Optimal location and sizing of small hybrid systems in micro-grid system using Volunteer Geographic Information

Javier Valdez, Sebastian Wöllmann, Roland Zink
INSTITUTE FOR APPLIED INFORMATICS

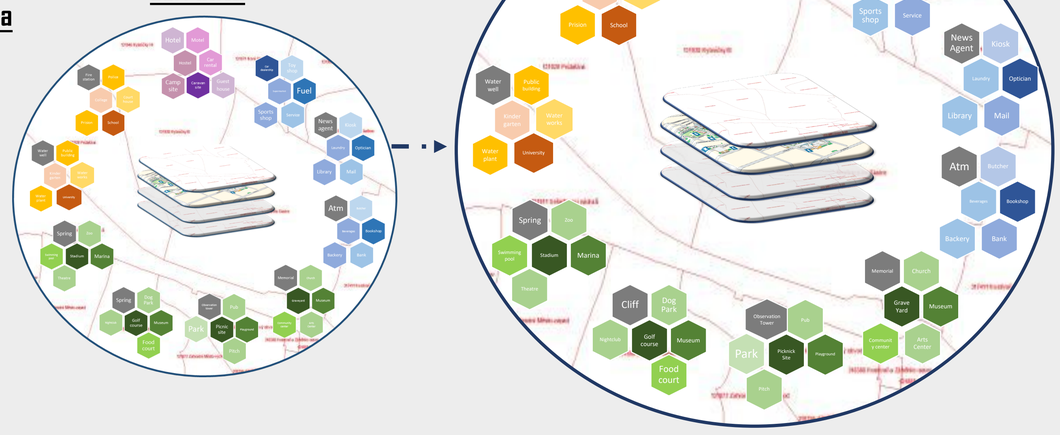
This study presents an optimization model for the optimal location and sizing of small hybrid systems in simulated micro-grids. By using an optimization model - in combination with COSMO-REA2 weather data - various micro-grids local energy systems are simulated using the Calliope energy simulation model. The Calliope optimization and simulation model is feed with GIS-data from different Volunteered Geographic Information projects, including OpenStreetMap. These allows to automatically allocate specific demand profiles to diverse OpenStreetMap building categories. Moreover, based on the characteristics of the OpenStreetMap data, a set of possible distributed energy resources) including renewables and fossil fueled generators are defined for each building category. The optimization model is applied for a set of scenarios based on different electricity prices and technological characteristics. This allows to assess the impact and profitability of the different technological options on the micro-grid configuration. Moreover, in order to assess the impact of each of the scenarios on the current distribution infrastructure, the results of the simulations are included on an existing model of the low and middle voltage network for Lower Bavaria, Germany. Finally, to facilitate their dissemination, the results of the simulation are stored in a PostgreSQL database, before they are delivered by a RESTful Laravel Server and displayed in an Angular Web-Application.

Volunteer Geographic Information

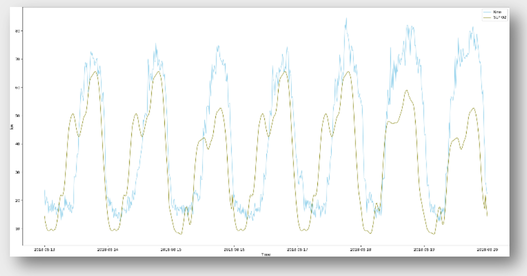
Advantages of using VGI data

Is free
Actualized constantly
Is detailed
Is rich
Is classified

OSM data



Industrial consumer profiles + standard profiles data



Public contribution to VGI data

It is defended that public entities, such as local administrations, public bodies and companies, foundations, etc., should participate in VGI activities. In the analysis of energy systems, what channels and methods are needed to share new data and geographic information among them and with the community?

Input data

Data validation

Most of the data used as inputs in the model have not been generated or designed for use in energy system modelling. Therefore, many of the data do not offer sufficient quality to be integrated into a microgrid optimization model. To solve this problem we work with different sources that show different aspects of the regions we want to model.

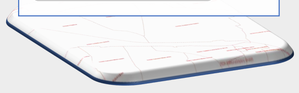
OSM data is completed with regional statistics on energy demand and supply in order to asses consumption scenarios

Official data and OSM

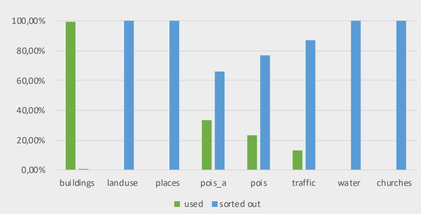
- Source for Pre-validation
- Errors identification
- Quality assessment

Regional databases

- Demographic statistics
- Energy demand
- Renewable potential



Pre-validation selection criteria



OSM is complemented with data on firms and renewable energy installations

Firm level data

- Pre-validation for firms and households
- Identification of big companies
- Assessment of hot-spots

Renewable energies potential

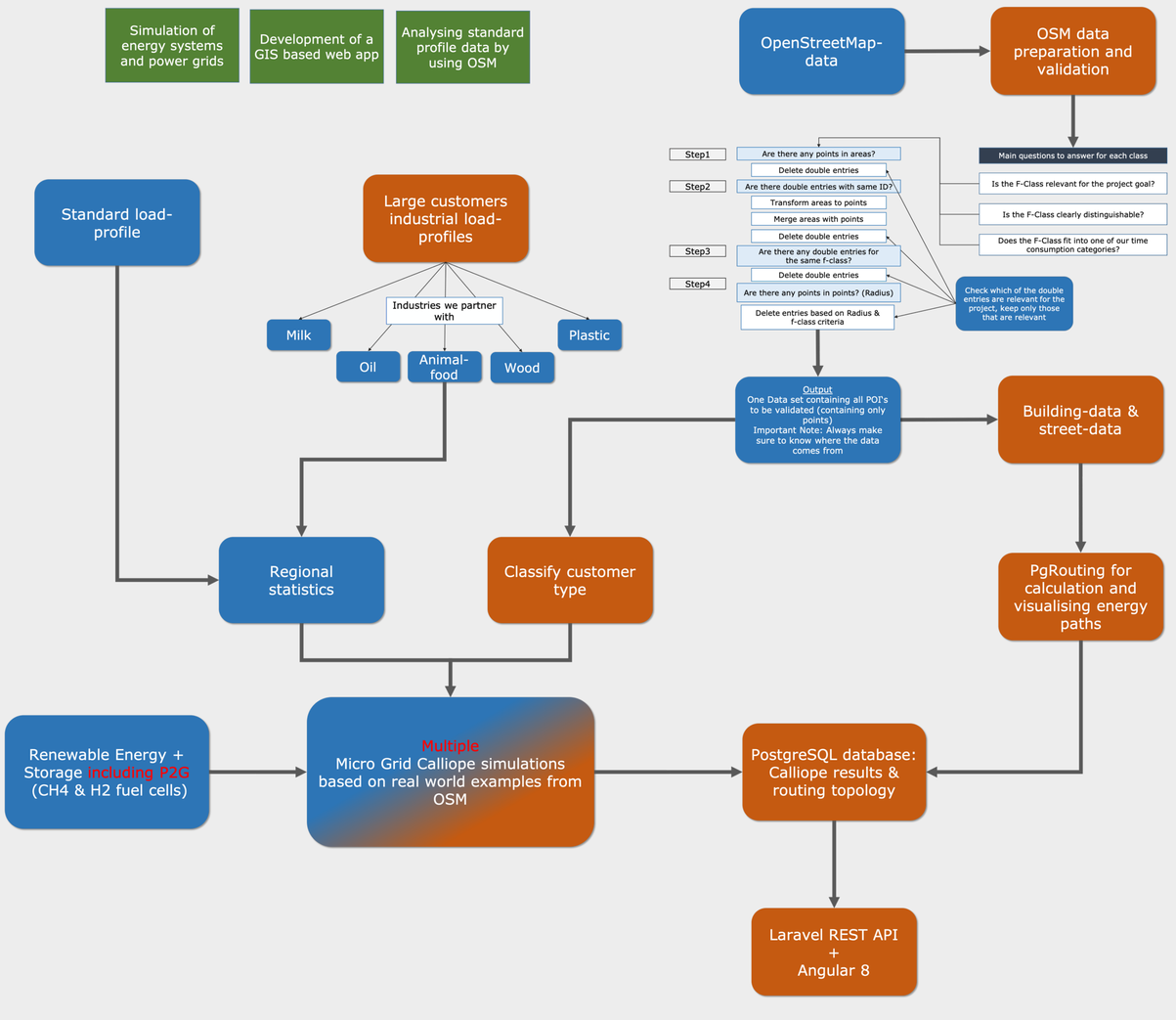
- Photovoltaic
- Wind
- Power-to-Gas

Methodology

WORK PACKAGES

- Simulation of energy systems and power grids
- Development of a GIS based web app
- Analysing standard profile data by using OSM

WORK FLOW



VGI Energy systems modelling dataset

The main output from the pre-validation and validation phase is a map of locations representing different types of energy prosumers. Each location is categorized using the official electrical standard load profiles.

The annual yearly statistics books allows to use estimations on the electricity demand for different sectors at the municipal level. This numbers are to reallocate the demand to each building

In order to generate the demand profiles, the normalized official electrical standard load profiles are re-scaled to represent the annual demand of the municipality. To asses the validity of this allocation, the standard demand profiles are validated and complemented with real data.

Validation

Step 1:
Determine region for validation: urban and rural case studies based on hot spots

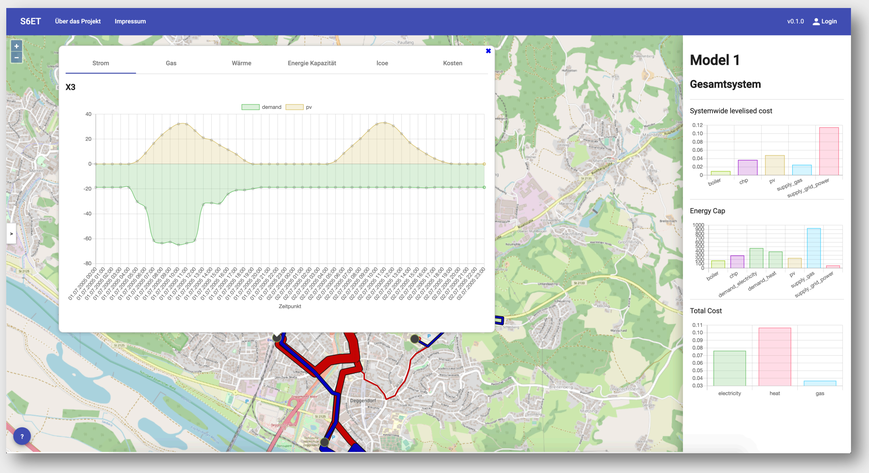
Step 2:
Comparison of F-Class and standard profiles with real (if possible open) data

Step 3:
Generate a database of VGI information linked to electricity consumption profiles

Results dissemination

Web based application

The results should be availed to as many people as possible, thus a web app is the optimal choice to be available on desktop, tablets and smartphones. By using modern design choices and languages like a REST-API and Angular 8, the application is fast, reliable and offers a good accessibility for the user.



Bundesministerium für Bildung und Forschung

javier.valdes@th-deg.de
sebastian.woellmann@th-deg.de
roland.zink@th-deg.de