Open and cross-sectoral planning of transmission and distribution grids

Driven by the expansion of renewable generation capacity and the progressing electrification of other energy sectors, the electrical grid increasingly faces new challenges: fluctuating supply of renewable energy and simultaneously a changing demand pattern caused by sector coupling. However, the integration of non-electric sectors such as gas, heat and e-mobility enables more flexibility options. This project aims to investigate the effects of sector coupling on the electrical grid and the benefits of new flexibility options.

Basic project information
- Project duration: Dec 2019 – Jul 2023
- Open-source and open-data project
- Project partner:
  - Freiburg University of Applied Sciences
  - Europa-Universität Flensburg
  - Reiner Lemoine Institute
  - German Aerospace Center (DLR) – Institute of Networked Energy Systems
  - Otto von Guericke University Magdeburg
  - Fraunhofer Institute for Energy Economics and Energy System Technology
- Funded by Federal Ministry for Economics and Climate Action
- Website: ego-n.org

Workflow Management
- eGo-n retrieves and processes data from several different external input sources which are all freely available and published under an open data license. The process handles data with different data types, such as spatial data with a high geographical resolution or load/generation time series with an hourly resolution.
- The workflow is composed of four different sections: database setup, data import, data processing and data export to the OpenEnergy Platform®. Each section consists of different tasks which are managed by Apache Airflow® and correspond with the local database.

Scenarios
- eGo2035
  - This scenario is based on the network expansion plan (NEP®), scenario C2035, which is characterized by a high penetration of sector-coupling flexibility options. Information on foreign countries origin in the TyNDL 2020©, scenario distributed energy.
- eGo100RE
  - This scenario depicts a scenario with 100% renewable generation. PyPSA-Eur-Sec® has been used as scenario generator.

Supply
- The national capacities for electrical supply depicted in figure 2 are taken from the network-expansion plan (NEP®), scenario C2035 and spatially allocated. Therefore, potential areas for the placement of renewable power plants (e.g. wind turbines onshore) are considered. Natural gas and Biogas potentials are attached to the corresponding methane buses. Heat is supplied by electricity (heat pumps and resistive heater), by gas (boilers and CHP) and by direct renewable heat generation (solar- and geothermal plants).

Figure 2: Installed capacity of electrical supply in Germany in eGo2035

Demand
- Figure 4: Demand in different aggregation levels

Flexibilities
- Demand Side Management
  - Potential comprises shifting of loads within the sectors of industry and CTS
  - Loads eligible to be shifted mainly derive from heating and cooling processes and selected energy-intensive industrial processes
  - Flexible shares are identified considering technical and sociotechnical potentials using the parametrization elaborated in Heitkötter et al.©

Dynamic Line Rating
- Capacities of overhead transmission lines fluctuate between 100% and 150% of their nominal values
- Depending on current weather data: solar radiation, wind speed and temperature
- Storage
  - Battery storage, heat stores and hydrogen stores as extendable flexibility option

E-Mobility
- Hourly travel and charging profiles for motorized individual travel are generated with SimBEV© using a stochastic approach based upon data from “Mobilität in Deutschland”©.
- Generation of a pool of electric vehicles (EV) profiles and random selection of profiles corresponding to the number of EVs within the medium voltage grids
- Base state-of-charge and flexibility time series per medium voltage grid derived from profiles considering several constraints

Sector-Coupling Technologies
- Sector-coupling technologies getting optimized in dispatch and capacity: fuel cells, electrolyzers, methanisation, Steam Methane Reformation

References: