EDCSproof

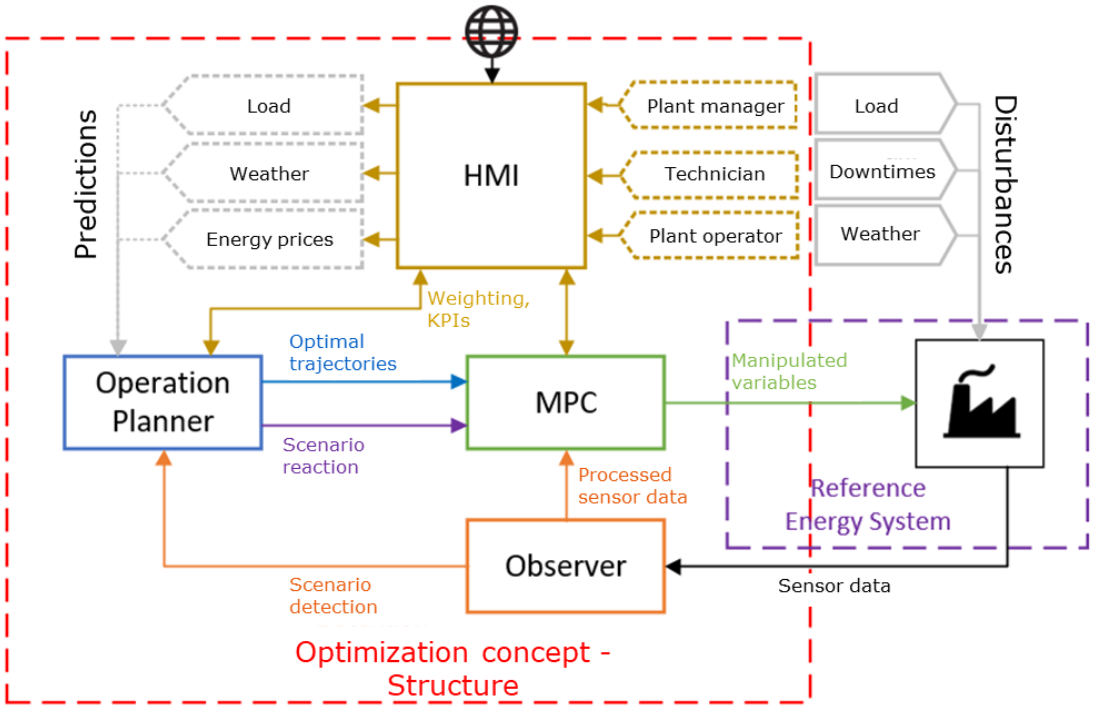

Figure 1: Visualisation of the Energy Demand Control System EDCS

Summary of project

The project Energy Demand Control System – PROcess Optimization For industrial low temperature systems (EDCSproof) developed a sustainable concept for the decarbonisation of industrial energy supply systems through the opportunities offered by digitalisation.
It is an online, predictive and holistic, reconfigurable control for industrial energy supply systems, which should enable integration of renewable energies by

- use of (thermal) energy storage
- flexible consumers for electricity networks (demand side management with dynamic tariffs)
- efficiency by optimum control of the system
- waste heat recovery with high temperature heat pumps

The concept was optimised in the laboratory, the scalability and applicability for different industrial sectors was analysed in a techno-economic and ecological evaluation.
The focus was on the development of an optimal process control for small and medium enterprises, that can thereby work as a flexible consumer for the electrical grid and optimize waste heat utilization with heat pumps.
The control concept mainly consists of (i) an operation planner with a prediction horizon of e.g. 24 hours (cmp. electricity markets) regularly calculating optimal trajectories for the actuators of the energy supply system, (ii) a model predictive controller with a shorter period (typically a few hours) to follow the trajectories of the operation planner as exact as

possible, (iii) an observer to estimate the current state of the system from measurement data, and (iv) an HMI for the operator interaction (e.g. input of the production plan, weighing of optimization objectives). The optimization model is based on operational characteristics of the assets, such as nominal and part load, ramping speed, minimum up and downtimes and delays. It is formulated as a Mixed Integer Linear Programming (MILP) model. It provides an operation schedule when to use which asset based on user defined objective functions such as minimal cost, least environment impact, etc.

Main challenges for the EDCS

- High implementation costs due to the modelling effort
- Human interactions due to semi-automated production processes and their predictions
- High computational effort due to combinatoric nature of the optimization problem, and the long prediction horizon
- Uncertainties of predictions of load or weather

Results

The control system has been successfully tested in AIT's lab for an energy system consisting of a high temperature heat pump, a thermal energy storage, a hot water boiler, and an electrical heating element, enabling the emulation of different industrial energy supply systems (gas boiler, high and low temperature waste heat, solar thermal etc.). The control system will be rolled out for further tests in different industrial sites starting this year in the follow-up project "Industry4Redispatch" (3rd Call – Energy Model Region), led by AIT, to increase TRL to 7, especially for the controller and HMI.

Learnings/recommendations

- Push digitalization to improve availability of measurement data for more accurate simulation models and demand forecasts.
- Push connectivity of components (supply, storages, consumers) with standardized protocols (e.g., OPC UA) to enable concepts like EDCSproof to optimally control the whole plant

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FACTS ABOUT THE PROJECT

IoT Category: performance optimization, flexibility
Goal: optimal process control to enable integration of renewable energy and waste heat recovery
Beneficiary: user, supplier, component manufacturer
Data required: energy demand profiles, performance data of energy suppliers and consumers, forecasts for electricity prices
Analysis method: simulation, demonstration
Modelling requirements: Dynamic simulations, Mixed integer linear programming
Quality-of-Service: close to real time
Project participants: AIT Austrian Institute of Technology GmbH, Technische Universität Wien – Institut für Energietechnik und Thermodynamik, Technische Universität Wien – Institut für Mechanik und Mechatronik, Montanuniversität Leoben – Lehrstuhl für Energieverbundtechnik, Wiesbauer Holding AG, Wiesbauer Gourmet, Fischer Brot GmbH, ILF Consulting Engineers Austria GmbH, evon GmbH, kleinkraft OG
Time schedule: 2018-2021
Technology availability: 7
Link to webpage: https://www.nefi.at/en/project/edcsproof