

Large scale demand response of heat pumps to support the national power system (SLAV)

RISE Research Institutes of Sweden

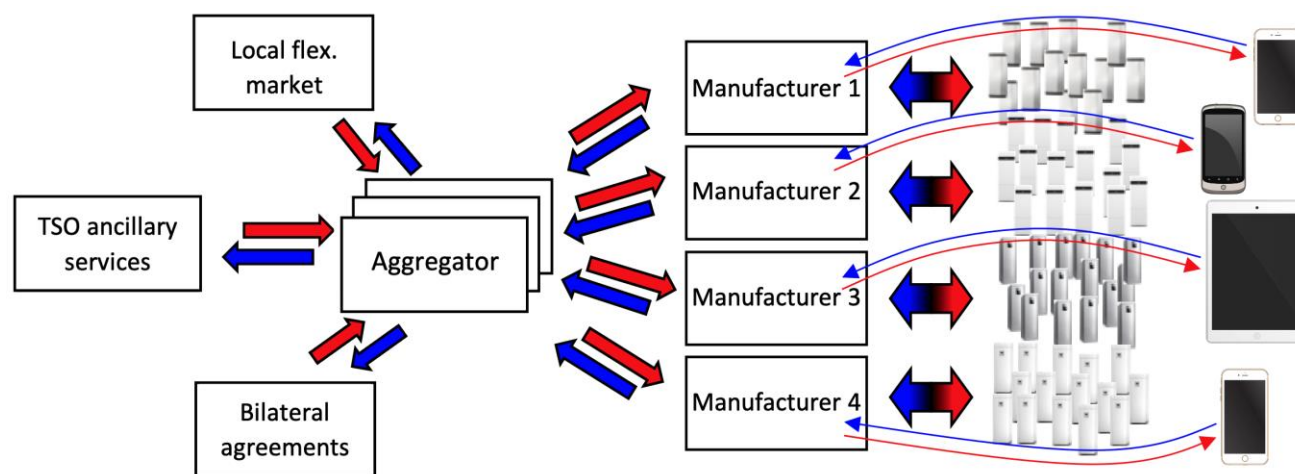


Figure 1: Overview of the communication flow for demand response from heat pumps using the manufacturers cloud solution.

Summary

In a power system with an increased share of electricity from intermittent renewable sources, such as wind and solar, a more flexible electricity consumption will be needed. The project has investigated possibilities and constraints for a concept where residential heat pumps are aggregated and controlled via the manufacturers cloud service to support the power system with demand response with focus on Svenska kraftnäts ancillary services, local flexibility markets or bilateral agreements.

The project covers several aspects, such as barriers related to technical constraints in the heat pumps and the electricity market as well as potential communication standards and cybersecurity. The results are based on expert interviews, literature review and field tests. Even though the project focuses on Swedish conditions the results are likely relevant in several countries.

Controlling individual heat pumps for demand response via the manufacturers' already existing cloud and application programming interface (API) would enable rapid deployment of heat pumps as a flexibility resource.

The manufacturers' cloud and API solutions have been in use for approximately ten years, which means that many installed heat pumps are ready to be used for flexibility purposes once the communication is in place. In Sweden all the major manufacturers of hydronic heat pumps provide users with functionalities for controlling and monitoring their heat pumps via an app, by connecting the heat pump to the manufacturer's cloud infrastructure. From a control point of view, functionality is still lacking to enable demand response to the power system via these cloud services, but as the hardware is in place since several years, the potential of heat pumps with the hardware already installed is assessed as large.

Results

Results from the project shows that the Swedish electricity market has several barriers that hinder heat pumps from offering demand response. One barrier is the minimum bid size for the balancing markets, which requires aggregating many heat pumps. Another barrier is the need to have the same balance responsible party (BRP) for all customers in a bid, but there are several BRPs in Sweden. A third barrier is the demand of real-time measurement of flexibility resources by the balancing service provider. This is a potential problem since today's heat pumps lack electricity meters, which risk to lower the accuracy of demand response measurements.

Within the project technical experts from the heat pump manufacturers were interviewed. They have a common ground in how fast their heat pumps can be controlled to decrease or increase power consumption. The auxiliary heater can change power in a second, but it may need new software adapted for flexibility. On/off compressors can also be turned off in a second, but they need some time to restart. Variable speed heat pumps are much slower to change power. It can take minutes to start or stop them or control their speed when they are already running.

For the communication between aggregator, the cloud service, and the individual heat pumps there are existing communication standards to use. A first, high level evaluation points out four interesting alternatives. OpenADR and IEEE 2030.5 are two US-based standards that seems to have great potential for enabling demand response from heat pumps. A potential drawback is that they are not that common in Europe today. Interesting European alternatives are EEBus and EFI/S2. All these four standards are free to use or can be bought at limited costs.

Heat pumps need to be controlled over the Internet to effectively contribute to flexibility. This can, as for all Internet-connected devices, make them vulnerable to cyberattacks. On top of

ensuring secure interaction with heat pumps, a key cybersecurity challenge stems from the long lifespan of the heat pump systems. Heat pumps are expected to operate for at least 15–20 years and new cyber threats may demand software and even hardware updates for many years.

The threat from cyber-attacks must be taken seriously as hacked heat pumps could, at least in the future, cause severe problems not only for the heat pump owner but also to the national power system.

FACTS ABOUT THE IOT CASE

IoT category: External control of heat pumps to support power grid with demand response

Heat supply: Residential heat pumps with hydronic heating systems

Heat source: air-, exhaust air- and ground source

Analysis method Expert interviews, literature review and field tests

Technology Readiness Level: Full concept: TRL 2, parts of the concept TRL 5

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