Learning about user engagement in smart grid niche development: An analysis of 4 smart grid projects

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CHAPTER 1: INTRODUCTION

Smart energy systems have become a research topic in various areas in the world. Experiments take place with smart energy products and services (SEPS), with the stability of the electricity grid and users' energy behaviour and response to financial incentives (Kendel, Lazaric, & Maréchal, 2017; Kessels, et al., 2016; Kobus, Klaassen, Mugge, & Schoormans, 2015). Aforementioned scholars have analysed the motives of behaviour and demand responses of users in recent years. However, it lacks empirical research on the level of users' involvement in the pilot projects and their relationship with other stakeholders involved in the projects.

In the Netherlands, the policy programme 'IPIN' (Innovation Programme Intelligent Networks) promoted special attention to user aspects and involvement in smart grid development. Hence, the Netherlands provide an interesting landscape to study user aspects. An explorative study shows that users are involved in a variety of ways: from no involvement at all to fully taking ownership of the energy system, although most projects are somewhat in the middle of involvement levels (Brouwers & van Mierlo, 2018). In this report, we provide in-depth knowledge on the user engagement in 4 pilot projects and all stakeholders' experiences in the projects and the related learning on this issue.

1.1 Theoretical perspective

Pilot projects provide new experiences for a range of stakeholders, for instance grid operators (DSOs), research institutions and consultancies, but also for users themselves. In line with Strategic Niche Management theory (Raven, 2012), stakeholders' experiences and the related learning can be of major significance for the future development of smart grids. Learning is defined as the development and specification of ideas inside a niche, in and through interaction with stakeholders, within experiments and their experiences in practice (van Mierlo, 2012). Over time, learning may aggregate and evolve into new generic ideas and rules that set out the path for the future. Figure 1 shows how learning in local experiments may lead to an emerging proto-regime, which is a sector that fulfils societal functions, such as energy provision in a fundamentally different way.

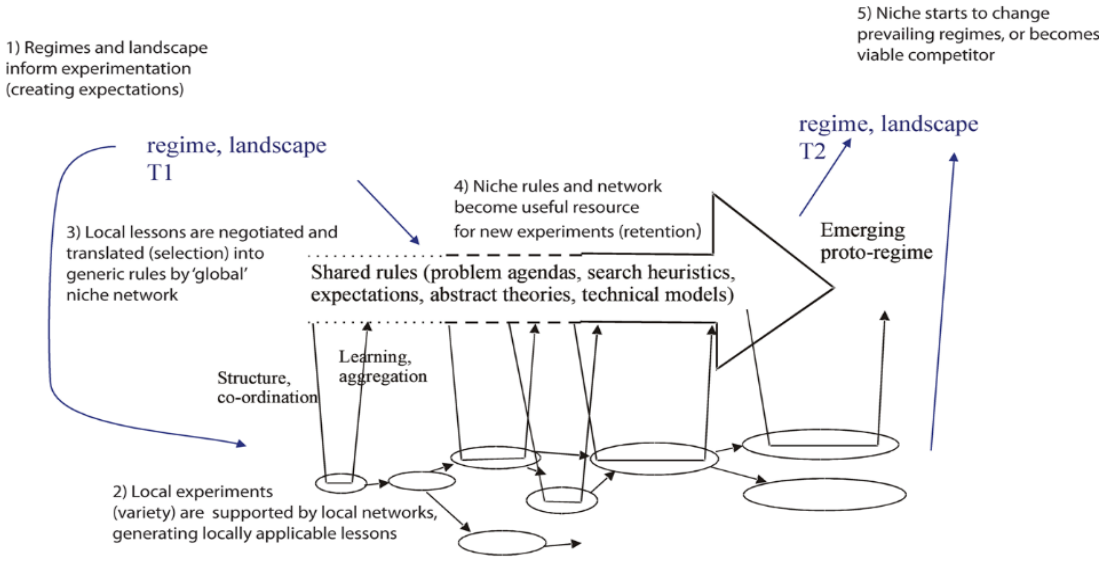

Figure 1: Learning in experiments and the aggregation of knowledge into generic, shared rules (Raven, 2012).

1.2 Research questions

The IPIN programme has reported about experiences in the IPIN pilot projects (RVO, 2015a), but so far it is unclear how these experiences lead to learning and the developments of new rules as well as adapted visions for the future of smart grids. It is also not known how t. It is unclear how experiences

are influenced by social relations, motives for participation and expectations upon the start of the projects and how the experiences affect the development of the smart grid niche. The main research question is: *What are the main learning experiences in (a selection of) Dutch pilot projects, especially on user aspects, and what does this mean for the development of the smart grid niche?*

The sub-research questions to be answered are:

- Which stakeholders are involved in the projects and in what way?
- For what reasons are stakeholders involved?
- What learning took place in the projects regarding user engagement?
- What knowledge flows in and out the projects and what knowledge is aggregated?

1.3 Methods

Existing smart grid pilot projects can provide insights about user involvement. For an in-depth study about learning in projects, we selected 4 Dutch projects that highly differ in their smart energy system features. By seeking diversity, we cover plural lessons learned in the pilot projects. The selected projects are (pseudo-)anonymized to ensure confidentiality of the interviewed stakeholders. In table 1, an overview can be found of the selected projects.

Table 1. An overview of the selected projects.

Name project	*Start date*	*End date*	*# households*	*Subsidized by*	*Features smart energy system*
The energy cooperative project	Jan. 2012	Sept. 2015	170	Agentschap NL (IPIN)	Domestic solar panels and invested in a collective solar park. No smart appliances, use of smart meters and feedback on energy levels via an app.
The HEMS project	Jan. 2012	Jan. 2015	40	Agentschap NL (IPIN)	Domestic solar panels, batteries, electric scooters, smart heat pumps, smart washing machines, a PowerMatcher (software system that regulates energy supply and demand). Smart meters and feedback via tablet.
The apartment building project	Jan. 2012	Jun. 2015	288	Agentschap NL (IPIN)	Wind energy via an energy company. Makes use of automated smart heat pumps.
The ambassador project	2011	2015	200	Utrecht Economic Board	Domestic solar panels, with households being able to choose 4 smart appliances. Smart meters were provided and demand was shifted by flexible tariffs.

Interviews were held with several stakeholders of each project (see table 2). In addition public project documentation available on the Internet was used[2]. Qualitative analysis of the interviews is conducted via the program Atlas.ti.

Table 2. Interviews per stakeholder group.

Stakeholder group	*Number of interviews*
Users	3
User representatives	2
Users – energy cooperative founders	2
DSO	2-3*
Technical researcher or consultant	2**
Social researcher or consultant	2
Economic researcher or consultant	1

*One interviewee was a social researcher at the time of the project, but currently works at the DSO and thus represents their views as well.

** Two technical consultants from two different projects were interviewed, yet they were employed by the same company.

[2] From: https://www.rvo.nl/onderwerpen/duurzaam-ondernemen/energie-en-milieu-innovaties/smart-grids.

CHAPTER 2: ROLES AND RELATIONSHIPS

2.1 Introduction

To understand how learning about user aspects influences the development of smart grids in the Netherlands, it is firstly necessary to know what stakeholders are involved and how. In this chapter it is examined which stakeholders participate in the projects and what their roles are. This constitutes the projects' social-technical networks. The chapter provides an answer to the first research question: *Which stakeholders are involved in the projects and in what way?*

For each project, first the energy system is described. Secondly, the type of stakeholders and their roles are described. This is done by providing an overview of the project's social network, and a description of the type of stakeholders and the responsibilities they bear in the project.

2.2 The projects

As the projects are anonymized, projects are named after a defining, unique feature. As such, the first project, described in section 2.2.1 is named the "energy cooperative project" due to the large role of the respective energy cooperative. The project in section 2.2.2 makes use and tests a home energy management system, making it the "HEMS project". The project in section 2.2.3 takes place in newly built real estate: an apartment complex. This makes it the "apartment building project". Lastly, the project in section 2.2.4, users are represented by 10 ambassadors, making it the "ambassador project".

2.2.1 The energy cooperative project

The energy cooperative project started in January 2012 and ran until September 2015. The project took place in existing real estate in a city and involved 170 participating households spread throughout this city. The households were member of a citizen cooperative that was part of the project consortium.

The energy system

The energy system consisted of solar panels, a smart meter and an insight home system consisting of a databox and an app. All residents were obliged to purchase solar panels, either with domestic solar panels or via a collective solar panel park. Residents received smart meters and a databox that sent data to the app. The app provided graphs on real-time energy usage. Residents also received a tablet as a gift, on which they could install the app. Later in the project, 4 electric cars were provided which were shared among participants. Lastly, the local DSO modernized 3 distribution transformers with data cables to follow electricity flows and make the grid smart.

Stakeholders involved and their roles

The social network of this project consists of the consortium, which is composed of technical parties and the energy cooperative, and social researchers and the energy supplier. Figure 2 shows the social network of the energy cooperative project.

Technical parties of the project consortium

The consortium consisted of four technical parties and a citizen cooperative (see figure 2). The technical parties were the local DSO, a Technical University and two technology suppliers that supply appliances for measuring and controlling energy. Each party had its own project manager.
The technical parties constructed a lab at the University in which a test site was built: a couple of households, a loading pole for electric vehicles and several distribution transformers that were connected to the households. In this lab, all components were tested to make sure that electricity would be ensured for the neighbourhood during experiments.

The role of the main project manager was fulfilled by the local DSO. The DSO was also responsible for distribution and installation of the smart meters, modernizing 3 distribution transformers and connecting households to the smart grid. The boxes that provided information on energy use were free for residents and provided by a daughter company of the DSO (which is out of business now).

The Technical University used the data that came out of the smart meter to develop a model of the grid. With this model tests could be conducted in a virtual environment. A Master student from the University (not in the consortium) studied what information users need to gain insight in their energy use. This student also differentiated between different sorts of users, by profiling users as 'the saver', 'the technologist' or 'the environmentalist'.

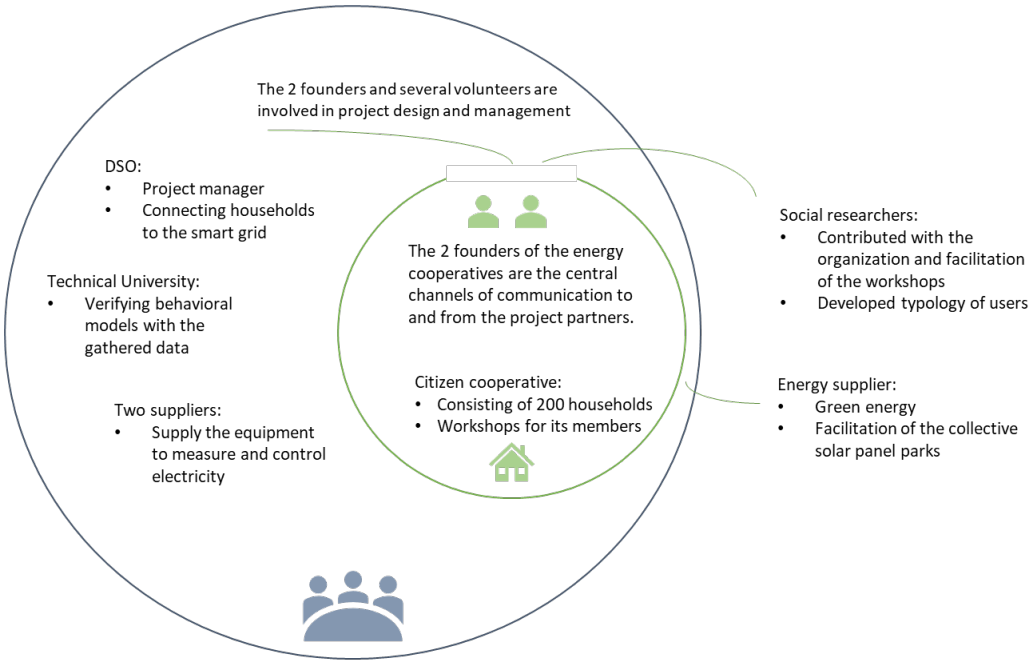

Figure 2: Social map of the energy cooperative project (the consortium in grey; households in green circle).

The supplier of green energy that was involved (at first) was also supposed to facilitate the sharing of energy between residents, but went bankrupt in the early stages of the project. The successor company supplied the residents with green energy, gave a collective discount and facilitated building the solar panel. However, the successor was not a member of the consortium and sharing of energy was abandoned as project goal.

Users in the project consortium

Two active inhabitants founded the citizen cooperative. They were the project manager 'client participation' and the general project manager. Residents could sign up voluntarily for the project. In order to do so they had to become an energy producer by purchasing solar panels. If their own roof was unfit for domestic solar panels, panels could be bought or rented in a collective solar panel park. Participants also had to accept smart meters, along which came the databox and app that provided additional information on their energy usage.

The project manager client participation organized participant meetings and working groups. In the working groups active participants could volunteer to help organize aspects of the project, such as shared electrical vehicles or facilitation of workshops. Several workshops were held with the help of volunteers. Ultimately, half of the households participated in the workshops and the other half never attended a workshop. A social scientist who stayed in the city for some time to conduct research on the project, helped to organize and facilitate the workshops. These workshops often had the topic of reducing energy usage by, for instance, reducing standby power.

2.2.2 The HEMS project

Project 2 was a small-scale project making use of a home energy management system and several smart appliances. It was a follow-up project (second phase, start in 2012) building on an earlier project (first phase, start in 2009). This second phase was subsidized by IPIN and took 3 years.

The project involved 40 households, of which 22 already participating in the first phase and 18 new households joining. Users became more involved in the second phase of the project, as the consortium wanted to develop consumer propositions that could be chosen. The project makes use of the

PowerMatcher, a software system that is designed to optimally match supply and demand of electricity and many smart appliances (RVO, 2013).

The energy system

The energy system consisted of solar panels and a home energy management system, being the PowerMatcher. The PowerMatcher ensures that the smart appliances balance electricity supply and demand, based on differential pricing. Peaks in energy usage reduce and in the future the system can be more balanced. Although residents are able to set some conditions, overall they did not actively have to participate in demand shifting.
The smart features consisted of both components that were already provided in the first phase of the project and some new ones for the second phase. In the first phase and second phase, the following was applied:

- Smart meters supplied to all households supplemented with the PowerMatcher with information on energy use
- A tablet with an app supplied to all households. It was originally let, but later provided as a gift. The app provided an energy monitor showing all energy streams in the house and energy use histories. The monitor also indicated which moments are favourable to use a dishwasher, dryer or vacuum cleaner.
- 2 electric scooters, which had a built-in chip acting as a PowerMatcher to ensure smart loading of the scooters. The chip was especially developed and produced by a chip maker for this project.
- Smart washing machines for all households
- Smart heat pump or a system combining heat and power, which could be chosen by households
- A battery bought by a few households

The second phase added the following:

- 10 electric vehicles
- 2 smart distribution transformers
- Residents were able to choose between a sustainable or most cost-effective proposition, meaning that the PowerMatcher worked slightly differently due to different priorities.
- Residents were able to exchange electricity with each other.

Lastly, in the neighbourhood a monitor displays both the energy use and production of the neighbourhood.

Stakeholders and their roles

The project consortium consisted of various types of stakeholders: a technical consultancy firm with expertise on energy, two organization that both helped to develop the PowerMatcher, and the local DSO. In the second phase users were given a more important role by the consortium and several researchers became involved who focused on the role and wishes of users. Figure 3 shows the social network of the HEMS project.

The consortium

The technical consultancy firm[3] supplied the project consortium with the overall project manager. This manager came from the department on innovations in smart energy. The firm enabled the exchange of electricity between residents and also gave a discount to residents who collectively wanted solar panels on the roof of a large school. Two residents of the project worked at this firm as well. The technical consultant also analysed several aspects in a street where houses already has solar panels, for instance whether the transformer in this street needed to be strengthened or how it had to be rebuilt. They also compared which households, if using a smart heat pump or using a micro combined heat and power system, provided more flexibility.

The local DSO entered the project not until the second phase. It took the role of a technical researcher, by analysing the effects the PowerMatcher can have on peak energy usage. The DSO also conducted

[3] Although the activities of the firm overlap strongly with research, the main research topic of this project was the PowerMatcher. Therefore we regard the firm's activities as providing supplementary information in a consultancy role.

research on the effects of price incentives on demand shifting. However, the DSO did not involve itself much when it came to the content of the project or the users.

The research organization that developed the PowerMatcher was, in this project, only responsible for delivering the technology. The software company was responsible for the design, realization and maintenance of the ICT and database around the PowerMatcher.

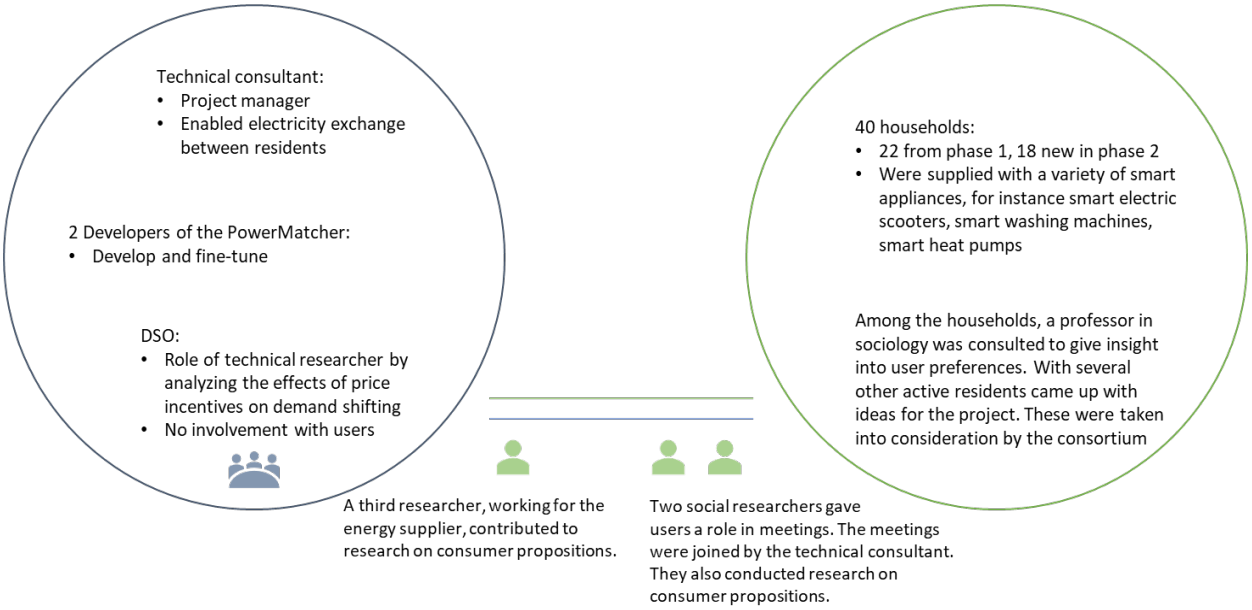

Figure 3: Social map of the HEMS project.

Additional partners

In the second phase of the project a new work package was introduced, that focused more on the consumers. For these tasks, two social researchers were involved, one from a technical university and one from a university of applied sciences. These researchers attended resident and project meetings and opened the floor for users. They specifically gave attention the users' needs and wishes. Another researcher worked for an energy supplier, to develop client propositions based on the technical system that was already established in the first phase.

Users

The technical appliances that were implemented in the houses in the first phase did not instigate an important role of the users. The PowerMatcher matched supply and demand without users having to adjust their behaviour. There was a feedback system on a website that displayed energy use, but users indicated that it did not have a major impact on their life.

In the second phase, users became more important. In addition to the research that was done on users as consumers, a professor in sociology was consulted to give his insight on consumers' wishes and bottom-up consumer participation. These ideas, for instance the electricity exchange, were taken into account by the technical consultant. The same professor had become a participant as well in the second phase of the project. He was also the founder of an energy cooperative. The cooperative however was not directly involved in the project. In addition to more influence in project design and management, users had more direct interaction as well. A couple of users provided demonstrations of their smart homes to visitors arranged by the technical consultancy firm.

Two social researchers gave users a place during meetings on the project progress. The meetings consisted usually of updates on the project and a discussion. The researchers also asked users about the frequency of interaction with fellow users, or (probed) on (subconscious) wishes the users had. The wishes, for instance on the abilities the tablet had, were taken into consideration and as such, users gained influence in the project management. During such meetings and discussions, the technical consultancy firm and the energy supplier were also present, whereas the DSO was not.

The research on users by the researcher representing the energy supplier resulted in two propositions, which gave users two options: a sustainability proposition or a cost saving proposition. Users still did not have to adjust their behaviour, but were able to get more insight due to the additional features that were introduced.

At the end of the project, all smart appliances were removed. Users had paid for the solar panels and heat pumps, and thus kept sustainability features, but these features are not 'smart' anymore.

2.2.3 The apartment building project

This was a project that took place in a single, newly built flat between January 2012 and October 2014 (RVO, 2015b). The project itself was subsidized by IPIN, yet the apartment building was available for this project thanks to a foundation that works on sustainable real estate and the local housing corporation. The project originally consisted of 4 stages, although the 4th stage never took place. The first stage consisted of making a plan and organization. The second focused predominantly on the implementation of technical aspects. The third stage started to involve users in the project by finding out what their needs and aspirations were. The fourth and last was meant to incorporate user behaviour in the project.

The energy system

The energy system consisted of a heat pump and the PowerMatcher. At the start of this project the PowerMatcher was already tested on a small scale in Hoogkerk (RVO, 2013). The PowerMatcher controls the heat pump and results in demand shifting without the involvement of users.

The heat pumps were supplied by a company specializing in in-home climate regulation and came in use on the 1st of April, 2013. The pumps worked on wind energy from the wind mill park Eemshaven via a traditional energy supplier. The PowerMatcher turned the heat pumps on whenever the amount of generated wind energy was high. The heat pumps were turned off when the amount of generated electricity was low. Users could install their preferred temperature level, but the PowerMatcher would take a range of 0.74 Degrees on both sides in order to have flexibility. For instance, if a user would set the temperature at 20 Degrees, the PowerMatcher would allow temperatures between 19,26 and 20,74 Degrees.

The project consortium envisioned to expand the project in later stages, by adding washing machines and dish washers. They also wanted to ask users to reduce energy consumption whenever wind energy production (or solar energy production) was low, and the other way around whenever production was high. The consortium started to think about how to approach this in the third stage of the project, but never executed the fourth stage that was meant for implementation. As such, users were never involved in demand shifting.

Stakeholders involved and their roles

The project consisted of several technical partners. Social consultants joined in stage 3 of the project, but were not involved in the steering board. Users were not involved in project design or management. Figure 4 shows the social network of the apartment building project.

Consortium

The DSO supplied the overall project manager for this project, although the responsibilities were handed over to a colleague during the course of the project (in 2013). Next to project management, the DSO analysed how the PowerMatcher affected the grid.

In the first two stages of the project a research organization and a software company were responsible for the PowerMatcher. The research organization developed the intelligence of the PowerMatcher by testing it in simulations and the field. The software company further developed the PowerMatcher to be able to use it on a larger scale.

Additional partners

In the third stage of the project, the consortium started to think about how to involve users and explaining the need for demand shifting. For this, they involved a social consultant (in the working group, not in the steering board) from the research organisation in the consortium. The social consultant led the research

on finding incentives for user behaviour, which was conducted by a survey. The survey execution however was done by the energy supplier, among its clients. Moreover, the social consultant made 2 movies intended for users with the aim to see how they responded to requests for demand shifting, but due to the abandoning of stage 4 the movies were never presented to users.

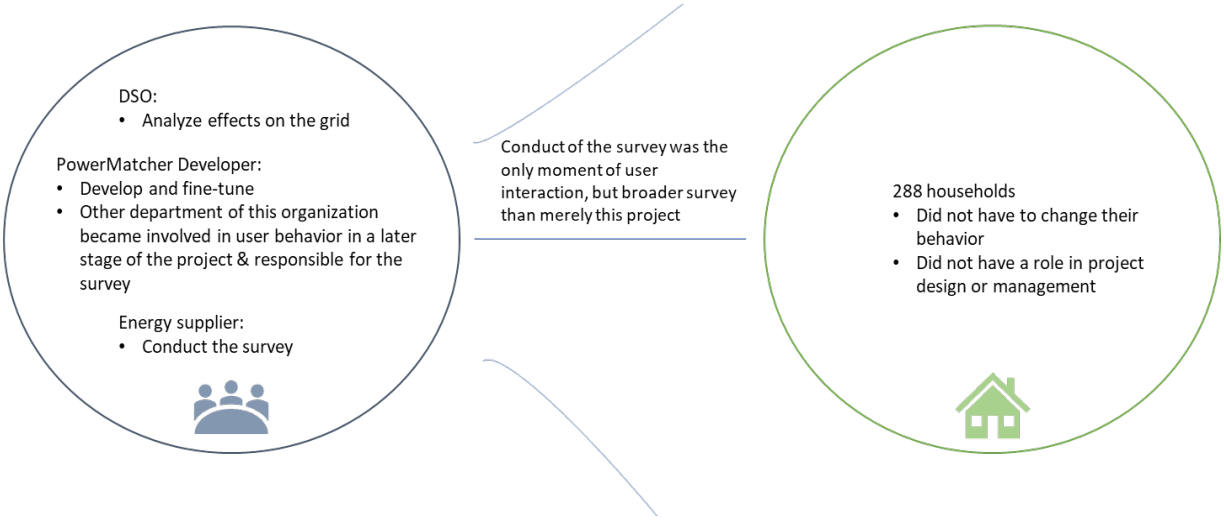

Figure 4: Social map of the apartment building project.

Users

The organization of the project was on the background. The heat pumps were built in in the new apartments. Therefore, they were owned by the users, either bought or rented. All residents of the flat were involved in the project, as moving in meant agreement on participation for the first 3-4 years. User participation was under the promise that the PowerMatcher and heat pump did not impact their comfort levels, but users did not interact with the consortium about the process or technical aspects of the project. Moreover, the combination of the two technologies ensured that users did not have to change their behaviour. As such, users did not have an active role in the project.

2.2.4 The ambassador project

The ambassador project was subsidized by regional authorities and ran in 2 cities between 2011 and 2015. In this report the city will be evaluated with the most households, being the city with 100 participating households. The authorities wanted a bottom up approach of the project. There were 10 active residents (called ambassadors) who were consistently involved in project management. Moreover, user behaviour and price incentives played an important role in the energy system.

The energy system

The project had a strong focus on the role of end users in an energy system. User behaviour was the dominant method of demand shifting, as opposed to resolving demand shifting with technology. Participating households got a system that allowed them to gain insight in their energy use. One of the components of this system were meters that registered energy use. Residents received 4 for free and were able to install them on appliances of their choosing, for instance on washing machines, dishwashers, solar panels or refrigerators. In a later stage, another tool was introduced, which could show information about energy use on a collective level and on energy use compared to other households. These systems were firstly installed at the houses of the 10 ambassadors, and thereafter in the remaining 90 households. Users also got pricing incentives, to change their behaviour. There were no automated smart appliances.

Stakeholders involved and their roles

The project was subsidized by the municipality and managed by a technical consultancy firm. It furthermore consisted of the local DSO and a small-scale economic research and consultancy firm. The project consortium had meetings on the management of the project and meetings with the ambassadors, who also had influence on decision making. Figure 5 shows the social network of the ambassador project.

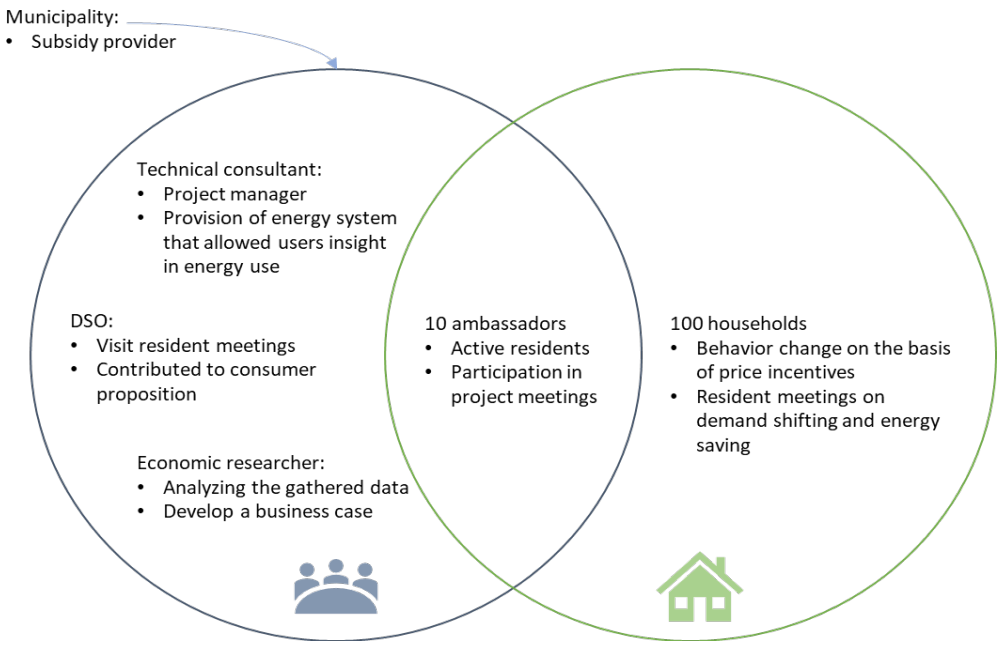

Figure 5: Social map of the ambassador project

Consortium

The consortium consisted of the technical consultant, the DSO and an economic researcher municipality was involved by providing subsidy and was involved in project management, but had no apparent responsibilities in the project.

The technical consultant acted as the project manager. Moreover, the consultant was responsible for the system that provided insight in energy use and the meters that could be installed on various appliances. When the system was successfully installed in the households of the ambassadors, a system update caused the installation at the other 90 households to be much more difficult. Although this was a responsibility of the system's supplier, the consultant felt responsible for installation. As a result, in an attempt to fix this problem, all 90 remaining households were visited in order to install the system personally.

The DSO got involved in a later stage of the project design, and was therefore not able to declare working hours on the subsidy. As such, the DSO invested working hours themselves. The DSO's focus was on the consumer side of the project, but took no active role in decisions or with regards to users. The representative of the DSO visited resident meetings to try and get an impression of relevant aspects for users. The DSO also supplied the smart meters that were required for this project, as a certain version and connection was desired. They also contributed to writing 1 of the consumer propositions, the *profit4all* proposition. The data that was used for this proposition was not analysed by the DSO. Finally, the DSO contributed to writing the results and the report of the project results.

The small-scale economic research and consultancy firm was a partner in the steering board and conducted research on the economic side of the project. The researchers wanted to develop a business case out of flexible energy demand, for which they took refrigerators as a source of flexibility. The economic researchers analysed how much flexibility could be created when having remote control of the refrigerators. However, they did not do this in reality. With the data, provided by the DSO, they calculated how many refrigerators would be required and what the profitability would be. Via smart meters the data was gathered and a weekly updated file in Excel was sent to the economic researchers. The preference of users was not yet taken into account.

Users

Users had an active role, by being involved in project design and management and by changing their energy behaviour. They were represented by one of the residents, who was also responsible for enlisting participants and the recruitment of active ambassadors. In early stages he mainly spread information

about the conceptual idea of the project. After that, he formed a core group of residents, who each stimulated more people to join the group. These were later called the ambassadors. Signing up for the project was made as simple as possible, with a contract in everyday language on a single A4 sheet of paper. The representative himself was the main communication channel between project consortium and users. Moreover, he organized the meetings for residents and facilitated the budgeting for the community.

Users had meetings with each other to gather ideas for the project. Whereas in early stages of the project users had ideas mainly about energy saving, later discussions resulted in the ambition to make the grid locally independent. In addition to resident meetings, the ambassadors also had monthly meetings with the project partners. Topics that were discussed were for instance around the question how solar energy that is produced in the neighbourhood can be used instead of it disappearing into the grid. Stakeholders emphasized that users could generate ideas, but they also made users aware that they could not do everything. An app was introduced that showed information on energy usage, but was also adjusted as a result of remarks that users made.

The residents also organized an excursion for themselves to a washing machine producer. The particular producer has a knowledge and experience centre on saving detergent and environmental aspects of water. After the excursion, users convinced the producer to get involved in the project. The producer gave 2 washing machines and 2 dryers as a gift to 2 households, provided that these households gave the producer information about how much energy they were able to save getting a new washing machine.

2.3 Conclusion

In this chapter the features of 4 selected projects are described with regard to the local energy system and the composition of the social network. Several conclusions can be drawn on the stakeholders involved and the extent of user involvement.

Dominant stakeholders in these 4 projects are DSOs, SEPS suppliers/developers and technical researchers and consultants. All DSOs conduct research on their grid and both the DSO and the technical researchers play roles as overall project manager. Energy suppliers and social consultants were not part of the consortia, despite their frequent occurrence in Dutch smart grid pilot projects (Brouwers & van Mierlo, 2018). Their role is distant in these 4 projects, for instance energy suppliers conducting surveys and economic research. It is thus interesting to note that energy suppliers take up the role of economic researcher as well (who is only present in 1 of the projects).

Social researchers and consultants were, although not in the consortium, present in all projects. In both the HEMS and the apartment building project these stakeholders were involved later in the project, when it became clear that users should be given more attention to. Social researchers/consultants influenced the role of users because they provided insight in users' wishes or gave a stage to users. In the energy cooperative project, the presence of social researchers and consultants did not have a large influence on the role of users as users were already presented via the cooperative.

In two projects in which users were actively involved and two projects were users were (less) actively involved. Moreover, in the two projects in which users were active the focus was on energy behaviour rather than demand shifting. In the two projects in which users were less active the focus was mainly on demand shifting, which was achieved by using smart appliances or a heat pump. Users were given energy insight tools in a total of three projects, including one in which they were less involved in.

Users are involved in project design and management in two ways: no involvement or a selection representing other users. Even though in the energy cooperative project the cooperative was part of the consortium, not all users were directly involved. Information and project organisation ran through intermediaries: the project managers in the energy cooperative project, the users' representative in the HEMS project and via ambassadors in the ambassador project. It appears that user behaviour plays a more dominant role in the energy system in projects where users are more involved, in essence the energy cooperative project and the ambassador project. In the next chapters, we will analyse the role of users and the experiences with user involvement further.

CHAPTER 3: MOTIVES AND GOALS

3.1 Introduction

After identifying which stakeholders constitute the social network in the 4 case study projects and which roles they have, this chapter focuses on the motives and goals the stakeholders have for participating in the projects. The goal is to understand how these motives influence the learning process later on. The chapter gives an answer to the second research question: *For what reasons are stakeholders involved?*

Special attention is given to the specificities of the context in which stakeholders operate and how this motivates them to invest their efforts in the projects. To understand how users are involved in smart grid pilot projects and how this relates to other stakeholders, we also focus on the perception of various stakeholders on the need for user involvement.

3.2 Motives and goals of the stakeholders

The motives and goals of the stakeholders are described per stakeholder. Each section covers a stakeholder group which is for some groups further divided.

3.2.1 The DSOs

In the projects three different DSOs have been involved, therefore their motivations on participation and user perspectives are all described a separate section. One DSO was involved in the apartment building project and the ambassador project, whereas the two other DSOs were involved in the HEMS project and the energy cooperative project respectively.

The DSO in the apartment building and ambassador project

This DSO is in favour of enhancing the grid, as it believes that this is the cheapest option. It argues that the cables that are currently in the ground will get older and need replacement eventually anyway. Thus, when they are replaced they may just as well be replaced with stronger cables. However, the DSO recognizes that grid enhancement cannot happen as quickly as local energy sources appear. As such, they are looking at ways to postpone grid enhancement.

> *"We have said for years, if we get capacity problems we will just enhance the grid. That is where we see some limitations now because we cannot enhance the grid as quickly as sustainable energy is appearing, with solar panels and wind. (…) Grid enhancement stays number one. But you can also look at alternative options."*

One of the interviewees gives another argument for the preference for grid enhancement, by referring to the *"temporary nature of demand shifting".* Her explanation indicates that the DSO is still unsure whether demand shifting will be enough and that the DSO is still unsure how to facilitate demand shifting.

> *"If you want to do this for the next twenty years, then it is cheaper to enhance the grid than work on demand shifting for twenty years. You also don't know if it gives the results you desire. You must do it on the short term and you must design your entire system that way. That is also tough for us. You have to know really well what you need, and you have to be able to steer very well."*

As such, collaboration in the apartment building project and the ambassador project was motivated by the search for exploring alternative options and to gain more experience with steering demand and the consequent results.

In the apartment building project, the DSO felt that it has few interactions with users in daily life, something that was no different in this project. The DSO sees this project as one that has a technological approach. It was assumed that if the project was a success, the same approach could be used in other projects and the technology could be upscaled. Clients' comfort levels were deemed important for success, as the DSO was hesitant to ask too much of users: *"It is also the question of how much you want to burden people."* Similarly, the DSO's perception of the goal of all IPIN projects was: *"…to gain learning experiences and how we can use wind energy without downgrading the client's comfort levels."*

In later stages of the project, the DSO aimed to ask users to lower their electricity use when supply of the wind park was low. However, the DSO (and the project consortium) was not sure how to approach residents and what to offer them in return, so in the third stage, it was decided to commission research for developing a users' approach. The research findings could be implemented in stage 4.

In the ambassador project the DSO's goal is not entirely clear. Other stakeholders perceived the DSO as less active and gave the fact that the DSO did not share in the subsidy as a possible explanation. In contrast the DSO stated this was because the DSO believed it was interesting to let other parties decide on features and activities in the project. In such a way the DSO would be able to examine the project's effect on the grid, without influencing the outcome by setting demands. However, the DSO also stated that this project was not so much about their own learning goals as gaining positive interactions with users. In this aspect the DSO feels that user relations should be improved so users gain a better understanding of the grid.

The DSO in the HEMS project

In the HEMS project, the overall project manager (a technical consultant) had difficulties getting the local DSO involved. This, despite him having connections with the DSO. When first approached in 2009 the DSO did not see space for innovation within laws and the energy market, therefore it saw no benefits of participating in the project. In the second phase however, when the project was subsidized by IPIN, the DSO decided to join the project. The interviewee is convinced that DSOs are willing to invest in innovation in (smart) grids, but is not sure whether this DSO would have joined the project without the subsidies. When the DSO did join, their goal in the project was to analyse the effects on the grid. Financial incentives for users a way to reduce peaks in energy usage.

The DSO in the energy cooperative project

The dominant motivation of this DSO was to analyse the effect of charging electric vehicles and large increases in energy use (done with a pressuretest in which users were involved) on the grid. As such, user behaviour in energy use was important for the DSO. The DSO therefore also focused on interaction with users and user participation in the project. Interestingly, the interviewee stated that local production of electricity forces the DSO to connect with people: *"the horizontally organized society does not match a vertically organized DSO."* Rather than distant feedback loops with society, this DSO hopes to have more integrated interaction.

3.2.2 The technical consultant

The company that acts as technical consultant is project manager in two of the projects (the HEMS project and the ambassador project).

The technical consultant in the HEMS project

The technical consultant considered the changing landscape of the energy system already in 2007. He saw several technologies that would be implemented in the future, for instance micro combined heat and power systems, electrical cars and the rise of solar panels. In this context the technical consultant wondered how various technologies would influence each other's development and the future market. With the changing landscape the technical consultant saw a changing role for citizens as well, from citizens to prosumers and a stakeholder in the market. However, the consultant believes that citizen do not know their new role. The consultant wanted to develop a project that would explore the changing energy market. This would become the HEMS project later on. He believed that users needed to be involved in this project, as he realized that citizens are not so interested in new technologies that are not directly connected to them. He believes users make a conscious decision for new products, based on value for money or emotions. To convince citizens for your product, one would have to be able to explain how energy products work together with other technologies.

Not all colleagues were convinced of the need for user involvement of the project and of the benefits of the project. The consultant states that he encountered quite the resistance from his manager: *"I had to set up such a project and my boss had the opinion that it was a complete waste of money to spend money on that."* He also describes that the dominant idea in his firm was that people get new technologies and they are happy with that. To convince the internal stakeholders, the consultant explained the project from a client perspective: *"Try to convince them to look at what they envision in other ways. So, not to only think from that one product, but from in integrated image on what the client faces."*

After the *"biggest hurdles to start"* (in the consultant's words) were overcome, the project's goal was to evaluate whether users found a completely automated system more attractive or less attractive than something which they could influence. This was partly because the consultants thought users would be afraid to lose control and reject the system. With this perspective the consultant wanted to involve users in decision making as well.

The technical consultant had high expectations of the HEMS project. He envisioned a market model that was based on this project: *"When we first started the project, I thought we had found 'the holy grail'."* However, in the first phase of the project several issues led to a very different approach in the second phase of the project. In the second phase the project leaders ensured to take users more into account, by focusing on discovering users' wishes and implementing these. The insights that led to this development are further elaborated upon in section 4.2.2.

The technical consultant in the ambassador project

The technical consultant in the ambassador project states that this was the first time that she made the switch to a user-centred approach, as opposed to a technological approach. According to her this project was set up because there were very few projects that took users' wishes as a basis for the project. The large difference with other projects made this particular project very important for them as well.

The question in this project was not so much how to make the neighbourhood more sustainable, as most of the users already had solar panels. The question was rather how to deal in a smart way with these technologies in the future:

> *"We were looking at a spot on the horizon for this project. So, if you want a solution that entails smart grids, or taking a step back: if you want a sustainable energy supply, and you want to keep that affordable, using flexibility is a good solution. But how should we do that?"*

3.2.3 The social consultants and researchers

Social consultants and researchers were present in all projects, but played a larger role in two of them. In the energy cooperative project social researchers played a smaller role. They were conducting research what information users need in order to change energy behaviour, and which types of users can be seen in the system. This was beneficial for the founders of the energy cooperative as well.

In the HEMS project one of the social consultants was also a user and a users' representative. He became involved because the technical consultant wanted to do more with users in the second stage of the project. The social consultant was also a user and a users' representative. Therefore, the goals and motivations of this stakeholder will be discussed in the user section. Another social consultant in the HEMS project worked on her promotional research during the course of the project, for which she analysed the energy related behaviour in relation to the new system. She states:

> *"I notice that the approach is often: 'We are going to do this, and users are involved. Oh right, they are important as well, what will we do with them?' Whereas you can also ask what they want. That is some of the tension I see."*

She expected users to have difficulties to work with the new system, because she saw that technologies were installed directly in users' houses.

In the apartment building project, the project consortium wanted to actively involve users in the project. The goal was to be able to tell people to lower their electricity usage when the wind energy supply was low, but they did not how to do this yet. The social consultant was convinced that demand shifting would be difficult for users, so she wanted to stimulate them to do so by a personal approach on aspects users find important. To find out what these aspects were, she initiated a survey. The survey was ultimately conducted by the energy supplier so that the motivations would not be limited to people in the apartment building, but would provide a more representative image of the energy supplier's clients and of society. The consultant regarded the project as a chance to work with storytelling as well. In the consultant's own environment and organization, storytelling was used frequently at that moment and she had just learned how to work with the method.

> *"What I found interesting back then was that we were working on this whole storytelling concept. You heard quite a lot about that. It was seen as a different intervention to influence behaviour. I found this interesting in this project because it was a really nice opportunity to work with storytelling."*

3.2.4 Economic researcher

Economic research was conducted in 3 projects, mostly to develop a consumer proposition. In two projects, the HEMS project and the apartment building project economic research was conducted by energy suppliers (both also collaborated with social consultants for this research). In both cases economic research focused on the value for consumers: in the HEMS project two consumer propositions were developed that led to a difference in working of the PowerMatcher, and in the apartment building project surveys were conducted to find out what value should be created for users in order to engage in demand shifting. Only in the ambassador project, economic research was conducted by an economic researcher.

In the ambassador project economic research was conducted by a team of a small economic consultancy company. The economic researcher saw that grid capacity problems arose in specific districts where a lot of citizens purchase solar panels. The dominant goal of one economic researcher that participated in one of the projects was to gather flexibility of electrical devices and develop a business case. The intention was to shift demand of electrical devices, such as refrigerators, in order to match the supply on the grid. In this sense, the question was whether demand shifting would be economically viable for both their own company and users. The researchers did not take into account preferences of users, but was only looking at the calculation of an economic reward for users.

The researcher had an additional idea for the more distant future: to partner with local energy cooperatives. The cooperatives would stimulate flexibility, which could be aggregated and for which the cooperatives would get a small share of the profit as well. This is motivated by the idea that cooperatives do not have much of a business case of their own and that the cooperatives are motivated by financial reasons.

> *"There was, and still is, this trend that energy cooperatives wanted to function autonomously from those energy suppliers. And we thought well, and I still think that this is right, those energy cooperatives do not have a business case on their own. They have to collaborate on certain points. And one of those things could be flexibility management. So, we could have a central cooperation, just like Rabobank, in which all these parties work together."*

3.2.5 Users

Users can take up several roles in a smart grid pilot project. The following roles have been identified: 1) users, 2) user representatives and 3) users representing an energy cooperative and being project manager. The motives of the users are discussed in the light of their roles.

Users

Overall, users had several motivations to join smart grid pilot projects. Motivations explicitly stated during the interviews are:

- Interest in sustainability & socially responsible behaviour
- Interest in energy (saving)
- Interest in reducing energy costs
- Interest in new technical developments
- Energy exchange with neighbours: local use of energy
- Lower dependence of energy suppliers
- Energy efficiency (from solar panels)
- Curiosity

For instance, one user stated: *"I have an interest in sustainability and climate issues since I was young"* and *"I really want to change the world a little bit. Especially in the field of a municipality being energy neutral."* Users tend to bring forward a combination of the mentioned reasons for participation. For instance, none of the users are only interested in energy efficiency or reducing energy costs, but regard this as additional benefits for participating in the project.

Users that participate in smart grid pilot projects have a range of arguments for doing so, but all interviewees referred to an interest in sustainability and energy. Reducing energy costs, lower dependence on energy suppliers and a more efficient use of (solar) energy are mentioned in lower frequency and are mentioned later in interviews. They are given less priority to. Users did not explicitly state that they have had certain expectations of the project, but seem to join for reasons of personal nature.

Users' representatives

The social consultant in the HEMS project, who was also a user and users' representative, was asked to give more insight into the wishes of consumers. This happened, because he and two other residents established an energy cooperative with fellow residents, aimed at energy production via solar panels, and making homes more sustainable. In this light several households in his street had purchased a heat pump. The professor posed his street as a candidate for participation in the project. Due to the technologies already being there, the project consortium selected this street for participation. In addition to making homes more sustainable, the energy cooperative is ambitious with regards to the future. They show willingness to contribute to infrastructure, as, they wanted to be able to store electricity, use electric cars, exchange electricity with each other and get their own local grid. The users' representative valued social cohesion as well for the sake of their energy cooperative and sustainability. According to the representative, citizens do not get motivated when merely focusing on energy. A strong local community and working in a small group are more important motivations for them. Lastly, the representative wants the cooperative to become more professional, because he considers this a key requirement for becoming independent of the large companies.

The users' representative in the ambassador project was asked by the regional authorities that provided the subsidy to fulfil this role in the project, thanks to his experience with bottom up approaches in the neighbourhood. A few years earlier he took a bottom up approach to get optical fibre installed in the neighbourhood district. The representative's personal drive is to bring people together, which was specified in this project to bringing project partners and users together. He sees himself as a mediator, but on the side of users. According to the representative, institutions find user participation very difficult:

> *"It was quite difficult. On the one hand everyone was very excited, but on the other hand they wanted nothing to do with this question. (…) One of those questions was like: 'How are we going to get 100 participants?' And I was like: 'I can have them ready next week.'"*

The representative sees bottom up movements as a repetitive phenomenon, but after achieving what they desired the motivation and drive subsides and the resident group collapses. It is interesting to note that the representative does not describe this as a problem. In contrast, a group like this should not be an entity, but he sees a collective, new group as more able to go against the establishment.

The energy cooperative

The energy cooperative saw the IPIN project as a chance to strengthen their energy cooperation and build the community: *"We used this project to make our cooperative large and strong."* They believe people enjoy such projects and that collaboration and joint participation in new experiences is believed to keep people involved in the energy cooperation for a relatively long period of time. In addition, it brings them new customers. For this reason, the cooperative had said from the start: *"We want to be a living lab."* The cars that were provided by the DSO to analyse charging behaviour, were turned into a shared car project by the cooperative. Due to this belief, the cooperative keeps this process going with new projects and new committees.

The cooperative wanted to produce energy as they did not want to be merely a mediator between citizens and regular energy suppliers. Therefore, citizens joining the project had to produce energy. They could do this via domestic solar panels or by joining a collective solar panel park. In this way, they were approached as a prosumer.

The project and the cooperative wanted to make people aware of their energy production and consumption. Their assumption was that awareness would lead to energy saving, for instance by showing people what happens if they turn on an electrical device. It was expected that this could lead up to a reduction of energy use of 15%. The project leaders wanted to know under what conditions energy saving occurs. Moreover, a question that arose was whether energy saving would be achieved through initial enthusiasm and fade later on. Another question was whether energy saving occurs because people are personally interested, or whether this can be stimulated through interaction with others in workshops. If energy saving occurs through interaction, peer pressure and collaboration, it was perceived that that would give the cooperation a rationale of existence. For this reason, the cooperation was interested to host a social researcher in the workshops.

3.3 Conclusion

Different stakeholder groups are involved for a variety of reasons, but within a group motives for participation largely overlap. Users have the largest range of motivations to participate in smart grid pilot projects.

All DSOs are currently working to find ways of dealing with new, local energy sources and finding solutions for capacity problems. Therefore, they all had the goal to examine the effect of demand shifting on the grid. DSOs are still unsure about the benefits of demand shifting, as it is perceived this is a temporary effect and difficult to achieve. However, they do expect there is some value to it, as they see potential for upscaling. User behaviour is therefore an interesting feature in research for the DSOs.

The technical consultant is primarily concerned with product development for smart grids. As users become a stakeholder in the energy market, users are seen as future clients. The consultant therefore aims to understand how users embrace new technologies in the energy transition. It is also interesting to note that the technical consultant had high expectations of the new market model that featured in the HEMS project.

Social researchers and consultants were found to be involved because of reasons of personal interests, especially in the case of researchers. They find their own way into the consortia. Social consultants become involved because they are asked by consortium partners. Some expect as well that demand shifting is quite difficult. Both the social researchers and consultants share an interest in the user behaviour or the relations (and tensions) between consortium partners and end users.

Economic researchers aim to develop a business case as they see there is value to be derived from smart grids. Overall, they believe that users are motivated by financial incentives, and one believes that energy cooperatives are susceptible to financial incentives as well.

In contrast, actual users' motivations go beyond financial incentives, with the most important being a personal interest in sustainability and/or an interest in energy. Cost reduction and becoming more self-proficient may be considered extra benefits. Community formation is found important by both the users' representatives and the energy cooperative. However, the representatives see communities as a method of achieving (local) change, whereas the cooperative sees communities as a method to strengthen their own cooperative.

CHAPTER 4: LESSONS LEARNED

4.1 Introduction

Lessons learned can be significant to the future development of smart grids. Lessons can integrate into a new set of rules that determine the new way things are done. Learning hence is a social process. Positive experiences may reinforce practices for the future, whereas negative experiences can inhibit future experiments. It is important to note that negative results do not necessarily entail a negative experience. Failures are just as important for learning about innovations as successes. In this chapter the lessons that are learned from the pilots are shared. It answers the third research question: *What learning took place in the projects regarding user engagement?*

4.2 Learning in the projects

In this section, the lessons learned are described per project.

4.2.1 The energy cooperative project

In the energy cooperative project several specific lessons have been learned. These lessons considered energy use and energy saving, ways to build a community, use of data by project partners, and technical lessons on the grid.

Use of energy insight systems for energy saving

Firstly, users in the project learned on their energy use and on energy saving measures. One of the project goals that was realized was to save energy by 15%, which was achieved by workshops on energy saving and energy insight tools. Users enjoyed these activities: *"We had so much fun in the workshops on energy savings and on electric vehicles. And to try different things with that. So, people did save energy."*

With regards to the insight systems, users learned that real-time energy monitoring was valuable. This was discovered because in this project there was both a website with data from the previous day, and an app that shows usage on the last 5 minutes. One of the initiators of the energy cooperative states:

> *"What was really appreciated, was that it was possible to monitor in real-time what your usage and production was. (…) If you want to analyse your electricity usage you want to know that now. If I turn off my light, I want to see that in my graph or table. If the sun is shining, I want to see that instantly. As you are playing with the behaviour of people, you have to reward that."*

A couple of months after the end of the project, the company that provided the app was discontinued, leading to an app that could not be used anymore. Users found this frustrating and disappointing.

Community of users

The founders learned that participation in such a project has a strengthening effect on the relationship between the user and the cooperative: *"So if you have joined in such a project, even though it is a combination of research and practical experiences, it works to attach people to your cooperative for a longer period of time, so that is good."* For the founders this also confirms their rationale of existence. A large part of the citizens that were active in this project are still active in the energy cooperative. They are still working on projects related to energy, such as water power.

Apart from this lesson, it also became clear that knowledge is lacking on how to involve a broader group of users. The founders want to make the cooperative even larger. Yet, they are struggling with the transition from subscription by the frontrunners to the subscription of the masses, in essence those people who are not interested in energy nor sustainability. The founder expected that this transition would be slightly easier than he found it to be.

Data use by project partners

In this project, stakeholders learned why users entrusted project partners with their data. Clarity on what would be done with the data, the sources to which it goes, and transparency were mentioned as the most important aspects to gain users' trust. Users were not concerned that their data was passed on to

the Technical University. The University was perceived a trustworthy party. The DSO was also entrusted with this, because it was not regarded as a commercial party. The box, that translated data from the smart meter to graphs on energy use, could in practice be thrown out, which resulted in a quick deletion of data. The founders of the energy cooperative spoke a fair amount with residents on this topic and concluded: *"if you make proper agreements and you stick to them, then things go okay."*

Relations in consortium

The relations in the consortium were evaluated positively. The consortium partners each had their own role in the project and the cooperative chose to leave all the technicalities to the technical parties. Both cooperative founders evaluated this decision as a good one.

Communication to the members of the cooperative went through the cooperative founders. Both project partners and the founders were content with this organisation. Moreover, the cooperative founders believe that partners were very happy with this way of involving users: "*a group of well-organized users were finally involved. If you look at the DSO for instance, they have a department on client processes, but this was completely new."*

The grid

Lastly, technical lessons on the grid were learned. The first of these considers the building of a smart grid itself. One of the founders of the energy cooperative provides an example in which citizens in the project were active in demand shifting.

> *"We have those solar panels and an electric car. Users think 'Oh good, the sun is shining so let's plug in my car, so I'll have a minimum of usage on the grid. But, the people who installed this have not taken this into account whatsoever. The car is on one phase of the grid and the solar panels on the other. This means that use of the net is double, whereas it could be zero. These are eye-openers. You think you are compensating, but that's not the case."*

This shows that smart grid realization needs to be more integrated into all aspects of society.

The energy cooperative project also conducted a so-called 'pressure-test', in which users were asked to use as much electricity as possible (by charging borrowed electric vehicles, baking pizzas and turning on all other devices). This caused the collapse of the grid and showed that the grid is not fit for the growing energy demand, which the DSO did not expect. The DSO was focusing on demand shifting of the electricity supply of the electric vehicles, using a PowerMatcher. However, via the smart grid's information stream it could be seen that the real troubles came from using that much electricity within the houses. The DSO, even though they were saddened that they were proven wrong, stated they were happy they learned such technicalities in this project.

4.2.2 The HEMS project

In the HEMS project, lessons were learned on the home energy management system (the PowerMatcher), the need for user involvement, issues of continued user involvement, uncertainties about the future, the differences in priorities for users (e.g. on energy saving versus cost saving), and on relations in the consortium (including the role of the DSO).

The home energy management system

Although some project partners expected that this project was the holy grail, they learned that the PowerMatcher is not yet fully developed and might get a very different working when scaling up the project. One of the issues that led to this conclusion was that, at times, the PowerMatcher (the software system that automatically shifted demand on the basis of prices) prioritised the entire system over the individual user. This was not well received by users. In the second phase of the project users could choose between two propositions: the cost-saving proposition or the sustainable proposition. The PowerMatcher got a slightly different working based on these propositions. Issues that arose were identified according to remarks from users: "*My PowerMatcher turns on, but the price is high at the moment*". Another case was where the heat pump was turned on by the PowerMatcher at night, when the user did not even need heat. As such, technical partners now believe that, in contrast to the holy grail, they have only seen the tip of the iceberg.

Need for more users' involvement

Project partners learned that users should be involved in smart grid pilot projects. In the first phase of the project, users stated that it did not impact their lives, but they still wanted to know how it worked. For instance, they did not know when the heat pump would turn on. The interface of the PowerMatcher in phase 1 did not meet the users' information needs. As they asked for more insight into the energy system, users became more involved.

The HEMS project became interesting for the technical consultant when users became more involved, as this gave the consultant consumer insights. According to the social researcher, reactions of the technical consultant were for instance: *"Wow, how interesting, I didn't know this happened".* The technical consultant stated on this: *"Those responses [of users] were really a surprise. We felt like we guided users very much and tried to involve them in the devices. (…) They also had different sorts of questions than we expected upfront."* The consultant takes these lessons along for the future. He states that he would not redo the approach of what he calls an *"enormous technology push"* that was taken in the first phase. He adds: *"With a little bit of effort we could have learned much more, and it would have been more fun for people to participate."* Moreover, the technical consultant sees benefits to involve users, as they are important actors to improve your product and gain support for bringing the product to the market.

The social researcher judges the project's approach towards users to be right, as the consortium aligned their goals to those of users. The decision to involve users more and the consequent involvement of the social researcher, led to users getting a podium in project meetings and the meetings becoming less one-directional.

Two conclusions were drawn when users became involved. Firstly, users were able to use the system very well and started washing when it was sunny merely after 14 days. According to the technical consultant this was because the users were involved in the design, which enabled them to understand the system as well. Secondly, the users were able to define with great clarity what they needed. The consultant believes this is because they were already familiar with the system thanks to phase 1, as they asked for feedback in the first phase, but users were not able to articulate their needs yet.

Users asked for ways to gain insight in the energy system. According to the social researcher, this is just so they know what is happening. They like being in control, but automatic appliances are also accepted if they know that it works well. The social researcher gives an example of participants saying to her: *"If the system works well than its okay. I want to be able to control what is going on, but if I don't notice anything than its okay as well."* With this learning the researcher envisions several types of smart appliances and an energy insight system in co-existence, with an adjusted fit for each type of user.

Users were able to exchange electricity with each other, but have not learned much about this topic. The electricity exchange was enabled by the technical consultant, but according to the users' representative they have not been provided with tools for insight into the working of this system.

Continued user involvement

Continued user involvement is an issue when projects are not financed anymore. Project partners take the lesson that users should be involved along to the future. However, when they leave, users are not capable of continuing the project themselves.

It was a disappointment for the users when the firm of the technical consultant did not finance any continuation of the project, after which they left. It is interesting to note that the users' representative himself said that a community-based approach has a low level of continuation. He says about this:

> *"We have the knowledge that we are still sharing, but there is no support to expand this. Well, how far can you mobilise volunteering? That extends to yourself, your street, your neighbourhood, your district, your city. But the highest drive is 'what does it do for me, and my neighbours?'. The willingness to put in effort decreases when the area gets larger. We don't have much time for volunteering. We all have a busy job and life."*

Potential for the future

Despite the learning that user involvement is feasible and useful, the potential of this is somewhat unclear. This is both due to a large group that is still not reached and the uncertainty of demand shifting. The technical consultant for instance is worried about the large group that is not yet reached. He states that the users involved in the project all had affinity with sustainability and that the average income level and education level was not "that of the average Dutch citizen". Yet, there is a group who is not interested in sustainability, but one that is very significant in the transition towards a sustainable energy system. This makes him concerned. He believes possible solutions to be focusing on including housing cooperatives and improve the options in sustainable technology, for instance improving the driving range of electric cars. The social researcher is unsure of the potential of demand shifting:

> *"As devices and houses increase in energy efficiency, the question arises how much flexibility there is that you can steer. (…) I believe that a lot of habits can change and not in regulation, it does not have to become as complicated as project 2. Yet, I think we are all still quite unsure."*

The technical consultant states that he has seen his expectation confirmed that users do not want to be concerned with the energy system too much. Trust and insight in the systems are two aspects you must facilitate. He believes that users will be content quite quickly, if the basic usage pattern is not affected negatively:

> *"Nobody will wait half an hour before they are going to put their pizza in the oven. Maybe 10 minutes, if it has an incentive of 15 Euros. But if it takes too long then I think immediately: 'leave me with your smart energy, I just want pizza'."*

Relations in consortium

The relations in the consortium worsened slightly over time, according to the technical consultant. It is unclear what caused this. Several interesting notions can be made with regards to the consortium relations. Firstly, the social researchers were involved as knowledge partners and were therefore not influential in the project management aspects. The research itself was also not prioritized in the project. Secondly, according to the technical consultant parties wanted to move in different directions and did not take the time to guide each other. Organisations held strategy meetings and consultations on next steps internally rather than with project partners. Some were more technically oriented and some were focusing more on the broader aspects of society. Despite these considerations the user representative states that it was a very pleasant team. Thirdly, the technical consultant also found that the DSO is still unsure of its role. In relation to smart grids, the DSO lacks IT knowledge and struggles with digitalising their infrastructure. However, for this project it did not cause major troubles.

4.2.3 The apartment building project

In the apartment building project the main lessons learned were on the energy system. Other lessons were that the value of flexibility is currently not sufficient.

The energy system

In this project many technical lessons have been learned. The DSO states that they have gotten *"some pretty nice results"*, and: *"It was a successful project and the technicalities of the project were realized."* However, the DSO states that the outcomes can vary depending on the environment. In this project the houses were new and therefore very well isolated. The DSO shows concern that these outcomes cannot be replicated in other areas, as houses build in the 50s or 60s are less well isolated.

Value of flexibility for users

The survey that was conducted among users and clients from the energy supplier led to the learning that users felt flexibility should save much more money than the project partners expected to. The project partners found these findings of the survey interesting. This, according to both the social consultant and the DSO.

The value that users attributed to flexibility was more than project partners expected, but also more than the DSO could deliver:

> *"We asked users in the survey, how large should the incentive be if send you a message 'hey, there is not much wind, can you turn of your washing machine or dish washer?'. What it for residents had to deliver was certainly about 200 Euros a year. We calculated quickly that we*

could deliver 60 or 70 Euros a year. That is such a big gap, we cannot realize that. So it is better to just put stronger cables into the ground."

Due to this lesson, user involvement was never really achieved in this project.

This project has taught project partners that user involvement is difficult to achieve. The DSO refers to "several challenges" when involving users, although he does not elaborate upon these other challenges. The DSO representative concludes that they should have thought about user involvement in an earlier stage, but he is not sure if they would be able to do the last step better. Overall, he is unsure when and how users should be involved, but at least it was concluded that it does not work to involve users halfway in a project that has technological approach.

The DSO concludes that they have learned on users' wishes and see that in nearly all cases now it is cheaper to enhance the grid. The DSO now waits for the market to develop. They refer to the difficulties regarding the value of flexibility for users and states: *"We do not shape the market. That is not the position we have. At the end the clients has to want so."* After this project, the DSO wonders what the biggest gain would be in demand shifting at end users.

Relations in consortium

Originally the project consisted of 4 stages, yet the fourth stage was never executed. This was because the stakeholders did not see clear leads of developing a product in the short term and testing this in the project. Therefore the fourth stage was disregarded. According to the interviewees, the collaboration did not cause any problems, even though in this project everyone had their own goal in the project. The DSO thought this made sense, because every party had to learn something.

4.2.4 The ambassador project

In the ambassador project lessons were learned on the use of energy insight systems, users' involvement, a flexibility market and collaboration in the consortium.

Use of energy insight systems

Users used energy insight systems and this had an effect on energy saving. This effect can still be seen. However, the technical consultant argues that this is predominantly thanks to the replacement of electrical devices and new plugs as merely a small part of energy saving arises through the awareness on turning off lights. It took users some effort to develop the habit of using energy insight systems at the start. The technical consultant states that, only in the beginning, weekly updates were necessary and that otherwise people would forget to use the system.

The response fatigued over time, but this was not considered a problem. The app with a game in which you would increase a level when gaining more points (which you could gain by saving energy) had a temporary effect, although this differed per household. As such, responses do not depend on the motivation of a single person, but on the construction of households as well. In one example that is given by the technical consultant kids have been involved in the game and are turning off all surplus electrical devices. After a while, they become disinterested. This decreases the game's effect regardless of the parents' behaviour. The technical consultant also stated there was an "ambassador in each family", for instance when people noticed that their wife was using electricity on the wrong moments. In other cases, users admitted that sometimes the energy insight tools were not used anymore after only a month already. Yet, one of the users believed this is not something to worry about. He believes that after a while you know what devices do to your energy usage and can work from that insight itself. The tools have then served their purpose.

The data that came out of the energy insight tool and smart meters was not considered a problem by the users. However, one of the economic researchers believes that the experiences in this project may not be sufficient to solve the issue in the future. When the market is more developed and data is sent to commercial parties, users feel different about accessibility of their data. In order to solve this in the future, the researcher believes that users need to be financially compensated for this. A technical consultant also refers to the tension that arises between primary owners of the data gathering tool, the end users, and the one who is managing the infrastructure and who wants to gain the maximum value out of this data. Such parties also need to take into account privacy issues.

Users' involvement

Users' motivations

Also in this project users were biased towards sustainability, but appeared to be focusing on cost mostly. This caused some problems for collaboration between project partners and users.

Users had various motivations for joining the project. Before starting the project, a survey was conducted among the residents. Ultimately the people that subscribed for the project were people that indicated they found sustainability (one of) the most important issue in energy. Yet according to the technical consultant, using energy saving warnings that focused on sustainability issues did not spark as much behaviour response as the messages that focused on costs. Local energy usage and exchanging electricity with each other was also appealing to users. This is both stated by users of this project themselves and the technical consultant.

At the start of the project users had just incremental knowledge on their own energy usage. According to the technical consultant the users talked in the first meeting merely about the potential of energy saving for improved sustainability. This resulted in energy saving being a big topic among users.

> *"There was someone who measured how much his printer had used, and there he enthusiastically started to elaborate upon this and showed several graphs. Then in a next meeting all of the sudden people started to bring electricity bills and compare them. They found out in the case of two neighbours, one of them used the double amount of electricity, even though they had the same number of children. They were wondering: 'how is that possible?' Then they went on analysing that."*

The users' representative outlines that the motivation to save energy was predominantly fed by the motivation to save money: *"Don't be mistaken, there is an enormous amount of money saved by the group of users. (…) This, predominantly by saving energy. And also by collective buy-in of energy contracts."*

Users learned during their excursion to a washing machine factory, predominantly about how new products can reduce energy usage. One of the users connects this to his own solar panels, which are already 15 years old, and therefore are not very productive compared to the newer panels.

A problem in this project was that the users' focus on energy saving issues did not match with the goals of the project partners. The technical consultant stated that the users' focus was not so interesting for various parties in the consortium, and the final report also stated that more input was needed from users. Users responded indignantly on this:

> *"What was seen, the residents immediately acted on issues that were important for the residents, such as savings. But that could also be on water or gas. So we were working on a much broader scope than just electricity yes, they only thought of that as complicated."*

And:

> *"We were a really fun group who were doing fun things. And that was slightly separated from the rest of the project. We were given insights and we just worked on energy savings. We were a loose vehicle, we just went forward. There was so much discussion going on about who does what, whereas we were fully working on the project."*

As such, the users and project partners did not move closer together over time.

Technical complexities

Users found it at times difficult to keep up in the meetings with the project consortium, as the meetings were quite technical. This leads the user to the conclusion that the technical aspects were very complex in this system:

> *"So, I noticed that it was technically quite complicated. Of course you have to register a lot, who delivers its electricity to whom? That could raise some discussion. (…) And what I mean with complicated… Well, all the terminology that was used during such a meeting. Yes, that was a bit too far for me. I am not a technician myself, that is what I mean with technically complicated."*

This is noticeable, because the energy system in this project was largely based on the insight system and did not consist of any smart appliances and real technical difficulties. Despite such perceived complexities, the user wants to be the system somewhat more automatic: *"so that you do not have to think about it yourself."*

Future user involvement

This project has shown that it is possible to involve users and have an active participation. The technical consultant believes that as long as you approach users in the right way, the acceptance rate is very high. Also the DSO states that they have gotten insight in how to involve the consumer. The most important lessons the DSO takes along is to ensure a small group that is more involved (like the 10 ambassadors in this project). The DSO states that they have already experimented with giving a smaller group a more active role and that this worked well in other projects. The representative thinks working more with users *"is nice"* to become more well-known among citizens and sees it as a good way to work on a better relationship with clients. However, the DSO struggles with the knowledge levels of users: *"You can see that people think about it and they just don't know. That leads me to think that we certainly still have some work to do."*

The project did not continue after the subsidy. Users were disappointed that no continuation took place in any form.

> *"For instance, you want the results to be much more aggregated. But all these knowledge institutions had something like, we want this information thank you very much, and then we'll continue to work with that. We are a bottom-up organisation. And they are not used to that, they only think top-down. (…) They are more from a sort of company perspective who needs to do something for its subsidies and want to acquire that money, write a report about it and then it's done and they're done with it. That feeling of top-down, 'surgery successful, patient deceased, next project'. You can write that down."*

Business case of flexibility

Developing a business case out of the flexibility of refrigerators appeared not feasible, at least with this number of households participating. The economic researcher shares his insights:

> *"What it would deliver was about 20 Euro per household. But if you want to organise this as a commercial company, the investments need to be returned from these 20 Euros as well. Besides, 20 Euros is only about 1% of the average yearly energy bill, whereas participating in flexibility should be financially rewarded. (…) Yes, I expected this number to be more."*

The economic researcher sees some potential for the future, when energy demand is higher due to electrification and supply is less predictable with more wind energy. The potential for demand shifting is seen by the DSO as well, but they continue to see demand shifting as temporary. The DSO states that demand shifting is still under research and it largely depends on which regulations are going to change. The DSO struggles with how the market will develop, as this is not a field of expertise within the DSO.

According to the economic researcher, the consortium did not present the results of the project objectively. The disappointing results of the flexibility business case have not been taken up as lessons learned. Instead, portrayed mostly are the positive achievements in this project. The researcher has seen various smart grid pilot projects who conducted similar studies, leading him to state: *"If you achieved adequate learning from this project, which could be done because the study had clear results, you don't have to set up all these other projects. (…) You save money on not executing other projects."* No other parties have stated such findings.

Relations in consortium

In this project the collaboration was not comfortable as the goals between project partners differed too much, a feeling that is shared by multiple parties. The DSO stated for instance: *"It was not really possible to make proper arrangements in such a collaboration because there were so many parties and everyone wanted something else."* For the DSO the reasons for the uncomfortable relations were unclear as various speculations are given: maybe the long-term goals were not well established for this project or maybe having different goals have inherent difficulties. The representative also believed that the goals that other parties had were changing over time, which resulted in them taking up a different role. At times, the DSO states, it felt like the overarching goal was to just finish the project and get their subsidies. As a result she was wondering whether it would be better to conduct research organised by themselves. The economic researcher refers to the *"sub-goals"* within such a group and that everyone has the mindset of *"what is in it for me"*, though he explicitly stated that this is not applicable for the technical consultant as they worked very hard on this project. Overall, the researcher believed that the project managers, including the subsidy providers, created a reporting regime rather than facilitating *"a creative exchange of information."*

4.3 Discussion and conclusions

In all of the projects, lessons have been learned on user involvement and on technical aspects. Moreover, in most of the projects some lessons have been learned on the use of energy insight tools, on collaboration in the pilot projects and on the value of flexibility.

After these projects the conclusion is drawn by various stakeholders that user involvement is important. This, even in the project that started off with a technological approach. However, the technical consultant still sees users as future clients and possibly supporting market introduction of a product. The DSOs have followed up on their ambition to interact with users, and envision an improved relationship with them.

Stakeholders mean to continue involving users in future projects, in the same way as they have in these projects (thus, via intermediaries). The DSO has already used the same methods of user involvement in other project, with positive results. In only one project the DSO still believes that user involvement is difficult to achieve.

Users are mostly motivated to join projects by an interest in energy issues. An interest in energy is often motivated by sustainability arguments. They are also mostly motivated by energy saving measures in the project, rather than demand shifting. Stakeholders have demonstrated worries about the transition to involving the group of users that is not intrinsically motivated by energy issues.

When projects are finished users have been left behind, causing feelings of disappointment and frustration. Apps were not working anymore, knowledge gained by the project was not disseminated to users and partners just left. This did not match the users' expectations of getting a smart grid or at least gaining something out of the project.

The used energy insight systems were evaluated by the users as useful and were mostly used to realise energy savings, equalling one projects' expectation of about a 15% energy reduction. Especially the possibility to gain real-time insight was deemed important. The decrease in using energy insight tools was not considered a problem or something that should be addressed in future pilots. Especially in the ambassador project the decrease in use is attributed to the increase of insight into the energy system. Thus after a while users know what happens to their electricity usage when they turn a light on or off and this lowers the need for the insight tools.

In two of the projects the different goals of consortium partners did not impede collaboration and in two project the difference in project goals was considered troublesome. It is not entirely clear why the difference in goals between consortium partners gave no troubles in some projects and did cause troubles in others. Despite the troubles in collaboration, stakeholders still stated that they have learned from the project, although in one case it did lead to doubts whether a project like this is useful for future endeavours.

The role of the DSO was critically reflected upon: the technical consultant focuses on the (lacking) IT competencies of the DSO and also the DSO themselves focus on their lacking experience with market development and user relationships. After these projects it is still uncertain what the role of the DSO will be in the future. So far it can be concluded that the DSOs are waiting for new legislation and the market to develop.

So far no business case can be developed out of flexibility and demand shifting. However, according to various parties there is still potential for business cases in the future, as wind and solar energy become more dominant and the energy demand rises.

Even though the projects differ enormously in energy system, user involvement and project partners, there are few project-specific lessons. Lessons are somewhat shared between the projects. This may have several reasons. Firstly, issues in collaboration and sometimes lack of alignment in project goals may have reduced the extent to which learning was facilitated. In such cases little real interaction took place. In such environments, especially technical lessons have been learned within organisations themselves. Secondly, complexity may have reduced the extent of learning, as it creates distance between project partners. DSOs may have less understanding of IT components and another understanding of

the grid than the technical consultant. There was also distance between consortium partners and users, as users could not keep up with the consortium partners in meetings or where not involved in the technical aspects of the pilot project. Users also came from one step back as they had little knowledge on energy usage and firstly focused on energy saving. Project- and context-specific lessons on demand shifting have not been learned yet for this reason.

Learning in the projects has influenced stakeholders' ideas about smart grids. Technical partners have learned that users should be involved in smart grid pilot projects, although the specific role of users is still unspecified. Both energy saving and demand shifting has been achieved, yet the potential of demand shifting is still unsure due to the difficulties of reaching user groups that are not interested in energy and the current unfeasibility of a flexibility market.

CHAPTER 5: KNOWLEDGE FLOWS

5.1 Introduction

After evaluating the lessons learned, it is important to know what lessons are impacting developments elsewhere and whether knowledge aggregation takes place. If knowledge aggregation takes place, new rules are formed that determine future development of the smart grid niche. It is therefore investigated what knowledge enters the projects and what knowledge disseminates from them. In this way, we can understand what topics in the niche are developed and remain underdeveloped. In addition, by considering the carriers of knowledge, we can understand where knowledge comes from, where it is headed and whether knowledge aggregation takes place. In this way, we can understand how the projects influence the development of smart grids and provide an answer to the research question: *What knowledge flows in and out the projects and what knowledge is aggregated?*

Knowledge flows are visualized for each project. Some in- and output are not very tangible to be recognizes as knowledge flows based on learning experiences. They are still described, to the extent that they have been mentioned by the interviewees. It is important to note that the account of knowledge flows is not complete. It is likely that all project partners and actors that participate in the project have both taken along additional lessons to the project, and taken additional lessons out of the project to other places.

5.2 Knowledge flows around the projects

5.2.1 The energy cooperative project

The energy cooperative project has no tangible knowledge streams that enter the project, but has several knowledge exchanges with other projects. The cooperative still disseminates results. An overview of the knowledge flows is depicted in figure 6.

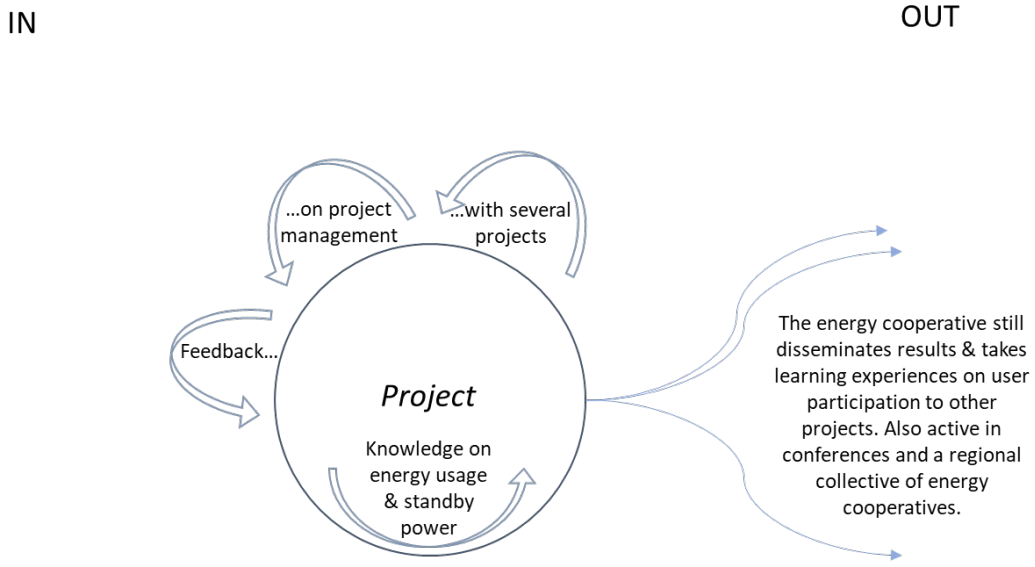

Figure 6: knowledge flows in, out and around the energy cooperative project.

The energy cooperative project has various knowledge exchanges with other projects that run in the Netherlands, who provide feedback on project management. One of these projects had a wind turbine and another project also had an energy cooperative in charge. Project managers also visited events on domestic renewable energy, such as those from the national network of energy cooperatives, in which they came into contact with other projects and cooperatives. There was also contact with the HEMS project discussed in this report. One of the working groups on energy usage went to visit a smart grid

pilot project in another city: *"They have a demonstration plot there. They also visited that and got devices. They really liked that. We really went on an excursion there."*

The cooperative still disseminates results in several ways to a wide range of actors. The project leader describes that their project and energy cooperative is seen as successful and is described in scientific literature. As a result, to this day it attracts people that want to know more about the project, such as scientists and energy actors. The citizen cooperative is also a member of a regional collective of local energy cooperatives, which was founded in 2016. As such, it is still sharing lessons learnt with the wider society.

5.2.2 The HEMS project

Many lessons concerning technical aspects that were learned in the first phase, were taken along to the second phase of the project. In this phase, the project focused more on users, as described in section 4.2.2. A complete overview of the knowledge flows can be found in figure 7.

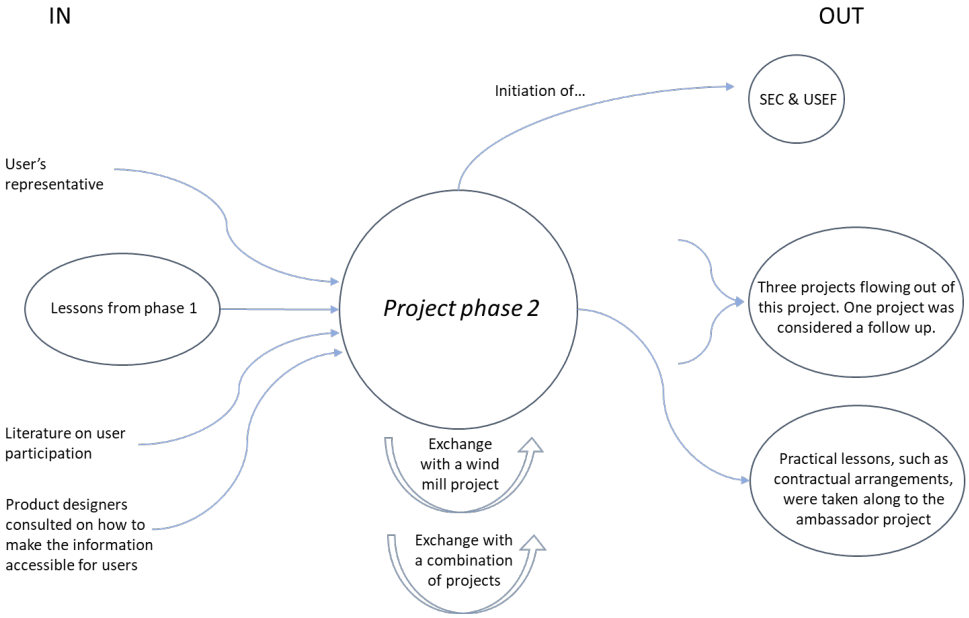

Figure 7: knowledge flows in, out and around the HEMS project.

As shown in figure 7, various knowledge flows enter the HEMS project. These focus mostly on user participation. The first, and largest, knowledge flow came from the first phase of the project, which taught stakeholders that users should be given insight into the system. Project leaders followed up on that realization in the second phase of the project. To find out what residents wanted, several knowledge sources were addressed. Workshops were held to find out what people needed to gain insight in the system. Student groups were reigned in to analyse the topic. A tender proposal was written to attract ICT specialists, who could make information more accessible to users. In order to gain insight into users' wishes for the product, a professor in sociology was approached as a social consultant for the project. As the social consultant lived in the project area, he became a users' representative. As such, stakeholders in the project investigated what people wanted from the project, in various ways. They also consulted other sources to validate their own findings. A social researcher found that literature gave two main approaches on changing user behaviour. Another project, that ran in the same period of time as this project, concluded similarly.

Knowledge exchanges occurred with a parallel running project, which was actually a combination of several projects, and the project that had a wind mill (which was mentioned as well in section 5.2.2). Firstly, The DSO's representative in the combined project shared a particular project document, which contained requirements of the information interface that users saw. The DSO also visited this project, to share stories and experience and to showcase what they were working on. One of the social researchers visited the parallel project as well. She looked at one of the resident demonstrations. Secondly, the wind mill project also made use of a home energy management system. In contrast to the HEMS project

(which started from a technical perspective and tried to incorporate user perspectives later), the wind mill project was designed from a user perspective. One of the examples that the technical consultant learned from this exchange, is that it is not necessary to provide an end-solution.

> *"What it taught me is that it is possible to set up simple services which are a step in the good direction. That is not the ultimate solution, but it is a step forward and simple in such a way that the user understands what is happening. Turning on your washing machine when it is sunny, everyone understands that that is useful. It is tricky that they have wind mills there, that is confusing. In this way people can understand better and better how the system works and are able to connect the dots."*

With regard to knowledge exchanges, the social researcher indicated that the community that is working on smart grid pilot projects is not particularly large, so that many people share certain lessons. These lessons are not specifically on the energy system, as the technical aspects can be quite different per project. Rather, the lessons are more general on project management and installation practices.

Several knowledge flows leave the project, which consider practical lessons but also follow up projects and the founding of collective organisations. The technical consultant describes the first phase of this project as a project that opened up people's eyes, showing "that the world is changing". In this phase, he set up organizations and large-scale pilots to ensure that this project was able to scale up. This resulted in the Smart Energy Collective (SEC). The technical consultant stated that the SEC had no direct correspondence with this project, but that lessons learned are "self-evidently" taken along. Via the SEC, three more projects have been set up, that used knowledge about the HEMS and barriers for upscaling from this project. One of these follow up projects consisted of 200 households and remote-controlled electrical boilers, heat pumps and solar panels. Although it is considered as a direct follow up project, the name is different because of the incorporation of some new project partners. The setup of the project also provided the basis for another organization that came into existence during the second phase of this project. This was the Universal Smart Energy Framework (USEF). The framework sets out the rules to make a flexibility market work. The goal is to standardize such rules, so that future products are developed according to this framework. Lastly, the lesson that users should be involved partly resulted in the ambassador project, as is stated by the technical consultant:

> *"Of course, you take lessons from this project along to the next pilot. That is how the ambassador project, as what was seen was that the first phase of this project was rather technical. Let us first demonstrate that this is jointly achievable at households."*

In addition, lessons on contractual arrangements were taken along to this project.

5.2.3 The apartment building project

The apartment building complex had one information stream entering the project and no direct knowledge exchanges with other projects. Results are disseminated by both the social consultant and the DSO. An overview of all knowledge flows is shown in figure 8.

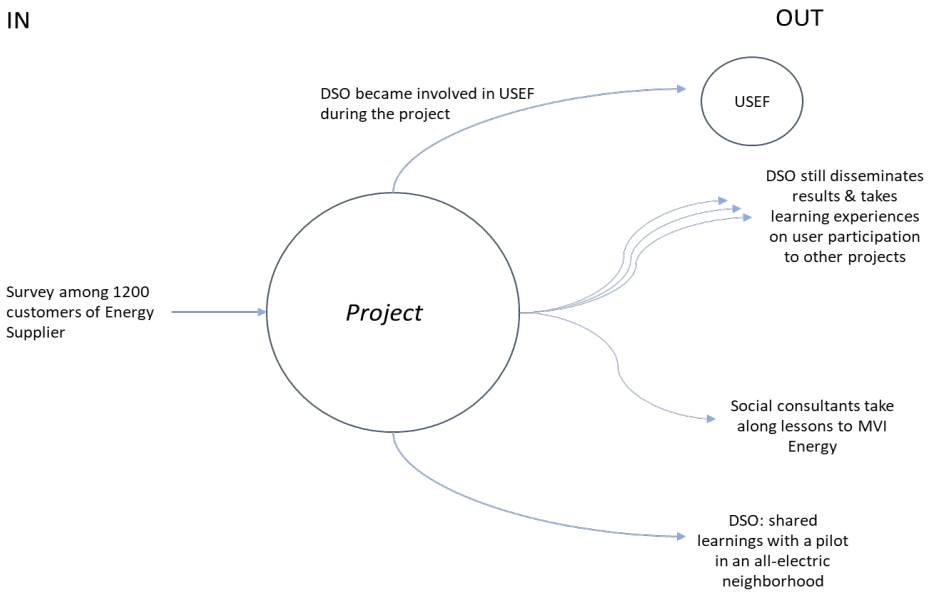

Figure 8: knowledge flows in, out and around the apartment building project.

Only one knowledge stream entered the project: the survey conducted among the clients of the energy supplier. This provided insight in the financial motivations for users to join in demand shifting. The social consultant who joined the project, was responsible for getting users involved but has not been shown to bring any concrete knowledge on user participation in this project.

Various knowledge flows left the project. Firstly, the social consultant, who worked on gaining information about users' motivation to get involved, takes these lessons along to governmental institutions for which she works as well: a domain of Topsector Energy called *Societal Responsible Innovating Energy* (in Dutch: MVI Energie). Secondly, the DSO states that they still get inquiries on these results and lessons learned. In this way lessons on technical aspects are still disseminated. The DSO was also involved in a pilot that ran in an all-electric neighbourhood. Despite the large differences between the all-electric project and the apartment building project, the DSO states that learnings between these two projects are *"certainly taken along"* within the DSO. Lastly, USEF started approximately halfway during the project and the DSO involved in this project joined USEF as well.

The lessons learned of this project have not contributed significantly to the further development of the PowerMatcher, because the PowerMatcher's system was handed over to the Flexiblepower Alliance Network (FAN). At the FAN, the system became an open source product, so it is possible for multiple actors to keep developing the product. The DSO involved in this project is also a member of FAN.

5.2.4 The ambassador project

An overview of the knowledge flows in the ambassador project is shown in figure 9.

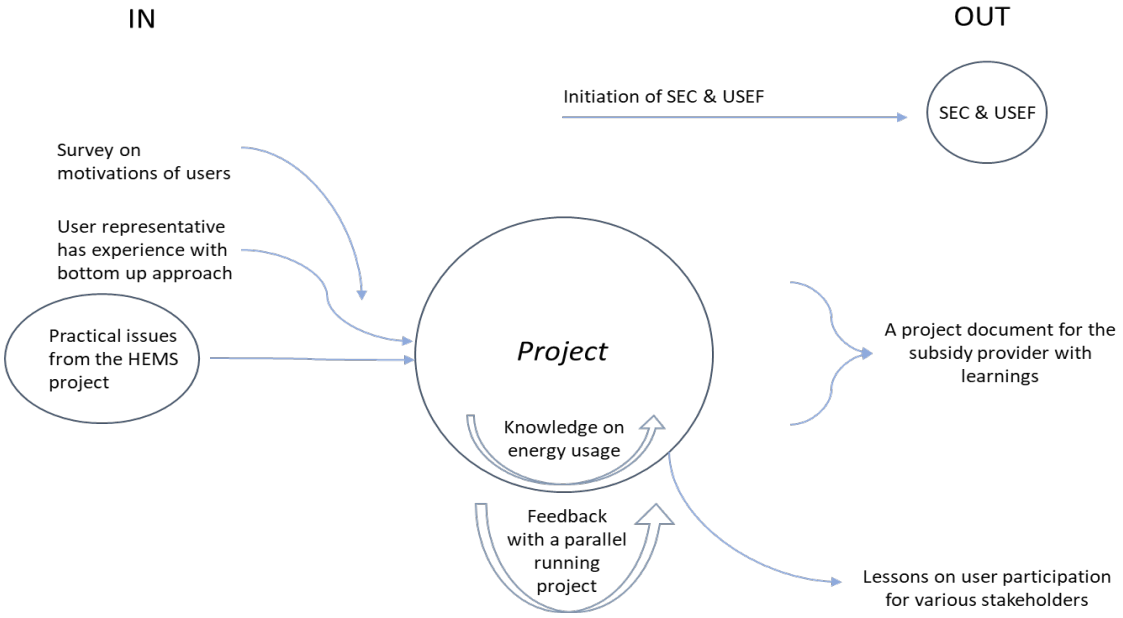

Figure 9: knowledge flows in, out and around the ambassador project.

The ambassador project has several knowledge flows that enter the project. First of all, the HEMS project was important knowledge input into this project. This, because the same technical consultant was involved within the project. Practical lessons were taken along by the project leaders, among others about contractual arrangements and the services offered to users (the sustainable and cost-saving propositions). The second knowledge inflow came from the users' representative who was asked to provide knowledge on users' participation and relations, because of his engagement on glass fibre installations in the neighbourhood. As such, his experience was an important contribution to the design of the project. Before the start of the project, a survey was conducted in the neighbourhood to learn more about the user preferences, values and wishes. Among survey respondents there were also citizens who did not subscribe for the project.

Knowledge exchange occurred within the project and in contact with a parallel running project (in a different city). The first, within the project, came from users themselves. During the project's resident meetings, it became clear that there was already much knowledge about energy usage and saving was prevalent among users. As such, users were responsible for knowledge dissemination within the project.

A parallel running project, which was conducted in a different city, was a source of feedback and knowledge exchange. The parallel running project had a slightly different scope, different approach to residents and some different project partners, but knowledge exchange was conducted on the price incentives that should be given to stimulate behaviour change in energy usage. In the other city for instance, barely any effect in behaviour was seen. This taught project managers that more extreme values in price incentives should be taken, to determine when an effect was shown.

A range of knowledge streams flow out of the project. Firstly, the DSO and the technical consultant both joined the SEC and USEF. Another knowledge stream runs through the DSO and covers user participation. Even though the DSO was not much involved with users in this project, it has still learnt on user participation. Lessons they have learnt are taken along to other projects they are currently conducting.

> *"We are trying to bring it together. Most of the pilots run via our team. In that way we really try to be in contact with each other or ensure that experiences are being shared with each other. So that aspects that did not go well are not happening again in another project."*

Lastly, according to the economic researcher, the lessons on what did not go well were barely taken into consideration in the final evaluation report. The specifics of these lessons and how these lessons were dealt with are further elaborated upon in the next chapter.

5.3 Conclusion

In 4 smart grid pilot projects the amount of knowledge streams varies largely, for instance when looking at the difference between the apartment building project and the HEMS project.

Knowledge on user aspects that enters the project is gathered mostly by attracting people with specific expertise, such as social consultants or representatives. Especially in the HEMS project and the apartment building project this is visible, because these projects had a technological approach. Some consultants (or social researchers) also consulted literature on participatory processes. In addition to the social consultants, users' representatives provide insights into users' motivation and needs. Knowledge that entered the project was also gathered via surveys (e.g. the apartment building project) or commissioned research (e.g. the HEMS project). This was mostly on the motivations of users to engage in the project or to develop (economic) propositions.

Most projects also share knowledge with each other. This does not usually happen through organized central meetings, but appears to be a matter of personal initiatives that are taken. According to several scholars, the HEMS project can partially attribute its relative success to such knowledge exchanges (Naber, Raven, Kouw, & Dassen, 2017). At times, knowledge appeared to be already available within the projects. This was especially visible when users interacted on energy usage and energy saving measures, such as in the energy cooperative project and the ambassador project.

Knowledge that is disseminated by the stakeholders considers mostly on user involvement. Technical lessons are not shared much, which might be because technical energy systems can be quite specific. However, an important role may lie ahead for the Smart Energy Collective and the Universal Smart Energy Framework as it aims to standardize the smart grid market.

Aggregation of knowledge streams that flow out of the project happens via research documents or collective meetings, such as IPIN documents or to other subsidy providers. The IPIN documents cover technical lessons, but also on user involvement. In such documents user involvement is seen as a matter of culture change and should be embedded in project organization. They focus on users' needs, but they still see users as future clients and share communication techniques for influencing (RVO, 2015a). However, most of the knowledge streams run via single persons or organizations. This is actually similar to both the knowledge entering the project and the mutual knowledge exchange.

The point that knowledge runs via single persons or organizations results in an important role in knowledge dissemination for those that are involved in a plurality of projects, mostly the DSOs and technical consultants. Lessons that run through such institutions seem to be evaluated and picked up internally. Economic and social researchers and consultants are not involved in more projects, meaning that they are less dominant in future smart grid development. Although (among others) DSOs and technical consultants take lessons on user participation along to other projects, users themselves stay in one project and therefore, users' experiences are not taken along to other projects without effort.

CHAPTER 6: CONCLUSIONS

This research and its conclusions concern 4 Dutch smart grid projects that ran between 2012 and 2015. Semi-structured interviews were conducted in order to get to answer the research questions regarding learning about user engagement. The case studies that differed largely in energy systems and social networks, provide a broad range of knowledge. The projects finished a couple of years ago, in which they were the first projects in which users were involved. This means that the experiences described are not necessarily representative for more recent smart grid projects. In addition, a clear recollection of data, events and memories was hindered at times due to the time that past. However, we interviewed the stakeholders recently, meaning that actual experiences informed their answers as well as the experiences in the early projects. Moreover, our findings are in line with some important literature studies (Naber, Raven, Kouw, & Dassen, 2017; Geelen, Reinders, & Keyson, 2013).

6.1 Conclusions

The 4 pilot projects have provided new experiences to a range of stakeholders, such as DSOs, research institutions, technical consultancies (and more) and users themselves. These experiences can have a significant influence on the future development of smart grids. This report answers the research question: *What are the main learning experiences in (in a selection of) Dutch pilot projects, especially on user aspects, and what does this mean for the development of the smart grid niche?*

The main learning experiences consider the involvement of users, the use of energy insight tools by users, the flexibility market, and the differences in project goals between users and consortium.

Stakeholders in different projects have drawn the same conclusion that user involvement is important and feasible. Stakeholders such as the technical consultant and economic researchers see the potential of user involvement and have already experimented with this in new pilot projects. This leads to a new 'rule' that technology-push approach is best not to be used. It is thus likely that users will continue to have an influence in smart grid development. However, ideas on how and why users should be involved have not become further specified. So far, user involvement takes place mainly via intermediaries.

In 3 projects users gained insight in their energy use via insight tools or the HEMS, sometimes in combination with working groups. Users found real-time data especially valuable. Some of the users stopped using their tools after a period of time, for which they gave the reason that they 'knew what was going on'. Essentially, they had gained the desired insight. As such, this indicates a phase of 'saturation' rather than the 'response fatigue' some other scholars speak about (Kessels *et al.,* 2016).

One of the integrative learnings is that flexibility is not yet a feasible business case. However, various stakeholders (such as the DSO and technical and economic consultants) see potential for the future when the proportion of electric vehicles increases and the number of solar panels rises.

The priorities of users and stakeholders do not necessarily align. Whereas demand shifting appears to be most important to corporate stakeholders, energy saving is more important to users. In at least one project, this caused tension between the groups.

The importance of user involvement is recognized and they are more consulted for the development of smart grids. However, lessons learned by stakeholders involved in multiple projects, such as those from the DSO, technical consultants and SEPS suppliers/developers, are more influential than those of stakeholders that are involved in one project, such as users or social consultants. In addition, users are often left behind after the end of the project. Therefore, those stakeholders playing a role in standardizing of future smart grid frameworks should ensure that users' experiences should be guaranteed.

Lastly, various stakeholders have showcased their concern for including a wider group of users in smart grid projects: a large group that appears not to be interested in energy issues, but that is important for the transition to sustainable energy. These 4 projects have provided no knowledge on how to include this group.

6.2 Recommendations

Firstly, we recommend to actively involve residents in pilot projects to learn more about user involvement and the positive and negative consequences of various roles and levels of engagement. Continuing to develop just projects focussing on demand shifting or energy saving, and involving users only via intermediaries, would limit the ability to make informed decisions about the future energy system.

Secondly, to gain knowledge on how to include users that are not interested in sustainability issues, we recommend setting up projects with different levels of user involvement to include all user groups.

Thirdly, to tackle feelings of abandonment participants experienced after the end of the project, we recommend ensuring project continuation in some form.

Lastly, it is important to ensure that users' experiences are taken along, preferably based upon users' own experiences rather than corporate stakeholders' experiences with user involvement. We emphasize that this is especially important when standardizing generic frameworks.

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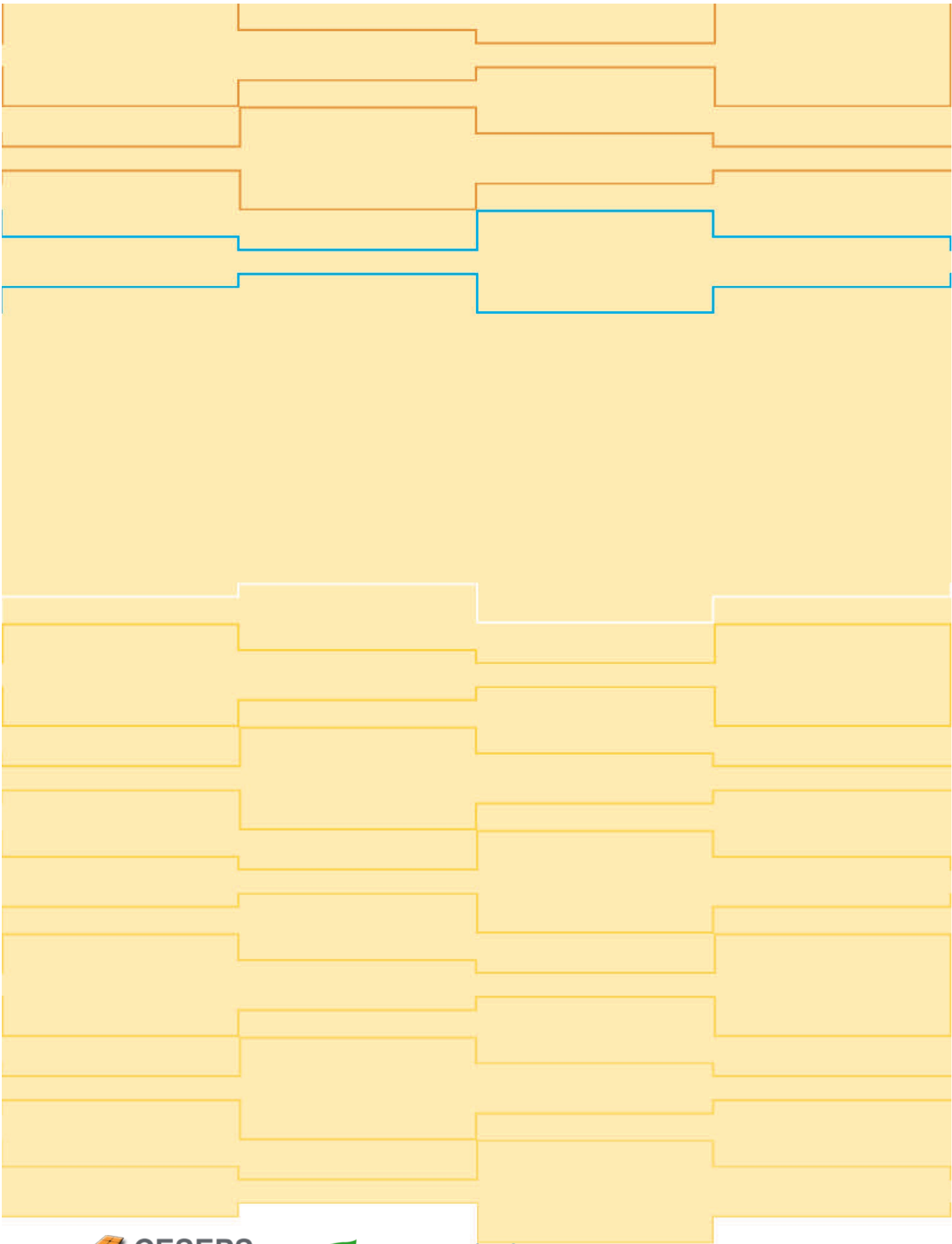

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