Flexi-Sync

DELIVERABLE 4.2 – DEMAND FLEXIBILITY CONNECTED THROUGH SMART HEAT GRID

VERSION 1.0

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About ERA-Net Smart Energy Systems

ERA-Net Smart Energy Systems (ERA-Net SES) is a transnational joint programming platform of 30 national and regional funding partners for initiating co-creation and promoting energy system innovation. The network of owners and managers of national and regional public funding programs along the innovation chain provides a sustainable and service oriented joint programming platform to finance projects in thematic areas like Smart Power Grids, Regional and Local Energy Systems, Heating and Cooling Networks, Digital Energy and Smart Services, etc.

Co-creating with partners that help to understand the needs of relevant stakeholders, we team up with intermediaries to provide an innovation eco-system supporting consortia for research, innovation, technical development, piloting and demonstration activities. These co-operations pave the way towards implementation in real-life environments and market introduction.

Beyond that, ERA-Net SES provides a Knowledge Community, involving key demo projects and experts from all over Europe, to facilitate learning between projects and programs from the local level up to the European level.

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1 DESCRIPTION OF DEMAND FLEXIBILITY

1.1 Demand side management system overview

The purpose of this deliverable is to describe the implementation of demand side management used in the Flexi-Sync project. This is based on the NODA Heat Network system in general and the DSM (Demand Side Management) module in particular. Figure 1 shows a conceptual overview of the DSM module. The core parts of the system are the Forecaster, Planner and Tracker that works with the vDERs (virtual Distributed Energy Resources). The first three operate on network level while each building (or control node) is represented by an individual vDER.

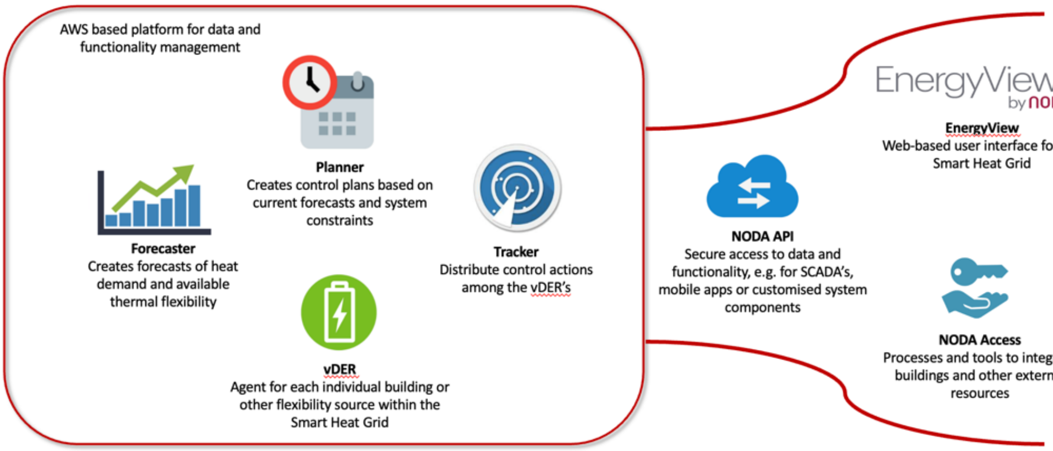

Figure 1: Overview of the DSM module in NODA Heat Network

Demand Side Management dynamically changes the demand boundaries by actually controlling the demand. The system actively correlates the demand to the operational requirements on production and distribution level, while still ensuring full quality of service among the customers. The system uses self-learning modelling on building level to create demand and response signatures of each customer. This complexity is manged within the system, while the network operator or external system can easily take full advantage of the thermal flexibility that the system harvests among any number of buildings. Figure 2 shows an overview of part of the user interface for the NODA Heat Network system.

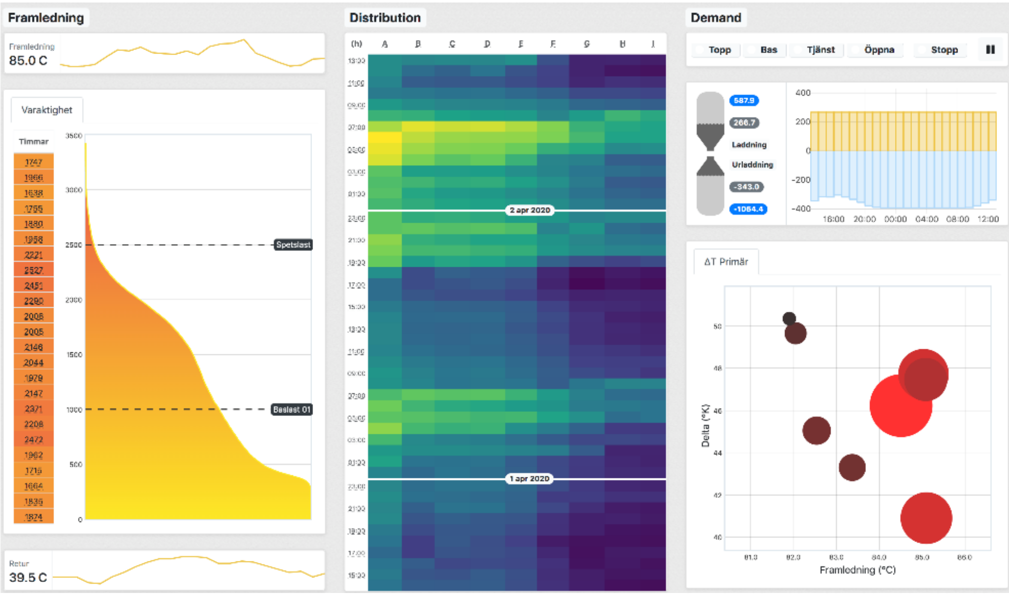

Figure 2: Screenshot of the EnergyView system of NODA Heat Network

Demand side management can work in many different ways depending on the requirements of the specific heat network. The most common application includes peak load reduction and demand profile balancing. Peak load reduction can be triggered reactively or proactively, or a combination of both. One common example is to use the differential pressure as a reactive trigger to the system. Another reactive trigger might be the activity of peak load boilers. Demand profile balancing normally uses proactive planning, based on heat demand forecasts. By reducing peaks and filling valleys in the profile, it is possible to change the demand profile while still delivering the same amount of energy. Demand Side Management can be combined in several different ways. Other common applications include active control of the return temperature, for the benefit of flue gas condensers, acting as virtual storage tanks to expand the capacity of its physical counterpart or being used as a “suspension system” for other parts of the NODA system.

In the Flexi-Sync project, the DSM module is integrated with the Utilifeed production optimization system. The Utilifeed system includes a digital twin of all production units, the distribution grid and all other buildings in the grid that are not providing flexibility. Together, these systems enable a co-optimization of the whole production and demand side in a district heating system and form the basis for the practical development in the Flexi-Sync project.

1.2 Response testing

The NODA system is self-learning in the sense that it uses data-driven methods to create models of the underlying thermal processes. This makes it possible for the system to estimate available thermal flexibility. An important part of that self-learning process is the usage of response testing. This basically means that the system performs control actions of different intensity and length, and then based on this is creates a model that represents the operational behaviour of the control point in question.

Figure 3 shows an example of a single response test. The purple line at the top is the supply temperature on the secondary side of the heating system, while the blue, somewhat jagged, line is the current demand in kW. In the middle of the figure a control action can be seen, and the purple and blue lines respond accordingly. During response testing both increase and decrease of default behaviour is performed.

Figure 3: Example of response test

2 DEMONSTRATION SITE IMPLEMENTATIONS

Demonstration site overview

There are six demonstration sites in Flexi-Sync, although only four of those include active control using NODA software on the demand side. All four sites have different types of access integration. Figure 4 shows a schematic overview of these four alternatives.

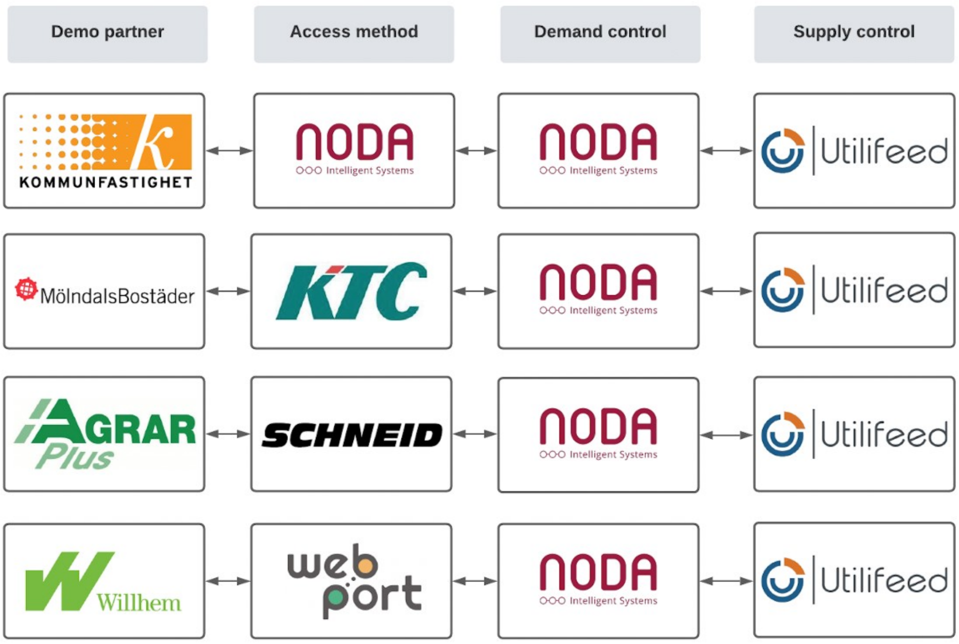

Figure 4: A schematic overview of the different control access integrations

Further elaboration on all six demonstrations sites is available below.

2.1 Mölndal (Sweden)

The Mölndal demonstrator is a traditional district heating system based on a combined heat and power (CHP) plant in combination with multiple heat boilers. The network delivers about 300 GWh annually. In the demonstration project, three buildings are connected to the Flexi-Sync system with the focus of evaluating the available thermal inertia. These buildings are using district heating as their sole source of heating for residential heating as well as domestic hot water. The buildings are all three of very similar type, i.e. multi-family residential buildings.

The buildings are connected with a KTC building controller system. Using gateways, the NODA system has been integrated with KTC. This KTC system includes aggregated data from indoor sensors, and this is also available to the NODA system through the same integration. Response testing has been performed and functionality is verified. Additional indoor data from individual sensors have been made available for one of the buildings by using the existing Ecoguard system. NODA already has an integration for Ecoguard and this was re-used within the project to gain access to that particular dataset. The added indoor sensors provide a good possibility to evaluate the impact on indoor climate in further detail.

2.2 Borås (Sweden)

The Borås demonstration site is district heating system using multiple combined heat and power generators as well as several heat water boilers using bio-mass, municipal waste and bio-oil. The system set-up also includes a 1.8 GWh thermal heat storage which is used to balance the heat demand of the network. The district heating system generates about 600 GWh district heating energy annually. Two multi-family residential buildings are part of the demonstration site. Both of these buildings feature a combination of heat pumps and district heating substations. The primary purpose of this demonstration site is to evaluate the combined use of heat pumps and district heating in relation to how they can be controlled from an optimisation perspective.

The buildings in the Borås site uses the Webport data management system to connect with the underlying heating controllers. The NODA system has been integrated with the Webport system in order to access the required data. End-to-end testing between Webport and NODA has been performed. Aggregated indoor temperature measurements are available through the Webport system. Response testing has been performed and functionality is verified.

2.3 Eskilstuna (Sweden)

The Eskilstuna demonstration site is a traditional district heating system with about 700 GWh of annual energy sold. The network has combined heat and power working in combination with a heat boiler. Both of these use bio-mass as the main fuel. In addition to this, the network also has four bio-oil boilers for peak capacity. The system also has four fossil oil-fired boilers in reserve. The demonstration area in Eskilstuna comprises two multi-family residential buildings. One of these buildings use district heating only for residential heating and domestic hot water. The other building also uses district heating, but combines this with a heat pump using hot air from the building ventilation exhaust as heating source. The focus of this demonstration site is to utilize the building inertia as well as to explore the co-existence of the district heating substation and the heat pump.

The demonstration site in Eskilstuna uses sensor override technology from NODA to integrate with the buildings in question. This relates to both district heating and heat pumps used in the project, and the different control points are accessed separately. In addition to this, indoor sensors have been installed to capture the dynamics of the buildings. All this sensory equipment is available through the NODA system. Response testing has been performed and functionality is verified.

2.4 Maria Lach (Austria)

The Maria Lach demonstration site is a district heating system with about 1.6 GWh of annual district heating delivery. The production is based on a heat plant using biomass from agricultural residues as a source of fuel. The system also includes a central storage tank as well as distributed storage tanks at the consumer side. There are also plans to add a combined heat & power generator in the future. There are currently three buildings that can be controlled within Flexi-Sync. However, all buildings, as well as production units, are already connected with a Schneid data management system, so this dataset is available for analysis-only access. The purpose of the demonstration site is to evaluate the ability to access thermal flexibility of the buildings, particularly in relation to optimizing the operations of the future combine heat & power unit.

The NODA system has been integrated with the Schneid controller system. As Schneid is used for both production and consumer installations in this demonstration site, this data is all available through the NODA system. The system integration between NODA and Schneid is done in collaboration with an Austrian partner to NODA as part of a sub-contracting scheme. Response testing has been performed and functionality is verified.

2.5 Berlin (Germany)

The Berlin demo site has been changed to a new site at Biesdorf, Grüne Aue. This site uses an innovative set-up including using heat pumps to extract heat from municipal wastewater and photovoltaic energy for the heat pump. The system is complemented by a gas boiler for peak management.

At this new site there won't be an opportunity to use flexibility in an operational live test. Demand flexibility is still a part of the demo site though simulation where measurement data from the other sites are used to create a model of the potential flexibility at this site. The model is then further configured and tuned based on the local conditions for the site in order to provide as realistic results as possible.

2.6 Palma de Mallorca (Spain)

Sampol operates the district heating system of the University of the Balearic Islands (UIB). In one of the buildings, the Campus Sport, there is a heated pool that is under study for demand response. The building has domestic hot water demand, HVAC demand and heated pool demand, with an auxiliary boiler in case the district heating is not able to cover the building demand. This auxiliary boiler is less efficient than district heating and is less environmentally friendly. The purpose of this demonstrations site is to support a reduction of usage of the auxiliary boiler by demand response based on the thermal inertia of the heated pool. Sampol is capable of operating the pool set point temperature ±0.7ºC, in a pool of 1500 m3.

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