Flexi-Sync

Flexible energy system integration using
concept development, demonstration and replication

DELIVERABLE 4.4 – FEATURE COMPLETE OPERATIONAL CO-OPTIMIZATION

VERSION 1.0

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ERA-Net Smart Energy Systems

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Smart Energy Systems ERA-Net

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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.

www.eranet-smartenergysystems.eu

1 SCOPE OF DELIVERABLE

The scope of this deliverable is to improve on D4.3, the minimum viable version of the co-optimization, and make it feature complete. By feature complete, we are referring to that the optimization should include all features that were specified in the project application. Features does not necessarily need to be polished enough to fit in a future commercial release of the co-optimization, but they should at least be in a prototype state where they add value to the demo sites they are tested on.

The largest part of this deliverable (D4.4) is release of several updates to Utilifeed Optimization Software (UOS), that add new features and/or improve on features included in D4.3, the minimum viable version of the co-optimization. The operational co-optimization now includes all features that were specified in the project application, presented in Table 1.

Table 1. List of features defined in the application and a plan for which demo site that will be utilized for testing and verifying each feature.

Demo site	AGR	SAM	VAT	MOE	BEM	EEM
Machine learning demand forecast	Yes	Yes	Yes	Yes	Yes	Yes
Operational co-optimization (Flexibility and production side)	Yes	Yes	Yes	Yes	Yes	Yes
Demand flexibility: Building thermal storage	Yes	Yes	Yes	Yes	Yes	Yes
Demand flexibility: Building heat pump	No	No	No	No	Yes	Yes
Grid flexibility	No	Yes	No	No	No	No
Electricity trading: Bid suggestions	Simulation only	2 day ahead (retroactive prices)	Day-ahead Intraday Balancing	Day-ahead Intraday Balancing	Day-ahead Intraday Balancing	Day-ahead Intraday Balancing
Other	-	Optimization also apples to district cooling grid.	Trading with other connected heat grids. Optimize use of PV.	Trading with other connected heat grids.	-	-
TRL Start of project- TRL End of project	TRL 3- 5	TRL 6-7	TRL 7-8	TRL 6-7	TRL 6-7	TRL 6-7

The demo site testing is not part of this deliverable, but it has been very valuable for providing feedback on the co-optimization service that has improved features and usability. At the time for publication of this deliverable, five demo sites has tested a full solution of the co-optimization in their daily operation through a web interface. The co-optimization has also interacted with the control systems for the demand flexibility and executed the control signal that is the output of the co-optimization. For the other two demo sites, the solution has been verified by running the models and analyzing the results, but the solution has not been interacting with the daily operation of the system. This verification is planned for a later date.

2 DESCRIPTION OF CO-OPTIMIZATION SERVICE

In short, the co-optimization service can be described as a set of tools that enables energy companies to optimize the operation of energy systems with a wider system boundary than what is traditionally used. The widened system boundary includes heating system in connected buildings, utilizing their flexibility for shifting heat demand in time and shifting heat source between district heat and heat from heat pumps.

The service includes the Utilifeed Optimization Software where a user can create a model of the full energy system and use it to optimize dispatch of heat generation, cooling generation, electricity trading, and utilization of flexibility for the upcoming hours and days. It also includes the NODA Smart heat grid which estimate the available flexibility in buildings, provide this information to the Utilifeed Optimization Software through an API and executes the control of the optimized flexibility.

1.1 Updates to major features already included in D4.3

API connection to EnergyPredict

Features in D4.3: The optimization automatically requests a demand forecast for heating and/or cooling grid(s) in the system over API. The forecasts are provided by EnergyPredict and are based on machine learning and data from every single substation in the grid(s).

Updates for D4.4: The forecast service has been updated with support for more providers of weather data, both historical data used for training models and forecast data for upcoming days. This enables the service to be used in all of Europe.

Component library

Features in D4.3: A component library with models for the following components have been created:

- Combined heat and power
- Heat only boiler
- Heat pump
- Absorption chiller
- Accumulator storage
- Dumping of excess heat
- Trading with neighbour DCH grid
- Heat recovery from e.g. subway tunnel
- Demand flexibility: Building thermal storage
- Demand flexibility: Building heat pump

Component from the library can be configured with a number of settings to accurately reflect the technical and economic conditions of each demo site. This is used as the foundation of the optimisation models that are created for each demo site. It is built as general as possible to replication at more sites after the project.

Updates for D4.4: The component library has been updated with new components for:

- PV generation
- Support for different fuels

- Configuration of connections between components
- Electricity price forecasts
- Distribution grid flexibility

Model generator and solver

Features in D4.3: Based on the input data for components and forecast for e.g. thermal demand, models are generated and sent to a solver that solves for the optimal dispatch each time an optimization is requested.

Updates for D4.4: Performance has been much improved and support has been added for running simulations for significantly longer time periods than the maximum of 10 days that was possible with the initial release.

Front end

Features in D4.3: A basic web interface has been created where the user can request the optimization and view the result in three graphs.

Updates for D4.4: The interface has been improved based on user feedback. Largest update is giving the user an interface for in depth configuration of the components in the system.

Back end infrastructure

Features in D4.3: The service has been integrated in Utilifeed Data & Analytics Platform and adjustments to existing and development of new back end infrastructure has been carried out. The service now runs on a scalable back end in a cloud environment that enables it at a later stage to be used daily at all six demo sites. Model configurations are stored in the back end for each demo site.

Updates for D4.4: Services has been updated to make the solution more robust and ensure it will work for more use cases.

1.2 New features in D4.4

Flexi connect API

An API connection has been set up between NODA smart heat grid and the Utilifeed platform. This API enables the Utilifeed platform to request forecasts for available flexibility in the connected building. Forecasts are available for both types of demand flexibility in this project: Building thermal storage and Building heat pump.

The same API is also used for sending plans for optimized utilization of the flexibility from Utilifeed Optimization Software to NODA smart heat grid.

The API has been included in live tests on all five demo sites that have demand flexibility through NODA smart heat grid.

Electricity trading

Utilifeed Optimization Software has been updated with support for optimizing electricity trading on different time horizons. This optimization is based on a forecast for electricity prices for the optimization period of the upcoming hours and days. The forecast is taken into account when optimizing the dispatch of all components that either generate or use electricity and specific taxes and/or fees can be set on a component level since they might be different for different components. The components that this optimization applies to include Combined heat and power, Heat pumps in district heating grid and Heat pumps in buildings with demand flexibility.

The optimization based on the electricity price forecast is the basis for deciding when the components should be operated and placing bids on Day-ahead or similar markets. The optimization also outputs marginal costs for each hour in the optimization period. This information can be used to assess the value of heating energy and electricity for the local energy system each hour. Based on this information and the prices set by Day-ahead and similar markets, bids can be made on shorter energy markets such as intraday or balancing.

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