Metadata for DAT_Energie-Workshop.csv

Input data for simulation of the energy workshop simulating the provision of electricity and heat for a small size German community.

Cite data set as:

Beuth Hochschule für Technik Berlin: Energie-Workshop (Daten), 2019.

Data description

Column 'Counter': Counter 1 – 8760 for the hour of a representative year

Column 'Demand_el [MWh]': Electric energy demand in MWh for the specified hour

Data processing:

1. Download Time Series Data for electric energy consumption in the German grid in 2015 from www.smard.de licenced by Bundesnetzagentur | SMARD.de under CC BY 4.0: P_el_Ger(t)
2. Compute hourly averages from 15min-values
3. Compute 99% and 1% Quantils from P_el_Ger(t): Q_P_Ger_99 and Q_P_Ger_01
4. Compute Time Series for a consumption rating factor:
   f_el(t) = (P_el_Ger(t) - Q_P_Ger_01) / (Q_P_Ger_99 - Q_P_Ger_01)
5. Compute Time Series for hourly electric energy demand:
   P_el(t) = P_low + f_el(t) * (P_high – P_low)
   by choosing P_low=0,5 MWh (representing characteristic low consumption level) and adapting P_high to 3,725 MWh to match a cumulated annual consumption of P_el_cum = 19,1 GWh which was separately assumed for the selected community.

Column 'Demand_th [MWh]': Thermal energy demand in MWh for the specified hour

Data processing:

1. Download Time Series Data for Q_th_DH(t) licensed CC BY-SA 4.0:
   Stadtwerke Flensburg GmbH. (2019). District heating network data for the city of Flensburg from 2014-2016 (Version 2019-01-31) [Data set]. Zenodo.
   http://doi.org/10.5281/zenodo.2562658
2. Select Data for 2015 only
3. Compute 99% and 1% Quantils from Q_th_DH(t): Q_Q_DH_99 and Q_Q_DH_01
4. Compute Time Series for a consumption rating factor:
   f_Q(t) = (Q_th_DH(t) - Q_Q_DH_01) / (Q_Q_DH_99 - Q_Q_DH_01)

5. Compute Time Series for hourly thermal energy demand:
   Q_th(t) = Q_low + f_Q(t) * (Q_high – Q_low)
   by choosing Q_low=3,5 MWh (representing characteristic low consumption level) and adapting Q_high to 26,5 MWh to match a cumulated annual consumption of Q_th_cum = 105 GWh which was separately assumed for the selected community.

Column 'Sol_irradiation [Wh/sqm]': Global solar irradiation (hourly sum) on a tilted surface in Wh/m² for location Braunschweig (Germany)

Data processing (Steps 2-9 are executed by a python script using the package 'pvlib'):

1. Download data set with hourly station observation of solar radiation for Braunschweig (Germany) from Deutscher Wetterdienst (DWD):
   DWD Climate Data Center (CDC): Hourly station observations of solar incoming (total/diffuse) and longwavedownward radiation for Germany, version recent, last accessed: 07.08.2019.
   URL:
   https://opendata.dwd.de/climate_environment/CDC/observations_germany/climate/hourly/solar/
2. Select data for the year 2015.
3. Extract time series of the following values: time of measurement, diffuse radiation (dhi), global radiation (ghi) and the solar zenith.
4. Convert units of dhi and ghi from J/cm² to Wh/m².
5. Replace fault measurement values ('-999') with Zeros ('0') in time series of dhi and ghi.
6. Calculate the sun position (solar azimuth) from time and location (here Braunschweig).
7. Calculate the direct normal irradance (dni) from ghi, dhi and the solar zenith.
8. Set surface tilt angle: 35 deg
9. Set surface orientation (surface azimuth): 180 deg (=South).
10. Compute time series with hourly values of total global irradiance on the tilted surface at the set location from in Wh/m² from: surface tilt angle, surface azimuth, solar zenith, solar azimuth, dni, ghi and dhi.

Column 'Wind_power [kW/unit]': Electrical power output in kW of a single wind turbine of type ENERCON E-82 E2 with 108m hub height at location Braunschweig (Germany), calculated from historical wind speed data from 2015 (hourly values).

Data processing (Steps 2-9 are executed by a python script using the package 'windpowerlib'):

1. Download data set with hourly station observation of wind speed and wind direction for Braunschweig (Germany) from Deutscher Wetterdienst (DWD):
   DWD Climate Data Center (CDC): Historical hourly station observations of wind speed and wind direction forGermany, version v006, 2018.
   URL:
   https://opendata.dwd.de/climate_environment/CDC/observations_germany/climate/hourly/wind/historical/
2. Select measurement data (time series) of wind speed in m/s at 10m height of the year 2015. Note: Time series from step 2 has 67 missing time steps and 16 time steps with fault values ('-999') in year 2015.
3. Fill missing time steps and fault values with Zeros ('0').
4. Create DataFrame with weather data with structure that fulfils requirements of 'windpowerlib': Multi-Index Coloums. First Index is the parameter name, e.g.

‘wind_speed’, second index is the height in meters (m) where parameter was measured, e.g. 10 or 80. We assume constant air temperature and pressure (density model).

5. Define wind turbine (ENERCON E-82 E2; hub height 108; rotor diameter 82m) in ‘windpowerlib’
6. Settings for power output calculation in ‘windpowerlib’:
    a. Use logarithmic wind speed model for wind speed at hub height
    b. density model: ideal gas
    c. power output model: use data set provided in the OpenEnergy Database (oedb) with access via ‘windpowerlib’
7. Compute time series with hourly values of wind power output of a single turbine in kW.