FHP

Flexible Heat and Power, connecting heat and power networks by harnessing the complexity in distributed thermal flexibility

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The main idea of FHP is to use the inertia of thermal processes to create flexibility for the power grid. This flexibility could act as a solution to preventing curtailment of renewable energy sources, such as wind turbines and photovoltaics. In FHP there are two different demonstration sites, one in Uden (NL) and one in Karlshamn (SE). The demonstration site in The Netherlands uses large thermal storage solutions such as the Ecovat system, while the Swedish demonstration site focuses on small, distributed power-to-heat systems, i.e. heat pumps in buildings. This newsletter is an update on the *Newsletter May 2019*, focusing on the demonstration site in Karlshamn, Sweden.

All the buildings used in FHP have existing controllers and heat pumps, so for FHP they were retrofitted to make them grid-enabled. To do this, a specific sensor-override technology is used, which makes the installation less intrusive and more cost efficient than traditional building automation solutions. The hardware used for this also includes clamp-on sensors for measuring temperatures in the radiator system going into and returning from the building, while also being connected to the power meter for the heat pumps. The connection to the power meter makes it possible to follow the power usage in near-real-time. In addition to this, the FHP system also supports wireless indoor sensors. The indoor sensors have been a vital part of the project, since they support the development of mathematical models of the indoor temperature. The models are important when building control systems such as the FHP system. The indoor sensors also make sure that the comfort for the tenants stays within the pre-defined boundaries.

For Karlshamn, the FHP demonstration site consists of both industrial and residential premises. The industrial premises were described in the newsletter from May 2019. Hence this newsletter will be focusing more on the residential premises.

The residential premises in the demonstrator are three smaller multi-family buildings located in the city centre and are typically for a smaller city like Karlshamn.

The first installation is in a building with three apartments, area 316m^2. It's heated by hot water radiators supplied by one NIBE F1145-12 (3-12kW) ground source heat pump (GSHP) located in the cellar.

Figure 1: Premise with three apartments, described as the first installation, located in the centre of the city.

The second installation consists of one major building of seven apartments and one minor building of one apartment, the eight apartments amounting to 688 m2. It has a complex heating system, located in the minor building. An oil burner, an electrical cartridge and a Mitsubishi (3-10kW) air-to-water heat pump all connected to a hot water radiator system provides the heating for the two buildings.

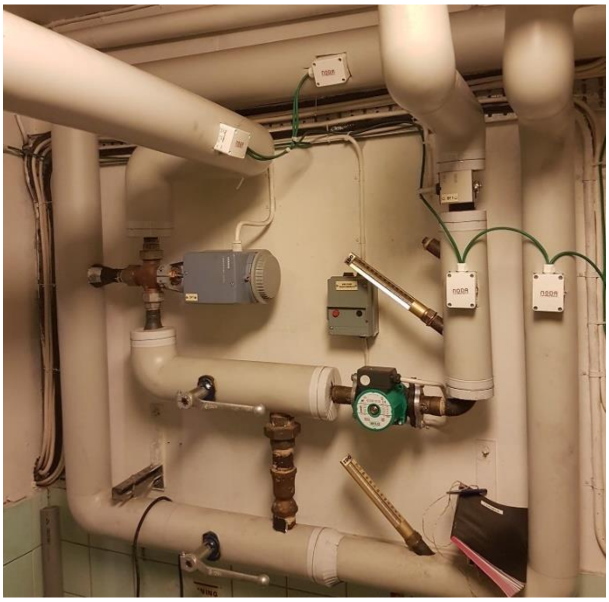

Figure 2: Clamp-on temperature sensors at place in the second installation.

The third installation consists of one major building from the early 20th century with three apartments and one smaller annex building built a couple of years ago, with two apartments of equal size – total area for both buildings are 250 m^2. As for the first installation, the third premise is heated through water radiators, while the smaller annex gets its heat from floor heating - both supplied from a NIBE F1155-12 (3-12kW) GSHP, located in the cellar of the major building.

At the pilot site different tests, based upon a test schedule, have been running during the project. Integration tests, serves to validate that the different parts developed by the partners within FHP work together as desired.

Other tests were the implementation and evaluation of different use cases (UC), predefined in the FHP project plan.

As an example: UC1 forecasts the load in the distribution grid and 24h-power profiles are calculated to let the FHP solution act on the day-ahead market.

Learnings from the installation, verification and validation of installed equipment shows potential to explore deeper in the future. Heat pumps for an example could be of different types.

On/Off: The compressor in the heat pump is either on and operating at a constant speed, or off.

Frequency controlled: The compressor can operate with variable frequency, i.e. at different speeds.

The on/off HP is more complicated to control using NODAs sensor override technology. As a follow up RISE did laboratory tests by based on the 24h- power profiles from UC1 used in Karlshamn. Which shows that a direct control is preferable when trying to steer to HP on the control signal based on a power profile, see figure 3.

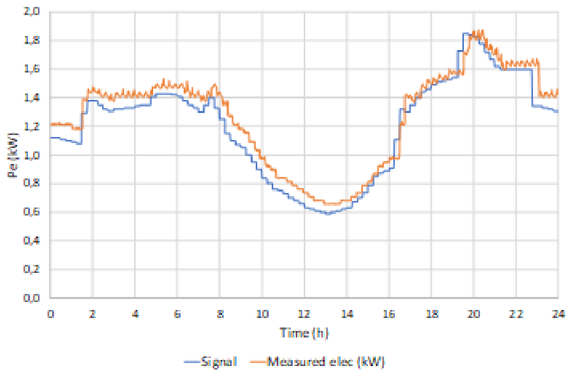

Figure 3: 24h-profile based on profiles used in Karlshamn (with some adjustments) tested in lab using direct control.

Another goal of the pilot testing was 'Data-driven building thermal characterization' with as little intervention from experts as possible. Through the exercise on pilots, we've learnt that existing infrastructures are far from ideal, to achieve expert free training of building models. But in the process, we've learnt what's needed and compiled a checklist to improve the future work making the training of models expert free.

This can go as follows:

- How many indoor temperature sensors do we have?
- Do we have direct heat meters for space heating?
- if not, is the heat pump used for space and hot water heating?
- If yes, does it do simultaneous heating, or mutually exclusive (if simultaneous heating, is there a corresponding meter for hot water tapped, if mutually exclusive, is there a way to tell when the heat pump is active for space heating)?
- Do we have sensors for the supply, return and mass flow rates (placed in the right place, is the supply return from space heating exclusively, does it have mixing from DHW etc)?
- If not do we have the meter readings for electricity, being consumed only by the heat pump?
- Are there any extra heating installations (oil boilers, electric room heaters)?
- How long has the building been commissioned, how much historical data is available.
- How easy or difficult is it to install new sensors.

More results and learnings will be published on our homepage as soon as the ongoing final work with the reports are finished.

Partners

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