Project: EnergyFlexLab

Figure 1: Main components in EnergyFlexLab.

Summary of project

EnergyFlexLab consists of a number of laboratories testing energy components and systems for a future flexible energy system, with increasing demands for intelligent control and sector coupling. The lab setup is testing real life scenarios of how much flexibility coupled technologies such as solar panels, battery systems, heat pumps and electric car chargers can add to our energy system.

The EnergyFlexLab test environment is a platform supported by smart grid and smart energy system knowledge and linked to a number of existing laboratories:

- Battery lab with accredited safety tests, single cell and pack level lifetime test facilities and grid connected Battery Energy Storage Systems (BESS).
- Heat Pump labs with testbeds for both small and large heat pumps and thermal storage.
- Electric Vehicle-lab with EV-chargers and test facility for EV-batteries.
- Energy efficiency labs e.g. EnergyFlexHouse with solar panels, which is a high-tech laboratory where complete, innovative energy solutions for the building industry can be developed, tested and demonstrated.

The infrastructure for EnergyFlexLab allows manufacturers of intelligent and embeddable energy components to have testing performed which supports a wide range of activities such as:

- Flexibility testing of intelligent components e.g. the optimization of simultane-

ously operated heat pump, PV inverter and EV charger.

- Data harvesting from industrial areas, ports, airports, construction sites etc.
- Household battery system dynamic testing for annual efficiency, flexibility etc.
- Testing of the ability of intelligent components to be controlled / controlled remotely.
- Simulation and models for flexible energy systems to optimize operating economy, combined energy efficiency, climate effect and component life.
- Knowledge and testing that supports integration with cloud- based solutions such as weather services, electricity market etc.

Hence the test facilities in EnergyFlexLab provides an opportunity to investigate how heat pump most optimally is to be used in future energy systems where the share of heat pumps are expected to increase. E.g. it can be investigated how better sector coupling between solar panels, batteries, and heat pumps can be done.

One of the concepts with EnergyFlexLab is that the components are self-protected, hence inputs for changing setpoints is only allowed within a certain range with safe operation.

Data, communication, and interfaces

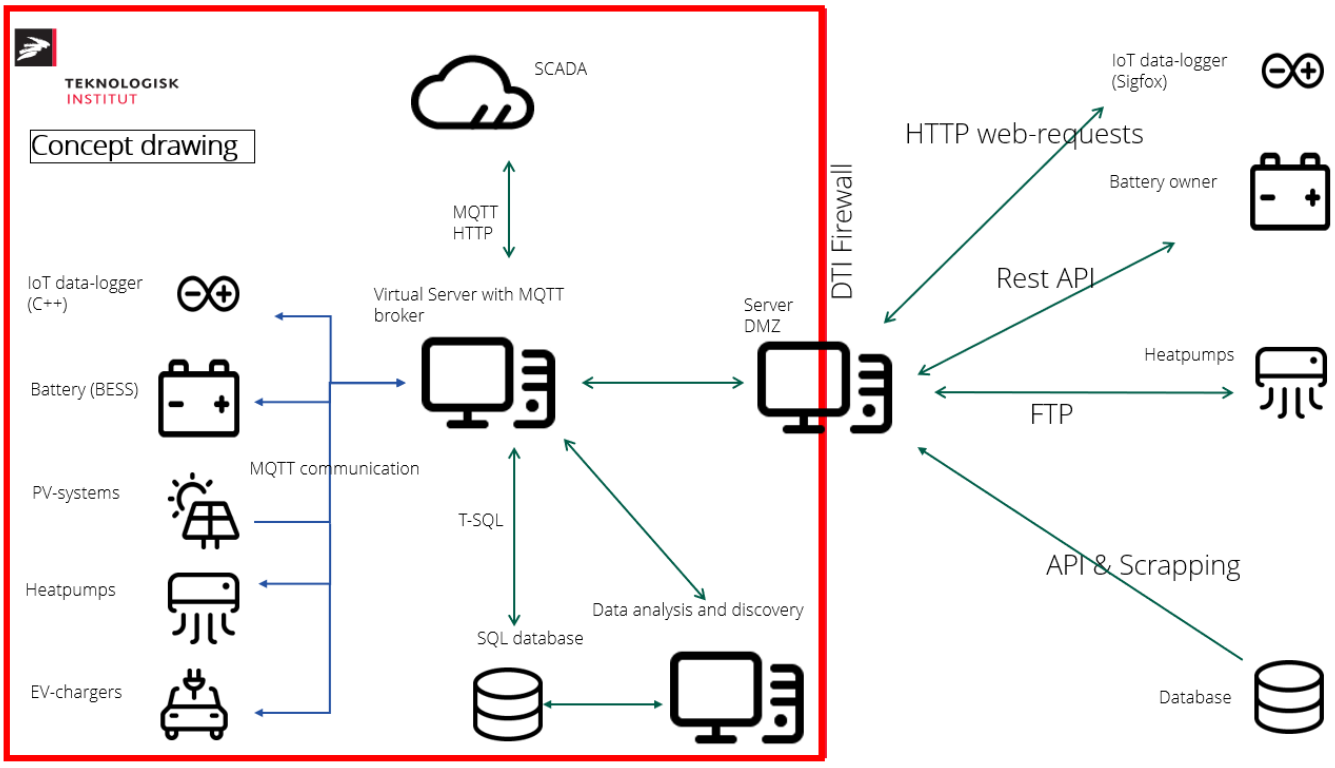
A key-feature of the EnergyFlexLab digital infrastructure is a modular setup that enables easy installation of new components and/or digital services "on-the-fly". Adding a new component and/or digital services does therefore not interrupt currently running tests at the EnergyFlexLab platform.

EnergyFlexLab as a digital platform located on its own separated virtual-LAN network within the IT system of Danish Technological Institut (DTI). This gives some extra benefits in both security and performance:

- Only systems with a granted access to the EnergyFlexLab LAN can see and control communication between components.
- A dedicated bandwith for fast and efficient data-communication between components whether they are located at DTI facilities in Aarhus, Odense or Taastrup.
- Dedicated access control for external customers who can get access to interact with specific components in EnergyFlexLab – and nothing more.
- The possibility to allow specific dataflow between EnergyFlexLab and external data-sources e.g. REST API, FTP-servers, Sigfox devices and more.

Besides energy components some core features are connected to the virtual-LAN as the IT-infrastructure backbone of EnergyFlexLab (please see Figure 2):

- SQL database where all data and metadata from components are saved for later analysis of historical data.
- Virtual servers with several controlling- and analysis-algorithms and feedback-loop to optimize the smart control.
- A frontend SCADA developer-tool referred to as YoDa (Your Data), where DTI-employees can share code and develop together. With this SCADA tool online interactive dashboards and control-systems are created and made accessible for external customers.
- A MQTT data communication protocol that enables fast and asynchronous data communication between components, servers and dashboards.



Concept sketch – EnergyFlexLab.

- Custom made data-acquisition devices that connects external components to the EnergyFlexLab platform for "Hard-ware -in-the-loop test".

This backbone of EnergyFlexLab makes the digital platform highly scalable, flexible, and easy to use across employees on DTI. The platform fills the needs of both DTI and the customers and partners, with whom DTI is working with.

Example

An example of the use of EnergyFlexLab is in the project "Future Green Construction sites", where a setup for intelligent electricity to a construction site is developed and demonstrated. Components in this energy system is e.g. electric vehicles, solar panels on the site hut, which is being heated by heat pumps, and energy storages which reduces the expenses by charging outside normal working time. This project helps to support the standards for how a construction site optimizes both its energy supply and use.

Another use of EnergyFlexLab is in the EU Horizon2020 project "ALIGHT" where European airports and stakeholders in the field of aviation together create the tools for a sustainable future of aviation. The project leader of "ALIGHT" is Copenhagen Airport, Denmark, which also act as the demo-site of the 4-year long project. One goal in the project is the implementation of a "Smart Energy Management System" for efficient and optimized use of sustainable energy from PV-systems by controlling e.g. BESS, buildings (electricity and HVAC) and electrified vehicles chargingpoints. The "Smart Energy Management System" is currently being tested in Energy-FlexLab to help the creator (a danish SMV) to optimize and test the control-algorithms before implementation in the real-life application.

FACTS ABOUT THE PROJECT

IoT Category: Grid services and optimized heat pump operation.
Goal: Provides opportunity for test of heat pumps systems in future flexible energy systems with sector coupling.
Beneficiary: Manufacturer and operator
Data required: Operating data for components in energy system and forecast inputs.
Analysis method: Analysis of heat pump operation during dynamic changing operating conditions.
Modelling requirements: An example is to use a dynamic model of a heat pump made in Dymola (Modelica) using the TIL library from TLK as starting point. Communication between model and EnergyFlexLab can be made with a Functional-mock-up-unit (FMU).
Quality-of-Service: Real-time
Project participants: EnergyFlexLab facilities is e.g. used in the Horizon project “Smart Island Energy Systems (SMILE)” and “ALIGHT”.
Time schedule: EnergyFlexLab facilities can be used continuously.
Technology availability: TRL 7-9 (depends on ernegy component)
Link to webpages:
https://www.dti.dk/energyflexlab-and-8211-testing-flexible-and-intelligent-energy-components/42286?cms.query=energyflexlab

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