HPCOM

Figure 1: Project about RD&D Strategy and Roadmap for Information- and communication technology in the heat pump area.

Summary of project

The main purpose of the project was to strengthen the development and implementation of information and data communication technology (ICT) and infrastructure in the area of individual heat pumps. Hence, the project covered data communication from household heat pump installations to the central systems – at distribution system operators, electricity suppliers and other service providers.

The project focused on knowledge sharing and was centered around state-of-the-art research, development, and demonstration (RD&D), standardization and testing facilities which have resulted in a RD&D Strategy and Roadmap for ICT in the heat pump area.

Together with up-to date knowledge within standardization and RD&D, this roadmap can be utilized by potential new projects within the area. The development of strategy and roadmap were done in close cooperation with the ICT- and heat pump industry, and at the same time the strategy was conveyed to the broader energy and Smart Grid industry.

The projects consisted of 5 work packages:

- WP1: Inputs to standards. Mapping of relevant standards, and inputs for future standardization work.
- WP2: Test environments. Field test and mapping of relevant test facilities in Europe.
- WP3: Development of datahub for heat pump.
- WP4: Knowledge sharing about ICT within R&D projects and development of roadmap and strategy.
- WP5: Future organization of activities and within the co-operative “Andelsselskabet Intelligent Energistyring”.

Learnings and results

<u>WP1:</u>

The participants are involved in various national and international working groups about standardization and ecodesign directives, and would like to influence the existing standards in order to better take smartgrids and data communication for heat pumps into account. Focus in WP1 was especially on existing testing standard

should support one combined test of the heat pumps energy performance together with the products data communication. Some of the most important standards identified were:

- IEC 61850-8-2, Standard for data communication: Communication networks and systems for power utility automation – Part 8-2: Specific Communication Service Mapping (SCSM) – Mapping to Extensible Messaging Presence Protocol (XMPP)
- DS/EN14511: Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling
- DS/EN14825: Air conditioners, liquid chilling packages and heat pumps, with electrically driven compressors, for space heating and cooling – Testing and rating at part load conditions and calculation of seasonal performance
- DS/EN16147: Heat pumps with electrically driven compressors - Testing, performance rating and requirements for marking of domestic hot water units

Beside these standards the interesting "SG Ready" specification from Bundesverband was introduced at this time, which specifies the communication between a heat pump and a service provider. This specification is however not standardized. From the review it was concluded, that both data communication standards and conformance testing standards need to be addressed as soon as possible as a joint European standardization effort, which was communicated to the committee CEN/TC113 on Heat pumps and air conditions units.

From the mapping it is was furthermore concluded that if a heat pump shall be used for other business services, the heat pump manufacturers need to open op for more API's, in order for external stakeholders to obtain an extended communication with the heat pump.

It was also identified that the Danish standard DS 469, which states that heat pump must be able to cover the heating demand for a house down to 7 °C without the use of a heating element, in some cases can lead to a lower efficiency. In other cases it can lead to a faster response to a smart grid as the heat pump is designed with a higher capacity than before.

FACTS ABOUT THE PROJECT

IoT Category: Mainly grid services.
Goal: Improved information- and data communication infrastructure within the area of individual heat pumps to support flexible operation in smart grid systems.
Beneficiary: User, aggregators, DSO.
Data required: HP operation data, grid prices.
Analysis method: Data analytics, model- and control engineering.
Modelling requirements: Dynamic models, diagnostics, data-driven.
Quality-of-Service: Real-time.
Project participants: Insero, Eurisco, Danish Technological Institute, Neogrid Technologies Andelsselskabet Intelligent Energistyring Amba.
Time schedule: 2014-2017.
Technology availability: TRL 7.
Funding: ForskVE (Energinet.dk)
Link to webpage:
https://energiforskning.dk/en/node/15330

WP2:

In WP2 a field test was made for a heat pump with the "SG Ready" specification. According to the specification the heat pump must be equipped with 2 digital control signals (2 bit protocol) which control the heat pump to operate in one of the following four modes:

- Normal operation
- Must stop
- High
- Must max

The SG Ready specification specifies that the "Must stop" mode as a maximum can be 2 hours, but other than that there are no details about how the electrical behavior of the heat pump in the transition between the different operation modes.

Ideally, an aggregator with authority to remote control the heat pump would like the heat pump to immediately react on a control signal, to accommodate the demands

for regulation of the electrical grid. In practice, there is however some challenges with this when using the SG Ready specification, for example that the specification does not specify a reset of the blocking of the heat pump after a shutdown, which the manufacturer has encoded in the heat pump. If the aggregator controls a pool of heat pumps this is not necessarily a problem, however if only one heat pump is controlled it would not be able to participate in the grid event on the desired point in time.

In the field test it was tested how the heat pump reacted when the "must stop" operation was switched off. In general the SG Ready specification does not specify details how the heat pump should react on the control signal, and it is up to the heat pump manufacturer themselves to define this. This means, the aggregator needs to modify its smart grid control to many different products which is not optimal.

The result from the field test showed that the 2-bit control concept is applicable to remote control a heat pump, however, some issues were observed during the field test. Among other things, that the heat pump after a shutdown was locked for 20 min in all conditions, and that the integral function of the degree minutes (a measurement of the current heating requirement in the house) was reset.

From the field test it was concluded that to be able to efficiently control the time for operation and electrical power use in the heat pump the SG Ready specification was inadequate. Only the Must stop function guarantees a reduction in power use. The increase in power uptake when switching to "High" or "Must max" only increased the power use momentarily if certain internal requirements was met in the heat pump, and if there is a heating demand in the house. The tested heat pump was an on/off controlled heat pump. If a frequency-controlled heat pump was used, it is expected that the heat pump better would be able to increase its power consumption instantaneously. It is however still required that there is a heating requirement in the house in order to be able to take up the heat from the heat pump. This problem could be reduced if the SG Ready specification also set requirement to a certain heat storage capacity for the heat pump installation, in order to issue a SG Ready specification for a heat pump.

WP3:

The developed principle for the datahub made in WP3 is shown in Figure 2.

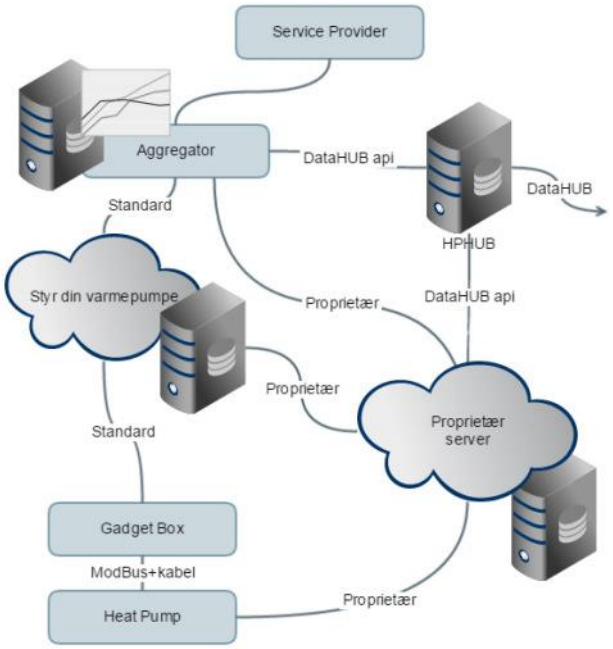

Figure 2: Principle for heat pump datahub (high level).

The developed principle includes several stakeholders with the following roles:

- End-user: Seeks optimal indoor climate with low cost and high energy efficiency.
- Manufacturer of heat pump: Needs remote data for maintenance of heat pump
- Aggregator: Owns and operate an IT system which can automatize the technical data collection and control the pool of heat pumps.
- Service provider: Sells services to the end user, e.g. smart control of the heat pump in relation to comfort and the electricity market.
- Balance responsible for the electricity grid: Has access to the electricity market regarding production and consumption, and hence is connected to the service provider.
- Heat pump datahub: Central data register with user accessible data for the heat pump.
- National datahub: Central and independent IT system to handle measurement data and business processes.
- Net company: Responsible for reading and sharing of measurements from electrical meters to the national datahub.

WP4:

In the strategy and roadmap work for expanding heat pumps potential for flexible use of electricity, the following points were identified as key enablers:

- Increased economic incentives with higher focus in variable electricity prices.
- Simplified administration and procedures for separate final settlements of heat pumps energy production and use.
- Implementation of standards for communication on an international level.
- Smart grid hardware and software needs to be developed further, and integrated in the control of the heat pumps and be a requirement for subsidies.

WP5:
The activities and knowledge base from HPCOM were in a longer period continued on the homepage www.hpcom.dk. However, the co-operative "Andelsselskabet Intelligent Energistyring was not continued after the project, as the electricity market at the time of the end of the project (2017) had relatively small variations. In addition to this, the legislation at this time did not create a high enough push for this kind of platform. Instead the heat pump manufactures have to a higher degree developed each of their own smart grid solutions, compared to a more shared platform.

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