

MSc thesis proposal**Household electricity demand flexibility and its effect on the feasibility of high-renewables Swiss energy future scenarios (2 Students)**

Chairs of Climate Policy (D-USYS) and Ecological System Design (D-BAUG)

High-level studies have shown the broad feasibility of very high shares of renewable generation, but many open questions about the specifics remain. In particular, the temporal matching of energy demand and supply have been identified as problematic. This project aims to build a better understanding of these with high detail, from the bottom-up, in order to assess the feasibility of scenarios for the future Swiss energy system. Close collaboration between the two student projects (and the two participating research groups) is an important component of this project, so this is an opportunity to be directly involved in interdisciplinary research to better understand the energy transition. Experience with energy modelling is a useful asset. The work is heavily quantitative so you should either know how to program or be willing to learn it during the course of the project, in Python or a similar language, such as R. Your supervisors will be able to point to you to appropriate resources to get up to speed with the required skills and assist you with technical questions.

Topic 1. Modular household electricity demand model

Supervision: Niko Heeren <nheeren@ethz.ch>, Stefan Pfenninger <stefan.pfenninger@usys.ethz.ch>

Goal: Development of a modular household electricity demand model

- The model should calculate (sub)-hourly energy demand profiles of different Swiss households. It is dependent on parameters, such as household size, occupation, building parameters, equipment, time (daytime and season)
- Provide an overview of existing approaches to simulate electricity demand at the household level with high resolution in time, and the ability to make all or part of that demand flexible
 - E.g. <http://www.lboro.ac.uk/research/crest/demand-model/>
 - Heeren 2011
- Validate the model with typical electricity demand profiles or measured data (to be obtained)
- (Optional) Include a space heat demand model

- We have data on the Swiss residential building stock in Switzerland, including census data on occupants
- Study different household types and discuss differences in demand. Optional: Include load management and energy storage strategies and investigate the potentials for future household electricity demand.

Topic 2. PV electricity generation scenarios

Supervision: Stefan Pfenninger <stefan.pfenninger@usys.ethz.ch>, Niko Heeren <nheeren@ethz.ch>

Goal: Modular method to generate detailed and realistic PV generation profiles at the building scale, and use these to produce aggregated scenarios at the regional and national scale

- Scenarios for deployment of PV in Switzerland based on policy such as the Energiestrategie 2050
- Rooftop-level simulation of PV power generation based on high-resolution satellite irradiance data and existing database of Swiss buildings, including data of three-dimensional roof shapes. Python code to run these simulations is available but various improvements are possible, for example, adding consideration of additional meteorological variables such as snowfall.
- Validation of simulations with our existing database of the output from real PV systems, which allows to correct for systematic bias in the satellite data
- Combining the scenarios for deployment and the PV generation simulations to create highly detailed, realistic Swiss PV generation potential, under different scenarios
- Some of the areas you will be able to explore in this project: GIS, renewable power simulation and optimisation models, meteorological data, satellite data

Contact us

If you are interested in either of these two proposals, please contact both supervisors by the email addresses given above.