Residential smart grid projects in the Netherlands: An overview of energy systems and stakeholders' and users' involvement

Authors: Hilde Brouwers, Barbara Mierlo

Twente: CESEPS/ Wageningen: Wageningen University and Research

22 February 2019

Residential smart grid projects in the Netherlands: an overview of energy systems and stakeholders' and users' involvement

Hilde Brouwers and Barbara van Mierlo

Twente: CESEPS/ Wageningen: Wageningen University and Research, Knowledge, Technology and Innovation

22 February 2019

Acknowledgement
This project received funding from the European Union's Horizon 2020 research and innovation programme under the ERA-Net Smart Grids plus grant agreement No 646039, from the Netherlands Organisation for Scientific Research (NWO) and from BMVIT/BMWFW under the Energy der Zukunft programme.

Table of Contents

List of Figures

List of Tables

1. Introduction

An active involvement of residential users is often seen as key to a successful development of smart grids in the housing sector. For this reason, energy companies and policy institutions are developing methods to involve the residents. The European Commission for instance pursues a so-named user-centric approach, involving an increased interest in electricity market opportunities, value added services, flexible demand for energy, lower prices, and microgeneration opportunities (European Smart Grids Technology Platform, 2006). Also scholars emphasize the importance of an active engagement of users, among others by stating that they should be "an empowered part of the system" (Obinna, Assessing residential Smart Grid pilot projects, products and services: Insights from stakeholders, end-users from a design perspective., 2017).

The existing smart grid pilot projects in residential areas are a rich source of information regarding the responses and experiences of users as well as their relationships with the various other stakeholders. In this document, we provide an overview of key characteristics of these residential projects in the Netherlands. In this country user aspects have received special attention since the IPIN (Innovation Programme Intelligent Networks) policy programme, which is why we expect them to be actively involved in the projects in a variety of ways.

The key characteristics of the Dutch residential smart grids projects have been identified by exploring the project documentation provided on websites and professional journals; they seemed to be rather well documented thanks to the policy programmes. We selected only the larger projects with 15 households or more as the smaller ones tend to be merely technical experiments rather than socio-technical pilot projects. The information about 31 projects is presented in this report in the following order:

- General features regarding years of implementation, location and size,
- A description of the features of the smart grid systems,
- The stakeholders involved in the projects and as far as known, their roles,
- Characteristics of the users' engagement in the projects.

The appendix provides an overview of all the projects.

2. General features Dutch residential smart grid projects

In total, 31 residential smart grid projects with 15 residents or more have been implemented in the Netherlands. For an overview of their locations and size see appendix 1. As shown in figure 1, the smart grid projects are distributed all over the country, apart from the southern provinces Zeeland and Limburg and the Northern province Friesland.

Figure 1: Location of the larger residential smart grid pilot projects.

As shown in figure 2, 8 projects started in 2012. These were all IPIN projects that ran for three years. This may have caused a slight decrease in new pilot projects after 2012, with just 2 projects starting in 2013 and no projects starting in 2014. In recent years this number is rising again, with 5 in 2016 and 7 in 2017. A large number of the projects (84%) is finished. Whether this also means that the smart grid elements of the energy systems have been removed is not known for all cases.

The pilot projects do not exhibit a preference for the duration of the project, as there is an equal number of projects that run for one or two years as projects that have longer running times. Some projects have not indicated an end date at all, especially the ones that have recently started or are in preparation. For instance, in the project Schoonschip residents are building a sustainable new district of Amsterdam, with many smart grid features. Another project does not have an end date because it just started testing its home energy management system, for instance the project Lyv Smart Living.

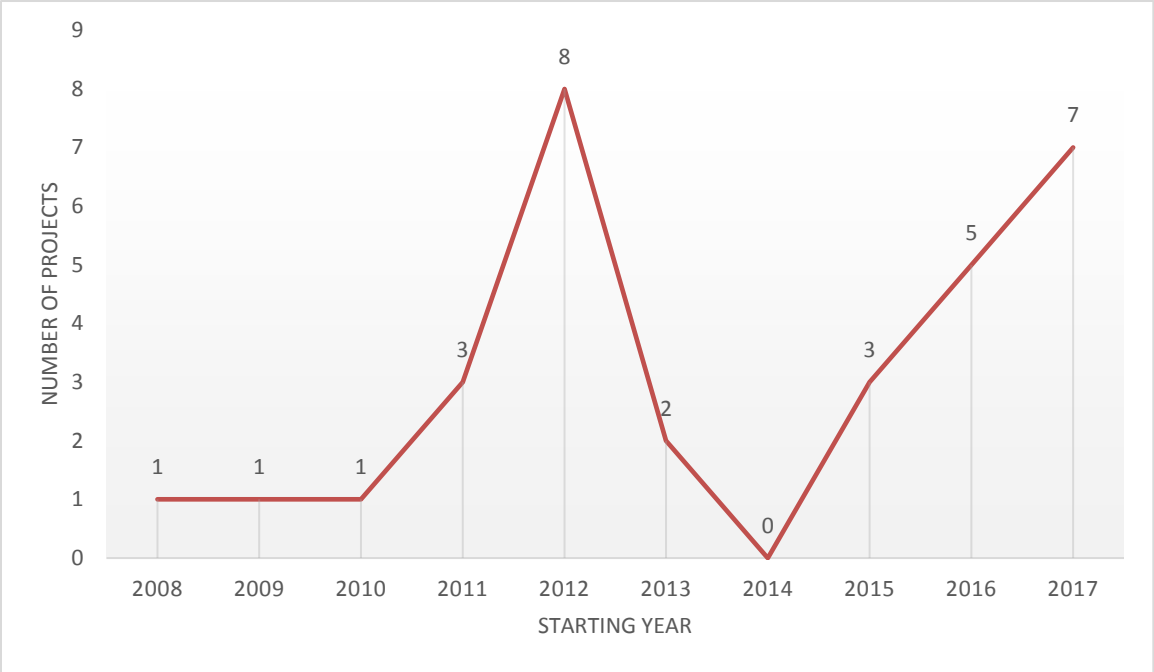

Figure 2: Number of smart grid pilot projects starting per year.

As mentioned this report includes only projects with a minimum participation rate of 15 households. Yet the number of households that participate in the projects varies considerable (see Appendix 1). As figure 3 shows, the smallest project has[1] a number of 17 participating households, which is followed by a project consisting of 22 households. More than half of the projects (59%) have between 26 and 250 participating households. Around 17% of the projects have a number of households that fall between 251 and 500 households and another 17% of the projects have over 500 participating households.

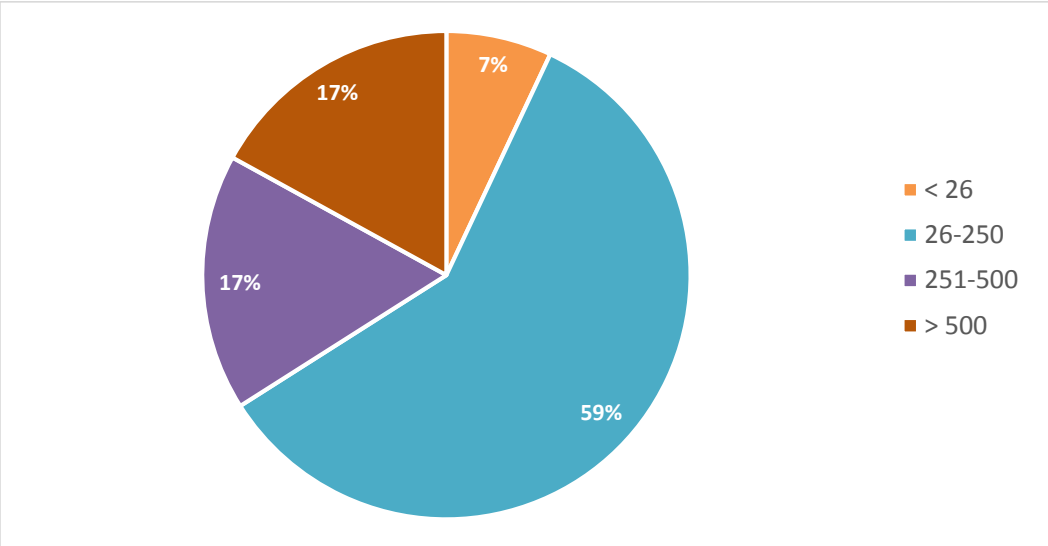

Figure 3: Number of participating households.

Several projects are growing, for instance the project Lyv Smart Lyving, which tests a home energy management and aims to scale up in the future, and EnergySense, which runs throughout the entire country and has the intention to keep growing in number of households. In Rijsenhout, 35 households started with a local pilot project and it is expected that another 550 households will become involved. The type of houses is often quite unknown, but it seems that in a significant number of known cases the participating households are living in rental houses. This may well be related to the high number of housing cooperatives, which are involved in 9 projects (30%). This is further elaborated upon in section 3.

[1] Although several projects have ended, we write this report in the present tense.

3. Smart energy systems

3.1 Renewable energy technologies

Of the 29 residential projects that provide information on the use of renewable energy technologies, the majority of the projects (87%) makes use of renewable energy. Hereafter, 22 projects (76%) provide information on which technologies are used. This information is depicted in the graph in figure 4. It is important to note that some residents have access to renewable energy via multiple sources, which is why the sum of all options that are shown in figure 4 is more than the number of cases that are considered. In 13% of the cases it was mentioned that the use of renewable energy was not mandatory, although households were free to choose from all options. As no information was given on which technologies were chosen, these cases are not taken into account in figure 4. Hybrid heat pumps have not explicitly been seen in these pilot projects.

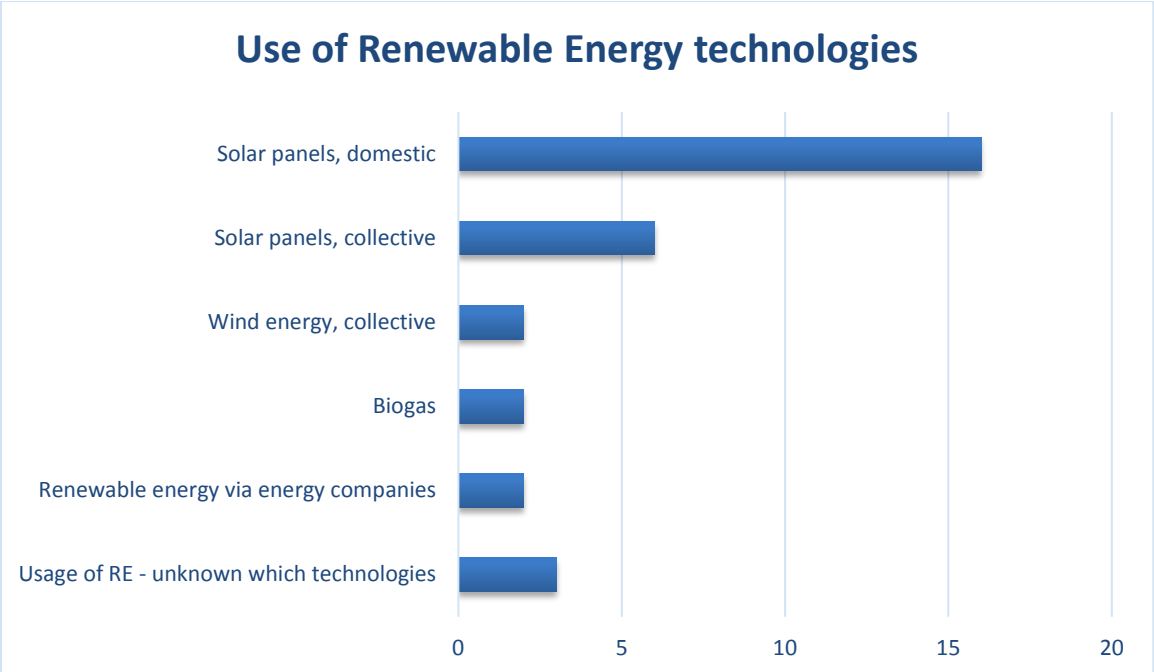

Figure 4: Applied energy technologies in smart grid projects.

As shown in the figure, domestic solar panels is the dominant technology used, by 73% of the projects that provide information. Cases in which residents make use of domestic solar panels, vary in ownership of these panels. The most obvious option, that the domestic solar panels are privately owned by the residents, has been confirmed in only 9 of the 16 cases. In Heijplaat, the housing corporation Woonbron has bought the domestic solar panels. In most other cases information on the ownership of the domestic solar panels was not provided. In the case of PowerMatching City all residents have their own solar panels, while they can share the generated electricity.

Solar parks are present in 6 projects: Intelligent Network Zeewolde, Cloud Power Texel, Together Smart with Energy, Returns For Everybody (location Utrecht) and Smart Grid Lochem. The project Gridflex Heeten is currently building a solar panel park. In Heeten and Smart Grid Lochem solar parks are combined with private solar panels. In 5 cases, it is verified that the solar panel parks are owned by citizen energy corporations.

Three projects make use of local wind energy production. These are Intelligent Network Zeewolde and i-Balance in Hooghalen. In Zeewolde, the wind park has been developed by the local citizen cooperation (Zeenergie), with the help of the municipality, the province of Flevoland and other parties. In Hooghalen, the company RWE Wind was interested in practical research around wind turbines and therefore supplied and financed this technology. Wind energy played a role in more than just these 2 cases as in 2 other projects wind energy was bought via regular energy companies, although it is possible that this happened in more cases.

Biogas is applied in the pilot projects Intelligent Network Zeewolde and MeppelEnergy for electricity use at moments without no wind or solar energy. The biomass required for biogas production was delivered via, for instance, farms.

Not in all smart grid pilot projects renewable energy is produced locally. In some projects, residents were not required to purchase their own renewable energy technologies, but for sustainability purposes they got green energy via energy companies.

3.2 Storage technologies

Of the 25 cases that provided information on the use of storage technologies, 56% of the projects incorporated such technologies in the energy systems (see figure 5). In the remaining 44% it was indicated that no storage technologies were used.

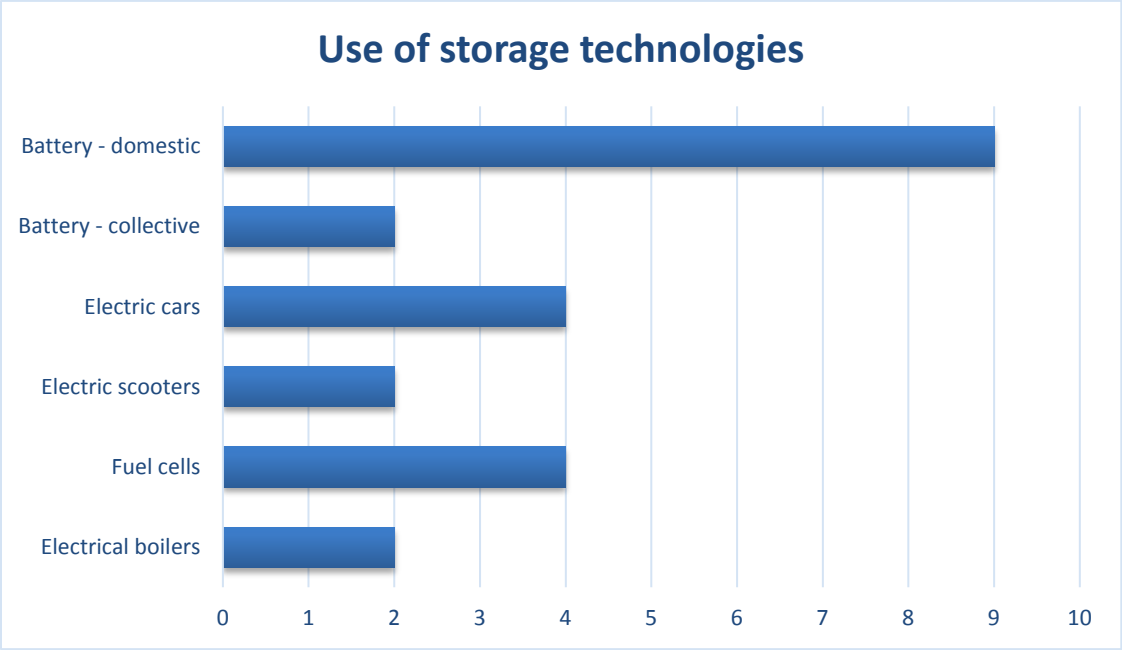

Figure 5: Applied storage technologies.

Domestic batteries are used most often, in 64% of the projects with storage technologies, for instance in Your Energy Moment 2.0 (location Breda), PowerMatching City and City-Zen. Two projects, Collective Battery Rijsenhout and Your Energy Moment 2.0 (location Etten-Leur), make use of collective batteries. Excess domestic solar energy is stored in the collective battery and can be accessed by all residents. Electric cars are in 4 cases used as a technology for storage, which are the projects i-Balance, Returns For Everybody, Smart Grid Lochem and Gridflex Heeten. In Returns For Everybody and Smart Grid Lochem the cars are shared by some residents, in the other projects this is not clear. There are also 2 projects with electric scooters: PowerMatching City and PowerMatching City 2.0. The scooters in these projects have a chip that allows them to charge intelligibly, making them a smart appliance as well. Not necessarily all residents involved in these projects are users of these electric vehicles.

Fuel cells are used in 4 projects, although not necessarily in all involved households. In EnergieKoplopers 1 and EnergieKoplopers 2 only 5 households were equipped with fuel cells. In these cases, the technology was tested rather than examined on its effect on demand shifting. Interestingly, in one pilot nine virtual fuel cells were used. Little information is given on experiences with such cells.

In 2 projects, electrical boilers have been encountered as a storage technology, mainly with the idea that water can be boiled during the day and hot water can be used in the evening or at night.

From the 8 cases in which the ownership of the storage technologies are clear, it generally seems that suppliers maintain ownership of the technologies. For instance in Smart Grid Lochem the electric vehicles were supplied by the DSO, as they wanted to test the effect on the grid. As a consequence, these devices are either removed or have to be “taken over” by the residents at the end of projects. In the project EnergieKoplopers the grid operator Alliander for instance removed the electric boiler while the heat pump could be taken over at the end of the project. In 2 projects, it was clear that the participating

residents owned the storage technologies. In both of these projects this concerns the electric car as storage technology.

3.3 Smart appliances

Of the 28 cases that provide information on smart appliances, 57% makes use of such technologies. In the majority of the projects more than 1 smart appliance is applied. Of the projects that provide information on the number of smart appliances that is used (12), 33% of the projects made use of 1 smart appliance, 50% made use of 2 or 3 smart appliances, and 17% made use of more than 3 smart appliances. For instance, Smart Grids Brabant merely made use of smart heat pumps, whereas PowerMatchingCity 2 and Hoog Dalem All Electric made use of three kinds of appliances: smart washing machines, smart dish washers and smart heat pumps.

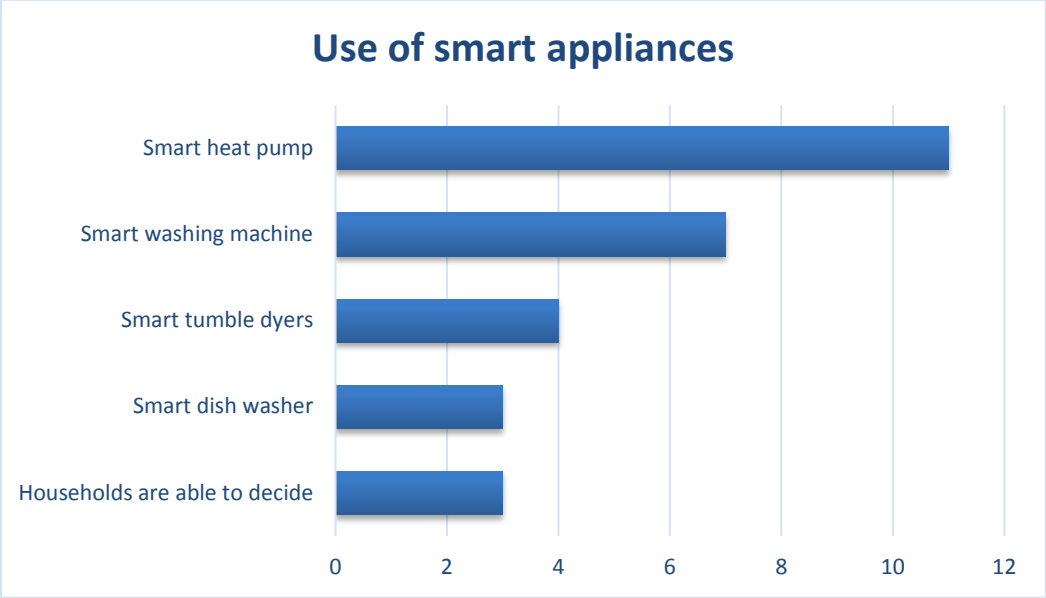

Figure 5: Applied smart appliances.

Overall, smart heat pumps were mostly used by projects (see figure 5). Smart washing machines, tumble dryers, freezers or refrigerators and cooking devices are also used, but less widely spread in the projects.

A total of 3 projects allowed their participants to choose between different options of smart appliances, hence in 20% of the projects that use smart appliances, participating households are free to choose which and how many smart appliances they want. For instance, for Lyv Smart Living the key goal is to test the software of home energy management systems. In this context the residents are free to choose appliances.

Smart appliances often appeared to be provided for residents that participate in pilot projects. The project documentation provides information about which parties are responsible for installing the smart appliances. However, it is not clear whether the smart appliances are a gift or are borrowed, and what the costs and conditions for residents are. Information about whether they keep the appliances after the ending of the project is also missing.

Although not a smart appliance, 2 projects also allow residents to choose a solar panel switch. This had both the advantage that the amount of generated electricity could be measured real-time, which was interesting for residents, and that the solar panels could be switched of in order to control electricity supply.

3.4 Demand management features

Demand management is an integral part of smart grids and thus all projects that provide information about demand management (29 projects) make use of demand management features.

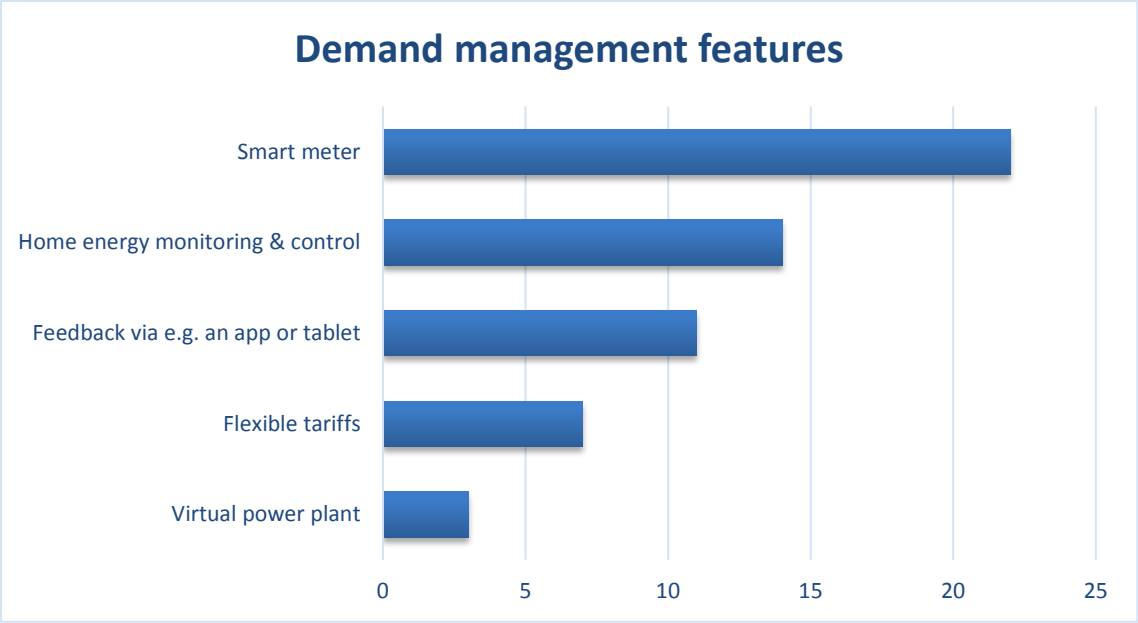

Figure 6: Applied demand management features.

In line with the trend of grid operators installing smart meters in households, in most of the pilot projects (22) residents have a smart meter at their disposal (76%). These are provided by DSOs as well. At the moment of writing there are 7 projects which do not make use of smart meters (24%) and 2 projects which are relatively new and do not (yet) provide any information about demand management features. In 50% of the projects with smart meters, feedback to users is also provided via an app, tablet or platform, such as in the projects Smart grid Lochem, Your Energy Moment (4x), Powermatching City (2x), and Collective Battery Rijsenhout.

There are 14 projects with a home energy management system (48%). Such a system is as often used without feedback as with feedback via an app, hence there are 7 projects that combine a HEMS with feedback and 7 projects that use a HEMS without an app. Projects that make use of a HEMS without feedback are for instance Couperus Smart Grid, PowerMatching City and Intelligent Network Zeewolde. In Couperus for instance the home energy management system controls the smart heat pump, without any user control or interaction. Projects that make use of a HEMS in combination with feedback are for instance PowerMatching City 2 and Collective Battery Rijsenhout.

Flexible tariffs are used in 8 projects. Most of these projects are spin-offs of earlier editions such as Your Energy Moment (four editions) and Returns For Everybody (two editions). Apart from these projects, usage of flexible tariffs is thus not widely spread. Little information is provided about the types of flexible tariffs (time of use or real time pricing), timescales, price differences and their overall complexity. In Your Energy Moment 2.0 dynamic tariffs are used on a 15 minutes basis.

Three projects have a virtual power plant. The project City-Zen has a virtual power plant as the most important energy system feature. This is an online platform which aggregates people's production and consumption of solar energy. A home battery lets residents store energy when electricity prices are low and discharge the battery when prices are high. Two other projects, EnergieKoplopers 1 and 2, use virtual power plants as well, but in these projects only nine households are connected to this system. which make use of a virtual power plant. In these three projects, demand shifting is not necessarily achieved by user behaviour but rather by the storage of electricity at favourable times.

4. The pilot projects' stakeholders

As can be seen in table 1 the number and type of stakeholders varies largely per project, but several aspects stand out nonetheless. In 90% of the 31 projects a DSO participates in the project. Grid operators are also most often project manager, namely in 40% of the projects. The various DSOs that operate in the Netherlands, which are Enexis, Stedin and Alliander, are all three equally involved.

Energy cooperatives are involved in 7 cases (23%): Smart Grid Lochem (where the cooperative is called LochemEnergie), Intelligent Network Zeewolde (Zeenergie), Cloud Power Texel (TexelEnergie), Collective Battery Rijsenhout (TegenStroom), Schoonschip (Schoonschip citizen initiative), Samen Slim met Energie (Duurzame energiecooperatie Haaren) and in Gridflex Heeten (Endona). In 3 projects they are the project manager and in another 3 they are in charge of the project with another stakeholder. Only in Rijsenhout, where the cooperative is officially an initiative of both citizens and the municipality, they are not in charge.

Table 1. Stakeholders involved in the projects.

Type of stakeholder	*Times involved*	*Times involved as project manager*
DSO	28	12
Energy cooperatives	7	6
Energy companies	10	0
Researchers / consultants	17	5
SEPS supplier or developer	19	2
Housing corporations	9	0
Regulatory bodies	9	2
Aggregator	1	0

Energy companies are not often mentioned as project partners in the project documentation. They figure in 32% of the cases, but never as project manager. The involved energy companies are Eneco, Essent, Greenchoice, Dong Energy (a Danish energy company) and TexelDevelopment. The latter is an energy company set up by a resident and member of TexelEnergie, who decided to set up his own company. TexelDevelopment is involved in the project Enercons. In the project Smart Grid Lochem the relatively small energy company Trianel went bankrupt during the project time, after which Eneco became involved. It is thus interesting to note that the involved stakeholders are not always static.

Researchers and consultants are involved in 54% of the projects. In the case of Returns For Everybody there are up to 8 different groups of researchers or consultants. Overall, the distribution between researchers and consultants on social/economic topics and on technical topics is almost equal (see table 2). It is interesting to note that technical research institutions such as TNO do not always merely conduct research but take up different roles. In Your Energy Moment 2.0 TNO has an advisory role and supports in the development of business models. Moreover, in Hooghalen TNO provided the software that was used for the project i-Balance, In Hoogkerk TNO provided the PowerMatcher for the second edition of the project PowerMatching City. In PowerMatching City there are more technical parties that take up unexpected roles, such as the energy research and consultancy firm DNV KEMA who is validating the cost-benefit models that are developed and the Technical University Delft who is studying community aspects of the project. In this way it is sometimes impossible to pinpoint a single role to a stakeholder.

Table 2. Types of researchers/consultants involved.

	Number of researchers/consultants
Technical	10
Economic or social	12

A recurring topic that the group of economic and social researchers focuses on are future business cases with dynamic tariffs or flexibility. For instance, in the project Returns For Everybody economic researchers aimed to develop a business case that used aggregated flexibility of refrigerators. In PowerMatching City the home energy management system had several business propositions and also in Couperus propositions were being developed. Such propositions differ in preference for sustainability or cost-saving and based on such choices they differ in working. Out of 5 projects in which a researcher/consultant acted as the project manager, there were 4 cases where DNV KEMA was the project manager. In the other case, another energy consultancy firm, 'Builddesk', was the project manager.

SEPS suppliers or developers are involved in 61% of the projects. Among them are Ecofys, IBM, ABB Group and ICT Automatisering. Such companies provide mostly ICT components. Other technologies, such as the PowerMatcher, have been provided by for instance research institutions. SEPS providers act as project manager in 2 projects. In these cases, which are Lyv Smart Lyving and i-Balance the developer had initiated the project. The Lyv Smart Living project is designed to test this energy management system. As such, the role of SEPS suppliers and researchers or consultants can overlap and be compared. This, as the systems in the pilot projects may be still under development or continuous improvement.

Housing corporations are involved in 29% of the pilot projects, for instance as one of the responsible parties to install smart appliances. However, they do not take up the role as project manager.

Regulatory bodies, such as municipalities or province government officials, are involved in 26% of the times (as far as their roles are acknowledged in the project information). Some of these projects aim for a city or city district to become carbon neutral, for instance in Heijplaat and Zeewolde. Local governments act as project manager in 2 cases, in Bothoven and in Meppel. In these cases, they are an initiator of the project as well.

In only one case, in Rijsenhout, an aggregator is involved in 2018, therefore it is not exactly known how the aggregator will work on the energy system. However, in Your Energy Moment 2.0 (Etten-Leur) and EnergieKoplopers other parties, such as SEPS developer or the energy company, partly act as aggregator.

5. Users' engagement with the projects

Users' engagement is related to feedback and financial incentives provided in the projects, technological features of the residential smart grid projects and their role in decision making processes. Financial incentives and feedback are discussed in section 3.4. In the sections below, we discuss the technological features that may instigate users' involvement and their role in the decision making processes.

5.1 Users' control and interdependence

User control
User control indicates the extent to which the users control their own electricity consumption and production by the use of the smart features: the smart appliances, renewable energy and storage technologies. The more control they have, the more their engagement is needed for a successful project. Total control over the usage means that users have control over, for instance, their smart washing machine or heat pump (scored as 1). The opposite would be when users have no control, and all the smart appliances are automated or functioning by external control (scored as -1). A situation in between these options, is when users can overrule their automated smart energy system features, set conditions like times or a part of the features is automatic (scored as 0).

The project information about the control of smart appliances is far from complete. As far as is known (11 projects, the smart heat pumps are automated (9 projects). The heat pump in the Couperus project for instance is coordinated by the PowerMatcher software. In Hoog Dalem the heat pump is controlled on the basis of outside temperature data. The smart boilers in Energiekoplopers 1 en 2 are being controlled externally.

Smart washing machines are presented in the documentation of 4 projects as 'semi-automatic'. PowerMatching City for instance combines automated heat pumps with semi-automatic washing machines: residents can define at what end time the laundry should be washed. In Hoog Dalem the heat pump is combined with a semi-automatic dishwasher, washing machine and an in-home energy management system.

Shared facilities
The interdependence among residents is assessed with the extent of shared facilities. This indicates to what extent the users are dependent on community members. The interdependence of users is large when they share energy technologies (scored as 1). An example of such shared facilities is shared electric vehicles between community members, or a shared battery. When all technologies work on a household level and the feedback they get on energy use/generation is measured on an individual household basis, the interdependence is nil (scored as -1). When households get feedback on energy use that is based on collective information (for instance information of the whole street, or a message that the sun is shining) without sharing technologies, the households are considered as moderately interdependent (scored as 0).

Of 25 projects trustworthy information about shared facilities is available. Of those, in 13 projects technologies were shared among the community members, sometimes in combination with shared information. These technologies involved collective PV systems, collective batteries and electric vehicles (see section 3). In Rijsenhout for example, a collective storage battery made households interdependent of each other. Also in Haarlemmermeer at the project Enercons a collective battery will be placed. The energy management system called the Smart Consumer Gateway, is developed by TexelDevelopment. It connects devices and storage technologies and, if allowed, sends data to other systems. Allowing this is a prerequisite to be able to make use of the collective battery. Cloud Power Texel combines the shared renewable energy technology (PV system), with personalised feedback. Residents were able to insert personal energy goals, such as a reduction of 10%, in a home energy monitoring system. This system then calculates in combination with weather predictions how much energy residents should be using a day.

In 2 projects data was shared among the residents without sharing a technology. Data about the planned use of smart washing machines were collected and compared with the aim to define the order of turning

on the washing machines automatically. In terms of data they are thus not interdependent, but the moments that their washing machines turn on do depend on other users. In the project Your Energy Moment 2.0 a group of users had smart appliances and got shared feedback in the form of dynamic tariffs that counted for all households.

In 8 projects the residents did not share anything. The feedback they get about energy levels is individualized for their household. A project in which the technological features stimulate users' engagement very little is Hoog Dalem. In this project all technologies and information on which the home energy management system works are individual, while the heat pumps are completely automated.

5.2 Users' involvement in decision making

The users' engagement is also related to organisational features of the projects, by the extent to which the (potential) users are involved in the decision-making process regarding the social and technical features of the projects, such as management structure, ownership relations, internal rules, characteristics of the smart grid system, feedback, pricing, how to evaluate, how to deal with problems and so on.

The extent to which users are involved is considered to cover the social organization-related dimensions. The first variable is the *influence during the project design*, covering the influence that the users had during the development phase of the smart grids projects. The second variable is the *influence on project management*, after the implementation of the smart grid project. Control means that users participate in important decisions or were in the lead (scored as 1). Users can also only be consulted (0), or not be involved at all (-1). There are 23 projects that have provided information on users involvement. However, little information is given into the specific topics users were consulted on.

Table 3. User involvement in project design and project management.

	User involvement in project management		
User involvement in project design	*1*	*0*	*-1*
1	11	1	-
0	-	2	-
-1	-	3	6

Table 3 shows how many projects involved users in the decision making processes. We discuss each group from the projects with the highest involvement in the upper left corner of the table to the projects with the lowest in the lower right corner.

Upper left: A total number of 11 projects fully involve users in important decisions during both the project design phase and project management phase. Of these 11 projects, 6 are initiated by an energy cooperative and the remaining 5 by local authorities and DSOs. One of the remaining 5 projects is Hoog Dalem All Electric and managed by the DSO Stedin. In this project users have participated in the brainstorm for the project design and are regularly asked how to proceed with the project. The Autonomous Energy District 2 is managed by regulatory bodies and based upon the wishes of users. Also in Meppel regulatory bodies involve users, taking a co-design perspective and ask users to determine the most pressing needs. Although the projects that fall in this category ask users to determine important aspect of project design and management, it does not necessarily mean that all residents feel ownership of the project. For instance in Smart Grid Lochem and Returns For Everybody, just a small group of active residents initiated the projects and participated in important meetings.

Upper middle: In the first edition of PowerMatching City users were involved in the project design phase to develop appealing services, but throughout the management phase users were consulted rather than involved in important decisions. This is the only project that falls into this category.

Middle: User consultation in both the project design and project management phase takes place in 2 projects, being in Bothoven, Enschede and PowerMatching City 2 in Hoogkerk. In the first project, users are consulted during the project design as the municipality is convinced of the importance of

citizens' acceptance for the ambition to develop Bothoven as an energy neutral neighbourhood. In the project PowerMatching City 2, the project design is based on feedback of the previous edition of PowerMatching City. In this way users are consulted for this phase. They are furthermore consulted during the project management phase as well and asked for feedback.

Lower middle: There are 3 projects that involved users only during the management phase, and not during design of the project. In the case of 2 projects, Your Energy Moment in Breda and Zwolle, users were able to sign up after the plans were made and where thus not involved in project design. However, throughout the project they were continuously asked for feedback.

Lower right: Lastly, there are 6 projects that do not seek users' involvement in decision making regarding project design and management at all. Instead, the residents are offered a predefined package which they can accept of refuse. In Heijplaat, users are triggered to sign up with small financial incentives. In EnergieKoplopers 2, residents are able to choose whether they want to sign a contract with an aggregator. However, this does not mean user involvement is not at all stimulated. For instance, in Your Energy Moment 2.0 users are kept up to date via newsletters and there are 3 information meetings on the project's progress.

Users' engagement
Summarising the ways in which the Dutch projects instigate users' engagement, table 4 provides an overview of the percentages of projects that include one or more of the features discussed above.

Table 4. Users' engagement through diverse project features.

	Much	*Moderate*	*None*
Information / feedback (N=27)	67%	26%	7%
Financial incentives (N=27)	30%	11%	59%
Ownership (N=24)	54%	38%	8%
Shared facilities (N=25)	12%	40%	52%
User control (N=14)	0%	43%	57%
Involvement in project design (N=24)	33%	25%	42%
Involvement in management (N=19)	32%	42%	26%

N indicates the number of projects that provided information on the respective issue.

The Dutch smart grid pilot projects currently engage users mostly through providing feedback on their energy use, via for instance apps and tablets. Financial incentives are used, though they are not dominant throughout the pilot projects. Despite lacking information about ownership op technologies it appears that most technologies are owned by residents. As discussed in section 3, the technologies they own are mainly domestic solar panels or domestic heat pumps. This also supports the conclusion that most of the technologies in the pilot projects are not shared. Merely a few projects make use of only shared technologies. Interestingly, of the projects that make use of smart appliances, none give full control to users. The appliances are in all projects either partly automated or fully controlled by an energy management system.

One in three projects give users a central place in project design and project management. Even though almost half of the projects do not involve users during project design, in more than half users are at least moderately involved, with increasing numbers for involvement in project management. For the project management phase the distribution may be slightly shifted as moderate involvement, such as asking for feedback, may be relatively easy to implement.

6. Conclusions

The 31 identified Dutch residential smart grids projects with more than 15 households vary considerably. Especially regarding the technical features of the smart grid systems: if and what kind of renewable energy source, smart appliances, storage technologies and demand management features et cetera are available.

In organisational terms the variation is less. DSOs, SEPS suppliers and developers and researchers are most often involved. They can hence be expected to be dominating the smart grid development in the Netherlands.

The extent to which users' involvement is stimulated technically by giving them control of the smart appliances seems quite limited. This may however not mean that the systems do not instigate users' involvement. Hansen & Borup show how even in the case of full automation, residents may show active engagement, for instance by connecting extra devices to the system (2018).

In a majority of the Dutch projects, voluntary changes in energy-intensive practices are deliberately stimulated merely by providing feedback about energy use (and costs), in diverse forms such as a tablet or an app.

The overview hence confirms the strong engineering focus on ICT-technologies noticed in many other accounts. As the presence of research for business cases shows, this is complemented with an economic rationality. In the words of Wolsink, this links to the scenario of network operators gaining power by increasing surveillance of domestic consumers and their energy consumption. In this scenario, demand regulation is the main driving force rather than the optimal use of renewable energy (2012).

In the majority of the projects users (partially) own parts of the local smart grid system. This may motivate them to take further control of their energy systems. Also, in a considerable amount of projects, users have played a fair role in the decision making process in the phases of project design and management. These projects may well provide some counterbalance in the future smart grid development. At least they provide ample opportunity to learn more about the key concerns of users in the light of the roles that others envision for them: demand shifters, energy savers, co-designers and co-providers (van Mierlo & Gültekin, 2018).

References

European Smart Grids Technology Platform. (2006). Vision and Strategy for Europe's Electricity Networks of the Future. Luxembourg: Office for Official Publications of the European Communities.

Hansen, M., & Borup, M. (2018). Smart grids and households: how are households consumers represented in experimental projects? Technology Analysis & Strategic Management, 30(3), 255-267.

Obinna, U. (2017). Assessing residential Smart Grid pilot projects, products and services: Insights from stakeholders, end-users from a design perspective. Delft: Delft University of Technology.

van Mierlo, B., & Gültekin, E. (2018). From consumer to co-provider in smart grid development? Assumptions and findings. ESEIA Conference. Dublin: Wageningen University and Research.

Wolsink, M. (2012). The research agenda on social acceptance of distributed generation in smart grids: Renewable as common pool resources. Renewable and Sustainable Energy Reviews, 16(1), 922-835.

CESEPS
Co-Evolution of Smart Energy Products and Services

Smart Grids Plus
ERA-Net