Master's Thesis

Development of an efficient energy system based on power to gas concept; integration of a gas turbine fueled by methanol

Project location: Paul Scherrer Institut (PSI), Villigen, Switzerland
Thermo-Chemical Processes (TCP)
Energy and Environment Research Division

Project supervisor: Dr. Hossein Madi (hossein.madi@psi.ch , main contact)
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Period: 4-6 months

Research background and context:

Hydrogen and methanol fuels can be carbon neutral when produced by means of excess wind or solar electricity. They are widely available, storable, market compatible and with established supply chains that can serve the energy transition. Combining innovative methanol synthesis processes for decentralized and local production of renewable fuels and coupling them with new developments in power systems, can make a leap forward in renewable highly efficient zero emission combustion and deliver a flexible highly efficient, decentral energy generation system for heating and cooling.

Objectives of tasks:

The goal of this thesis is to define an energy system that simulates for every hour of a year the production of electricity by PV and/or wind power plants for a given local unit (e.g. demand profile of a village). The model calculates the necessary operation hours of electrolysis, battery, methanol synthesis, storage, gas turbine engine and etc., to minimize the gap between energy supply and a given energy demand. Further, minimum sizes for tanks, batteries etc. should be derived. The simulation tool will be extended by the options and technical requirements of a gas turbine and will be used to derive the needed or desirable temporal flexibility of such a system. Varying the boundary conditions will give a good indication of how sensitive the system response is and usability on the assumed technical flexibility parameters.

This is a modeling/simulation project focusing on the sizing and dynamic behavior of the defined energy system elements. The energy system is consisting of electrolysis, battery, methanol synthesis, storage and a gas turbine engine.

Tasks and responsibilities are:

- Analysis of the demand profiles (electricity, heat and gas).
- Identification of the boundary conditions for the energy flux management system and analyse various cases.
- Modify the existing code and introduce new units.

Your background:

- Master student in chemical/mechanical/process engineering or related field.
- Excellent skill in programming and simulation (Matlab or Python simulation tool).
- Keen to work in teams on an applied project.
- Good command of English, writing and speaking.