Case Studies

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ANNEX 57

Flexibility by implementation of heat pumps in multi-vector energy systems and thermal networks

Demo No.: D-002	Location/City: Uppsala	Country: Sweden
Project name (short and full title): New forms of cooperation in the energy market (#klok_el)		
Quotation: "We are convinced that demand-flexibility through aggregators will be a very important issue in our future energy systems."		
Schedule of the demo project (research study): 2014 - 2018		**Year of realisation:** 2018
Leader organisation (owner, constructor, solution developer, research inst., etc.): Sustainable Innovation AB		
Participating organisations – demonstration project part (involved other organisations): Ngenic AB, Enertech AB, Upplands Energi AB		
Budget of the demo (invest/monitoring etc.):		

Summary of the project:

In 2014, Sustainable Innovation AB together with Ngenic AB, whose focus is energy efficiency and optimizing, the local energy company Uppsala Energi AB and the heat pump manufacturer Enertech AB started the project *"New forms of cooperation in the energy market",* co-financed by the Swedish Energy Agency. The purpose of the project was to engage both customers and electricity grid companies to reduce the energy consumption used for heating at times when the electricity grid is overstrained and thereby also reduce the power peaks in the grid. The aim with the project was to demonstrate an achievable controllable demand response of 1 MW using Ngenics heat control installed in 500 single family buildings with hydronic heating systems.

New forms of cooperation between customers, grid companies and electricity retailers has become more popular and user friendly when it comes to smart electricity grids and online products which contributes to energy efficiency and power balance. An important advantage with these smart grids is that it enables a more flexible distribution of electricity where customers have the possibility to transfer parts of the control of their usage to electricity grid companies in order to balance the load in the electricity grid.

The project proved that with controlling 250 systems (different types of heat pumps and electric boilers) it is possible to achieve 1,5 MW demand response by morning and evening stops. The indoor climate and comfort among the costumers are not affected but instead more stable. In order to cover longer time spans and larger powers, larger groupings and more systems in groups can be used and then relieved to have as little individual impact for the end user as possible. This new efficient control has subsequently led to energy savings for heat pumps up to around 10 % since solar radiation is utilized in a more efficient way, besides a more consistent temperature can be maintained. This

control is based on the costumers hydronic heating system and is therefore easily adjusted when the electricity grid is strained. The system itself is controlled by three devices which measures the temperature indoors and outdoors as well as the amount of solar radiation. These measurements are then compiled in order to automatically optimize the indoor climate based on the data collected by the units.

Another aspect has also come to play a role in the project where the costumer participation is in focus. Initially, it was thought that it would be difficult to entice people to participate in the project even though it was not needed to be financed privately, but after a certain period it was seen that not only was the systems and installation free of charge, but as a costumer also got better indoor climate conditions and a certain energy efficiency. This project creates the conditions for bringing 100 % renewable energy into the electricity grid.

Results

- Through improved control, the system has been stabilized and therefore contributed to energy efficiency
- By controlling the systems, an energy saving is made to around 10 %
- The project has had a substantial contribution to increased knowledge of how demand response can simplify renewable energy production
- Positive feedback from participating costumers in the project
- The project was able to reduce power peaks in the grid by 1,5 MW using demand response from 250 single family houses with hydronic heating systems

Published articles (paper, article etc.):

- Lindborg et al, (2018). Nya samverkansmodeller på energimarknaden, Eskilstuna (In Swedish).

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Picture/Map (eye catcher)

If available Homepage address: https://sustainableinnovation.se/projekt/nya-samverkansmodeller-pa-energimarknaden-klok_el/

Project classes:

RD&D status

Large-scale demonstration	Small-scale demonstration	Lab scale (results based on measurements)	Design study (results based on simulation)
☐	☐	☐	☐

Type of heat pump

Decentralized HP (cold district heating)	Centralized HP with a district heating system
☐	☐
Heating	Cooling
☐	☐

Heat source of HP: Geothermal probes

Power supply for HP (electricity grid, PV, wind turbine etc.): electricity grid

Buildings

New buildings	Existing buildings	Mix of new and existing buildings
☐	☐	☐
Residential	Non-residential	Mixed use

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☐	☐	☐

Energy storage

Battery storage		Thermal energy storage	
Centralized	Decentralized	Centralized	Decentralized
☐	☐	☐	☐

Control for the flexible heat pump operation

Heat driven control[1]	Predictive control[2]	Rule based control[3]
☐	☐	☐

1. General description of the project

Suggested content:
background / location / main objectives of the project / project organisation / budget and schedule etc. / general description of the system.

Additional pictures/Schemes etc.

2. Building and system description of the project

[1] Operation of heat pumps to the cover heat demand depending on ambient temperatures
[2] Operation of heat pump using a model based heat demand prediction
[3] Heat pumps are controlled by a set of predefined rules (e.g. heat pump operation with blocking time)

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Suggested content:
system concept and optimization / innovative components /description of measurement data or simulation results / software tools etc.

3. Energy supply – scheme of the heat supply system:

Suggested content: description of the heat supply system (including strategies for the transformation of district heating system - especially for existing district heating systems)

4. Flexibility – scheme and control strategy of the system:

Suggested content: Scheme of data collection and handling

5. Description of the business model with a flexible HP-operation

Suggested content: energy saving potential / cost saving potentials (investment and operating cost) etc.

6. Results of the project

Suggested content: energy saving potential / cost saving potentials (investment and operating cost) /CO2 Reduction / integration of renewable sources etc.

7. Challenges / socio economical barriers and opportunities

Suggested content: discrepancy between value offering and customer needs / risk related / cooperation with stakeholders / installation of heat pump (e.g. limited available space for the heat pump installation, using existing heat centre etc.) / revenue structure etc.

8. Additional information: Flexibility options

Share of heat sources (in %)	1. Heat source: 2. Heat source: 3. Heat source:	%
Share of power supply (power grid, PV-units at site, wind turbine at site etc.)	1. Power supply: 2. Power supply: 3. Power supply:	%
System boundary by calculation of the SPF		
Seasonal performance factor in design and measured (SPF)		
COP of HeatPump at the design condition (point in °C or traverse as function in °C), independent of site boundaries		
COP incl. all peripheral devices at source and sink side		
Location of heat pump (e.g. heating centre (centralized heating installation), using existing infrastructure etc.)		

Contents: district heating network

Land area for buildings served by heat distribution network		m²
Total heated floor area in buildings connected		m²
Trench length for heat distribution network		m
Heating capacity		kW
Heat annually supplied into the heat distribution network		MWh/a
Heat annually delivered from the heat distribution network		MWh/a
Annual average supply temperature in the heat distribution network		°C
Annual average return temperature in the heat distribution network		°C
Heat generation based on renewable sources		MWh/a
Share of renewable sources		%

Contents: description of energy storage system

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Energy storage type:	
Storage size (capacity):	
Term of flexibility:	
Storage temperature (thermal energy storage)	

Contents: indicators for flexible heat pump operations

Cost (potential cost saving)		
Thermal level (losses of thermal comfort)		
Load matching factors (load supply & load cover factors)		