Development of Simultaneity Factors in PEV Charging Processes

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Instruction:

The use of the open-source Tool for the calculation of simultaneity factors of Electric Vehicles (EV) (i.e. battery electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEV)) charging processes is presented.

1st Step: Download and Installation

- Go to https://doi.org/10.5281/zenodo.3364366

- Using Matlab: Download the m.file (SimultaneityFactorTool.m) and load profiles (householdprofile.mat)

 OR

- Without Matlab: Install Installer.exe

2nd Step: User Interface

The user interface is divided into the Section "Input Data" and "Results". In the following the two sections are explained in detail.

3rd Step: Input Data (1)

- For every value a default value is preset (in parentheses), but most values can be modified by the user. Specific input data (e.g. average charging durations) can only be changed in the program code.

- All input profiles have time intervals of 15 minutes. This can be changed in the code, but makes the according adjustment of the time resolution of input load profiles necessary.

1. Households and EV (1a)

- Number of Households (10): To represent the loads of a household, a profile is chosen randomly out of a database with 365.000 profiles. All profiles in the database have a yearly energy consumption of 1000 kWh. Hence, the chosen profile is scaled according to the yearly energy consumption per household.

- Yearly energy consumption/ household [kWh/a] (3216 kWh/a)

- Number of EV (10)

- Daily used EV (78%): This parameter describes the percentage of EV charged at the same day. For modifying this value, fix the slider on the desired share;

- Simulated days (1000): The Tool calculates the maximum simultaneity factor on a daily basis. This calculation is then repeated to determine the probability of the occurrence of a specific simultaneity factor. Consequently, a higher amount of simulated days increases the accuracy of the results, but also increases the simulation time.

2. SoC [%] (1b)

Here you have two options:

- Switch the slider to "On". The SoC at the beginning of the charging process is determined according to the distribution of Fig.1 and the final SoC is automatically set to 100%.
OR
- Switch the two slider to the desired values. The SoC limits (SoC at the beginning and SoC at the end of the charging process) are set individually.
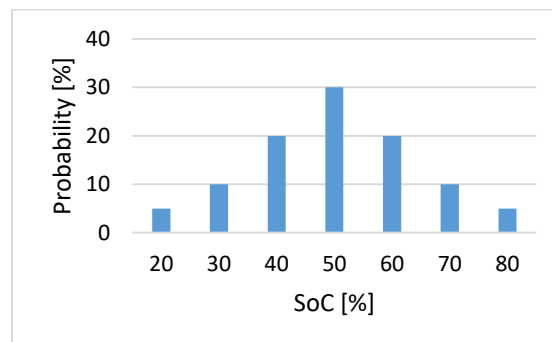

Fig. 1 Distribution of the SoC at the beginning of the charging process.

3. Charging power distribution [%] (1c)

Within the Tool you have the opportunity to take into account simultaneously different charging rates. The default charging power distribution follows [4] and the further calculations are performed on the average charging rate. In the presettings, the Tool differentiates between 3.7kW, 7.4kW, 11kW, 22kW, 44kW with a share of 73.7%, 0%, 21.5%, 3.5% and 1.3%, respectively.

4. Share EV class [%] (1d)

The Tool differentiates between PHEV and BEV and three vehicle classes (small, medium, big). The share of the individual vehicle classes was calculated from [7].

	Share EV class [%]		
	small	medium	big
BEV	7	3	5
PHEV	5	40	40

5. Energy Capacity [kWh] (1e)

The battery capacity data for BEV and PHEV for the underlying setting are taken from [10].

	Battery capacity [kWh]		
	small	medium	big
BEV	30.46	37.9	75
PHEV	8.4	12.26	8.4

6. Unbalanced Charging (1f)

In order to represent the more realistic case, an additional feature of the Tool is the differentiation between balanced and unbalanced charging of EV. If the slider is switched to "On", there is an unbalanced distribution of the individual EVs for a three-phase system. In this case, the simultaneity factors for the individual phases are calculated. However, due to the lack of data, the household loads remains symmetrically spread over the three phases.

4th Step: Push the green Calculate Button

Calculate

5th Step: Results ②

- Overview: User Interface

1. Simulation Time

Can be found on the right of the Calculate Button.

2. Results EV (2a)

The Tool calculates to the corresponding EV input data the following results:

- Average energy capacity

- Average charging power

- Max. simultaneity factor

- Probability max. simultaneity factor

- Percentiles (99.9th, 99th, 95th, 90th, 50th)

In addition, the following two plots are generated. The x-axis describes the simultaneity factor/ maximum daily EV peak power and the y-axis the number of events per year.
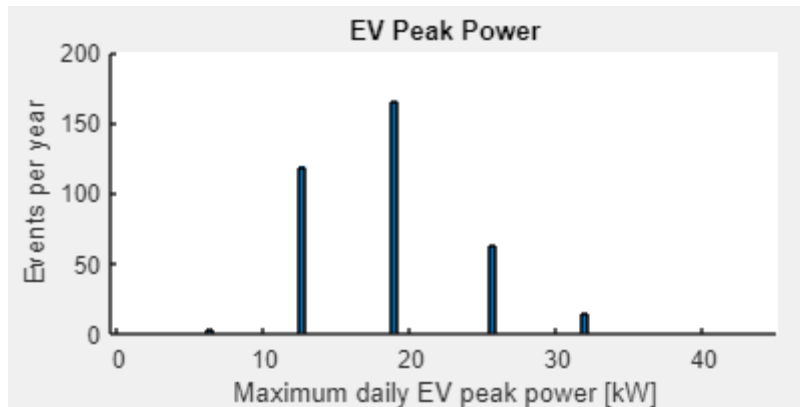
o   Distribution of the simultaneity factor of EV: (2b)
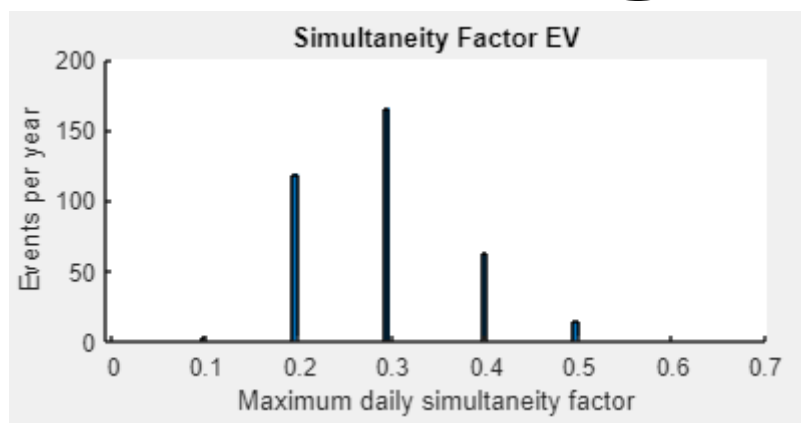
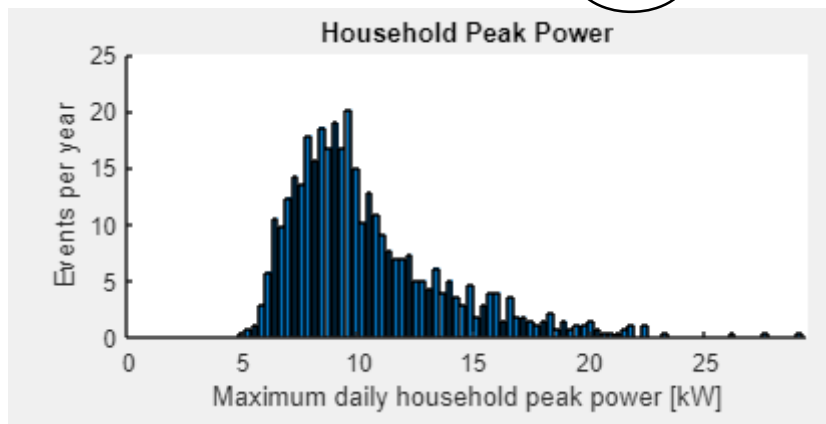 o Distribution of EV Peak Power: **2c**

3. Results households **2d**

The Tool calculates to the corresponding household input data the following results:

  - Peak load household

  - Percentiles (99th, 90th, 50th)

In addition, the following plot is generated. The x-axis describes maximum daily household peak power and the y-axis the number of events per year.

  o Distribution of the household peak power: **2e**
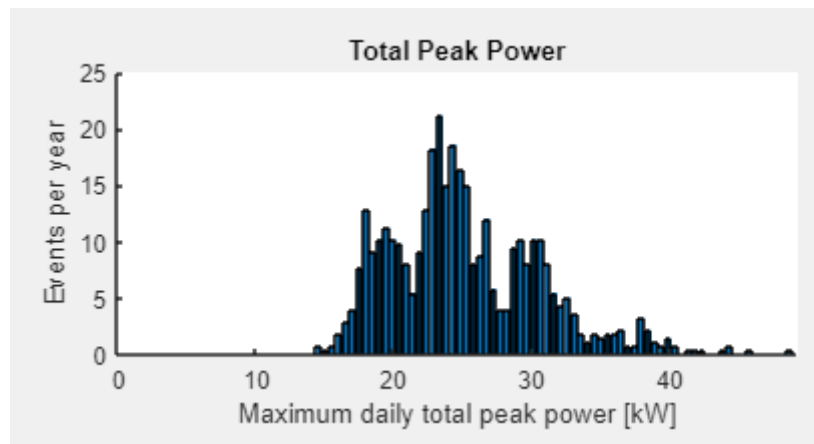

4. Results total load **2f**

The Tool calculates to the corresponding input data the following results:

  - Total peak load (EV + households)

  - Percentiles (99th, 90th, 50th)

In addition, the following plot is generated. The x-axis describes maximum daily total peak power and the y-axis the number of events per year.

○ Distribution of the total peak power: (2g)

Total Peak Power

Further Information:

- If you use the same Matlab window on different screens (external screen) you have to close the Matlab window to guarantee the screen adoption of the Simultaneity Factor Tool.
- For further information please refer to the paper "Development of a Tool for the Determination of Simultaneity Factors in PEV Charging Processes" which was presented at the E-Mobility Power System Integration Symposium 2019 in Dublin.