The Bornholm Flexibility Platform

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TABLE OF CONTENTS

1 Introduction

This technical report summarizes the work of maintaining the Bornholm Flexibility Platform in the EcoGrid 2.0 project. In the scope of the EcoGrid 2.0 project, this report covers the two work packages WP7.1, “System maintenance” and WP7.3 “System robustness and stability”.

The operational work, both maintaining equipment and being in contact with participants, has been carried out by Bornholms Energi og Forsyning (BEOF) during the whole project. In short, the Bornholm Flexibility Platform covers 1.000 demand response equipment (DRE) in private households on Bornholm. The DRE controls electrical consumption by controlling heat pumps and direct heating in the households. Additionally, the DRE collects data from the households, particularly temperature data, which is regularly retrieved by a central data system.

The maintenance of the flexibility platform ensures that the DRE, and thereby flexibility, is ready and available for the aggregator and is therefore critical for the aggregator’s business model. If the availability is low, so is the aggregator’s ability to deliver flexibility. To be relevant for future aggregators, this report focuses on how to optimize the business model through three aspects:

- minimizing the work of maintaining the DREs,
- increasing the uptime of the DREs and thereby increasing the amount of flexibility, and
- ensuring a trust-based relationship with the customers without unnecessary interaction.

The report consists of six sections. The first section is a summary of the overall findings and recommendation from the work of maintaining the Bornholm Flexibility Platform. They are generic issues and not related to the specific type of DREs used in EcoGrid 2.0 on Bornholm.

The next section is a brief description of the historic background of the Bornholm Flexibility Platform and its relation to the EcoGrid EU-project. After that, the specific types of DRE used in the platform and technical setup these interact with are described, again very briefly. The more detailed technical description can be found in the referenced EcoGrid EU report.

As mentioned, the DRE is installed in the private households on Bornholm. The interaction and communication with the household owners are a vital part of the operational work of the aggregator. It helps to ensure a high customer satisfaction by establishing trust and thereby ensures the flexibility is ready and available. In the fourth section, the interaction and communication with the household owners is described. The interaction and communication with the household owners is seen as a way of maintaining both the participants’ trust and indirectly the DRE, as the many simple issues with the equipment can be maintained by the owners themselves, e.g. changing batteries or restarting the equipment.

In the fifth section, the tools used to monitor the Bornholm Flexibility Platform and the Customer Relationship Management (CRM) systems used to coordinate technicians visits in households are described. These two toolsets form the Aggregator Operational Tool and are the backbone of BEOFs operational work. The sixth and final section is a short conclusion.

Abbreviations

BEOF	Bornholms Energi og Forsyning is owner of the local DSO, El-Net Øst A/S, on Bornholm.
CRM	Customer relationship management is an approach to manage a company's interaction with current and potential customers. It uses data analysis about customers' history with a company to improve business relationships with customers, specifically focusing on customer retention and ultimately driving sales growth.
DR	Demand Response is a change in the power consumption of an electric utility customer to better match the demand for power with the supply. In EcoGrid 2.0 the DR is electric heating through heat pumps and direct heating.
DRE	Demand Response Equipment is the technical system used to control the demand response and gather data from the environment related to the demand response in control, e.g. indoor temperature.
DSO	Distribution System Operator is the company which handles the final stage in the delivery of electric power; it manages the distribution grid that carries electricity from the transmission system to individual consumers.
EV	Electric vehicle, a vehicle using an electric motor instead of an internal combustion engine.
HEMS	Home Energy Management System is a specialized system to monitor, control and plan the energy consumption in a house or building. The HEMS will often also perform the task of the DRE, as it does in the EcoGrid 2.0 setup.
ISP	Internet Service Provider is an organization that provides services for accessing, using, or participating in the Internet.

Sources: Wikipedia; www.beof.dk

2 Optimising the Aggregator's Business Model

A robust and stable access to the control of the demand responses in the aggregator's portfolio is crucial for the business model of the aggregator. If the maintenance cost is high, a business model will not be viable, as the cost scales with the amount of controlled DR. And similar, if the uptime of the DRE, or data network connection to it, is low, the business model will not be viable either. Therefore, optimising robustness, stability and connectivity to the DRE is of great importance for the aggregator.

Below, five recommendations to keep the uptime of the DRE high and the maintain cost low are given. The recommendations are not concerned with the specific equipment used in the EcoGrid EU and EcoGrid 2.0 project but are aimed to be general, so they can be applied for several types of demand response and not only electric heating and heat pumps. At the end of the report a range of more specific recommendations are listed.

Ensure reliable internet connectivity

The accessibility of the DRE depends largely on the data network connection to it. Using the customer's internet connection introduces a range of instability issues: a change of Internet Service Provider (ISP) or router, an erroneous router, an overloaded network, ISP service errors and similar will all affect the access to the DRE. Using a dedicated mobile network connection is expensive and may not always be available, for instance in basements or dense forests.

Use a specialised control unit

Use demand response equipment that has been developed specifically for the required purpose, e.g. turning on and off heating. The more extra functionality included in the system, the more errors will occur and the more questions from customers will arise. If extra functionalities are deemed necessary these should be included through integrations with external systems, e.g. calendar control through an external calendar system that users are accustomed with.

Minimize and simplify user interfaces

Make the number of systems, e.g. webpages and control interfaces, that the customer must engage with as intuitive and simple as possible. This is especially important, if the customer is expected to only rarely interact with the DRE. Additionally, the more the customer is expected to configure on their own and the more complex this control is, the higher the need of resources for support, teaching and manuals.

Limit the amount of sensors

Limit the use of sensors so they alone match the required measurements for the flexibility platform. The tendency of measuring as much as possible, e.g. air quality, humidity, power consumption of all appliances, will lead to unnecessary data traffic, issues with failed sensors and

misguided perception that all available measurements should be applied. Often an IOT device has multiple sensors included, yet perhaps only one of the measurements is relevant.

Minimize the dependencies on batteries

Minimize or avoid the use the batteries. The only good thing with devices and sensors that quickly run out of battery is that the customer will know how to change the batteries. In many cases, the battery will last for years and the owner will have forgotten how to change them. This will result in need for support and service visits. Using devices and sensors that run on batteries will require an alarm system to inform customers of when the power batteries get low. If sensors use power supplies, make sure this will not be unplugged.

Make critical control intuitive

When an aggregator controls demand response this most likely means control of critical parts of the customers life, e.g. heating, EV-charging or similar. By consequence, and to make sure that customer will give the aggregator control over the DR, a mechanism for the customer to temporarily disable the aggregators' control is important. The need for this will only occur rarely and therefore the control must be simple and intuitive, and it must be clear for the customer, that the control is disabled. Even seemingly simple processes, like logging into a website, can be a significant issue, especially if customers only need to enter the website rarely. As a result, the customer may not trust mechanisms and may call support and be very insisting in the need for help. A simple switch next to the control unit, with an indicating light, would most likely be ideal.

3 Historic background

The EcoGrid 2.0 project was established as a continuation of the previous EcoGrid EU project (2011-2015), see the report *EcoGridEU, 2016*. EcoGrid EU had demonstrated advanced control of demand response with 2.000 households participating on Bornholm and this had required large investments in IT and contact with citizens on Bornholm. The flexibility platform that EcoGrid 2.0 inherited consisted of a) nearly 1.000 Home Energy Management Systems (HEMS) on Bornholm and b) a trust-based contact with the owners of these households. To retrieve data from the HEMS installations, and especially to control them, a complex IT-system was developed in EcoGrid EU and located on an IBM Blade Server at BEOFs facilities in Rønne, Bornholm. Altogether, this allowed for EcoGrid 2.0 to proceed further on a journey, much like with a multistage rocket, towards flexibility in the electricity markets.

However, inheriting the flexibility platform on Bornholm also meant that EcoGrid 2.0 had to maintain a very large amount of HEMS installations that were getting old. Many installations were dismantled during the project which meant that the number of participants went down to 800 at the end of the project. There were multiple reasons for this (see below), but it was also done to remove dysfunctional equipment. The maintenance of both the HEMS and the trust-based relation to the participants have been handled by BEOF. The HEMSs were getting old when inherited and have not been specifically designed to be used as they have been in the project. Thus, it has required a very large effort to keep the installations online and available for demonstrations to the partners.

The Bornholm Flexibility Plaform

- 1.000 demand response installations in private homes on Bornholm to control participants' electric heating.
- The DR controlled: 40% heat pumps and 60% direct heating
- Home Energy Management Systems (HEMS) used: 40% Siemens Synco Living, 60% Greenwave Reality
- Household types: 25% summerhouses, 75% residential houses

4 Types of Households and Technical Setup

The 1.000 households that agreed to participate in EcoGrid 2.0, after having been part of EcoGrid EU, are characterized in several ways. When monitoring and planning maintenance of the installations, two categories have been particularly important: the type of household and the type of HEMS.

On the household side, there are residential houses (ca. 75%) and summerhouses (ca. 25%). Summerhouses have showed to be much more demanding and difficult to maintain than the residential houses, among others because the owners are rarely in the summerhouses and the summerhouses are rented out. This means that internet connectivity is difficult to maintain and planning of service visits is difficult and time consuming.

On the technical side, two types of HEMSs were inherited: the Greenwave Reality System (called GWR, ca. 60%) and the Siemens Synco Living system (called Siemens, ca. 40%). The GWR system was used to control heat pumps (liquid based) and electric heat panels. The Siemens systems was used only for controlling electric heat panels. In addition to the HEMS installation, all the household had an advanced Landis+Gyr smart meter installed in EcoGrid EU. The smart meter sends consumption data to El-Net Øst A/S (the DSO on Bornholm) for billing etc. and is also loaded into a database available for the EcoGrid 2.0 partners. The data has a resolution of 5 minutes and is sent over cellular network every 12 hours. For a more detailed description of participants and technical setup, see the reports EcoGridEU 2016 and EcoGridEU 2013.

When maintaining the flexibility platform, the information about the type of system and type of household have been essential to communicate with the owner and plan visits by technicians. In addition to these two categories, all participants were registered as either active, passive or deregistered participants. During the project, HEMS installations were dismantled and or registered as passive, if they for some reason could not be used for testing in the demonstrations. There were multiple reasons for dismantling equipment, among others:

- the ownership of a house changed, e.g house sold, owner had died, owner went bankrupt
- the heat source was changed, e.g. heat panels to air based heat pump,
- there were no or very little power consumption in house, e.g. summerhouses,
- recurring issues with internet connectivity for HEMS or smart meter

Passive participants were people who wanted to keep their HEMS installation until the end of the EcoGrid 2.0 project but were not tested upon. Other categorizations were also used in the monitoring and planning of the installations, e.g. type of internet connection and location on Bornholm.

4.1 Individual or aggregated control of heating

The two types of HEMS used in EcoGrid EU and 2.0 were originally designed to be used by the individual owner to control the heating of his or her house. In EcoGrid 2.0 however, the HEMSs are primarily operated on an aggregated level as a pool of resources through the control

mechanisms designed by the aggregators. In the end of the project, the control of the heating was controlled by fully automatic procedures.

In EcoGrid EU, the participants were encouraged to use the web-based systems to control their heating with HEMS by following a price signal for the electricity. With the strong focus on aggregation in EcoGrid 2.0, this was not an important aspect and consequently has not been continued. However, when an EcoGrid-household was sold in the project period, the new owners were introduced to the HEMS for controlling their heat. This was first and foremost the case with the Siemens HEMS which has both a display in the house and a web-server that allows it to be controlled remotely.

Throughout EcoGrid 2.0 a large amount of the calls from participants have been about getting access to the Siemens ClimaxIC, which is used to control the Siemens HEMS remotely. This has especially been the case with summerhouse owners and owners that were rarely in their household. The Siemens HEMS itself is very robust and reliable, so often the lack of access has been caused by issues with the internet connectivity in the household, main power has been shut off, dead batteries in a room sensor, or the participant was using an outdated internet browser. Whatever the reason, such inquires require much effort to handle, especially if the participant only uses the HEMS control system a few times a year.

Thus, when designing an infrastructure for controlling demand response through aggregation, it should be thoroughly considered whether functionality for individual control of the heating should be part of the technical setup. Not only does this require many resources in developing and maintaining a graphical user interface (GUI), but it will also result in many calls from users on how to control the heating and require extra resources for manuals and teaching.

Recommendation: *Consider whether the HEMS should include control interfaces for the customer or should be controlled by the aggregator alone.*

4.2 Type of household and access to hems installations

In the project, the summerhouse owners have been of relatively little value, but required a high amount of resources. Being a summerhouse, the heating is rarely turned on during the heating season or is set to a very low limit (5° or 10° Celsius). When heating is turned on in the heating season, usually in the holidays, the houseowners expect it to be on all the time, especially if the summerhouse is rented out, which is quite normal. This means that the amount of flexibility (load decrease) for the summerhouses is small. In terms of load increase, on the other hand, the amount of flexibility is high, but this type of flexibility has only been tested a few times, as it increases the electricity bill of the houseowner.

As mentioned above, it is often the summerhouse owners that have contacted BEOF with inquires. As the summerhouse owners are rarely in the house, especially when the technicians have time for visits, it has been necessary to get access to the house and HEMS in other ways. This has often been by a key box or through other people, who have a key to the summerhouse. In the latter case, this heavily increases the complexity of arranging a visit by the technician and the time used by the technician.

Recommendation: *Consider whether to include summerhouses in a flexibility platform, as they require another type of service and intensity of support.*

5 Interactions with participants

All the communication with the EcoGrid 2.0 participants has been through BEOF. The purpose of the contact has been:

- to maintain the commitment of the participants,
- to maintain the trust-based relationship between the participants and the project,
- to communicate about the progress of the project,
- to encourage participants to take actions in the project, and
- to maintain the HEMS installations so they were ready and available for testing.

In this chapter the interaction between BEOF and the participants is characterised and described, to prepare future aggregators on how best to communicate and engage with their customers.

BEOF's interaction with the participants have been through several channels. The interaction is here separated into two categories: a) mass communication about the project and b) direct interaction with individual participants about the HEMS installations or participation in the project. The communication channels are depicted in figure 1.

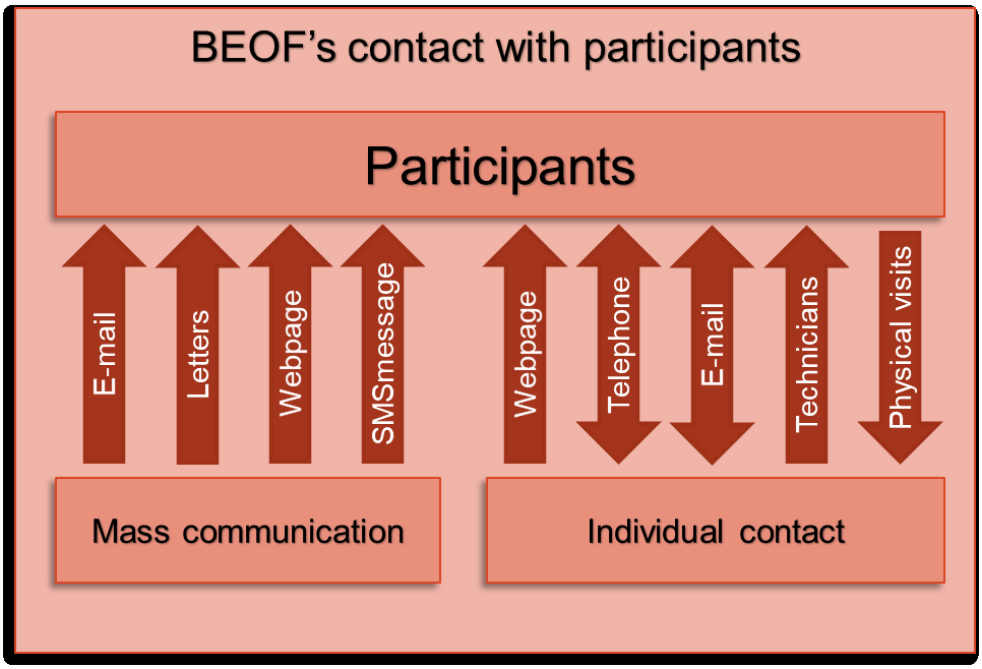

Figure 1: The different communication channels for interacting with participants.

5.1 Mass communication about the project

The mass communication from BEOF to the participants consisted of the four types: e-mail, letters, webpage and SMS messages. Four types of mass communication were sent:

Newsletters: information sent on regular basis about the process of the project, media coverage of EcoGrid 2.0, contact information during holidays, etc. The newsletters were sent to all active participants in the project.

General information: important information about specific changes or upcoming events were sent less frequently to all passive and active participants. An example of this was in the last two quarters of the project where participants were informed about the end of the project and that technicians had to visit their houses to dismantle the HEMS installations. In most cases this information was also sent by letters, especially when the e-mail of a participant bounced.

Service messages: information about maintenance or failures of the IT-systems that participants used. Information about upcoming flexibility activation was also sent on an experiential basis. This information was communicated to participants through the webpage and SMS messages.

WP6-related information: information about the web portal and products (see WP6 deliveries) were sent through the same channels as the newsletters and general information. Here the content of the e-mails and letters was made in close collaboration with the partners in WP6.

5.2 Interaction with individual participants

In terms resources, most of the interaction with the participants has been the individual contact. The individual contact with the participants has been to maintain the HEMS installations so they were online and available for the aggregators to test on. Below, the different types of contact with the participants during the EcoGrid 2.0 project is listed.

Webpage: The webpage was used for various types of information specifically about the individual. In the third and final heating season, the participant could log in to the webpage and be informed about upcoming flexibility activations later that day. This information was also sent as text messages, but meant that participants would receive a very large amount of messages and it was therefore stopped again.

Outgoing telephone calls: most of the outgoing calls have been to a) guide participants to get offline HEMS installations back online and b) to plan visits to the household by technicians to primarily maintain, but also install and dismantle, HEMS installations. These calls have primarily been made by student workers outside office hours when participants are home. In situations where participants had technical questions or were, for one or another reason, reluctant to talk, the technicians or an office worker made the calls.

E-mails: participants have throughout the project been encouraged to contact BEOF by e-mail, as this would make it easier to respond. The participants have done so and often the inquiry has resulted in a call to the participant afterwards.

Incoming telephone calls: in the first two years of the project participants could call the back office during work hours (Monday to Friday 08:00 to 16:00) and would be redirected to a warden on BEOF's power plant outside work hours. In the last year of the project, this was narrowed down to contact hours on Monday and Thursday from 15:00-18:00. This required less resources and made it possible to have more people answering the phone.

Visits by technicians: See section 5.3 below.

Participants visiting the BEOF office: in a few cases, especially with elderly people, participants have visited the office of BEOF with specific questions about the project. These questions have been similar to telephone calls.

5.3 The role of the technicians

In most of the project, BEOF have had two full time technicians working on maintaining the HEMS installations. Their tasks have varied and been very diverse. These have covered changing batteries, restarting HEMS installations, replacing malfunctioning devices, updated internet connections, updating installations to new heating sources, etc. The large need of technicians in the project reflects that the HEMS installations are old, erroneous and in some cases prototypic (e.g. uses the battery too fast).

But just as much, they have talked participants into staying in the project, trained participants in using all the involved systems in the project, and in general maintained the trust-based relation. Their valuable work has been thoroughly documented by CBS throughout the project.

5.4 The five most frequent inquires

The individual inquiries from participants have been very diverse. The most frequent inquiries are listed below and have been received through all the channels listed above.

1) **Access to systems**
   Most of the contact has been concerning access to the IT-systems that the participants use. Participants have contacted BEOF about access to the Siemens HEMS system to control the heating in summerhouses. It is estimated that over the projects full duration 80% of the inquires have been about summerhouses.

2) **Erroneous systems and lack of heating**
   Complaints about erroneous systems, sometimes resulting in lack of heating, were most dominant in the first two heating seasons with initial tests and many errors. In the third and last heating season, there was an increased amount of complaints of lack of heating, due to the very high number of tests. In most cases the participants have been helped to disable the HEMS installation.

3) **Web portal and products**
   Especially in the weeks after launching the new web portal with products, the amount of inquiries was high. Besides how to log in to the web portal, participants asked about the choice of products and what the consequences would be. This also occurred during third heating season, when the web portal was updated, and the choice of products simplified, but here the amount of inquiries was much lower.

4) **Information about changes**
   Frequently during the project, participants have called or sent e-mails to inform the BEOF team about various changes surrounding the HEMS installations in their house. Usually this has been about internet connection or updated heat sources. In most cases this has required visits by technicians, either to make changes in the HEMS installation or dismantle it.

5) **Changing planned visits**
   Calls and e-mails by participants to change previously planned visits by the technicians.

5.5 Conclusion

In this section, a summary of the interaction between the participants on Bornholm and the BEOF operation team has been described and categorized. The summary will help both future aggregators and other R&D projects to better plan the communication and interaction with the customers or participants. From the summarised experiences, three recommendations are given.

Recommendation: *Make it easy for the customer to operate their own HEMS, especially make it simple to disable the aggregator's control.*

Recommendation: *Keep the amount of IT-systems that the customer must use to a bare minimum and make access easy.*

Recommendation: *Do not underestimate the value of the technician to establish and maintain the trust-based relationship with the customer.*

6 Maintaining the Bornholm Flexibility Platform

With the dedicated purpose of maintaining the HEMS installations, the BEOF team have had the task of operation on Bornholm. In future scenarios this work could either be handled by the aggregator itself or by a subcontractor. In EcoGrid 2.0, the role of the aggregator and the operator were separated. BEOF has acted as subcontractor for IBM and Insero, who had the role of aggregator. The IT-systems to support this work are an extensive combination of ordinary customer-relationship management (CRM) functionalities together with specialised systems, among other for tracking the state of the HEMS and to access the history of activations of the flexibility. This high-level view of the aggregator operation tool is depicted in figure 2.

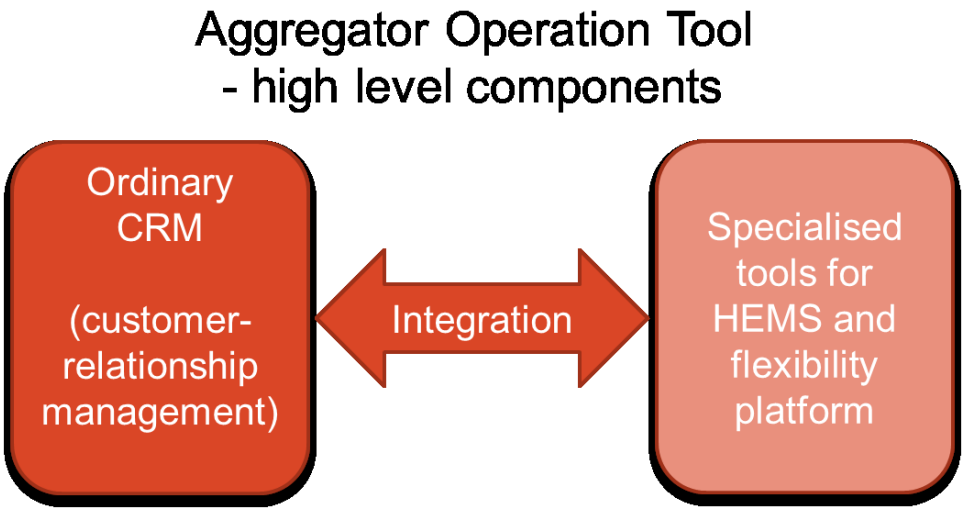

Figure 2: High-level depiction of the aggregator tool.

In the following two sections, a list of identified functionalities and tools vital to or relevant for operating and maintaining a HEMS flexibility is described. Due to a limitation of resources and especially due to the old HEMSs, the functionalities available for BEOF in EcoGrid 2.0 have not been as extensive and well-functioning as they would in a future scenario. Thus, the listed functionalities are both a summary of the used functionalities and functionalities identified to enhance the task of operating the flexibility platform.

6.1 Customer-relationship management

For all types of business that involves an ongoing relationship with customers, the need to manage this relationship is vital. Customer-relationship management (CRM) systems are extremely common and often specialised to the type of business they are used within. The most basic functionalities of the CRM are also relevant for the aggregator, or subcontractor, to manage the contact and interaction with the customers:

Basic information about the customer and customer's installation

The foundation of the CRM system is the information concerning the individual customer. This includes unique identification, contact information and similar. But it may also include information

about the type of heating being controlled, the customer's subscription, type of household and control unit, access to control unit. Locational information about the customer is used to plan driving routes for the technicians.

History of contact with the customer

Another common part of a CRM system is a history of contact with the customer. This include both the service visits by technicians, calls and e-mails with the customer, changes to the installation etc. Free text is often used for quoting e-mails, for description of tasks and contacts and for comments to these. In respect of the customer, legalised through GDPR, it is important to leave out sensitive personal data, e.g. health status or similar, about the customer.

Calendar for visits and tasks concerning the customers

Both the technicians and the back office need a collective calendar to keep track of tasks concerning the customer. It includes the planned visits by the technicians, but also other tasks, such as contacting a specific customer at a specific time.

Warehouse

A module or system to keep track of the installed equipment and equipment in the company's warehouse.

Data analysis

To assist the different part of the aggregator's business, but also to better plan the maintenance, functionality to analyse the different CRM data is important. One example of this data analysis is to fine tune the length of service visits, another is to estimate an extra or reduced price for customers based on various parameters.

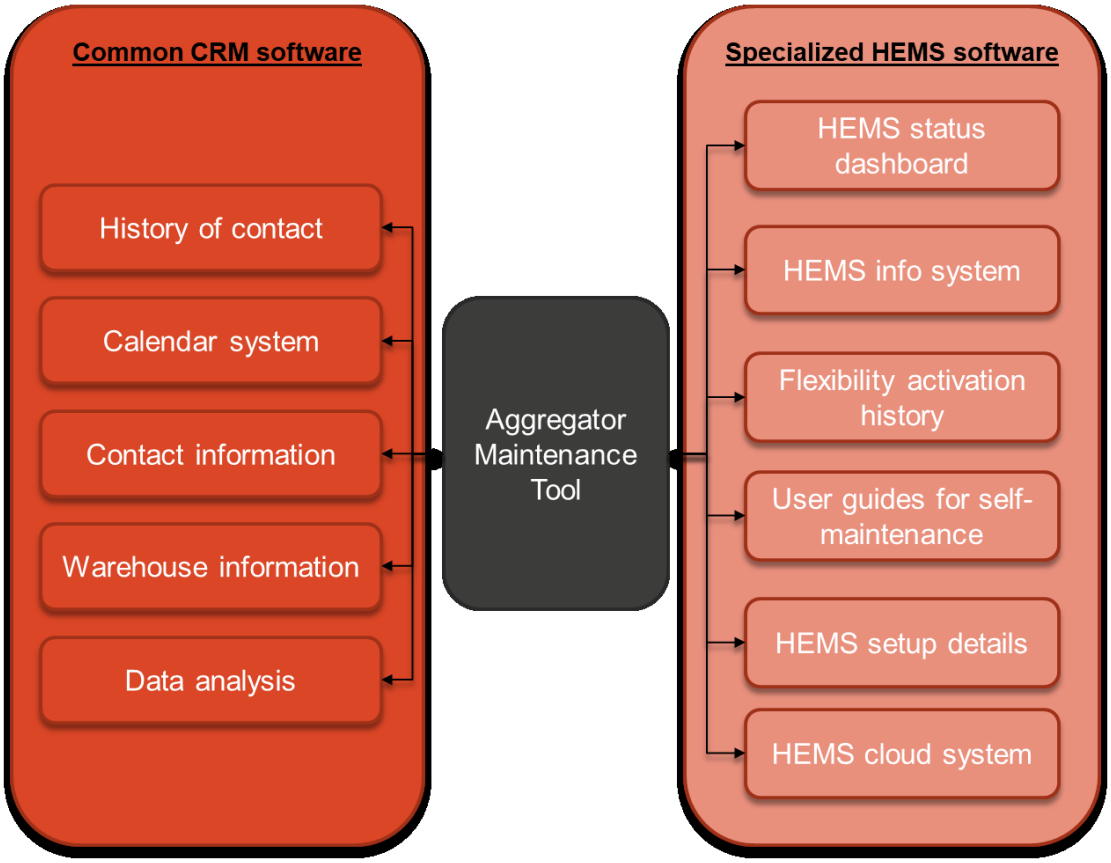

Figure 3: an architectural depiction of the applied and integrated functionalities and information systems in the aggregator maintenance tool.

6.2 Specialised monitor systems

In connection with the ordinary CRM functionalities, a set of more specialised sources of information must be available for the operation and maintenance of the installations. This information serves two parts, one gives visibility into the platform of installed HEMSs, the other eases the maintenance both from the operator's and from the customers' side.

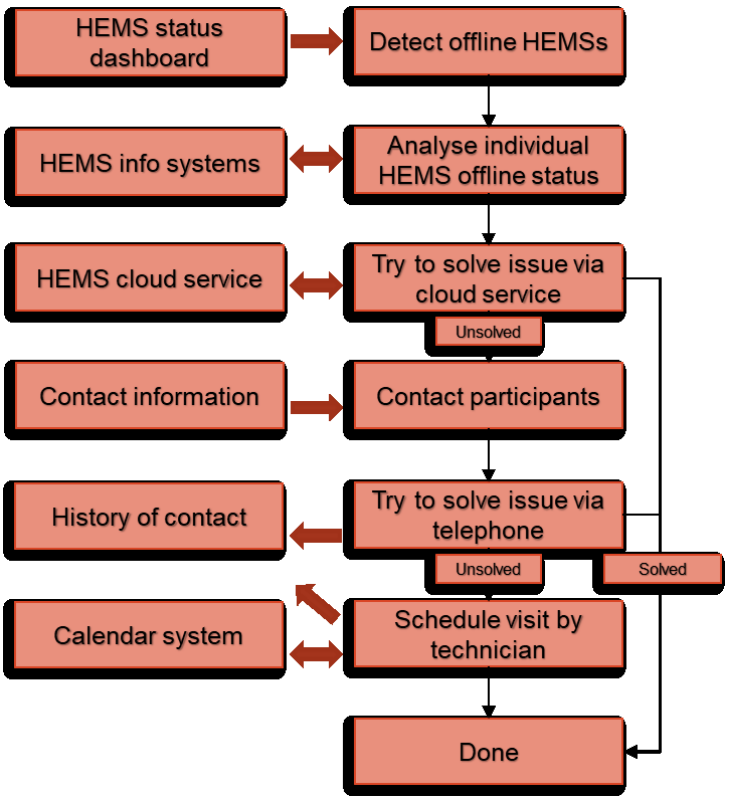

Figure 4: workflow for detecting offline HEMSs, get them online remotely or plan visits by technicians.

Live status about HEMS availability

The first and foremost important information for the operator of the flexibility platform, is the at any given time status of the HEMS installations. On a high level this information tells whether there is access to the HEMS at all, and on a more fine-grained level the information will contain error codes, logs and activity logs. This information will allow either to handle the issue remotely or to plan a visit, where the technician knows what to expect beforehand.

History of activations of HEMSs

This information contains logs for the individual HEMSs of when they have been activated, for how long and for what purpose. The information is important for the back office and technician in the contact with the customers, but may also assist error tracking.

Guides for self-maintenance to customers

This information should be seen more as manual or guide available for the customers and will allow them to make simple maintenance tasks themselves. The tasks could be resetting equipment, changing batteries, changing minor configuration and especially how to disable the aggregator's control of the heating. The last part is important as it gives control back to the customer and will ensure their acceptance of the aggregators' control.

Remote maintenance of HEMSs

The functionality or system allows the operator of the flexibility platform to perform maintenance remotely. Two examples of this include rebooting the HEMS and making changes to the configuration of the HEMS. Such a functionality lessens the need for technicians to visit the customer and thereby lowers the cost of maintaining the platform.

When selecting back office employees and technicians, they must have the required skills and training to use the different systems and functionalities in their daily work. Configuring and maintaining the HEMS and specialised IT-systems, used in relation to the HEMS, require IT-technical skills by the technicians and back office employees. The employees will have to familiarize themselves with software and interfaces that are not off-the-shelf products with familiar interfaces. This is a general issue for back office and technicians, but with HEMS equipment the complexity will most likely be higher. In addition, the operator must devote resources to develop and refine these specialised IT-systems and integrate them with the used CRM systems.

6.3 Conclusion

The operation and maintenance of a HEMS flexibility platform requires a range of functionalities and information. In their combination these will allow the operator to quickly identify failed or inaccessible HEMS installations, to easily get an overview of the specific installation and of the history of contact with the owner, so they can solve issues remotely, through a telephone call with the owner or easily plan a visit by the technician.

The overall aim is to ensure high customer satisfaction and high uptime of the HEMS installations while at the same time keeping the operation cost down to ensure a viable business model for the aggregator.

7 List of recommendations

In the following, the findings and recommendations from BEOFs work in EcoGrid 2.0 are summarized. It is important to see these as coming from a 6-year long experience with a large-scale, prototypic IOT network.

To broaden the applicability of these, “Demand Reponse Equipment” (DRE) is used rather than HEMS, to underline that these recommendations, or principles, also apply to other types of DR, e.g. EV charging/discharging. By DRE the following is meant: the microcomputer installed in the household, often called “gateway”, together with the devices and sensors which in their combination control the DR. The DRE can either be an integrated part of or be retrofitted with the DR equipment (e.g. heat pump, charger or EV).

In a broad sense, the task of maintaining the DREs can be separated into three categories: 1) maintenance of the DRE, 2) maintenance of the environment and hardware surrounding but not part of the DRE, and 3) supporting and training the customer with the use of the DRE and living with flexibility activations. The “outgoing” contact has been related to 1) and 2), each with an equally large proportion, while the incoming contact is almost solely related to 3). As a rough estimate half of the used resources in EcoGrid 2.0 are related to 1) and 2) while the other half is related to 3).

7.1 Maintenance of the DRE

Integrated vs. retrofitted: Using an integrated DRE will make it more reliable, but also result in increased complexity if multiple types of appliances, and thereby DREs, are used.

Specialised DRE: Select a DRE that has been developed specifically for the required purpose. A more complex system with increased functionality, may be more prone to err.

Minimize the number of sensors: Clarify the required measurements needed to operate the DRE and estimate the flexibility and then minimize the number of sensors to only deliver these measurements.

Empowering alarms: Ensure that information and alarm systems enable the customers to solve issues themselves.

Battery issues: Minimize use of batteries, ensure it is intuitive and easy to change them and make sure that customers get alarms when they run out.

7.2 Maintenance of the environment and hardware

Reliable internet connectivity: Ensure reliable and if possible dedicated data connectivity to the DRE. Using the customers internet connection will heavily increase the need for support, not at all related to the DRE.

Easy access to DRE: Make sure that the technicians’ access to the DRE is easy, e.g. in an easily accessible box outside or place inside the house.

7.3 Supporting the customer

Customer access to DRE: If the customers are supposed to access and use to the DRE, this will heavily increase the need for support, training and service visits. This use could be setting temperature set points or EV charging percentages.

Minimize complexity: Keep the amount of IT-systems that the customer must use to an absolute minimum and make access easy.

Information about flexibility use: Make it easy for customers to find out if the absence of heating, charging or similar is due to flexibility activation (or a fault) and when the appliance will be turned on again.

Simplify operation: Simplify the means of operating the DRE. Particularly make it easy to override or temporarily disable the aggregators control of the appliance.

Physical interfaces: For important and immediately required information about and control of the flexibility activations, ensure this is available through physical interfaces such as small displays, lights and switches, rather than only relying on webpages and apps.

Technicians as ambassadors: The technicians are important ambassadors of the aggregator and ensure the trust-based relationship with the customer.

8 References

EcoGridEU 2013, “EcoGrid EU: From Design to Implementation”, Energinet.dk

EcoGridEU 2016, “EcoGrid EU: A Prototype for European Smart Grids, Deliverable D6.7, Overall evaluation and conclusion”, Energinet.dk

Read more at www.ecogrid.dk