

# Load profile generation: from individual houses to districts

Tobias Blanke, Solar-Institut Jülich  
Joachim Göttsche, Solar-Institut Jülich  
Prof. Dr. B. Döring, FH Aachen



# Agenda

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- Basic idea
- Approaches
- Examples

# Basic idea

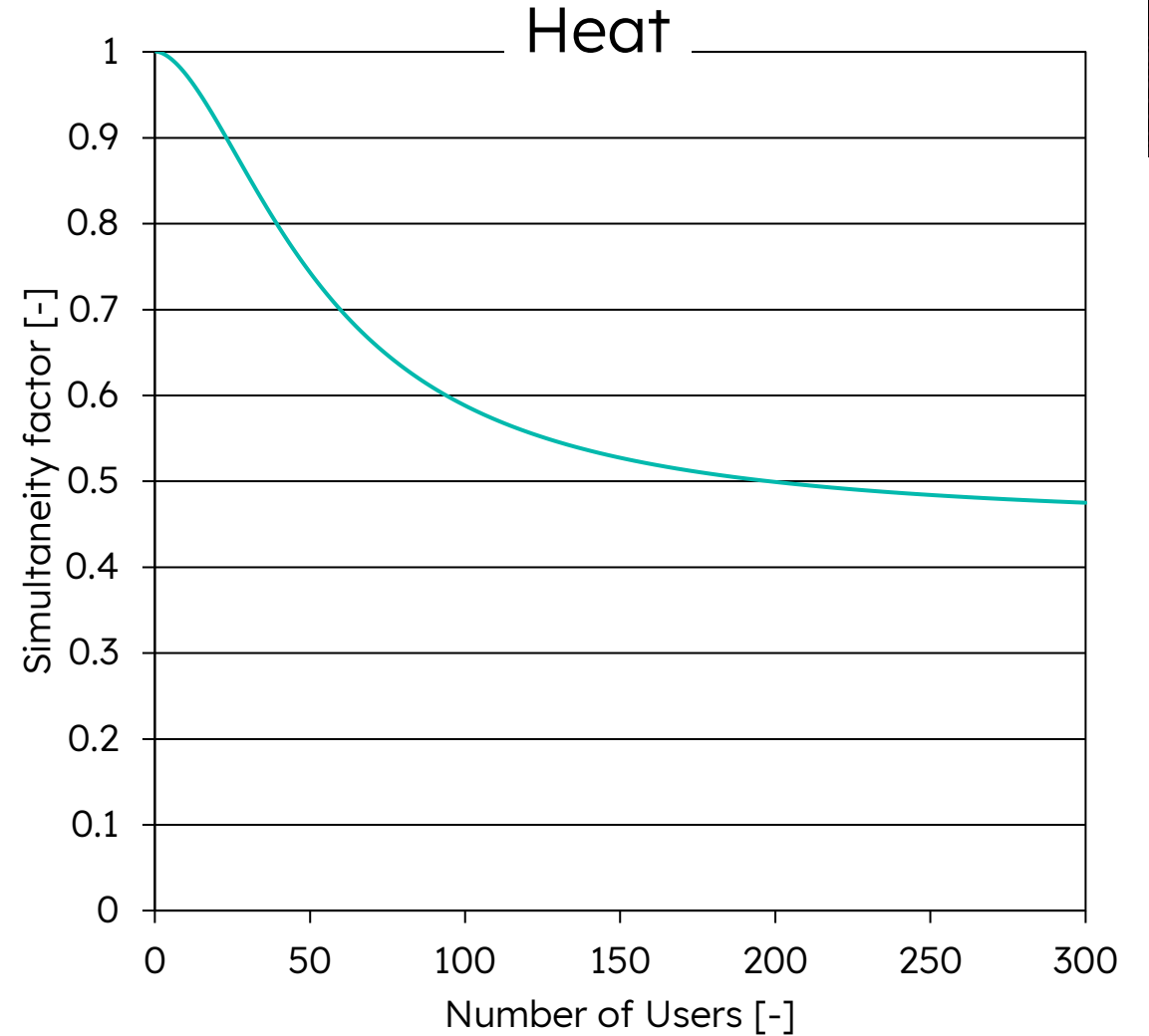
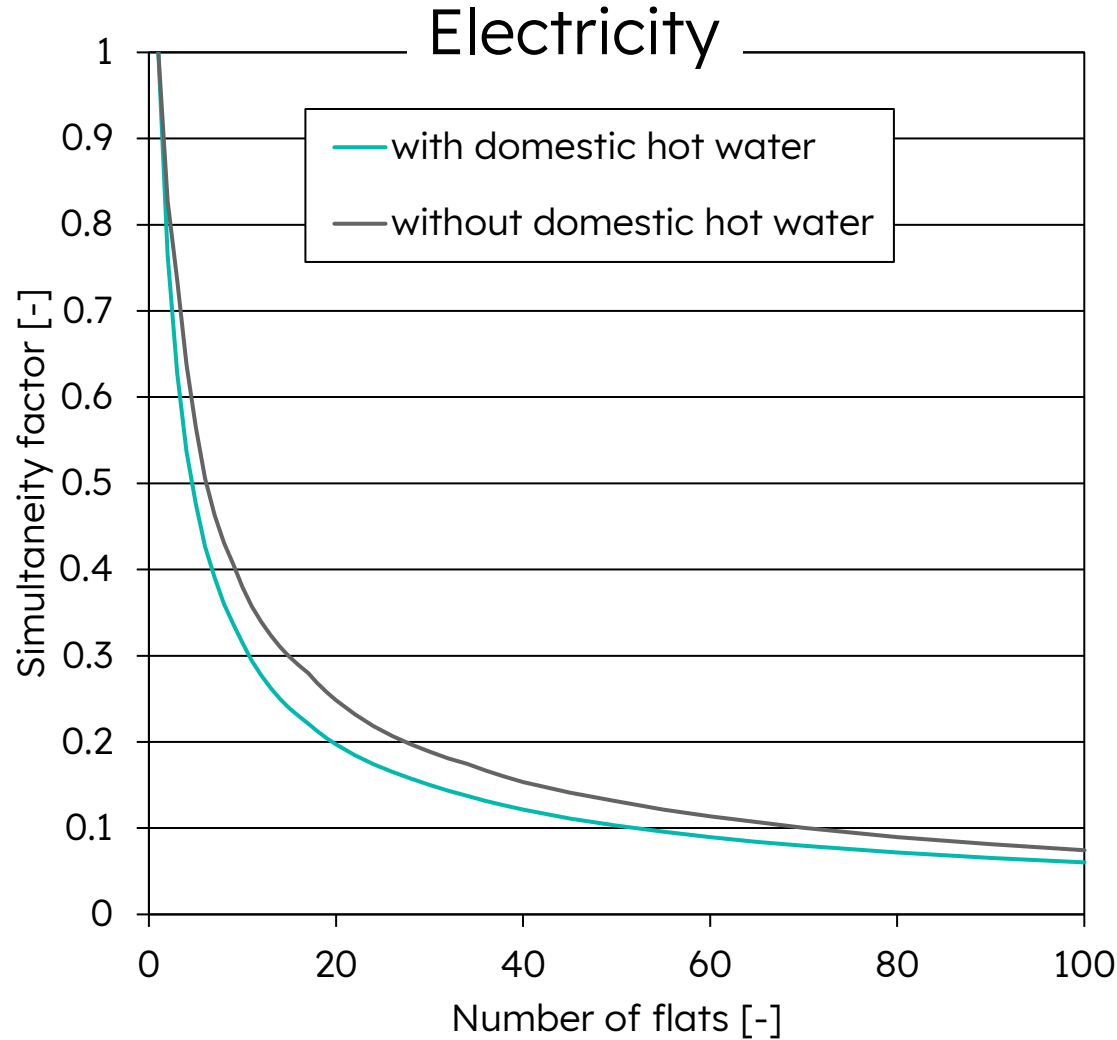
- Given:
  - 1 calculated load profile
  - Simultaneity factor ( $SF$ ) from literature

$$SF = \frac{\max(\text{sum profil})}{\max(\text{single profile}) \cdot \text{number of profiles}}$$

- Searched:
  - Quarter load profile for N houses



# Simultaneity factor dependence from literature

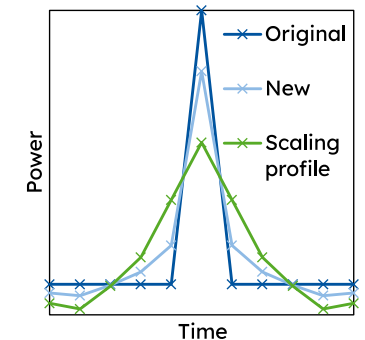
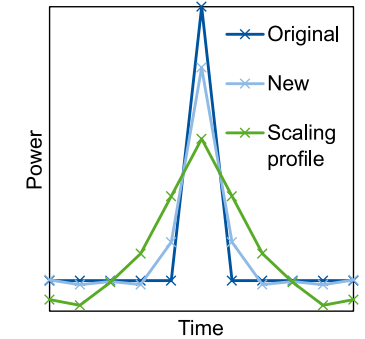
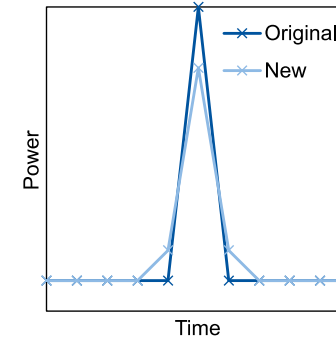
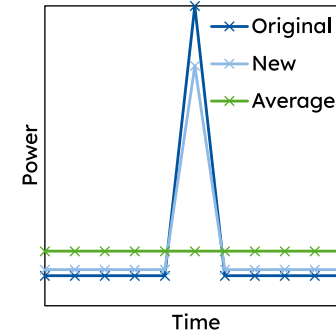


Quelle GZF: DIN18051-1

Quelle GZF: <https://www.rehau.com/downloads/109808/fachartikel-gleichzeitigkeit.pdf>

# 4 different approaches

- Average approach
- Reference profile approach
- Normal distribution approach
- Normal distribution with reference profile approach



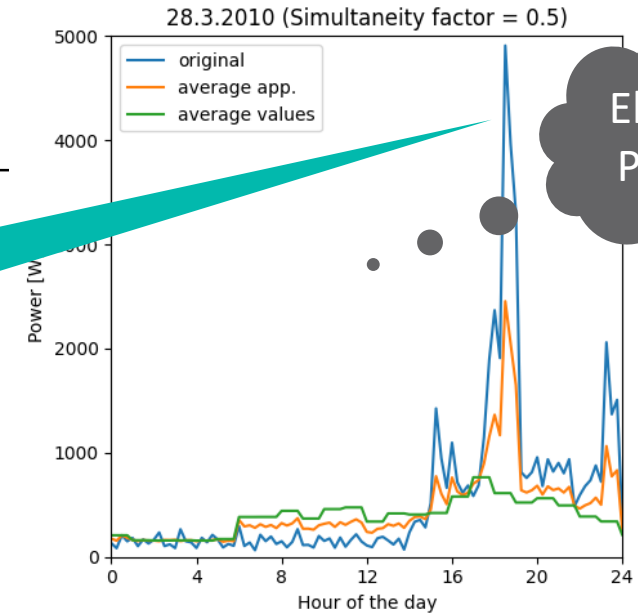
# Average approach

- $P_{new}(t) = P_{orig}(t) \cdot S + P_{avg} \cdot (1 - S)$

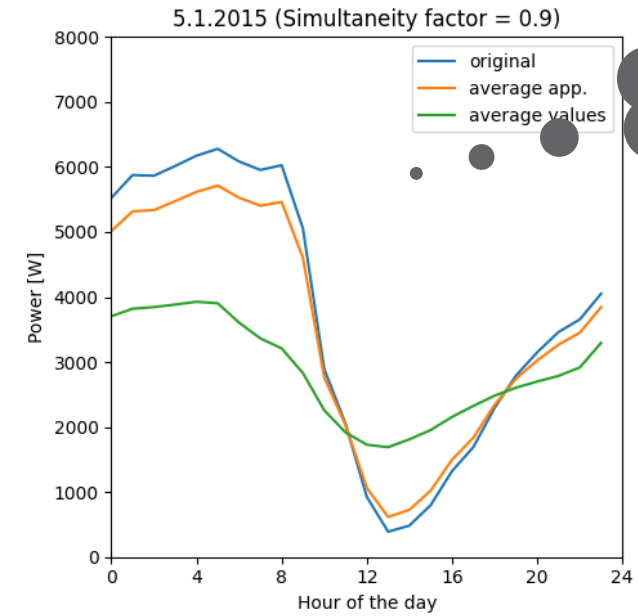
- $$S = \frac{SF \cdot \max(P_{orig}^t) \forall t \in i - P_{avg}^i}{\max(P_{orig}^t) \forall t \in i - P_{avg}^i}$$

- $P_{new}$ : new scaled profile
- $P_{orig}$ : original profile
- $P_{avg}$ : average values
- $S$ : Scaling values
- $SF$ : Simultaneity factor

HTW Berlin Profile<sup>1</sup>



Electric Profile



Space Heating Profile

<sup>1</sup> <https://solar.htw-berlin.de/elektrische-lastprofile-fuer-wohngebaeude/>

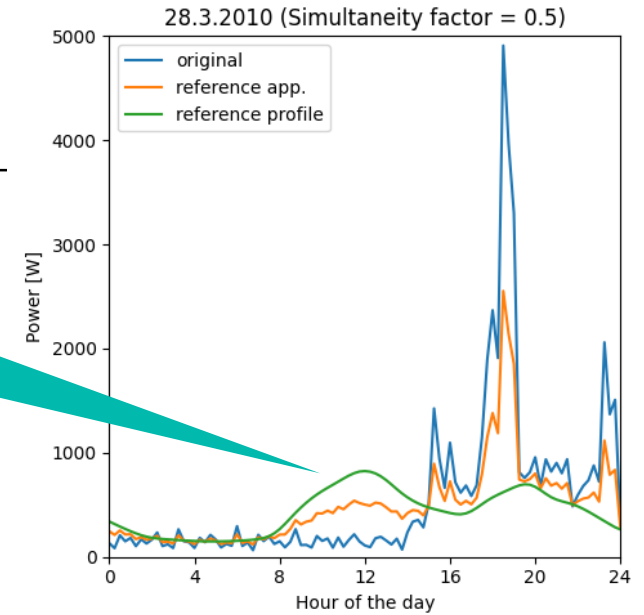
# Reference approach

- $P_{new}(t) = P_{orig}(t) \cdot S + P_{ref}(t) \cdot (1 - S)$

- $$S = \frac{SF \cdot \max(P_{orig}^t) \forall t \in i - P_{ref}^j}{\max(P_{orig}^t) \forall t \in i - P_{ref}^j}$$

- $P_{new}$ : new scaled profile
- $P_{orig}$ : original profile
- $P_{ref}$ : reference profile
- $S$ : Scaling values
- $SF$ : Simultaneity factor
- $j$ : time step in which the original profile has its maximal value

BDEW  
Electrical  
Profile<sup>1</sup>



HTW  
Berlin  
Profile<sup>2</sup>



<sup>1</sup> <https://www.bdew.de/energie/standardlastprofile-strom/>

<sup>2</sup> Dis: Entwicklung und Anwendung parametrisierter Standard-Lastprofile  
<https://mediatum.ub.tum.de/doc/601557/601557.pdf> 27.06.2023 | 7

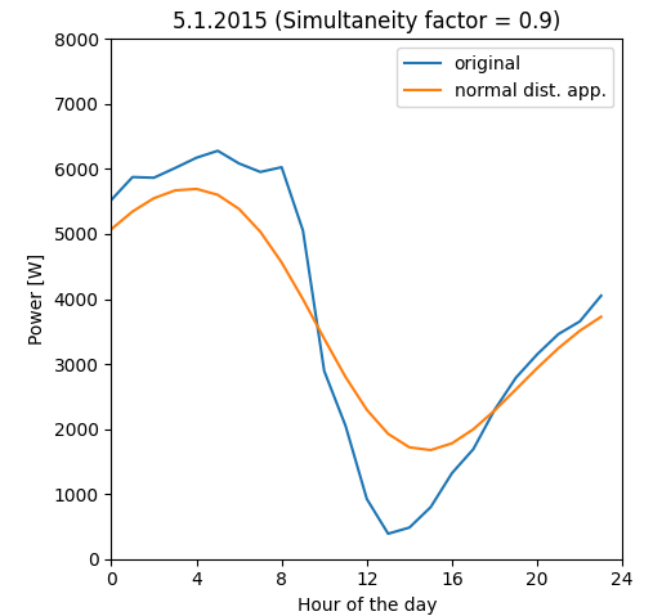
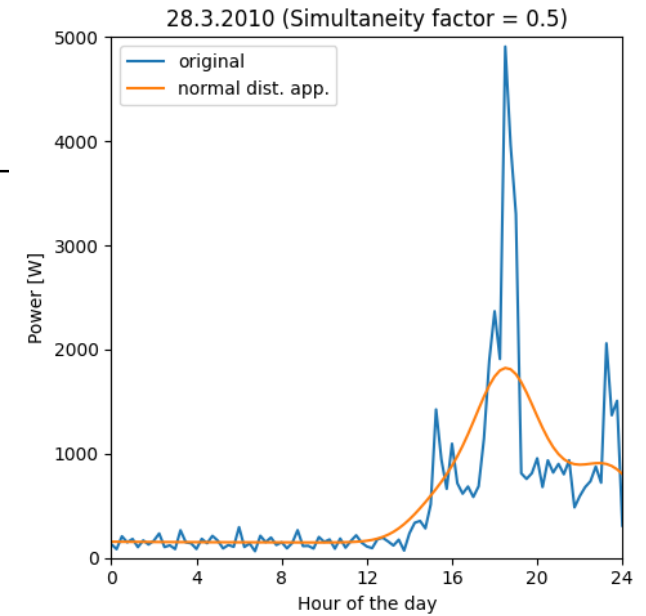
# Normal distribution approach

- $P_{new}(t) = \sum_{i=t-4\cdot\sigma}^{t+4\cdot\sigma} NDI(i, t) \cdot P_{orig}(i)$

- $NDI(x, t) = \int_{x-\frac{\delta t}{2}}^{x+\frac{\delta t}{2}} ND(x, t) \delta x$

- $ND(x, t) = \frac{e^{-\frac{(x-t)^2}{2\cdot\sigma^2}}}{\sqrt{2\cdot\pi\cdot\sigma^2}}$        $\sigma$  as parameter to adjust simultaneity

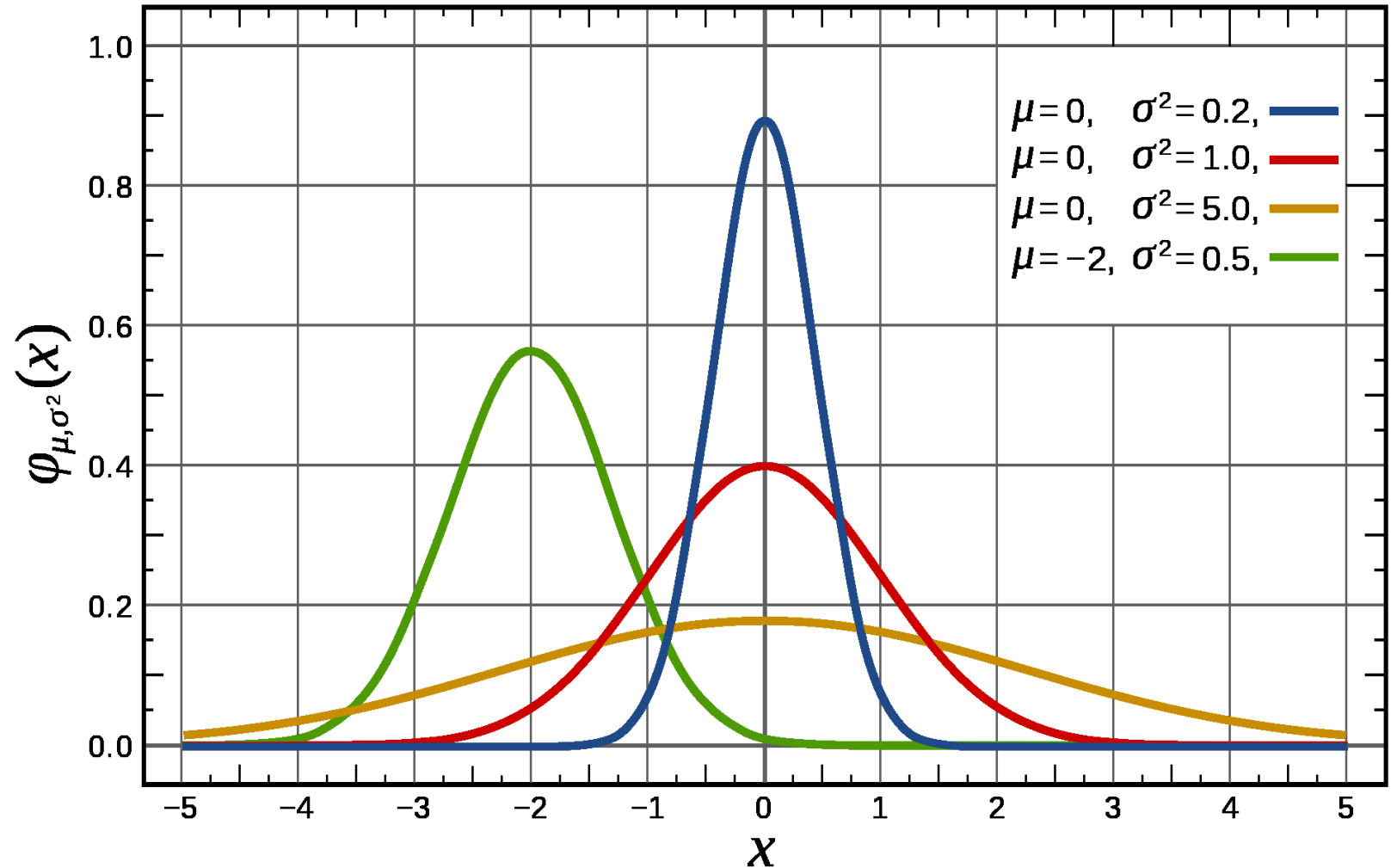
- $P_{new}$ : new scaled profile
- $P_{orig}$ : original profile
- $ND$ : normal distribution function
- $NDI$ : integration of normal distribution
- $\delta t$ : time step
- $\sigma$ : variance



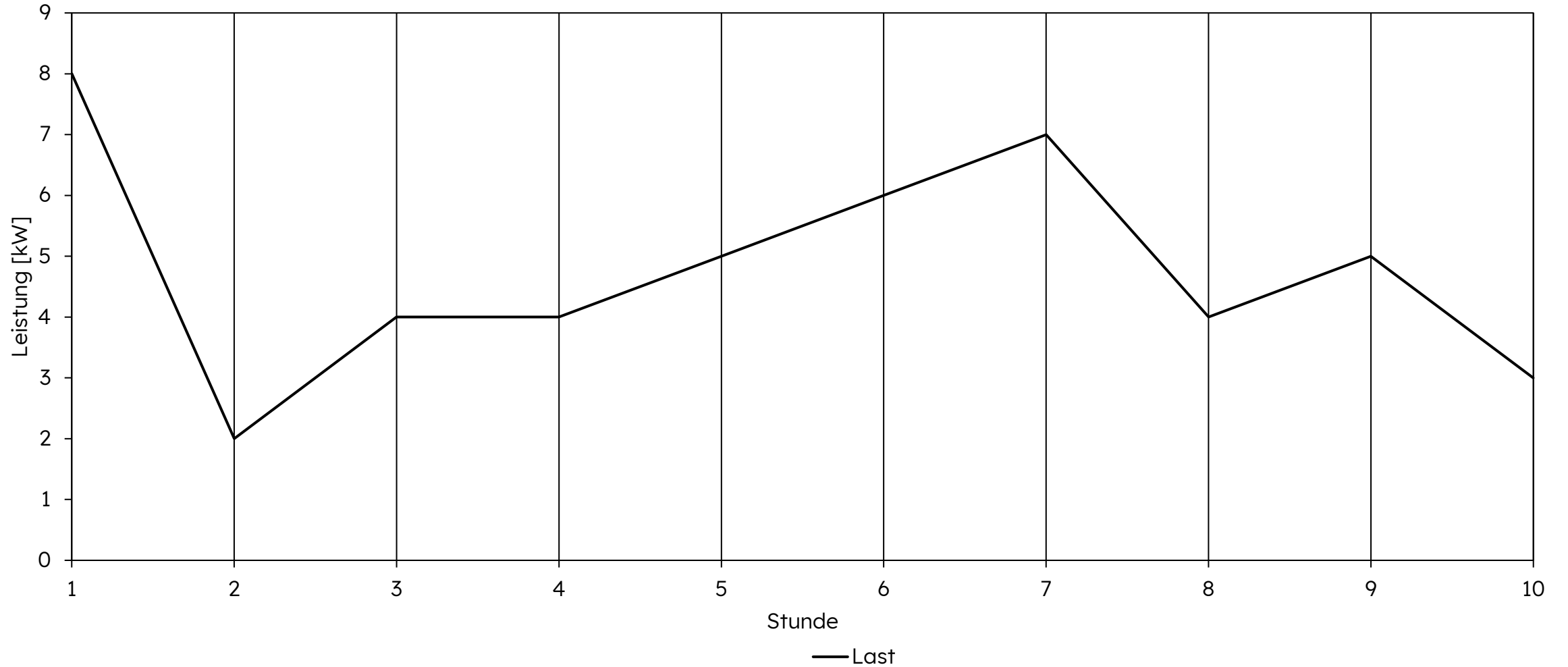


## Normal distribution

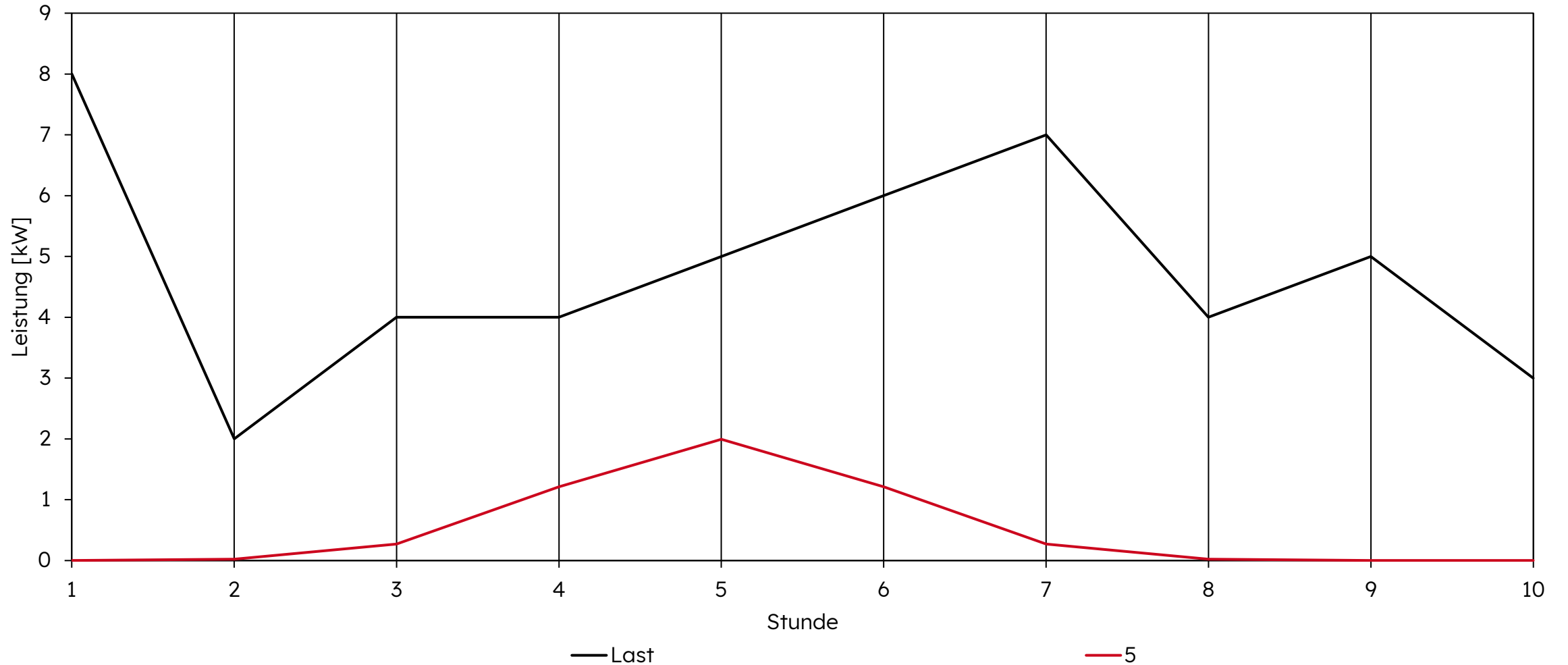
$$ND = \frac{e^{-\frac{(x-\mu)^2}{2\cdot\sigma^2}}}{\sqrt{2\cdot\pi\cdot\sigma^2}}$$



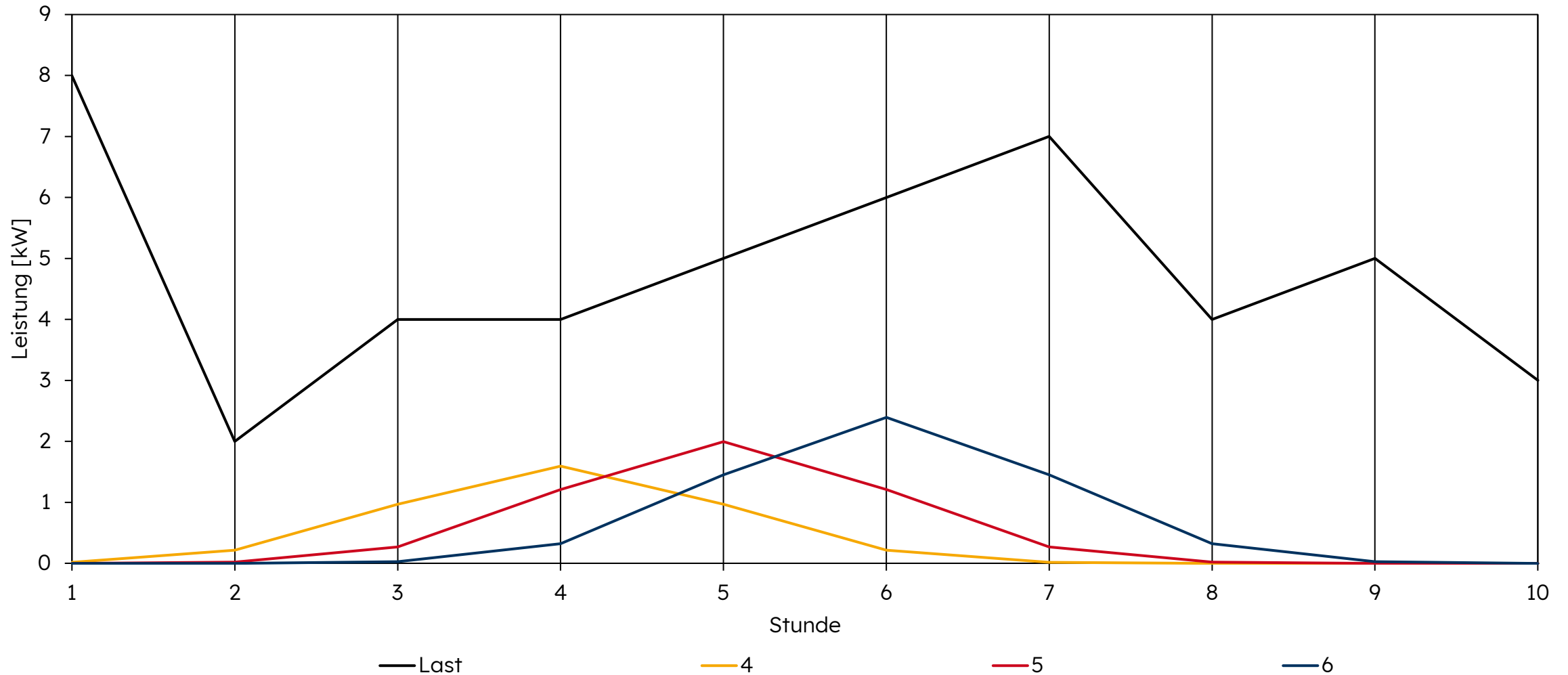
# Example: Original Profile



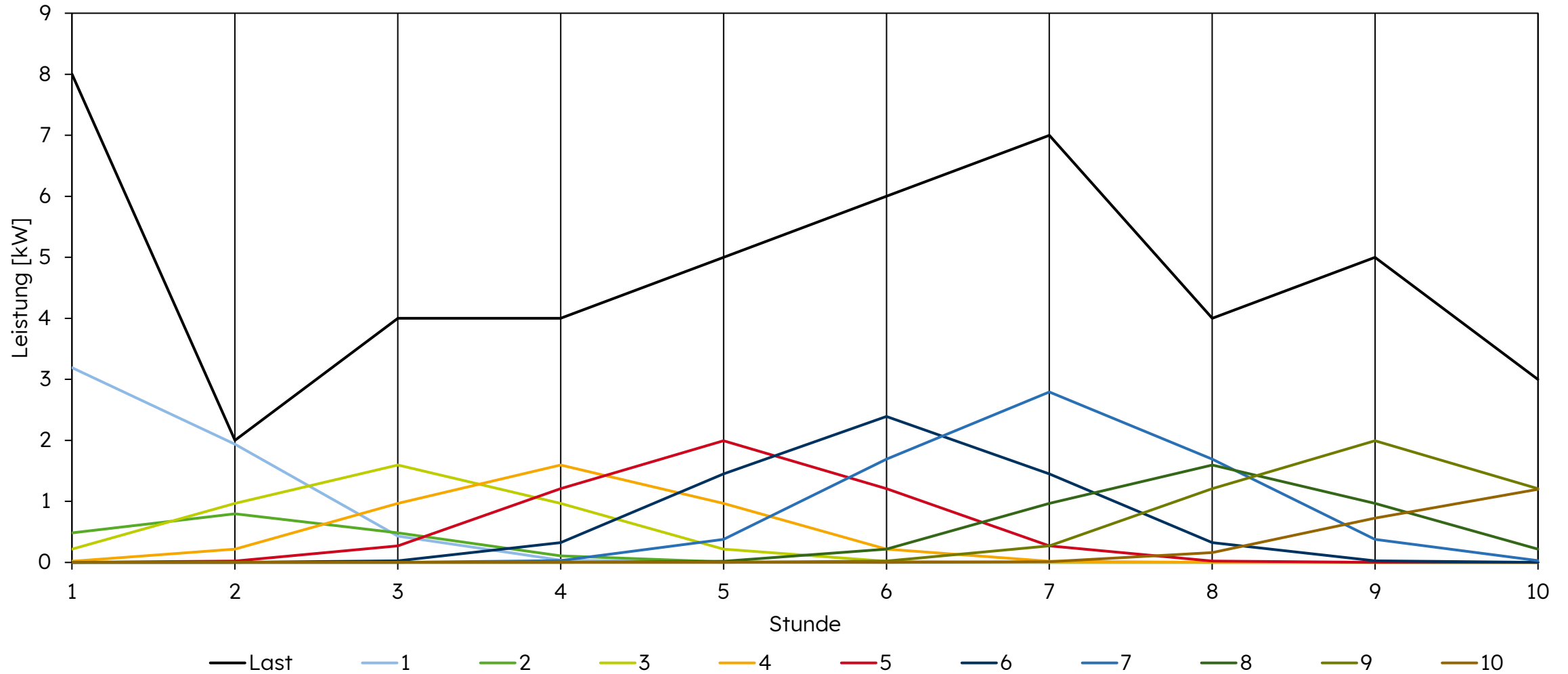
# Example: Normal distribution at time step 5



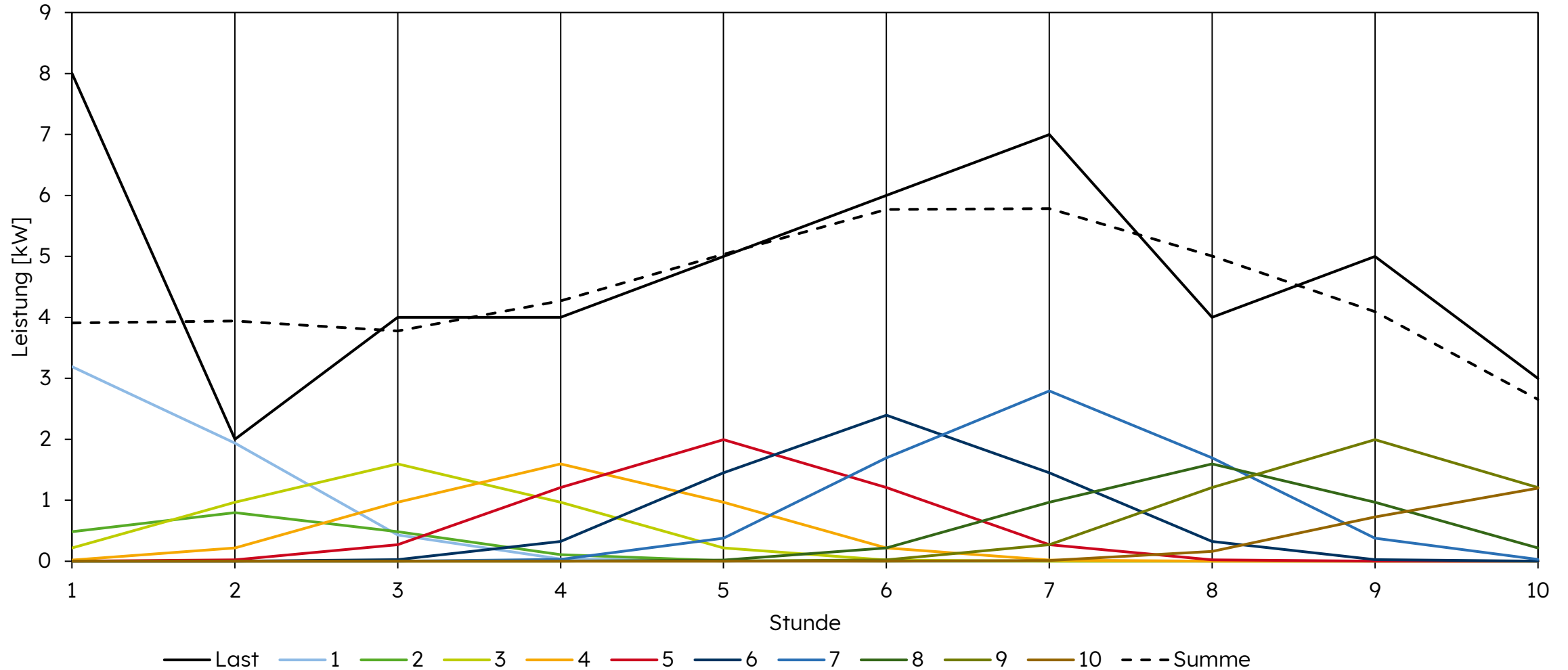
# Example: Normal distribution at time steps 4 to 6



# Example: Normal distribution at all time steps



# Example: sum of all single normal distributions (dotted line)



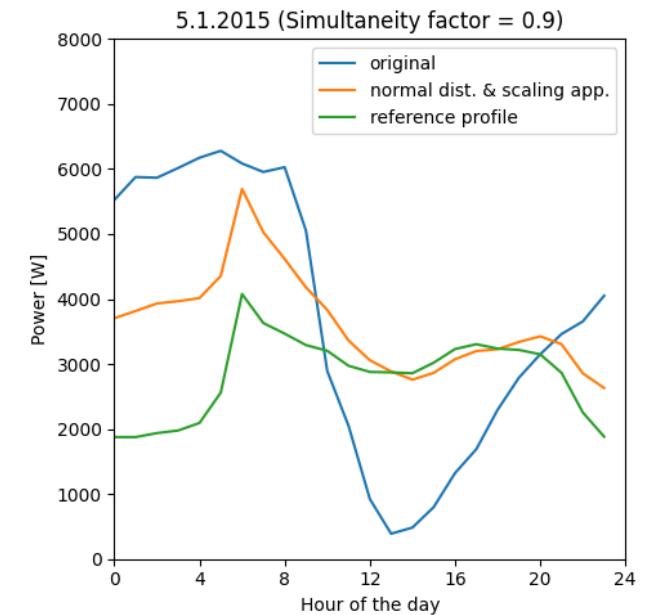
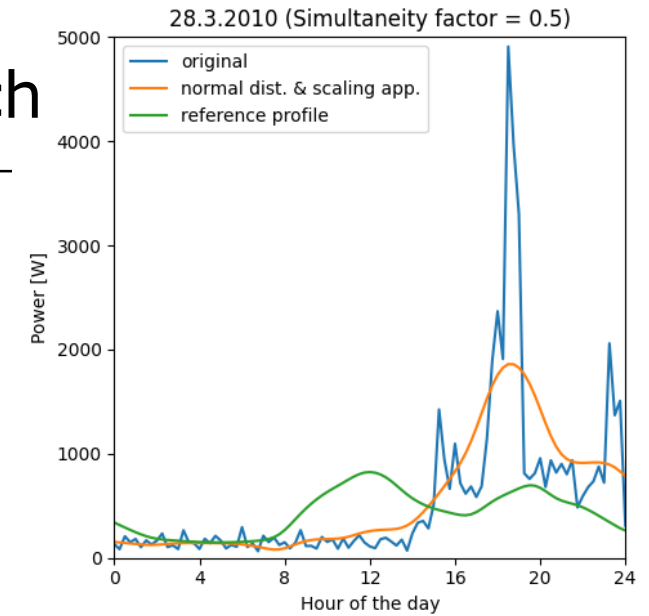
# Normal distribution and reference profile approach

- $$P_{new}(t) = P_{ref}(t) + \sum_{i=t-4\cdot\sigma}^{t+4\cdot\sigma} NDI(i, t) \cdot (P_{orig}(i) - P_{ref}(i))$$

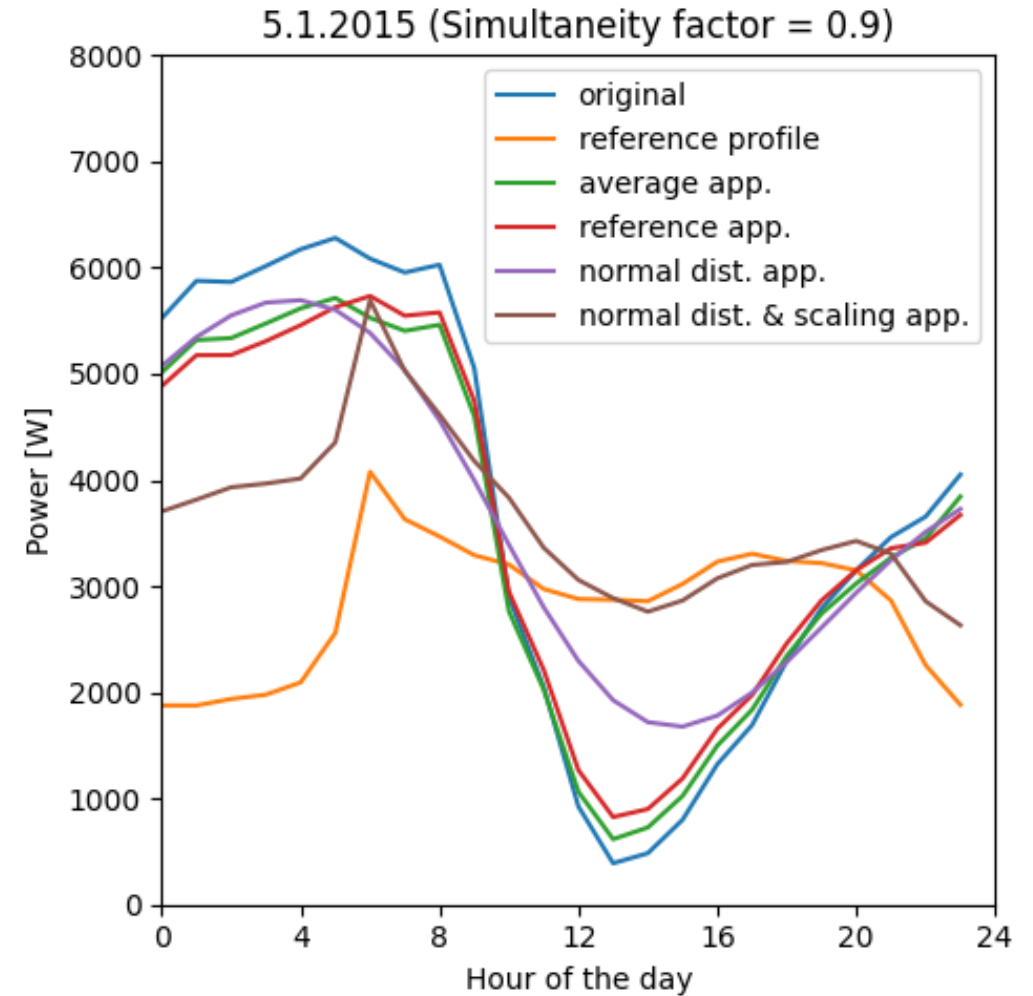
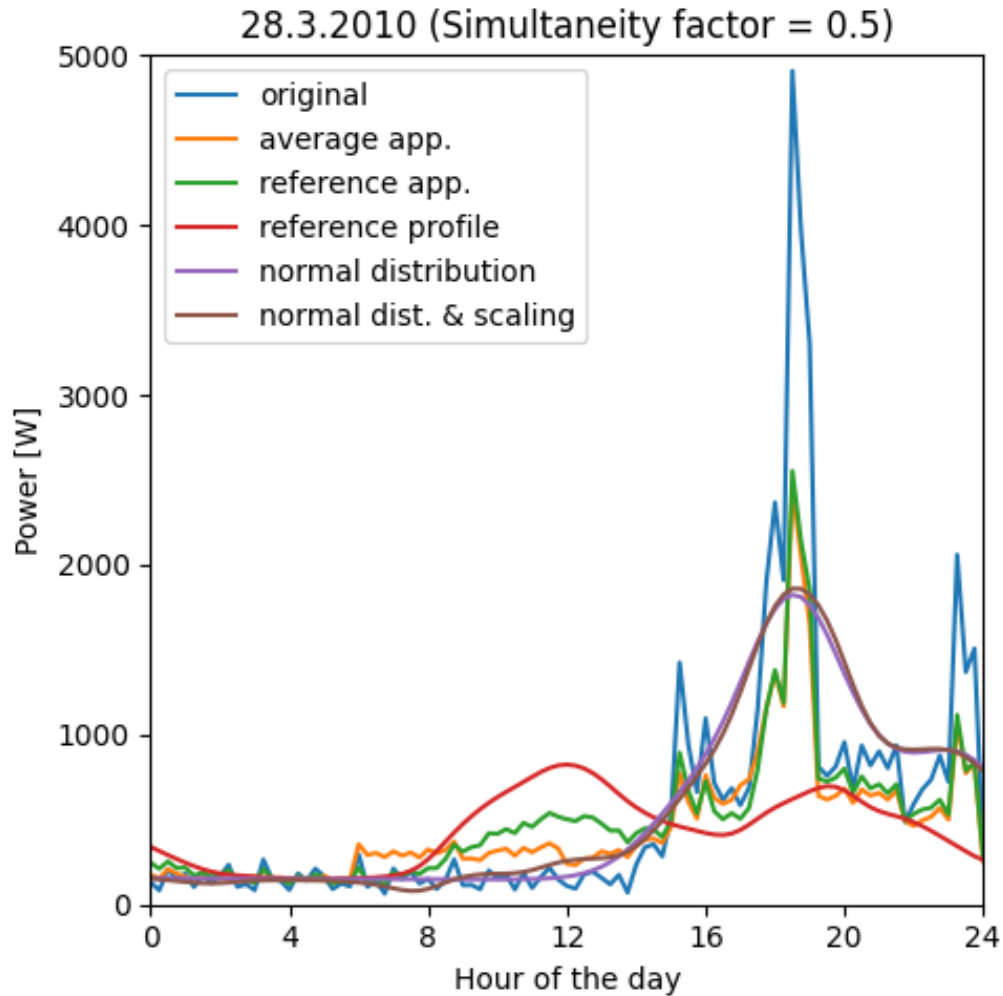
- $$NDI(x, t) = \int_{x-\frac{\delta t}{2}}^{x+\frac{\delta t}{2}} ND(x, t) \delta x$$

- $$ND(x, t) = \frac{e^{-\frac{(x-t)^2}{2\cdot\sigma^2}}}{\sqrt{2\cdot\pi\cdot\sigma^2}}$$

- $P_{new}$ : new scaled profile
- $P_{orig}$ : original profile
- $P_{ref}$ : reference profile
- $ND$ : normal distribution function
- $NDI$ : integration of normal distribution
- $\delta t$ : time step
- $\sigma$ : variance



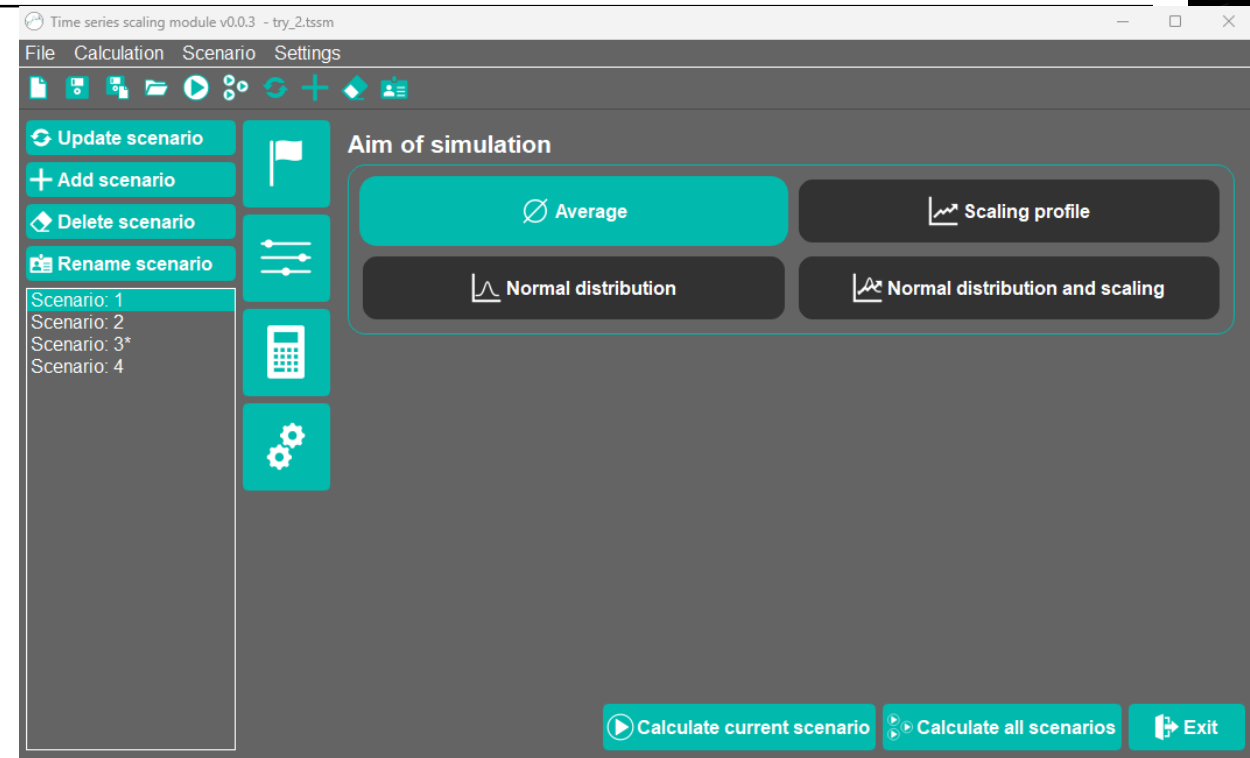
# Comparison of all approaches





# Where to find?

- More information:  
<https://tssm.readthedocs.io/en/latest/>
- Git:  
<https://git.fh-aachen.de/tb5152e/tssm>
- Pip (python instance):  
pip install tssm
- Also available as matlab version
  
- Graphical User Interface (In progress)
- Standalone app:  
<https://fh-aachen.sciebo.de/s/2K0a3rRj4grk2YP>



## **Wir bauen Gebäude für Jahrzehnte also lasst uns sie auch für Jahrzehnte entwickeln!**

We build buildings for decades so let us design them for decades!