KEMA recruited participants for the project by advertising in a local journal, which provided more than enough candidates. Depending on the specific situation KEMA gave a strict advise to the participants for the system that could best be installed. Kema communicated to the end-users that the real pay-off would not match the initial invented system as thought of.
They also tested the support under end-users for some ideas for smart appliances. Furthermore they had several communication moments with end-users about the design and functionality of the portal.
In order to inspire the confidence of end-users in the system, they communicated very clearly how the systems works and that it acts in their advantage.

Use of userknowledge
They tested the support of end-users for some ideas for smart appliances. Furthermore they had several communication moments with end-users about the design and functionality of the portal. Several moments in time were chosen since users have to develop their needs in time. At first they have no clear vision about their needs.
People want to compare themselves with other people in the project. Furthermore they would like to set some goals for themselves I order to get to work more actively with the system and get insight about the effects of their behaviour.
Though the project had a very technological focus at first, they gradually found out that it is essential to get the user needs in the picture. And that these user-needs provide essential design information. Furthermore they found out that these user-needs are evolving over time, and so should the functionalities of the system.
→ Like a forecasting advice on the energy price in the next hour.

In the next phase the thermostat will be replaced based on the user-feedback. Furthermore, the user's contribution will be better visualised, inter alia by paying off financially based on their behaviour. The interface for electrical transport and the user portal will be adapted, and more services for end-users will be developed all based on user-knowledge collected in the meetings.

Representation users
Kema makes the assumption that in the future the big energy platforms will not be able to come with a competitive energy tariff in comparison with the costs for own generation of energy by means of solar panels. Therefore they assume that end-users should get their own access to the market.
From there on they started thinking and analysing what should be changed and how could the future system look like. The following criteria are resulting from this: the solution should be appliance independent; the

solution should make a free delivery of energy possible as well as controlling the capacity of the grid. And it should prove that the system can work completely automatic without influencing the comfort of people.
From these criteria you can deduct that in the project Hoogkerk they did not very much thought about the utility or usability of the system for end-users other then that it should not encounter any inconvenience from the system.
In the choice for the main system end-users had little influence. The choice between mirco-cogeneration device and heat pump is very much dependent on the specific situation of the household; size of the energy demand and house specifications like isolation and floor heating etc.

For the development of the smart appliances (dishwasher and washing machine) KEMA did involve the end-users in the development.
Later on they also developed a portal for the users to supply them with information. In this development process they also actively involved the end-users, though this development process didn't had their main priority. They are also aware of the time span people need to develop their requirements.
Though for the development of the system in the first phase KEMA didn't involved end-users perspective, they are very well working on the involvement and representation of users in the development of the system for the second phase. They found out that the flexibility of the change in behaviour is limited. People hold on to the things they are promised, so good communication is very important. Furthermore they are exploring, under users, which functionalities they want more.
Furthermore, Frits thinks that for the really technical development aspects of the system, like the market arrangement and privacy and security aspects, the user should be represented by an organisation with more in-depth knowledge like 'bits of freedom' or 'de consumentenbond'. This since it is difficult, if not impossible, for end-users to make a deliberate decision about what is best for them.

Least coded:
Learning points, Expectations-gap, motivation users, users utility/usability, success factors, project characteristics, context

Learning points
Technology should not be reduced on functionality or comfort of people. Involving users is essential, they will develop more services etc for the users and involve them in the process. They are also aware of the time span people need to develop their requirements. Furthermore they found out that these user-needs are evolving over time, and so should the functionalities of the system.
The combined action between technology and services is still a big challenge.
In the next phase they will also increase the monitoring on participants, what do they think and how does this evolve during the project.

Expectations-gap
There is a difference between the fictive market created for the system and the regular market, which creates difference in benefits. But Frits states that users are aware of this fact.
KEMA experienced further that the flexibility in behavioural change is limited. If people are told that their new heat pump will safe 20% energy they want to see it.
Users expected to see more about their contribution to the whole system; which effect has their behaviour and the installed system. This was in the first phase not at all clear. Furthermore they would like to act more, for instance by creating goals and get advised how to achieve those goals.
Trust in the system and that it acts in the users' advance is not obvious.

Motivation users
KEMA was looking for people who were willing to get to work with the new innovation. People who just needed a new heating system were not selected. Though people needed to pay €1000 in advance, they are earning it back during the project.
Furthermore, all participants have something with sustainability. But some are participating since they are very interested in the technology while others extremely sustainable. In general people find the comfort of the system the most important, than the costs and on third place they name sustainability.

Users' utility/usability

The initial value for users was a system which maintains their comfort level but provides financial benefits. Frits states that the utility for users is the great amount of comfort, which is often greater than they were used to. Furthermore there is the feeling that they contribute to sustainability.
Though, the usability can be better if the example of the thermostat is taken into account. In the next phase usability and utility will be increase by developing more user-services.

Success factors
Frits states that PowerMatching City Hoogkerk is successful because of three reasons:

- Small-scaliness; with a small amount of parties they created the best solution for a small amount of participants. All parties were very open and honest about their interests in the project
- They made use of already approved technologies. In this way the project was partly about things they already gained knowledge about and partly new and innovative.
- Every party used their expertise to the fullest

It is important to have a clear vision of the problem you want to solve and where you are going with the project. And if this is clear you have to find a good match between what is possible and what is feasible.

Project characteristics
In Hoogkerk they changed the heating system. One half of the households received a heat pump system and the other half received a micro-cogeneration device.
Participants were selected based on the fit of the home situation with the project goals. Furthermore they wanted a mix of family compositions and a mix of house types.

Interview with the doctoral student of PowerMatching City Hoogkerk

In the person of Manon Vos-Vlamings (Hanze hogeschool) on 13th April 2012

General reflection on the interview

Duration:	+/- 1 hour
Location:	At home at Manon's place in Meppel.
Motive to cooperate:	Manon is as a doctoral student involved in the project PMC Hoogkerk. She is also active as a teacher on the Hanzehogeschool, so she knows how important data collection is for graduate students.
Small matters:	This was my 1st interview day. This day I have had another interview before I interviewed Manon.

Course of the interview:
Since the interview took place at Manon's place, the interview passed in a calm and pleasant way. Manon told me very openly about her experiences on the project, about her research and her findings. Including her experiences with the things that didn't go so well, and the things she would have done different if she should have had more influence on the project course.

Most coded
Representation users, Objectives project, Context, Use of user-knowledge, Handling problems, Smart grid solution, Problems

Representation users
In the development process of the portal, the user is actively involved from the beginning. At the start, user-requirements for the portal are collect by means of a brainstorm with the users.
Users were not so well represented in the initial main system. This is shown by the fact that the system goal and the goal of the individual households turned out, not to be matching. Later on, when this was noticed, the project organisation started to work on this by creating more dialogue between technology and users. This will be carried through in the 2nd phase.
Furthermore, from a smart grid game it became clear that the strategy included in the game was not matching with the view of the people. So users are not so well represented in the system. From this can be deduced that involving users in the development process was initially not a main focus. For the second phase this will be a main focus though, since they learned that it is nevertheless very important.

Objectives project
The objective of the project was very much a technological objective to prove they were able to realize peak-shaving. The second phase is aimed at scaling up the project. Furthermore, the organisation selected a variety of houses and household for the project in order to test the system in various conditions.
Showing the measured energy data to the residents was more a side issue for the organisation. Though it didn't had their focus, Manon was appointed to think about the lay-out of the user-portal. Her personal objective in the project is to create a dialogue between technology and households in order to reach the goals of both system and household. The results, however, will only become visible in the 2nd phase.
During the 1st phase the organisation became more and more convinced of the need to look also at the user-side. Therefore, they lately started a work package-user with different stakeholders to increase the acceptance of the system among residents in the 2nd phase.
An objective for the 2nd phase is to change the whole billing process.

Context (Important information)
Manon stresses the possible shortcomings by not taking into account the user-side. She states that negative effects like a rebound effect can arise. Residents may increase their energy usage due to the fact that they think they don't have to be economical any more with energy usage since they have all kinds of sustainable technologies in their houses. So her research focuses on how a dialogue between households and system can avoid negative effects when introducing such new system. This negative effect can also be created by a gap in expectations between households and organisation. In general, technology is created to realize goals of the users. But in this case the technology is created to realize greater social goals which may not mach the individual goals of the households. You have to bring those two closer together.

In this case residents are not experts on the field of technology, so when speaking about changing behaviour and the mechanisms behind that, you need a translator, according tot Manon. People do not understand it very well; example lack of back flow meter.
Another doctoral student (Daphne van Geelen) is dealing with the mutual relations between households and the advances it can create.

Use of user-knowledge
For the development of the user-portal they actively collected the user-perspective and they are using it to shape the portal. By means of the organizing residents evenings, they also identify other bottlenecks which they try to solve. Like the expectation gap between system en households, and the problems with the thermostat. They are taking this quite serious since standard solutions are not selected if this does not generate a proper solution, though interest entanglement also plays a big role in arranging focus for different problems.
Though they initially did not use any user-knowledge, in the course of the first phase they collected more and more user-knowledge which will be applied mainly in the 2nd phase of the project. (The fact that they appointed two researchers on this field to translate user-knowledge to propositions, indicates they are taking it seriously.)

Problems
- Technical problems inter alia during installation. This is mainly due to the newness of the technology. Getting the various components working together was hard. This caused some problems and discomfort for residents.
- Some technical problems were also due to local contingencies like the specific conditions of the house. Though I think these are also caused due to incompetence of installers with the new technologies.
- There is a gap in expectations (and objectives) of the system between organisation (who created the system according to their objectives) and residents. Residents expected to safe energy and thought they would have more insight in the effect of their actions. This problem may be arisen due to a lack of clear communication, but also due to unexpected troubles during the execution of the project plan. There were actually a few functionalities of the system which should have been working already in phase 1 which are not functional yet. This is also mainly caused by the newness of the technology.
- Interest entanglement among stakeholders in the organisation plays a role in arranging focus for different problems. User-related problems did not has a main focus and are not always taken up so extended.
- Energy is a whole different type of consumer-product. People are not aware of their usage and purchase. Energy is just something that is always there. According to Manon, you can not simply say that consciousness leads to behavioural change, more is needed.
- Communicating beforehand about the working of the system may not always work when it is quite complex. From Hoogkerk it turned out that people started to understand it when they communicated the working a second time, after the residents had some experience with the system themselves.
- The organisation installed a new thermostat with less functionality, though the reduction of functionality was system which a good decision, it goes against people's perception of what is good. So the usability in the sense of amount of functionality was a problem here. Though this might be only perception and caused by user-routines.

Handling Problems
- The organisation appointed two researchers in order to identify problems at the user-side and translate these in (technological) propositions.
- The organisation picks up the 'user-knowledge' and seems to apply this is the development process of the system.
- System functionalities which are delayed and have not been working in the 1st phase, will be realised in the 2nd phase, sometimes even improved with new information. Other functionalities, like the thermostat, are improved in the 2nd phase.

Smart Grid Solution
The PowerMatcher, which can match demand and supply of energy. A user-portal which visualizes energy data on supply and demand, this is information exchange in one direction. The system is centrally directed and fully automatic. Participants get a fixed financial compensation for the energy exchange on the virtual market.

Least coded
Communication with users, Local knowledge, Expectations-gap, Creating support/ involvement, Project characteristics, Motivation users, Users utility/usability.

Communication with users
They (KEMA) communicated with the participants that they would get all kinds of sustainable technology in their houses and that they would be part of a smart grid. At first it was not the intention to give the users information and feedback on their energy usage, later on they decided to do so since they had the knowledge anyway.
The first meeting with the users was before there was any technology installed. This first meeting was inter alia used to collect 'portal needs' under the users. These user-meetings were organised every 3 to 4 months. At the end of the first phase they introduced a community portal. The goal is to increase complicity with the project and create a platform to exchange information between users. They executed a Smart grid game to create insight in the system and their contribution.
Though KEMA communicated about the project and the meaning beforehand, the story seemed more valuable when it was explained again later on. After some experience with the system people had specific questions about things they didn't understand. After the second explanation they had a better understanding. They then also understood better that they are participating in an innovation project and not an energy savings project. Understanding increases involvement according to Manon.
Communication seemed not to be optimal since there was a mismatch between system goals and expected goals from households.

Local Knowledge
The implementation of the system caused various problems in various houses due to peculiarities in the various settings. Since participating houses are existing houses and not new, every situation was different, so they had to technically adjust the system to the specific situation.
Furthermore, from the smart grid game it became clear that people have their very own vision what is good or bad, though this vision may stroke with reality or the optimal result. But if people act according to their own beliefs and vision, the desired effect may not be reached. This was also the case with the new thermostat which had less functionality, and though this reduction of functionality was the optimal solution it goes against people's perception of what is good. Another point of attention is that people not always act the way they say they do. Behaviour is often unintentional.

Expectations-gap
According to Manon most households thought that they would safe energy with the smart grid system. Unfortunately there is not enough insight to determine if the individual households safe energy. In some cases the bill turned out to be higher and in other cases it turned out to be lower. But what causes this increase or decrease is not clear. The efficiency of the heat pump and micro-cogeneration device are not clear. This results in unfamiliarity about the benefits.
The expectation gap in utility of the system may also be caused by unclear communication. Though KEMA communicated the meaning of the smart grid beforehand, it only became clear when it was lately explained a second time. Probably since people now had experienced the technology and came up with some specific questions.
Another thing is that people expected to act more, they like to influence their energy consumption and the total result with their own actions, but at the moment this is not possible yet. They would like to see the result of their actions.

Creating support/ involvement
Wim Timmerman was already active in a small group of people who were doing small sustainable project in the neighbourhood. Karin Bloemdaal, who was responsible for recruitment, contacted this group of people. Furthermore people had to pay €1000 in advance, which was very cheap for the amount of technology delivered. Some people mentioned they needed a new condensing boiler, for whom the project was a nice opportunity. Though, Manon mentioned that they also received a lot of trouble.
For the 2nd phase they are trying to create more support by introducing a community portal where people can exchange experiences with others and become more involved in the project. If this works is not yet known. Though it can be better, there is already al lot of support under participants since nobody dropped out of the

project after the first 3 years, everyone will be cooperating in the 2nd phase of the project. This is probably due to a change in strategy during the project, they know have greater focus on the end-users; they are being involved more in the project and the communication became more clear.

Project characteristics

The project started with 24 households three years ago and the participants all have very different houses and family compositions.

Furthermore the project has a clear top-down approach; users played a minor role especially in the beginning. This is also reflected in the fact that the smart grid solution is mainly a solution for a societal goal and the corresponding technical problems. Though besides the societal goal there is a individual goal of the households which may differ. This has not get very much attention in the project initially.

Motivation users

All participants are people who are concerned with technology or the development of it. Or they are concerned with sustainability. There are also a few people who were interested since they were in need of a new condensing boiler and found it an interesting project. Furthermore they get some sort of financial reward during the project.

Users' utility/usability

The smart grid solution in Hoogkerk is mainly a solution for a societal goal and the corresponding technical problems. Though besides the societal goal there is an individual goal of the households which may differ. This has not get very much attention in the project initially. By giving it more attention the users' utility can be increased and therefore the acceptance.

Furthermore, the system contained a new thermostat which had less functionality than most people were used to. Though the thermostat had enough functionality to let the system work in the most optimal way, people felt different about it. Since the thermostat could only be put on the lower standby function for 7 hours, many people came home in a cold house, therefore the alternative was to leave the thermostat high. But this didn't fell good either. So the usability of the thermostat was underperforming. In phase 2 of the project the thermostat will be replaced with a programmable one.

Interview with one of the residents participating in PowerMatching city Hoogkerk

In the person of Wim Timmerman on 13th April 2012

General reflection on the interview

Duration:	+/- 1 hour
Location:	At home at Wim's place in Hoogkerk (Groningen)
Motive to cooperate:	I met Wim at a conference about Local energy companies. When I told him about by research he invited me to visit him and take a look at energy system in his house, since he is participating in the PowerMatching project. Furthermore, Wim is a teacher and doctoral student at Hanzehogeschool and participating in all kinds of sustainable working groups inter alia Grunneger power.
Small matters:	Wim is living in quite a big separate house with his wife. They don't have any children, are both working and are very sober energy users. Though they are living in an old house they isolated the place extensively.

Course of the interview:
Since the interview took place at Wim's place, the interview passed in a calm and pleasant way. Most of the interview took place with Wim only. During the last part of the interview Wim's wife (Dieth) was joining which gave some interesting results since Dieth has sometimes a completely different opinion on things.

Most coded
Context, Motivation users, Communication with users, Creating support/involvement, Expectations-gap, Problems, Smart Grid solution

Context
Wim started to tell something about Grunneger Power, a local energy collective in Groningen. Frans Stockman is one of the initiators of the collective and is a retired professor on social cohesion. Frans has done some research and work, before the foundation of Grunneger Power, to make his own neighbourhood energy neutral. Wim himself is also involved in Grunneger Power.

Motivation users
Wim and his wife Dieth were already very sustainable minded before participating in the project. They use energy very poorly and they prefer to wear a big sweater instead of increasing the house temperature.
When asked explicitly, they state that they were curious about this new technology and they would like to add something to this new energy future.
Their general perception is that most other participants of the project are not that green minded, only a few. For most participants it's a mix; the also find the new technology interesting and hope to safe money.

Communication with users
Wim was already participating in a working group which executed all kinds of sustainable projects in the Hoogkerk neighbourhood. KEMA first started to contact this group by e-mail. Later on KEMA recruited people by advertising in the local journal. People had to pay €1000 for participating is a pilot project on sustainable energy technology for 2.5-3 years. KEMA communicated that they wanted to test their new technologies in practice.
KEMA gives some information on energy usage and supply by means of a portal, this information is however very minimal and not always clear, like the 'virtual solar panels'. Information on the working of the micro combined heat and power system seems not clear to Wim, though Wim has a heat pump in his house.
The decision for the system was not joined by the participants. KEMA gave a fixed 'advise' on the best choice based on the specific household situation and house specifications. They did, however, have the ability to choose an intelligent washing machine a dishwasher. They choice was however an yes or no choice, it was, due to financial reasons, not possible to choose one of the two. Wim and his wife therefore decided not to participate in the intelligent alliance part.

Creating support/involvement
Based on experiences at Grunneger Power, Wim states that the investments are the biggest issues. People like

the idea's and want to participate but don't want to invest too much and also the long payback time is a big issue since people don't know if they want to stay for the next 5-10 years on the same location. Grunneger Power wants to stay a local initiative since this generates recognisability.
KEMA has chosen a neighbourhood for their pilot project which was already actively involved in sustainability projects. They recruited people by means of an advertisement; people had to pay €1000 in advance and get all new technologies tot cooperate with the test for 2.5-3 years. Since all participants will also participate in phase 2, Wim states that people indeed see the benefits of it. A social platform (forum) could help to solve mutual problems, according to Wim.

Expectations-gap
Ideally Wim would like that the project would contribute to energy saving. But up till now this is not the case. Furthermore he expected more feedback on the effect of his energy behaviour. He can only see that his energy usage is different (more electricity and less gas), but it is not clear what causes this change. In this way the added value is not visible. This was also promised at the start of the project, mentioned in their contract, that they would get a financial bonus if they were performing great. Up till now, this is not the case and they still receive the monthly financial reward which was established only for the start-up period.
Wim and Dieth would like to get more insight in their contribution to sustainability and their CO_2 savings. This to get really triggered to change your behaviour. Though they are still very enthusiastic about the project they hope to get more feedback on behaviour and results in the next phase of the project.
Dieth's perception is that some other participants also expected to safe some more money, though this is not mentioned very explicitly. Personally she don't thinks the financial benefit is not that interesting.
They both find that the usability and energy awareness are declined with the new thermostat. They think they can safe more energy if the thermostat is improved. They would also like the thermostat to be remote controlled. And Wim would like to read out thing on a distance. Furthermore they dislike the user-interface of the portal, also the fact that it is only visible on the computer they dislike, this could be improved.
Furthermore they would like to role of the participants to be more active. They would like to get more options to act themselves and explore the possibilities.

Problems
Wim and Dieth find the new thermostat the biggest issue and limitation. Before the project they had a programmable one and the new one is some kind of on/off thermostat. You can only handle it manually which takes some time to get it heated up.
Another thing is that during the winter season the heat pump can not be used since its efficiency drop dramatically if temperature drops as well. There were even some problems with icing on the heat pump which makes it very loud and eventually it breaks down. So under 3^{o}C the heat pump is not used anymore.
Some people had nuisance because of the noise the heat pump made due to not proper installation.
At the moment, they don't have any insight in when it is the best time to use energy, for instance to use the washing machine.
Wim and Dieth had hoped to get more insight in the effect of their energy behaviour and in the effect of the system on their energy usage. At the moment, the utility of the system is not visible. Also other (promised) functionalities like the dynamic pricing are not working yet.
Some things visualised at the portal are not clear, like the virtual solar panels.
In general there were a lot of technical problems which had to do with letting the different sub-systems cooperate with each other. Also the software faced some shortcomings.

Smart Grid solution
- On-off thermostat, which can be set stand-by only for 7 hours. Furthermore, its temperature can be set on room-temperature or system-temperature (heat of the water running through the tubes.
- Smart meter with a special server which can intelligently send and lead data. It can also steer for instance the heat pump.
- As back-up they have a central heating system which can take over or add heat if the heat pump alone is not sufficient.
- Furthermore, there is a online portal which provides limited information on demand and supply of energy.
- The system also comprises a lot of solar panels situated on the KEMA roof and a windmill which is virtually included.
- The PowerMatcher is a system (algorithm) which brings together supply and demand of energy by means

of price incentives. (not working completely)

- Everything is steered from a central point; the residents don't have to do anything.
- Smart appliances like a washing machine and dishwasher are connected to the PowerMatcher. But also electric cars and electric scooters are connected to the system.

Least coded

Context, Use of user-knowledge, Representation users, Users' utility/usability, Objectives project, Success factors, Handling problems

Use of user-knowledge

Based on user-knowledge the thermostat will be replaced in the 2nd phase of the project for one with more functionalities and setting options.
Residents could only choose whether or not they wanted the smart appliances. In setting the propositions for those smart appliances, KEMA used user-knowledge by involving them in the development process.
User-knowledge is used in designing the new user-portal (more insight and interaction) and developing propositions for the smart appliances. Furthermore they collected user-knowledge on the usability and utility of the system in general, based on this knowledge, improvements will be instituted in the next phase.

Representation users

Residents haven't had a choice in the type of system, since the best option is identified and installed based on their specific household. Inter alia they looked at the average energy use of the household, and house specifications (isolation, floor heating etc.) .They could only choose whether or not they wanted the smart appliances. In the propositions the user is represented by themselves. They were actively involved in the process.
Initially the users were not (very well) represented in the system. The main goal was to make the technology working in practice. This is reflected in the first phase by the deviating system-expectations of residents. Also the fact that the portal was very limited can be seen as a reflection that the organisation didn't (very well) think about the users of the system. Later on, when Manon joint the project, more focus on the users developed and user perspectives were identified. This was done by organising residents-meetings and set up a portal-design group of residents who can express their needs.

Users' utility/usability

The systems' thermostat has less functionality than the old thermostat Wim and his wife had before the project. This makes that Wim and Dieth perceive the thermostat as less valuable for them and for the system. The online user-portal is perceived as not so valuable due to the limited amount of insight it presents. And the information presented is not always clear and the fact that they can only get this information online is also perceived as a limitation. This all makes them not using the portal very much and perceiving the utility of the project as not visible.

Objectives project

What they communicated was that the project was a test with sustainable energy technology. Though it was not the focus of the project,KEMA communicated that energy saving was something they expected the system to make a contribution to. Partly because they expected that the participants would become more aware of their energy behaviour.

Success factors

The fact that the user perspective will be getting more focus in the 2nd phase of the project and the fact that the information on user perspective gained in phase 1 will be translated to improvements in phase 2.
That despite of all the problems, people are still enthusiastic and that all participants remain participating in phase 2 of the project.

Handling problems

Based on user-feedback, the problematic thermostat will be replaced for a new one with more setting options. The heat pump software is adjusted in such a way that it will no longer put on if temperature drops beneath 3 degrees, this to prevent problems and breaking down.

Interview 1; One of the residents participating in PowerMatching city Hoogkerk

Most coded

Communication with users, Local knowledge, Smart Grid Solution, Motivation users, Problems, Expectations-gap, Users' utility/ usability

Communication with users

Frits Bliek explained that natural gas can be used far more flexible as energy supply source than electricity. Therefore it is more appropriate to generate centrally instead of electricity. That is why the micro combined heat and power system is so efficient.
The residents are seem well informed about the working of the system; that their micro combined heat and power system can serve as a buffer and deliver electricity to other houses when there is no sun or wind. Though, this is not quite working according to the interviewee.

Local knowledge

The interviewee states that the system is producing a lot of heat, although they've had it isolated already. The system is furthermore located in the same room as their two refrigerators, which is obviously not ideal. But because of this heat they do not have to turn on the heater very often. Furthermore the Sterling engine makes a lot of noise when running. So, for the heat they want to leave the door open, and for the noise they want to close it. So they are playing with the door to reach their comfort level.

Smart Grid Solution

If somewhere else in the grid they need energy, the combined heat and power system of the interviewee will turn on. The heat, which he doesn't need at that moment, will be stored in the boiler and the electricity is supplied to the grid. Though it is not yet completely functioning in this way according to the interviewee. Furthermore there is a portal display showing their energy generation.

Motivation users

Their old condensing boiler was broken, so they needed a new heating system. This test project was a way to get a new heating system quite cheaply. Furthermore they had an interest in the technology; they already knew something about it, especially about the sterling engine.
Furthermore, the man of the house thinks the portal is not very valuable. It's all about the end-bill, therefore his motivation seems quite financial. The only thing they like about the portal is that they can show other people what their system is doing, for instance when they are on vacation.
Furthermore they state that they wouldn't have bought a combined heat and power system if they wouldn't participate in the project. They find it far to expensive and not profitable, for this reason they wouldn't recommend it to there friends and family either.

Problems

They find it hard to determine if their financial benefit is due to the powermatching sytem or due to the high efficiency of the combined heat and power system. Fact is that they use less electricity. But they are also stating that the powermatching part is not yet working completely.
Furthermore they had a lot of technical problems and received a new system. But it took two (winter) days to install the system, which made them face to cold.
Another problem is that the boiler turns on for short moments to compensate its heat loss, even though there is no heat demand at that moment. This happens even when they are not at home and on vacation. They think this wastes energy.
The system is placed near their living room which produces some nuisance due to noise and heat production of the system. Furthermore there is some uncertainty about the maintenance of the system when the project stops.

Expectations-gap

They expected to use less electricity and this is indeed the case, and they saved money. The only thing is that they don't have a very good insight about their gas performance since they didn't keep track of it from the start; no functionality is included in the system.
The women of the house prefers to play more like a game, safe energy, safe money and see the result of your personal actions. The man does not think this is valuable because it would be a virtual game since he hasn't

got the means to influence his behaviour. *It seems as if he thinks in problems not in possibilities in this aspect*

Users' utility/ usability
The utility of the system is for them that they got cheaply a new heating system which they already needed and the fact that it saves money as well. Sometimes they mention the fact that it is also good for the environment, but this is really secondary, it only seems a nice side issue. The fact that the energy bill is lower at the end of the year is what counts.
On the other hand, they woman of the house states she would like to expand the system with solar panels. But this is mainly because this makes the meter turn back. It seems as if they only want it if they don't have to invest themselves "ze hebben toch weer geld gekregen dus.."
They don't use the portal very often, it is not very valuable to them. They only use it to show it to their family and friends. (Image?) Though, the woman in the house does not always understand the portal equally well. The man on the other hand states that the portal is typical such thing where a lot of effort is put in without getting a satisfied longstanding effect. It's like a glossy magazine according to him.

Least coded
Motivation users, Smart Grid Solution, Local knowledge, Communication with users, Change in user behaviour, Creating support/involvement, Handling problems

Change in user behaviour
They both state that they didn't change their energy behaviour until now. They also state that they are a bit carelessly with timing their washes in the washing machine.

Creating support/involvement
They both state that they don't feel like having more contact with other participants. I think in general that support can only be created, in the case of these people, if there is a financial benefit. Further they like it if everything is organised for them.

Handling problems
The first period they had a lot of technical failures in their system. The organisation first placed a back up heating system but eventually a new combines heat and power system is installed which works much better.

Interview 2; One of the residents participating in PowerMatching city Hoogkerk

Most coded

Creating support/involvement, Change in user-behaviour, Opinion Smart Grid solution, Motivation users, Problems, Users' utility/usability, Expectations-gap

Creating support/involvement

The interviewee states that he doesn't need more interaction with other participants about energy usage and system. If he wants to safe energy he'll use the internet to get more information and tips. Since he can not change anything about the system he thinks there is no need to communicate about it with other people. Furthermore he is satisfied about the project since the organisation reacted well on system failures and also about the resident-meetings he is satisfied.

Change in user-behaviour

He doesn't think his energy behaviour changed during the project because he was already quite aware of his energy usage; turning switched completely off and using compact fluorescent lamps.

Opinion Smart Grid solution

The interviewee feels a preference for controlling in-house and not from outside as it the case at the moment. But how this looks like is not quite clear since he admits that the heat pump could maybe controlled better from the outside since the organisation can measure things.

Motivation users

He registered for the project last-minute so he didn't informed himself that well. He thought he would participate in an energy savings project. At the moment he changed his mind and no longer expects to safe energy. Now he is fine with limiting the expansion of regular energy generation platforms., though it would still be nice to safe some energy.

Problems

In the first part of the project there were some starting problems. During the icy spell the system ran to hard and later on it stopped completely. Furthermore it is hard to predict if the system saves energy, the interviewee has to wait till the end of the year to see the bill.
He doesn't perceive the thermostat as a big problem but it would be nice if it was a programmable one. Furthermore he thinks the heat pump makes quite some noise, and the system also takes quite some space. For the appearance it would be better to build a cap fitting around it.

Users' utility/usability

The interviewee doesn't use the user-portal very much. Before the project he didn't checked his energy usage weekly. And since the portal has no functionalities to optimise something in the house, he doesn't see its utility. Also the fact that it isn't possible to check for natural gas usage is a shortcoming.
He likes the fact that the system probably limits the expansion of regular energy generation platforms.
At the heat pump it is possible to set the temperature of the tap water; this is valuable because he tries to safe energy in this way.
He also states that it is fine that the system is automated; that the system makes the choices for him, although he can't influence it positively by his own behaviour.

Expectations-gap

At first he expected to participate in an energy savings project. And although he still would like to achieve some energy savings but in the meanwhile he is aware that this isn't the main focus of the project, and he is fine with that. In general he is fairly satisfied with the project despite the problems the systems faced in the beginning. On the other hand he would like the portal to have more functionality in order to optimise energy usage in his house; some sort of advise. He also would like to have more insight in his natural gas usage. Ideally he would like to generate as much energy as he uses. So he wants to be energy neutral, but he thinks this is not realistic.

Least coded
Users' utility/usability, Problems, Motivation users, Opinion Smart Grid solution, Change in user-behaviour, Creating support/involvement, Handling problems

Handling problems
When the heat pump really didn't function anymore, the organisation installed new software. In general he is satisfied with the problem handling.

Interview 3; One of the residents participating in PowerMatching city Hoogkerk

Most coded

Handling problems, Creating support/involvement, Opinion smart grid solution, Communication with users, Problems, Users' utility/usability, Expectations-gap

Handling problems

The interviewee mentions he has had a year of misery with the system, but he is happy there was a back-up system which could take over if the system failed again. Though he things the service and quality of the emergency service (storingsdienst) was very bad. It took in general a week for someone to come by, which was most of the time someone who didn't know what to do about it. The third new system is however wonderfully working very well.

Creating support/involvement

When the system works properly there is no need to interact with other people about the system. Also to communicate with other participants about energy savings/usage is useful for the interviewee. Because it is almost impossible to compare different situations with each other; different houses, different family compositions and different ways of living. Everyone has it's own comfort level.

Opinion smart grid solution

The interviewee thinks there is a need to let yourself be guided by the system in order to get the best intelligent network. Ideally he doesn't want to notice anything about the system. It had has to operate optimal in favour of the user (lowest costs). He thinks the system can make the best choices since he doesn't has the information.

Communication with users

It was communicated to him that all technologies had proved themselves, nevertheless he got a lot of problems with the system.

For the interviewee it is not clear why the system starts running around half past eleven in the evening when he is in bed. KEMA told him they are not guiding such actions at distance yet. He thinks this is strange. Especially because they are not taking action on this, though they can measure al the actions at his home. He want to get more insight in these aspects and want to know what his contribution is and it this is right and explicable.

At first, he didn't saw the intelligent network aspect completely. Now he can visualise it but from a user-perspective he still thinks that, at the moment, it isn't functioning as a smart grid yet. It isn't visible for him.

Problems

The first year was one of misery since the micro combined heat and power system continued to fail. After a year of substituting various parts and getting various new systems, the third system replacement is now working well. But he is not pleased about the service which took very long and was of insufficient quality. This was not what he expected since it was told the technologies were already proofed.

Furthermore he doesn't have insight in his energy usage, electricity as well as gas. This is partly due to all the technical problems.

For the interviewee it is not clear why the system starts running around half past eleven in the evening (or other foreign times) when he is in bed. KEMA told him they are not guiding such actions at distance yet. He thinks this is strange. Especially because they are not taking action on this, though they can measure al the actions at his home.

Furthermore he prefers another thermostat, one which is programmable or by all means more than the 6.9 hours which is now the only option. This time is to short for a night or working day. In general he thinks it's a simple but good thermostat, it could only be improved by adding some options.

Users' utility/usability

The utility of the system is for the user the fact that it is interesting new technology which is more environmentally conscious; to get maximum efficiency and profit from it. Optimum efficiency is achieved by using natural gas as a source for both heat and electricity.

Lack of insight in energy usage of both gas and electricity. The portal is not very valuable since it isn't providing such exiting or valuable information you feel like using it weekly.

Furthermore the interviewee thinks it is good that the system is fully automated and that it makes decisions for the residents; in their advance. Ideally he don't want to notice anything about the system, only the lower energy bill.

Expectations-gap
More insight in his own energy usage and supply and his contribution to the smart grid system, is this right and explicable. This is something what misses. He doesn't feel like the whole intelligent network thing is working yet, though he finds this an interesting part. He would like it if this aspects is developed further, it may use all information on his energy usage, and make the network as optimal as possible with all this data. Though the network may already be intelligent, it is not yet visible, if this is the case it has to be showed in some way. Furthermore, the thermostat is perceived as a bit simple, some more options are preferred to set the stand-by time; 6.9 hours is a bit of an odd time interval.

Least coded
Communication with users, Opinion smart grid solution, Creating support/involvement, Handling problems, Motivation users, Change in user behaviour, Context

Motivation users
The interviewee was interested since he likes new technologies and the fact that it may be technology which yields energy savings and uses energy more efficient which can bring some profits. He is already fairly environmentally conscious when applying for the project. Although he states that he likes the technology aspect more, he likes to know how everything works.
He is environmentally conscious in the way he uses products. Sparing with chemicals and cleaning liquids as well as limiting waste. But on the other side he has a big expansive car which is not that environmentally friendly; he admits he is susceptible for such things.

Change in user behaviour
He didn't change his energy behaviour during the lifespan of the project. He was already fairly conscious about his energy usage, the project didn't change it positively or negatively. He would like to apply for the smart washing machine and dish washer but he wasn't selected.

Interview 4; One of the residents participating in PowerMatching city Hoogkerk

Most coded
Objectives project, Handling problems, Change in user behaviour, Communication with users, Problems, Users' utility/usability, Expectations-gap.

Objectives project
According to the interviewee the objective of the project is to match energy supply and demand by employing the moments of low energy usage. This to shave the peak moments. Furthermore, the technology is proved on a more efficient use.
At first he thought the project was also contributing to energy saving, but later on it become clear the main objective was peak shaving.

Handling problems
The handling of problems is not perceived as logical. If there is a problem, various people come by to look and work on it. This gives transfer problems; it can be organised more efficient according to the interviewee. Sometimes problems stand over, like the smart appliances. At first a lot of work is done to get it working and suddenly you hear nothing for 2-3 months although it is still not working. It isn't finished.

Change in user behaviour
They are not yet used to the routine of pressing the thermostat button to set it stand-by when going to bed. They forget about it a lot. And the interviewee thinks this will never be a routine for them.
At the beginning they where far more active with checking their energy usage and supply but this decreases over time.
In general they think they are using more energy since they are attending the project, since they heat their home more continuously than previously was the case.
With the knowledge from powermatching city they are running their washing machine and dishwasher around 3 at night since this seems to be the best time.

Communication with users
Students had done some research in comparing the previous energy usage with the energy usage at this moment, but he hasn't got any results.
The interviewee's perception is that the system is not working optimal yet. It could me more intelligent by including weather and outside temperature information in the system for instance. Furthermore, it isn't clear to him if his own solar panels are taken along in the project.
Communication about problems in the working of the system, like the washing machine and dishwasher, can be more up-to-date. Sometimes they don't hear anything for 2-3 months while it still isn't working.
At first, the interviewee thought that the project was also contributing to energy saving, but later on he understood that peak shaving (more efficient use) was the main goal. Tough he would like to get a very clear explanation about the working of the boiler in relation to the heat pump, this is not clear.

Problems
* The project let to a decrease in ability to play with various temperatures in-house. Since he is now heating the house continuously on the same temperature he thinks he is using more energy. Furthermore, he forgets about stand-by setting most of the time when going to bed, to work etc.
* He thinks the system is not exploiting all the possibilities at the moment. If this was developed further he expects that energy savings are possible.
* The working of the system and relation between various components is not completely clear. In general, communication can be better. Also on the progress of the project.
* Problems are not solved efficiently since different people are send by to look and work on the problem. This gives problems in transfer of information about the problem.

Users' utility/usability
He finds the system less usable compared to the previous situation since he isn't able to fluctuate temperature during the day. Therefore he has a higher comfort level since temperature in more continuous, but he is not profiting from it since he is often away or sleeping.

The portal was valuable in the beginning, now it isn't used very often any more.

Expectations-gap
He would like to get more thermostat functionalities to fluctuate in temperature during the day and program it. Furthermore he thinks the system can be more valuable if it is developed more intelligently, especially on the field of energy savings. For instance by including information in weather and outside temperatures and make the system anticipate on that.
Also the portal may get some extra functionalities in order to get more active with creating more benefits in own house. Ideally he would like to find the perfect match between his comfort level and an energy consumption which is as low as possible. He would like to get some advise on optimal energy consumption times. For instance about when it is the best time to shower; in the morning or evening.
Furthermore he would like to get more insight about the whole working of the system and interrelationships.

Least coded
Change in user behaviour, Handling problems, Objectives project, Creating support/involvement, Context

Creating support/involvement
The interviewee is not in need for more interaction with the other participants. The current meetings are enough.

Context
This household has a heat pump system and they have their own solar panels.

Interview 5; One of the residents participating in PowerMatching city Hoogkerk

Most coded
Creating support/involvement, Problems, Change in user-behaviour, Motivation users, Communication with users, Expectations-gap, Users' utility/usability

Creating support/involvement
More interaction with other participants is not perceived as valuable since comparison is very hard between different houses and households. Some kind of summary per quarter is suggested as a good option.

Problems
Not many problems with the heat pump system have occurred. At the start the heat pump was not functioning well, but this was fixed right away.
The installation was however not so well executed. The closure of the smoke outlet was not good, which made the tube popping of at night. Their daughter slept in the attic where the system stood which caused exposure to flue gasses for a while. And the ceiling was damaged as well. But the most annoying is that it took Imtech 1.5 years to fix it completely, since the files was lost.

Change in user-behaviour
No they didn't really changed there energy behaviour besides the fact that they are decreasing the temperature only one degree when going to bed, not more. This makes the house more comfortable since it isn't that cold in the morning than. The interviewee mentions their house is already very good isolated, so he doesn't know what to change in his behaviour.

Motivation users
Energy saving is not their first motivation to participate at the project. Their motivation is more from an environmental perspective and to show their kids (4) it is important to use alternative energy sources. That they see it is important to invest in this development although you're not profiting from it right away. It is necessary to invest now to stimulate the development of alternative energy sources.
Furthermore their old condensing boiler was not so good, it failed in delivering comfort in heating and warm water.

Communication with users
Communication with KEMA is perceived as good. The system is working great and they report it if something is wrong. Information supply is good and adequate.
They also communicated about a new function; a button you can push before you go to bed which makes that the heating system starts to heat an hour before you get up in the morning.

Expectations-gap
The expected to increase their comfort by participating since their old system failed in delivering comfort in heating and warm water. This expectation is fulfilled.
In the future he would like the system to be expanded with solar panels and a wash dryer. Furthermore the thermostat system could be developed further, although they are already happy with it.
Another possible option he suggests is a quarter summery of the results of all participants.

Users' utility/usability
The utility of the system is for them that their comfort level increased, since their previous system failed in delivering comfort in heating and warm water. Furthermore they want show their kids (4) it is important to use alternative energy sources. That they see it is important to invest in this development although you're not profiting from it right away. It is necessary to invest now to stimulate the development of alternative energy sources.
They thermostat system they perceive as simple but good usable; it works better than their previous thermostat. The user-portal is not very much used by them. Every few months they look at their energy meters though to get insight in their usage.
The system would get more value for them if it is expanded with more alternative energy source like solar panels and a smart wash dryer.

Least coded

Motivation users, Change in user-behaviour, , Problems, Creating support/involvement, Context, Handling problems

Context

Their old heating system was a condensing boiler which was eleven years old and had some serious shortcomings.

Handling problems

They are very satisfied with the problem handling of KEMA and the mutual communication. They are however not satisfied with the problem handling of Imtech which took 1.5 years. (See problems)

Interview 6; One of the residents participating in PowerMatching city Hoogkerk

Most coded
Smart grid solution, Communication with users, Local Knowledge, Objectives project, Users' utility/usability, Problems, Expectations-gap

Smart grid solution
The interviewee had a heat pump system is his house.

Communication with users
Communication can be better, especially on the field of keeping participants up to date on the progress if things are not working yet. On a general level, the working of the heat pump system is clear to the users. More interaction with other users should be nice as an inspiration (f), for instance by means of the portal. The man in the house thinks it would also be nice if KEMA would tell more frequently about the technology.
The women in the house states that she's quite lazy, therefore she preferred a monthly mail with her energy usage and supply information, instead of looking it up herself.
They didn't get any advise on which temperature should be best, only that it isn't optimal to turn it very low. It seems as if they are not completely aware of the fact the system is making already the most optimal decision for them.

Local Knowledge
While installing the system they didn't know how big it would be. Now it is installed in their storage place, which is now completely filled. They can not get to the shelves anymore. The system should have been installed more efficient in the small space.
The house in fairly new (2005) and has a convertor well, which uses about 30% more energy than a conventional system with radiators. There is a case against their builder since they have plus plus windows and perfectly isolated the house, but it does not result in the low energy usage as promised, due to the convertor well.

Motivation users
The participated in the project since the man in the house was very interested in the technology. The woman in the house was however very curious what it should fetch. They expected to use less energy by heating with a constant flow.

Objectives project
They wanted to reach high comfort and low energy usage. Furthermore, the man in the house wants to learn more about the system and how it works.

Users' utility/usability
The expected decrease in energy usage is not reached. The first year they even used more energy, but this may also be caused by the hard winter period and the fact that the wife was home a lot due to illness.
The portal is not used very much, the man states that he thinks it is difficult to link the portal information with his own energy meters. The portal would become more valuable if it would give more detailed information on consumption and demand in the grid. They would like to act more based on this information; he wants to see the game aspect (trading) more.
They use the new thermostat in the same way as they used their old one. They set it on about 17 degrees if they are not at home, and 19 degrees if they are at home.

Problems
It is hard to determine if the energy consumption increases/decreased or stayed the same, since every season is different the first year had a strong winter and.
At the moment they have problems with the barrel for warm water, it has to stay on 70 degrees but it doesn't. So now they have to turn on the heating to get warm water.
They had problems with the heat pump when the temperature was outside around the freezing point. Is made a lot of noise and the system froze. But that is fixed.
Another thing is that the heat pump has to be cleaned. Dirt and condense are not transported completely in

the back which makes the blower run very hard. Though they have a service contract with Imtech, they haven't cleaned the system yet.
The system is not optimally placed what concerns the space of their storage room.
It is not possible to see what causes a peak consumption visualised on the portal.
The are participating in the smart appliance project but their washing machine and dishwasher are still not being connected to the network. The interviewees are not kept up to date, the last time they heard something was two months ago. They then states that someone should come by soon. They would like to be up dated more often.

Expectations-gap
The woman of the house expected to see very quickly what the heat pump yields; how much energy it saves. They expected to save energy since they are heating more constant with a heat pump. But until now they don't know. Last year their energy bill was even higher (less gas but more electricity), but it was a harsh winter as well. The also expected the organisation to communicate more about the general results (yields) of the project. The portal is not very valuable in this aspect; it is not quite clear what the link is between the user portal and their own energy meters. The portal could become more valuable if it provides more interesting information and if the organisation calls more attention to it; the wife would like to get lured to the portal, otherwise she doesn't think about it.
They also expected to get more insight in the impact of the small 'computer-park' in the attic of the man of the house. This insight is not yet present. The man of the house has special interest in the technology and how the whole system works, this insight is not yet reached. Based on the information on the portal he can't determine why his heat pumps turns on at very odd times, he would like to get more detailed information.
They also expected to receive more information about the current situation of development of the smart appliances, the organisation does not look very active to get it all working. Since these appliance still not working, they are not contributing to more efficient use and financial savings.
More interaction with other users should be nice as an inspiration for their own household (f), for instance by means of the portal. Inter alia to get tips and get to think about changes they can make in their own household. The man in the house thinks it would also be nice if KEMA would tell more frequently about the technology.

Least coded
Local knowledge, Communication with users, Smart grid solution, Representation users, Handling problems, Change in user-behaviour, Context

Representation users
These users don't seem very well represented in the initial system since there are a lot of deviations in their expectations of the system and what it could actually can do.

Handling problems
Problems were handled nicely. Only the new system was placed a bit spacious. But these residents mention that there are not pick up the phone very quickly if there are small problems.

Change in user-behaviour
They think they are a bit more aware of their energy consumption, but they've always been quite frugal with energy. They also think that the effect was bigger if they have had more contact with other participants; if she have had continued to participate in the design group for instance.

Context
The man in the house has its own 'computer-park' in the attic according to his wife. But the wife has her own 'sewing machine park'. They also have a convertor well in their house, which uses about 30% more energy than a conventional system with radiators.

Interview with the Project leader of the HIS system at project Ulft

In the person of Danny de Pater (Liandon) on June 7th 2012

<u>General reflection on the interview</u>

Duration:	1/2 hour
Location:	At the central hall at Alliander Bellevue, Arnhem
Motive to cooperate:	It was quite hard to get an appointment with Danny since he was very busy. But since I am doing by graduate internship at Alliander, the interview itself was very nice.
Small matters:	This was the first interview I executed on the project 'energy neutral houses in Ulft

Course of the interview:
Liandon developed the In Home System, which is applied in the energy neutral houses. Danny de Pater was project leader of this project at Liandon. The interview is therefore mainly focused on the IHS system. In general the interview passed very pleasant.

<u>Most coded</u>
Project approach-organisation, Creating support-involvement, Learning points, Success factors, Use of user-knowledge, Representation users, Smart grid solution

Project approach-organisation
The housing association Wonion wanted to build energy neutral houses and therefore they organised a contest. Different companies came up with different concepts to reach energy neutral houses. Eventually installer Klein Poelhuis won the contest. Since Klein Poelhuis wanted some kind of monitoring system for the residents, and Alliander was already in conversation with Wonion about the IHS system, they were brought into contact with one another.

Creating support-involvement
Although the IHS system is developed mainly for organisations like Wonion, the system could also provide added value for the residents. By means of communicating those benefits to the residents (insight in their energy consumption by means of a display), installation of the system is more easy accessible.
Also the construction of Wonion buying the system and the residents paying a monthly fee for the service of the system is something which creates support. Residents themselves should not easily be motivated to do such an investment.
Furthermore they decided to start with a few (simple) functionalities. The system is able to execute far more functionalities, especially on the field of directing energy flows, but since everything is new to the residents this is a first step. They have to get use to it slowly. *(→ small steps is also something that is mentioned by frits bliek)*

Learning points
Their internal planning to develop a proto type was a bit too short. Some more time to test is internally would be better. Although the external drive can motivate people to work extremely hard.

Success factors
The communication with all the other parties is seen as the success factor of the project. Be in contact with one another continuously and solving issues directly.

Use of user-knowledge
They skipped the steering aspect of IHS from the original concepts since people (residents as well as Wonion) seem to be a bit reluctant against it. From research it also became clear that people are not willing to invest in a monitoring system like IHS . But since the housing association does see the added value, they are investing in it and the residents are paying a monthly service fee.
If people are living in their houses for a while (1year +), feedback from residents will be gathered and this may implicate adjustment.

Representation users
Liandon did research under users about their perception against steering functions. Since users are a bit reluctant to such functions they decided to skip those parts of the initial concept of IHS. Another aspects they did research about is the willingness to invest in such a system; users proved not to be very willing. They now have a different concept with housing associations investing and residents paying a monthly fee.
They have however not done any research within the current group of people living in the energy neutral houses. Though they did research in various target groups.
In the future when people and the system are both completely settled, feedback on the system will be gathered from the users. Currently this is still to early.

Smart grid solution
The IHS is a monitoring system which can visualise real time energy flows in the house. So electricity, gas, water and heat flows. Furthermore it is connected to the smart meter to check for validity.
IHS visualises the generated energy and the consumption in the 10 different groups of the house. The IHS is connected to the Powerrouter. The powerrouter is a convertor and smart steering system which decides if the generated energy is used in the house or delivered back to grid.
A special demand of Wonion was that the residents should see their energy consumption at all times, so not by the internet. Therefore they developed the display which in situated in the corridor.
Furthermore, the houses are isolated very well which makes them in need of very little energy. They also have a heat pump (ventilation air?), solar water heating device and solar panels. As a back up, they installed extra electrical re-heaters.

Least coded:
Users' utility/usability, Motivation users, Context. Problems, Communication with users

Users' utility/usability
Users' utility of IHS is that they can get insight in their energy generation versus their energy consumption.

Motivation users
For the energy neutral houses, Wonion initially intended to select people with a green mindset. But eventually they changed this and now there are living people with various motivations. Mainly people which were living in a street which is demolished.

Context
The project is initiated by Wonion, a houses association which has a special interest in sustainable projects. Therefore the organised a contest for organisations to design a concept for energy neutral houses.

Problems
Problems had to do with planning, since the product was still in development phase. Furthermore there were technical challenge that had to be taken. The test phase brought up many issues (i.a. applications that didn't work properly) but hereafter the initial installation went well.

Communication with users
The plan is that a consultant will give the residents advise based on their energy consumption (which is facilitated by IHS). At first Klein Poelhuis will offer this service but in the future Wonion will most probably fulfil this task.
Furthermore the organisation (Wonion & Klein Poelhuis) communicated very clear to the residents that phrase 'energy neutral house' does not mean it is self-evidently energy neutral, it depends on their own energy consumption. With some awareness on this field it should be possible though.

Interview with the Project leader of installer Klein Poelhuis at project Ulft

In the person of Hans Keunen (Klein Poelhuis) on June 8th 2012

<u>General reflection on the interview</u>

Duration:	+/- 30 minutes
Location:	The project neighbourhood, in their show house.
Motive to cooperate:	Hans was motivated to cooperate probably because he really beliefs in their new and innovative approach. He wants to share this with the world.
Small matters:	The interview is executed during the weekly consulting hours in the neighbourhood.

Course of the interview:
Although the interview was executed during the weekly consulting hours for the residents, the few interruptions were not perceived as harassing. In the last part of the interview, Marco of builder Klomps joins the interview.

<u>Most coded</u>
Success factors, Users' utility/usability, Smart grid solution, Creating support/involvement, Change in user behaviour, Project approach-organisation, Communication with users

Success factors
Where normally builder and installer go away after delivering the new house estate, they didn't choose so. They give 3 months of intensive support after delivering the house, with every Friday afternoon some consulting hours in the neighbourhood. In this way problems are handled quickly and more efficient. In this way people don't get frustrated when having a problem; which can cause that problems become bigger. Another success factor is communication with residents. Before delivery they already had some meeting with the residents where they explained the technology. After delivery they get an explanation about the working of the technology and how to use it, but this is done in a separate house. This to get people's full attention and not let them be distracted by other things in their own house.
Also other expected trouble with, for instance, mould in their kitchen cupboard due to construction moisture, are communicated and explained beforehand. In this way less problems occur.

Users' utility/usability
The system is valuable for users since energy consumption can be seen real-time per electricity group. In this way they can act upon their own energy consumption. Something which is not possible, or only limited, if only total energy consumption is visualised. Furthermore it is very usable since the display is situated in the corridor and everything is visualised graphically. This gives a clear overview right away, which motivates people to take action. Shortcomings of (old) appliances can also become visible in this way.
Furthermore, the houses are very comfortable since there is no form of draught what so ever.
People get personal advise on their energy consumption, especially if it deviates extremely from other residents.

Smart grid solution
People need a monitoring system to change their energy consumption, technology alone is not sufficient to reach an energy neutral living. They have to change their behaviour. The monitoring system visualises their energy consumption in each of the ten electricity groups. It is visualised on a display in the corridor. Besides the monitoring system, the houses are very well isolated, they have solar panels, solar water heating, a heat pump (ventilation air?), and people have to use energy economic appliances.
People also have to adjust their heating behaviour since the new heating system is slower than their old system. Is takes little energy to keep temperature but it takes much energy to fluctuate in temperature.

Creating support/involvement
The organisation tries to create support under residents by giving them intensive guidance the first three months after delivery of their house. This to solve problems related to building and new technology, but also to help them to reach the goal of energy neutrality; to change their energy consumption behaviour. One way of offering this guidance is by organising a consultant afternoon each Friday at their neighbourhood. Another

way is by displaying their energy consumption graphically per electricity group. According to Hans, housewife's love such graphs which make cause and effect clear right away. The residents also receive gift-coupon of €300 which they can spend to by appliances. But only appliances with energy label A or AA.

Change in user behaviour
To live energy neutral is possible in these houses, but people have to make some adjustments. They should not use energy intensive appliance like wash dryers and dish washers. Other energy intensive appliances, like refrigerators, washing machines and TV's should energy economical variants. Furthermore, it is not preferable to fluctuate house-temperature much. It is best to keep temperature constant, since this takes the least energy. Furthermore they have to be aware of their energy consumption to notice waste of energy, for instance due to old appliances leaking energy. But also being aware of the amount of energy consumes while their children use the computer.
At the moment, monitoring has not really started yet since the first months after moving in are not representative due to preparations of the house etc. Especially the winter will tell whether the residents' behaviour changed positively. If the organisation measures an very odd and high energy consumption, they will talk about this.

Project approach-organisation
Klomps and Klein Poelhuis won the contest of best energy neutral concept, which made them earn the contract to build 39? energy neutral houses. They won because they included a monitoring system in the concept. They give 3 months of intensive support after delivering the house, with every Friday afternoon some consulting hours in the neighbourhood; to make people aware of their energy behaviour and to solve problems.
Before the houses were delivered, they had some meetings with the residents. And the working of the technology is explained in a different house. This to make sure people don't get distracted by other things. Furthermore, they gave the residents gift coupons to buy energy economic appliances for €300. They also give people advice based on their energy consumption, especially if it is relatively high.

Communication with users
The organisation communicated with the residents about what the technology contains. How the system should be used (differently). How, with which behaviour, they have the best chance to reach energy neutrality. What they can see on the display. Furthermore they will be warned if there energy consumption is relatively high. A consultant will come and talk about it.

Least coded:
Problems, Local knowledge, Representation users, Motivation users

Problems
The first three months it isn't really possible to give residents intensive support, since they are to busy with settling in their houses. Energy consumption is not representative. No big problems occurred yet, only some regular small building problems.

Local knowledge
Example of the military who is only one day at home per week. So they gave him special advise on how to use the system. Constant system temperature of 17 degrees, and when he is at home, his had to do some additional heating with little electric heaters.

Representation users
The current residents have not been represented as such. But by creating the system concept they put themselves in the role of the user. But there hasn't been done extensive research on what should be best for a user perspective.

Motivation users
Since the house are social houses, the residents are from all kinds of types. Though these houses are more expensive in rent than other similar size houses, people did make their choice conscious. On the other hand, people can also safe money their energy bill, which may make it eventually even cheaper to live there.

Motivation can thus be various. Although Hans thinks these people are not very suitable to live in these special houses.

Interview with a resident of the energy neutral houses at project Ulft

In the person of Peter de Lorijn and his wife on June 29th 2012

<u>General reflection on the interview</u>

Duration:	+/- 30 minutes
Location:	The energy neutral house of Peter and his wife.
Motive to cooperate:	Peter and his wife are retired and home a lot. So they had the time and liked to talk about their special home. All kids moved out already.
Small matters:	They are living in their house for 7 months now. They got the key at January 23rd.

Course of the interview:
Peter and his wife were very friendly and we sat very quietly in their winter-garden. They were telling very enthusiastic about their house and the foregoing process. Though they were telling very easily I noticed that their answers kept being very general; not very detailed. Although I then asked more specific questions, the answers kept general. Maybe this implicates they are not very active with the subject.

<u>**Most coded**</u>
Creating support/involvement, Context, Expectations-gap, Problems, Change in user behaviour, Communication with users, Users' utility/usability

Creating support/involvement
They are not extremely triggered by the competition to use the least energy. They still want to live normal. But the gift vouchers to buy energy economic appliance seems to have worked out very well. They bought a new refrigerator and a new electrical cooking device.

Context
On January 23rd they got the key to their new house. So they are living there for 7 months now. The delivery was surprisingly 6 months earlier than expected. They think this created some building problems. They had to register for this house. Though their old house would be demolished, these energy neutral houses were not the only option for these residents.

Expectations-gap
They expected to live in a house with is a bit more expensive in rent, but has a lower energy bill. This is also the case, so their expectations are fulfilled. A function Peter would like to have is to turn the lights on and off at once at distance.

Problems
There have been some small technical problems due to the newness of the technology. A bigger problem is the fact that it took them 7 months to find out the solar panels of Peter were not installed properly. Only half of the panels has been working the past 7 months.
Another problem is that the monitoring system is still not working since internet cannot be installed yet. Therefore they still cannot see their energy consumption and energy generation on the display. Also the first three months of intensive support are planed to early since the system is not yet working completely.

Change in user behaviour
The new heating system is less flexible for fluctuating the temperature quickly. So to fluctuate in temperature anyway, Peter and his wife use their winter-garden. Because of all the glass walls it gets quickly warm in there. So if they quickly want to heat-up the livingroom a few degrees, they open the door to the winter-garden.
In top of the winter-garden a drying plateau is situated to dry laundry very quickly. In a few hours the laundry dries, so they don't use any wash dryer anymore. They don't use any dishwasher anymore even. Partly because they want to spare energy, but also because all kids are moved out currently, so there is less need of using a dishwasher.
The display can be set according to the situation; sleeping mode, middle mode or abscent mode. The system than adjusts to this mode and uses as little energy as possible. This is perceived as very handy. Though they are aware, and keep track of their energy consumption, they generally live in the same way. Still watching tv when

they feel like it.

Communication with users
At first they received information about the project from Wonion. When the house was allocated to them there were a series of meetings. These were about the intention of the project. But also about the different way of using the technology and the means by which energy neutrality can be reached.
In general communication with Wonion and Klein Poelhuis is very good, but contact with Klomps is perceived as very bad. They do not fulfil promises and it takes them very long to solve problems. At first they found the Friday afternoon consulting hours very handy, but now the call Hans directly if something is wrong.
Although I think Peter and his wife do not completely understand the working of the system, they in general know how to use it and how not to use it.

Users' utility/usability
They find their house very beautiful and comfortable. Another benefit is that their energy bill will be very small. Furthermore it seems as if they have no problems at all to adjust their energy behaviour to the new system.
To create some temperature fluctuations after all, they intelligently use their winter-garden to flow in some heat into the living room. Also the drying plateau is perceived as a great place to dry the laundry, the are in no need of a dryer. They also don't use the dishwasher anymore, but this is also due to a change in family composition.
The display can be set according to the situation; sleeping mode, middle mode or absent mode. The system than adjusts to this mode and uses as little energy as possible. This is perceived as very handy and usable.
Insight in the energy flows of the house is still limiting because a lack of internet.
An valuable additional functionality would be to turn on/off the lights at distance.

Least coded
Change in user behaviour, Problems, Expectations-gap, Context, Creating support/involvement, Motivation users, Handling problems

Motivation users
They choose this house since they preferred a new build house and this one they found very special. They don't mind this house is more expensive in rental since their energy bill will be (most probably) around 1/6th of their normal bill.

Handling problems
Problem handling is in general very good. Only Klomps is making a mess of it. They do not fulfil promises and it takes very long to solve problems. No hands-on mentality.

Interview with one of the initiators of 'Morgen Groene Energie'

In the person of Ernst vd Leij on May 25th 2012

<u>General reflection on the interview</u>

Duration:	+/- 1 hour
Location:	The office of 'Brink group' in Eindhoven were Ernst is working as well.
Motive to cooperate:	Ernst was very willing to cooperate and tell me everything about their local energy cooperation 'Morgen Groene Energie'. Sharing knowledge is important for the development.

Course of the interview:
The interview took place in a quite meeting room where the interview passes in a pleasant way. Ernst was very clear and open about his visions on a local energy cooperation and stimulating people.

<u>Most coded</u>
Problems, Use of user-knowledge, Creating support/involvement, Objectives project, Representation users, Smart grid solution

Problems
It is not possible yet to nett (salderen) with households if the solar panels are situated somewhere else. Therefore it is harder to create a businesscase.
A main issue when starting projects for households is that they are not organised. It is hard and takes a lot of time to get people together.
Very complex projects with more intelligent aspects are still very difficult since these kind of projects require a big investment. And if people are already prepared to do a big investment, they also want to be in control about everything, which is not possible in a cooperation. As a cooperation it is also hard to lend any money from banks since there is not pledge. So they now try to make the government cover their business model.
More marketing in needed to grow and attract more members. Marketing is expensive though.

Use of user-knowledge
Normal people cannot decide what is good for them, for instance when buying solar panels. They are not familiar with the new technology and the variety of possibilities, and therefore they have no overview. Morgen Groene energy sends some independent advisers to help them in this selection process. They look at what is best for them in their specific situation. Furthermore they are organising a good price by organising it locally. The standard model is i.a. based on aesthetic looks. They are using volunteers to give advise and organise everything for the people. Since Morgen Groene Energie as a cooperation, all members have control in what is happening (except for the first year). So also on the decision which technologies is invested in.
Furthermore Morgen Groene Energy has representative for different target groups. For these different target groups different projects are organised, based on their specific needs. Like elderly who want to do something with green energy but are afraid they will not reach the get it paid back. So they are trying to find something on this issue; for instance as a gift for children of grandchildren. Idea's are first 'tested' within their own target group.

Creating support/involvement
Morgen Groene Energie is targeting on big part of the people who are not into green energy and almost never switched from energy supplier. They think this group can only be triggered by creating a real business case; people have to receive a real benefit, otherwise it will not work.
Furthermore they believe in the strength of acting locally. Doing project which can be seen by people in their own village, is the best marketing. So they are not advertising to attract members. People have to act from their own conviction. They only show themselves on a few local events, like the annual village market. Gaining the confidence of people is important.
They are also creating support and awareness by doing projects on schools. In this way children make their parents more aware by telling them about the school-project. In this way they like to access more people.
When starting a new project they try to select households which are already organised in some kind, otherwise it is very hard to get people together. Furthermore they try to create support by representing different target groups in their ideas and projects.

Objectives project
They aim at getting sustainability concrete for people in the Netherlands. And to make it concrete for everyone they think sustainability should be healthy business; for the members as well as for the cooperation. They aim at moving the big mass and this is only possible if they benefit from it, otherwise it well never be a success. The final goal is to become a cooperation which is completely self-sufficient in renewable energy generation. But first the cooperation starts mainly as a purchasing organisation, while slowly increasing local generation. Right from the start they want to act and organise good business in projects generating locally.
Their objective is to get many participants (members) in a small area (village). And the cooperation has no profit motive.

Representation users
They try to represent the big mass of people who are not green minded and should move to another energy supplier that quickly. They are representing them by thinking that these people would like a financial benefit to change to green energy.
They are, as a cooperation themselves also a representing of the village people. Because they act as an independent advisor (by means of volunteers) for people to help them making decisions in the new and unclear market of sustainable energy. And try to make the best deal for everyone based on their individual requirements. People are then advised about the best deal, but can always deviate from it.
Every project has its own taskforce containing of volunteers, some with more background knowledge than others. Furthermore, every age-group is represented by someone of the board who will bring idea's back in their own environment to discuss them. And all members influence the cooperation by expressing themselves on the members-meeting.

Smart grid solution
The projects which are already executed are the hydroelectric stations. In the Dommel (small river) seven watermills are placed two of them have already a hydroelectric turbine, and the others will get one soon. Furthermore they executed a purchase project on solar panels. The second project is already in process. And they are also busy with two bigger solar panel projects. One project aims to place solar panels an a primary school and the second project aims at placing solar panels on a shopping centre.
They consciously made the choice to not invest in projects that got to do with infrastructures, since such projects are very capital intensive and are not suitable for a cooperation. But eventually the members will decide in what way the energy will be generated in the future.

Least coded:
Users' utility/usability, Communication with users, Success factors, Local knowledge, Context

Users' utility/usability
The users' utility is that people get greener energy for less money than grey energy. Furthermore they act as a facilitator for people in an highly complex market of sustainable energy technology. People get independent advice, and get the best price for technology which fits their situation best. Furthermore they get to say what future projects of Morgen Groene Energie should be.

Communication with users
If people want to invest in sustainable energy technology they can get some independent help by explaining what the possibilities are and getting some advice in what suits them best. But they are free to choose whatever they want. Providing good information is very essential.

Success factors
Their professional approach and by making healthy business cases. Their hands-on mentality; they started doing projects right away instead of keep on talking. Providing people with good and independent information. And showing the (project) results to the people.

Local knowledge
The biggest problem they face is the covering of the investments. So they try to solve this by searching a locally provided solution, to make the project successful. For instance the solar panels on the primary school. They ask all the school children to invest €100 in the project, an amount of money they will get back when leaving school. In this way an interest free loan is created.

Furthermore they are thinking about special projects for elderly which fit the needs of this target group, since payback time may not always be reached with elderly.

Context
Ernst started Morgen Groene Energie with a friend who has a similar view on things, quite entrepreneurial. They both invested some money in the cooperation.
Nuenen got 8000 inhabitants. And the concept of Morgen Groene Energie may be used in other villages.

Interview with one of the initiators of 'Duurzaam Hoonhorst'

In the person of Timo Veen on April 13th 2012

<u>General reflection on the interview</u>

Duration:	+/- 1 hour
Location:	At the community centre of Hoonhorst. This is the place the cooperation has its meetings.
Motive to cooperate:	Timo was right away very willing to cooperate. But only if he could have a version of my thesis as well. Sharing information is and learning from others is important for Timo and their cooperation.

Course of the interview:
Timo was very friendly and open during the interview. Unfortunately, after half an hour other people entered the meeting room who also had meeting. This made the interview a bit noisy. But I it doesn't feel like it has influenced the interview significantly.

<u>Most coded</u>
Users' utility/usability, Problems, Creating support/involvement, Objectives project, Representation users, Use of user-knowledge, Technical solution

Users' utility/usability
The solar panels generate financial benefit since the cooperation gave the participants their paid VAT back. They also arranged that people with less money could rent solar panels. They also get a financial benefit since they only pay 80% of the normal kWh price of grey energy. Furthermore, when making a choice for solar panels, local entrepreneurs are preferred and price and quality are important as well. Duurzaam Hoonhorst helps their villagers by making a choice for them since the market is very unclear with lots of variations in types; people don't know what to choose. Also the implementation process is controlled by Duurzaam Hoonhorst.
The residents also benefit from the projects for local associations, in this way associations have a easier existence which is beneficial for the members. The life expectancy of these associations increases by means of these projects. This makes the village more liveable. The cooperation is, in general, constantly looking for projects which aim at making use of local resources more efficiently. Energy saving project are also included.

Problems
A project to collectively isolate houses was not that successful. Although people noticed themselves that they were interested to isolate their houses, not many people signed up for the project. This was mainly because the project was executed quite quick. Getting your house isolated is fairly expensive; a lot of people didn't had the money yet. Especially the combination of investing in solar panels, which is also a significant investment, and not much later the isolation project, was a bit too much for people. Though, Timo states that they didn't analysed this small failure so well.
Another thing which didn't worked out was to bring people a tip of the week or month. The idea was that people themselves should come up with these tips and that the battle to save the most energy really should come to live. The lack of fight competition and enthusiasm is most probably since the intended battle website never came online. This website should have been made by a volunteer, but he dropped out eventually.
A big future challenge is to get enough investment money for future project, when their 1.5 million on subsidy is used.

Creating support/involvement
To create attention and reach out to all villagers they make user of the village newspaper, internet, twitter, and local associations. They are also present at local festivities. Furthermore they organise different events/projects for different target groups. For the elderly they organised some *intensive guidance* by showing them the possibilities if thing are getting hard on their own. Explaining and showing how internet shops work, and what the possibilities are of care farms. But also the rental solar panels for people with small amounts of money is a way to create more support within the village.
They also create awareness by determining who generated the most energy per m^2 on a weekly basis, who has saved most at the end of the year wins €2500. And informing people in general about the possibilities to save

energy. People are now talking about this even in their sports canteen.
But the village people of Hoonhorst already did a lot of things together, they are quite a close community who feel connected to the village. Since the village people were worried about the liveability of the village, projects aim to strengthen the liveability of the village. This is a common pillar helps to create support and involvement. But the financial trigger is important as well.

Objectives project
The main objective of Duurzaam Hoonhorst is to increase the **liveability** in the village of Hoonhorst. So the projects are very diverse. It is for instance important for the liveability that there are social services like a school, library, sports associations, church and out-of-school care for children. This is where sustainable energy comes is. If these social services have a lower energy bill, they can exist more easily. In this way social services can be maintained. Another aspect is **economy**. They find it important that there is employment in the village; to let the farmer be a famer, and that nearby camp sites can welcome guests. This attracts companies which are supportive to farmers and the tourist business. Furthermore all projects have to be pragmatic and realistic for the general villager. The third component is the **social aspect**. Elderly should get opportunities which help them to live at home longer, for instance.

Representation users
The user perspective is very well represented in the objective of Duuzaam Hoonhorst. The cooperation started with the goal to do something about the worries that the village became unliveable in the future.
But also in individual projects the users are well represented. They executed EPA advises for the individual houses and executed a questionnaire under these households. This to determine what the current situation of the houses is and what people want. Do they already have a clear opinion about how they want to generate energy for instance. Or do they like to have more information first, in the form of an advise or talk. These EPA advises and questionnaire was the starting point. Based on these results they started organising projects.
For the solar panels everyone of the core team specialised in various types of solar panels and convertors. They made a choice based on this specialised knowledge since they think it is too much as people have to choose themselves; a lot of people will then drop out. They also decided to do a collective procurement and people could apply for one system; one convertor and installation package. In this way they achieved a very good price. They also choose an installer which was local but they also took into account possible risks. So they choose to relieve (ontzorgen) villages by offering one package of good quality with guarantees and installation. Duurzaam Hoonhorst did the control during installation.
In case of the manure, they sat down with all stakeholders, plus an external expert, to make a plan which is beneficial to all stakeholders. All stakeholders were also involved when developing the plans for a heating grid which runs on compost. Here they also included external experts like a group of students, a technical advisor and an architects office.
Wind energy is not beloved by the villagers due to landscape pollution, so they are not planning to do any projects with this kind of energy, although Timo himself is very positive about wind energy since this can make this village energy neutral.

Use of user-knowledge
Projects that were focused on the villagers like the solar panels and the house isolation were initiated due to an user-need. But the choice for a specific interpretation of the system was not based on large-scale user input. This was done by the core team of Duurzaam Hoonhorst who did some studies about the possibilities and made a choose based on their own perspective and the objectives of the cooperation.
The projects which are not specifically focused on the villagers like the heat grid with generated heat from compost and the manure project, both came into being by meetings with all stakeholders and some experts. The project had to be profitable for all stakeholders, otherwise it wouldn't continue.

Technical solution
Duurzaam Hoonhorst is executing projects which increase liveability of the village. Projects related to sustainable energy generation and energy savings are stand alone project which are not connected to each other or have any intelligence by means of ICT.
The projects they already executed are a project for solar panels and a project to isolate houses. The solar panel project also contains a rental track for people who cannot afford to buy their own solar panels. Ideas at an advanced stage are: the heat grid with heat extraction from compost, and the manure digester which has to turn the surplus of manure into biogas.

Least coded:
Project approach-organisation, Motivation users, Success factors, Context, Change in user behaviour

Project approach-organisation
The core team of Duurzaam Hoonhorst is very active to participate in all kinds of events and conferences to spread the word and move other people to act locally. In order to sustain future projects when their subsidy has been used, they are exploring the possibilities to get loans from banks or pension funds. They think this is possible since their projects are making about 5% return.
Furthermore they want to make Hoonhorst a brand. A place where tourist can look at all the beautiful things and buy products from Hoonhorst and where other initiatives can learn from. Furthermore they are only executing projects which are local, so windmills at the sea are no option.

Motivation users
The motive for people to participate is projects is a combination of a financial benefit and working on a more liveable future of Hoonhorst.

Success factors
They are consciously giving extra care to certain target groups, like elderly. Hoonhorst is further a small village with a close community and the cooperation aims at projects which serve a common pilar; liveability. The personal drive to make Duurzaam Hoonhorst successful is also mentioned as important by Timo.

Context
Hoonhorst is a small village with 600 inhabitants at the core and 600 inhabitants in the outlying. Duurzaam Hoonhorst has won a subsidy of 1.5 million euro. Furthermore the village has about 23 associations and foundations.
The province of Overijsel is very active with stimulating a sustainable society. The money the province uses for these kinds of activities is money they earned by selling energy companies. Ruub Lubbers' second house is locates in Hoonhorst, and he thinks sustainability is very important. So sometimes Ruub Lubbers helps the core team in various manners.

Change in user behaviour
The cooperation tries to change the behaviour of users by organising an energy generation contest. Every week they have to hand in their meter positions and every week they determine who has generated the most energy per m^2. Who has generated the most energy at the end of the year wins €2500.
Furthermore, they try to make people more aware of the possibilities to save energy by organising small events where people get information.

Interview with one of the initiators of 'Wetering Duurzaam'

In the person of Maartje Romme on May 30th 2012

<u>General reflection on the interview</u>

Duration:	+/- 45 minutes
Location:	At home at Maartjes' place; in her garden.
Motive to cooperate:	Maartje was very willing to talk to me. Most probably because she beliefs that knowledge should be shared more. There are to much isolated initiatives.

Course of the interview:
Maartje was very friendly and the atmosphere was nice, so the interview went good. Nevertheless I found it sometimes hard to get detailed answers from Maartje. Sometimes the answers continued to be a bit abstract or vague.

<u>Most coded</u>
Objectives project, Creating support/involvement, Use of user-knowledge, Local knowledge, Project approach-organisation, Smart grid solution, Representation users

Objectives project
Wetering Duurzaam is set up from a thought about sustainability. But instead of just a one or a few aspects of sustainability Maartje emphasizes the fact that sustainability is a holistic concept. She believes that when the various aspects are not balanced or you can loose track of becoming sustainable at all. And although they are now mainly focussing on the energy part of sustainability, they want to approach it sustainable is every way; organisation, finance etc. Furthermore she beliefs sustainability really requires a bottom-up process.
The project is aimed at getting the Wetering neighbourhood energy neutral since this energy neutrality is a requirement of the subsidy (SEF) they are getting (most probably). But if energy neutrality can not be reached, subsidy will not have to be paid back.

Creating support/involvement
Strong bonds within the neighbourhood and **recognisability** are important according to Maartje. She thinks that when there is a strong bond with the neighbourhood, there is also more trust in the organisation and a lot of (human)power can be generated to get things working. **Visibility** of new technology (demonstration) and sharing experiences, is also important to create support within the neighbourhood. Support also has to do with balances power rations, balances capital distribution and balanced ownership distribution. All people have to feel they have interest in it and they have to feel seen and taking seriously.

Use of user-knowledge
During the first meeting they discussed various topics in the field of sustainability. Energy was one of the topics and this study group met again quickly after the meeting. It than became clear that sustainable energy is such a specialised field, that the residents themselves got no further. They needed some specialised knowledge. So when looking out for help Maartje got into the world and market of sustainable energy, which is already very active and dynamic. Then a possibility came by to get subsidy. This makes that sustainable energy is the main focus at the moment. The subsidy requires the project to aim at energy neutrality. But if it cannot be reached, it isn't a problem. The subsidy they want to use for further steps in investigation and creating plans. They aim at getting the energy costs around the same level as people have today.
In their way to look for the best opportunity for a heating system and electricity system, the core team first executed a lot of orienting talks with experts and advisers. But they found out quickly that they wouldn't be able to reach energy neutrality by means of individual measures. For the residual demand they have to look for collective measures.
In order to get people involved in and support the plans, Maartje beliefs in supplying people with the right information. Furthermore she beliefs that people should get the possibility to make the step when they are ready for it (for instance when their old boiler has to be replaced). So she aims at making a action plan with various steps they can undertake.

Local knowledge
In this neighbourhood the houses are very close together and there are often more households living in one

building. This main individual households have very little room for sustainable energy measures. Therefore they are also looking at some collective measures. These collective measures, however, have to be tuned with the individual households. Fur instance when changing high temperature to low temperature heating systems.

Project approach-organisation
It really has to be a bottom-up process. But they need external information and advisers to help them with the development of the plans. So people from the neighbourhood who already have some technical knowledge in this field are involved in the meetings with the external experts. They represent the neighbourhood and execute a control function. So they organised a sounding board of 3 people from the neighbourhood and 3 or 4 external experts. This sounding board reflects on the plans of the external advisers.
At the moment, the project only focuses on individuals, not on companies.

Smart grid solution
Wetering Duurzaam is still in the idea phase. They are still looking for the best solution. Since individual measures cannot provide energy neutrality, the solution will most probably be a combination of individual and collective measures. They aim at monthly costs that are about the same as the current energy costs. Future increases in energy prices may be included though. Furthermore they are thinking of an action plan where people can choose to execute one or more steps towards energy neutrality, and set additional steps a few years later.

Representation users
Maartje strongly feels that people's perspective should be heard and taking into account seriously. This is done by organising many meetings for residents in the neighbourhood and providing them with enough information. In their search for a technical solution to become energy neutral, some residents of the neighbourhood with knowledge on this topic are representing the neighbourhood and executing a control function. A sounding board of 3 people from the neighbourhood and 3 or 4 external experts reflect on the plans of the external advisers. Users are thus very much represented by themselves since they are making choices by themselves based on the information that is provided to them.

Least coded:
Motivation users

Motivation users
There are no real statistics on the motivation of people to participate in the plans. But a lot of people want to improve the world by making their own neighbourhood more sustainable. Furthermore, people are vey distrustful against energy companies. They feel they are cheated by paying to much money.

Appendix B: Management Samenvatting

De energie industrie is zich, over de hele wereld, aan het voorbereiden op de energietransitie naar duurzame energie opwekking. De toenemende vraag naar elektriciteit en grootschalige lokale opwek van duurzame energie hebben een grote impact op het huidige elektriciteitsnetwerk. De toenemende elektriciteitsvraag vereist een infrastructuur met een grotere capaciteit en decentrale energie opwekking vereist een elektriciteitsnet dat elektriciteitsstromen in twee richtingen ondersteunt. Op dit moment veroorzaakt grootschalige opwekking van duurzame energie problemen in het net doordat energie vraag en aanbod moeilijker te managen is aangezien zon en wind niet altijd voor handen zijn. (AgentschapNL, 2011[1,2]) De energie industrie moet zich dus gaan aanpassen en herdefiniëren hoe energie opgewekt, gedistribueerd en gebruikt zou moeten worden, om in de toekomst om te kunnen gaan met de uitdagingen die de energietransitie met zich meebrengt (KEMA, 2011). Naast de herziening van het technologische en institutionele proces, zal ook de rol van de eindgebruikers heroverwogen moeten worden. Huishoudelijke energie gebruikers zullen in de toekomst ook steeds vaker de rol van energie producent op zich nemen doordat ze de duurzame energie opgewekt in hun huizen, terug gaan leveren aan het net (Top Team Energy, 2011). Ook worden huishoudelijke eindgebruikers belangrijker doordat ze een essentiële rol spelen als het gaat om het lokaal afstemmen van energie vraag en aanbod (Top Team Energy, 2011). Bewoners zullen in de toekomst flexibeler moeten zijn, en met name energie gebruiken als deze voorhanden is. Technologie en regelgeving zal deze gedragsverandering moeten faciliteren.
Gegeven de historische tradities dat huishoudelijke eindgebruikers niet bewust zijn van hun energieconsumptie en het gebrek van de energie industrie om deze gebruikers te betrekken; vraagt een succesvolle energie transitie om een grotere focus op huishoudelijke gebruikers. Om daar een bijdrage aan te leveren heeft dit onderzoek onderzocht hoe verschillende projecten met betrekking tot duurzame energie systemen omgaan met de betrokkenheid van de gebruiker, en of belanghebbenden de rol en input van gebruikers herdefiniëren.
Het concept 'local practical knowledge' is in deze master thesis gebruikt als een lijdraad door het verkenningsproces. Dit concept komt voort uit de theorie van Fleck (1993, 1994) over technologische configuraties. 'Local practical knowledge' refereert naar specifieke gebruikers eisen, gerelateerd aan de bruikbaarheid en waarde (betekenis) van het systeem, waaraan een technologisch systeem zou moeten voldoen om het systeem succesvol te implementeren.
Het doel van deze master thesis is om de acquisitie (specificatie en selectie) en adoptie van duurzame energie systemen in een lokale setting te onderzoeken, en te verkenning in welke mate het perspectief van de lokale gebruiker met betrekking tot de waarde en bruikbaarheid van het systeem meegenomen is. Het onderzoek beantwoord daarom de volgende onderzoeksvraag:

Hoe wordt 'local practical knowledge' gebruikt om de architectuur van duurzame energiesystemen vorm te geven in pilots geïnitieerd door organisaties en projecten van burgers in Nederland?

Zowel pilot projecten door organisaties en lokale initiatieven door burgers worden onderzocht omdat beide waardevolle inzichten kunnen verstekken over hoe gebruikers betrokken worden en wat 'local practical knowledge' inhoud in een huishoudelijke setting. Dergelijke burgerinitiatieven hebben, zeer waarschijnlijk, gemakkelijker toegang tot kennis over de gebruiksomgeving. Strategieën voor het verzamelen van gebruiker kennis, en de rol van de gebruiker kennis in het acquisitie en adoptie proces kan daarom afwijken in burger initiatieven ten opzichte van pilots op initiatief van organisaties.
Het antwoord op de onderzoeksvraag wordt gevonden door het beantwoorden van de volgende subvragen:

1. *Hoe zijn gebruikers en hun visie gerepresenteerd is een specifieke lokale setting, in the verschillende fasen in the ontwikkelproces; selectie, implementatie en adoptie?*

2. *Hoe zijn verschillende projecten omgegaan met gebruikerskennis in het ontwikkelproces van duurzame energie systemen in Nederland?*

Het onderzoek is uitgevoerd door de verzameling van kwalitatieve data d.m.v. semigestructureerde interviews bij drie burger initiatieven ('Morgen Groene energie', 'Duurzaam Hoonhorst' en 'Wetering Duurzaam'), en twee pilot projecten door organisaties ('PowerMatching city Hoogkerk', 'Smart Power system Ulft'). De interview data is aangevuld met secundaire data bronnen en geanalyseerd door middel van verschillende codeer methoden. De analyse bestond uit een iteratief proces van data collectie, data reductie, data vergelijking en conclusies trekken/verificatie. Nadat alle data verzameld was, werden alleen de stappen data reductie, data vergelijking en conclusies trekken, nog herhaald voor het laatste deel van het onderzoek.

Representatie eindgebruiker
Uit de analyse bleek dat gebruikers op een verschillende manier gerepresenteerd worden in de verschillende projecten. Bij *burgerinitiatieven* werden gebruikers voornamelijk gerepresenteerd door zichzelf en hun eigen mening. Ze participeerden actief in de specificatie en selectie fase van het ontwikkelproces door het uiten van hun wensen en behoeften op een directe of indirecte wijze. Gebruikers in burgerinitiatieven zijn niet gerepresenteerd in de implementatie en adoptie fase. Uit de analyse bleek dat de systemen die toegepast worden in burgerinitiatieven beter gecategoriseerd kunnen worden als generiek systeem dan als configuratie. Een van de voordelen van een generiek systeem is dat de implementatie relatief gemakkelijk is. Betrokkenheid van gebruikers of vertegenwoordigers in de implementatie en adoptie fase is niet vereist voor een succesvolle implementatie van zulke systemen.
Binnen de projecten van organisaties zijn gebruikers gerepresenteerd op verschillende manieren. In de specificatie en selectie fase zijn gebruikers vooral gerepresenteerd door aannames op basis van de ideeën van het ontwerp organisatie. Dit patroon is in lijn met 'indirect representation' beschreven door Peine en Herrmann (2012). In de implementatie en adoptie fase zijn een aantal verschillen geïdentificeerd. Tijdens de implementatie en adoptie fase van 'PowerMatching city Hoogkerk' begon de organisatie gebruikers te betrekken in het verder ontwikkel proces van het systeem. Gebruikers konden hun mening en eisen uitten in driemaandelijkse meetings, brainstorm sessies, enquêtes en door te participeren in een speciale design groep. Deze feedback werd vertaald naar specifieke technologische eisen door experts met verschillende achtergronden. Dit patroon is in lijn met 'direct participation' beschreven door Peine en Herrmann (2012).
In het project 'Smart Power System Ulft' heeft het ontwikkelproces pas net de implementatie fase bereikt. Hoewel het systeem hier nog niet helemaal werkt, is de organisatie nog niet begonnen met het betrekken van bewoners in het verdere ontwikkelproces. Op het moment lijkt het ernaast uit te zien dat de problemen voornamelijk van een technologische aard zijn en verwacht wordt dat deze problemen opgelost kunnen worden zonder specifieke kennis van de bewoners.

De verwerking van gebruikerskennis
Bij burgerinitiatieven wordt alleen gebruik gemaakt van gebruikerskennis in de specificatie en selectie fase. Soms wordt er een adviseur, een bewoner of een externe, aangewezen om te helpen met specificatie en selectie van het duurzame energie systeem op basis van de gebruikerseisen. Gebruikerskennis is in deze burgerinitiatieven gerelateerd aan de motieven van bewoners om een duurzaam energie systeem aan te schaffen. Uit de interviews kwamen een aantal motieven naar voren: geldbesparing, bijdrage aan een duurzame leefomgevingen en bijdrage aan de leefbaarheid van het dorp. Deze motieven hebben de selectie van een specifiek duurzaam energie systeem beïnvloed. Maar gedurende het verdere ontwikkelproces van implementatie en adoptie is er geen gebruik gemaakt van gebruikerskennis.
De pilot projecten door organisaties maakten op verschillende manieren gebruik van gebruikerskennis. Binnen het project 'Smart Power System Ulft' heeft de organisatie aangenomen

dat bewoners hun energieconsumptie zouden moeten aanpassen om energie neutraal te kunnen leven. De organisatie heeft er daarom voor gekozen om een monitoringsapparaat aan het systeem toe te voegen en technologieën voor het meten en modelleren van energie stromen. De gegenereerde en geconsumeerde energiestromen zijn nu gemakkelijke te bekijken en het systeem is erg praktisch en simpel in gebruik.
De organisatie van 'PowerMatching city Hoogkerk' heeft gebruikerskennis op een uitgebreidere manier gebruikt. De organisatie begon bewoners te betrekken in de implementatie fase en verzamelende dat tijdens bijeenkomsten met bewoners, brainstorm sessie en enquêtes. Een speciale design groep genereerde ook gebruikerskennis doordat deze groep van erg betrokken bewoners feedback gaf gedurende verschillende stappen in het ontwikkelproces. Op deze manier fungeerde ze als een klankbord. Het verzamelen van feedback was een stap in een iteratief ontwikkel proces welke bestond uit: data verzamelen van bewoners, analyse van de feedback door experts, product ontwikkeling en terug naar de bewoners voor testen. De analyse door experts is een uitdagend gedeelte omdat de experts hier de feedback moeten vertalen naar specifieke technologische eisen. De organisatie heeft deze uitdagingen doorstaan door een PhD student aan te stellen voor het onderzoek naar de gebruikerskant van het project. Zij heeft de juiste competenties voor het verzamelen van de juiste gegevens bij bewoners. De analyse kreeg verder externe input van andere onderzoekers in het netwerk van de PhD student en verschillende betrokken producenten. De rol van de PhD student in het project 'PowerMatching city Hoogkerk' is in lijn met het idee van een 'facilitator' (Vennix, 1998). De facilitator creëert condities die een open dialoog faciliteren, waar kennis diffusie tussen verschillende actoren mogelijk wordt en waar leerprocessen ontstaan. De aangestelde PhD student faciliteert een open dialoog tussen de organisatie en de bewoners door het verzamelen van geschikte feedback en de vertaling naar specifieke gebruikers eisen.

Terugkijkend naar de uitgevoerde analyse kan geconcludeerd worden dat 'local practical knowledge' verschillende vormen aan kan nemen en dat het niet altijd op dezelfde mate invloed heeft op de ontwikkeling van duurzame energie systemen. Desondanks biedt dit onderzoek een aantal interessante praktische implicaties:
Innovatie- en Project Managers zouden zich bewust moeten zijn van het fenomeen 'configuraties' en de bijbehorende uitdagingen die de implementatie van dit type technologie met zich meebrengt. Het vergaren van specifieke gebruikerskennis wordt belangrijker naar mate het duurzame energie systeem een meer configuratie eigenschappen heeft. Er moet in dit geval speciale aandacht zijn voor de manier waarop feedback van bewoners verzameld wordt, hoe deze data vertaald wordt naar specifieke eisen van bewoners en aanpassingen aan de technologie. Consumenten ontwikkelen namelijk hun wensen en eisen naarmate ze het systeem gebruiken en dus door de tijd.
Het is dus essentieel om bewust na te denken over een bekwaam persoon die het innovatieproces kan faciliteren en wie kan bemiddelen tussen bewoners, producenten en organisaties. Uit het onderzoek is gebleken dat bewoners over het algemeen wantrouwig tegenover organisaties staan, en dat men niet erg bereid zijn om open te zijn over hun ervaringen en gedachten. Zoals blijkt uit de resultaten, kan het aanstellen van een onafhankelijke onderzoeker met de juiste capaciteiten een mogelijke manier zijn om met deze uitdagingen om te gaan. Het is in dit proces belangrijk dat bewoners zich gehoord voelen en dat hun visies meegenomen worden in de verdere ontwikkeling van de technologie. Omdat pilot projecten van duurzame energie systemen vaak lange termijn en kapitaal intensieve projecten zijn, is het voor managers belangrijk dat ze gebruik maken van de ervaringen van andere projecten die het implementatie proces van configuraties al doorlopen hebben.