Battery modeling requirements for stationary storage systems

Daniel Kucevic

Technical University of Munich

Department of Electrical and Computer Engineering

Institute for Electrical Energy Storage Technology

openmod workshop, 22 May 2019

Introduction

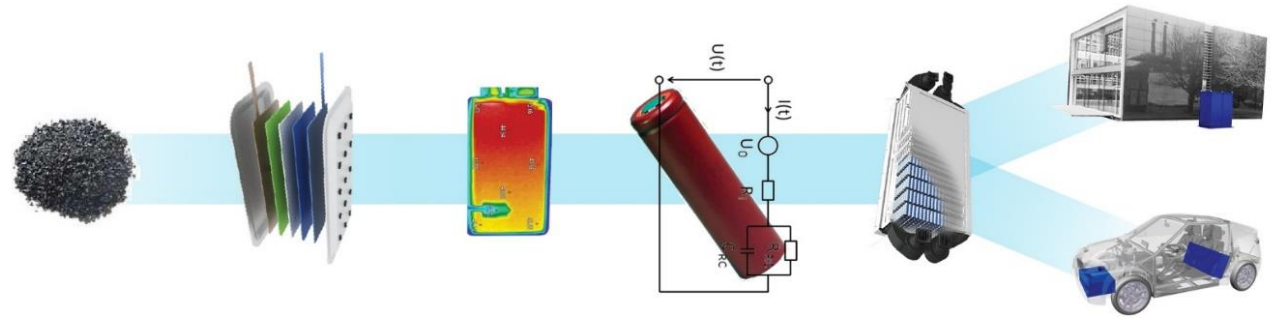
Who I am?

Daniel Kucevic
Technical University of Munich
Department of Electrical and Computer Engineering
Institute for Electrical Energy Storage Technology

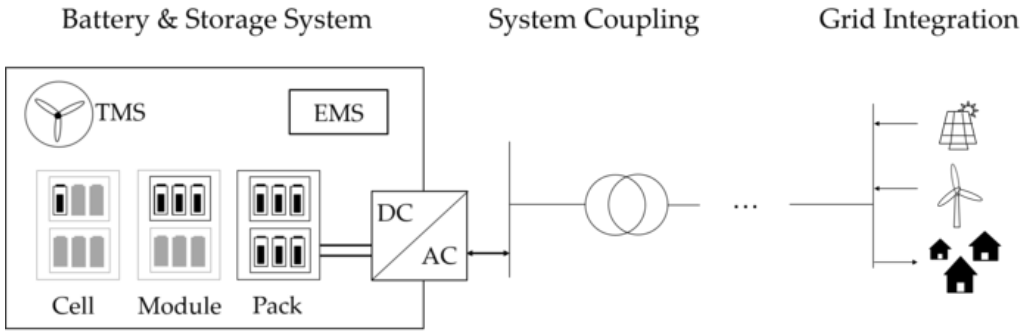
Masterthesis: Capacity increase of a medium voltage urban grid by meshing (@SWM)

PhD. Thesis: Optimal Placement and Sizing of Battery Energy Storage Systems in Modern Power Grids

Introduction



Introduction



Forschungsprojekt
EffSkalBatt

open_BEA

Storage LINK

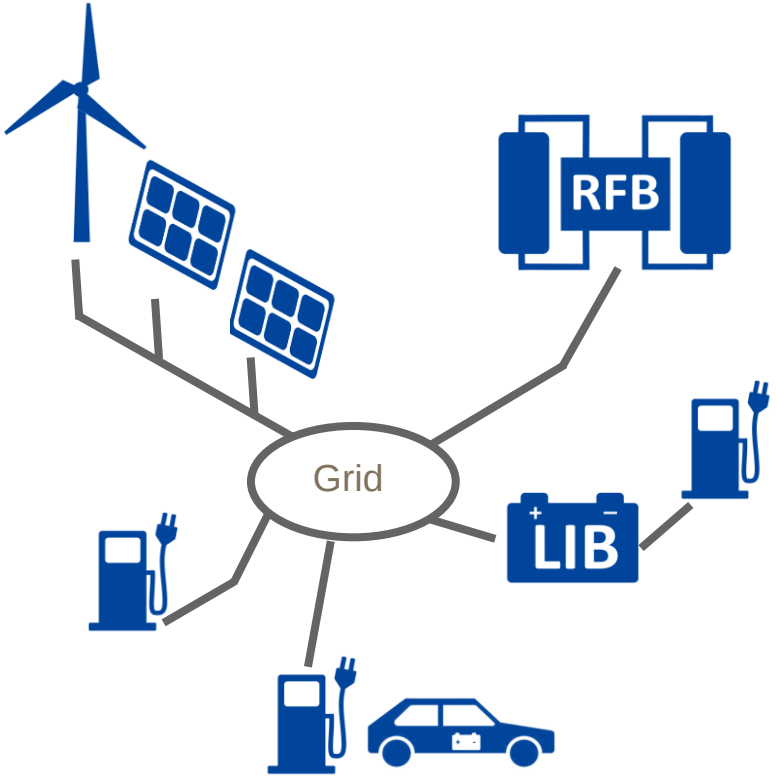
Efficiency & 2nd life

Modelling & Grid-simulation

Optimization & Multi-Use

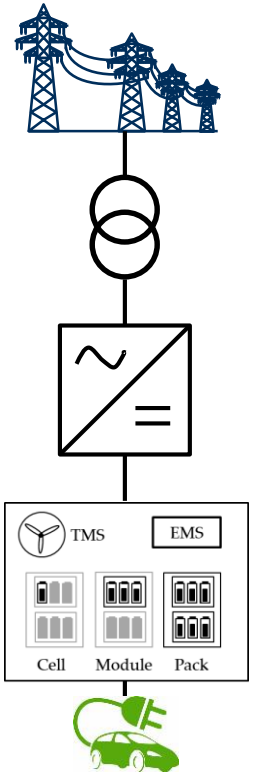
Motivation

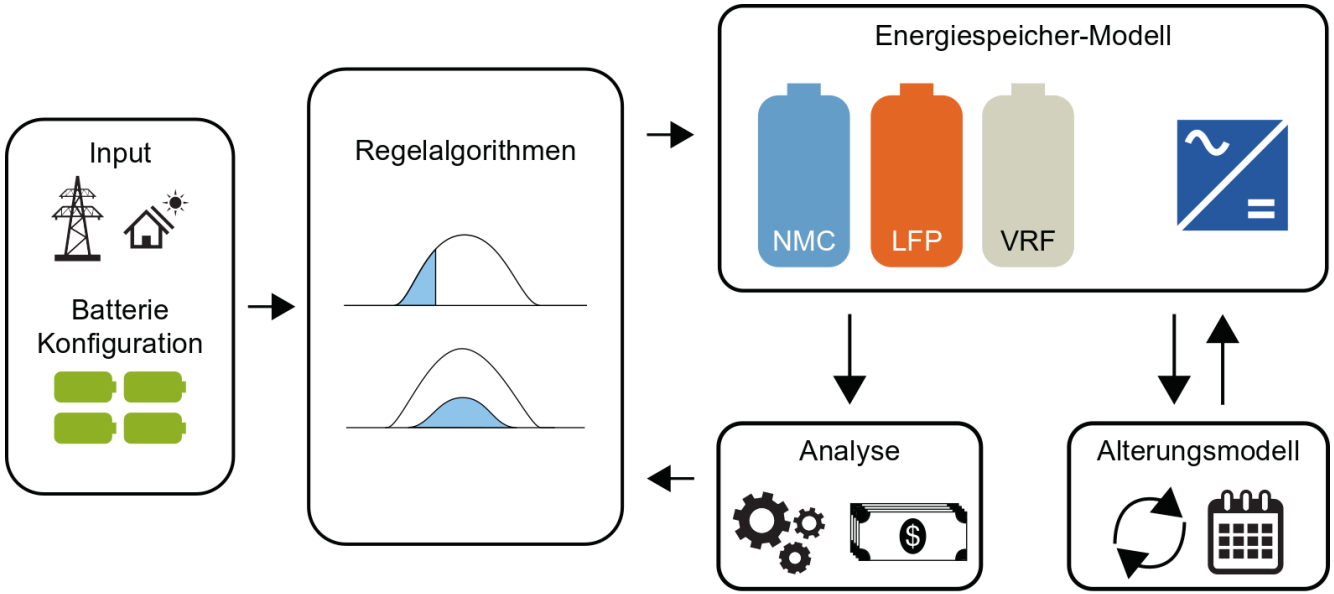
- SimSES is a modular open-source simulation framework that allows a technical and economic analysis of stationary storage systems.
- Conversion to Python → open-source
- As part of the research project open_BEA, a grid model will be coupled with SimSES



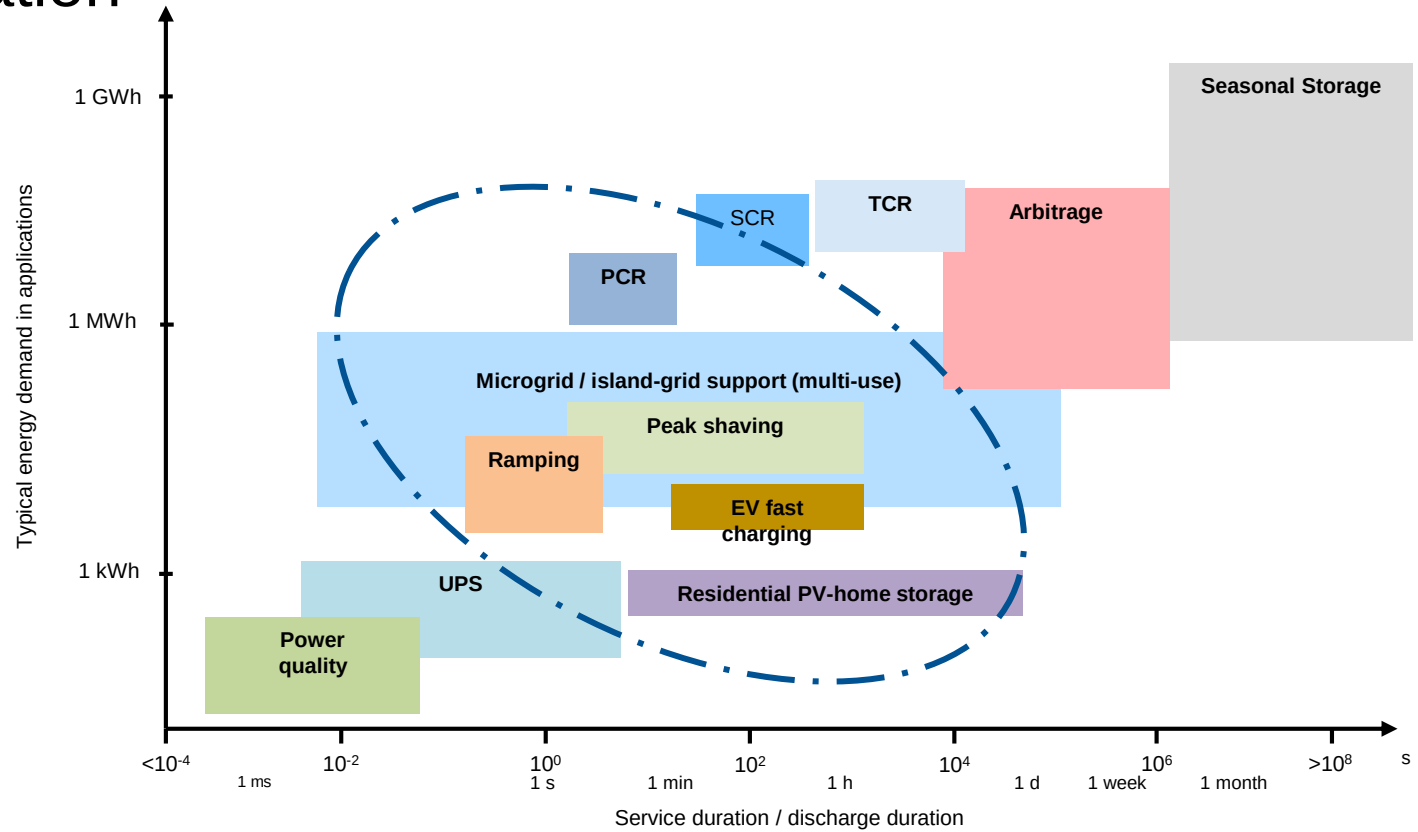
Simulationframework SimSES

SimSES (Simulation of stationary energy storage systems) is a modular open-source simulation framework and available via: www.simses.org

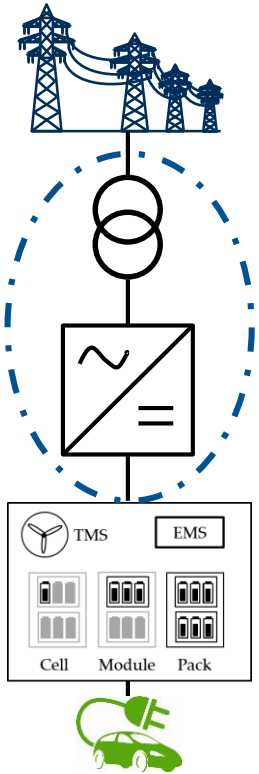




Motivation


Typical energy demand in applications
1 GWh
1 MWh
1 kWh
Seasonal Storage
SCR
TCR
Arbitrage
PCR
Microgrid / island-grid support (multi-use)
Peak shaving
Ramping
EV fast charging
UPS
Residential PV-home storage
Power quality
<10-4
1 ms
10-2
1 s
100
1 min
102
1 h
104
1 d
106
1 week
1 month
>108
s
Service duration / discharge duration

Structure Simulationsoftware SimSES



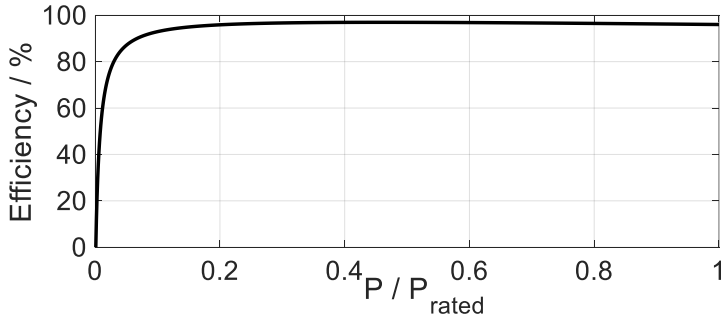
Transformer

- Based on investigations on a 1.4 MW / 1.2 MWh storage at the TUM campus in Garching
- Alternative: literature values / data sheet information

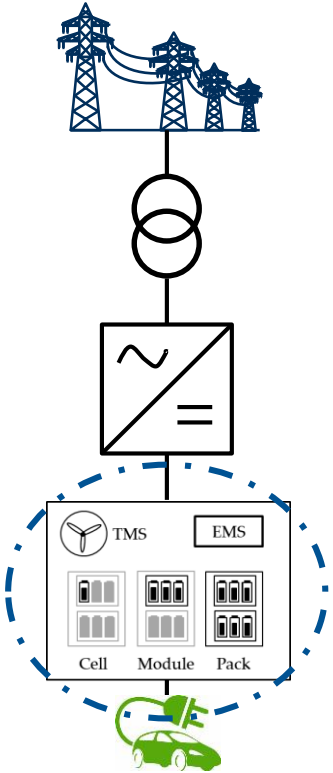
Power electronics

- Simple / Modular
- Investigations on two stationary storage systems
- Alternative: literature values / data sheet information

Source: SmartPower



Structure Simulationsoftware SimSES

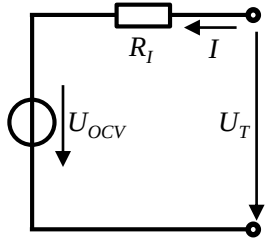


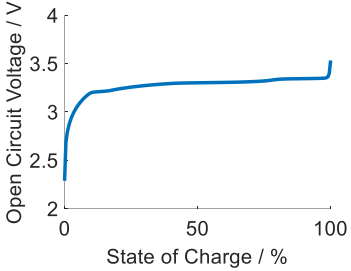
Battery Model

- quivalent circuit model (OCV + R_i)
- Temperature-dependent resistance
- 1D thermal model

Aging Model

- Superposition Cyclic + Cal. Alterung

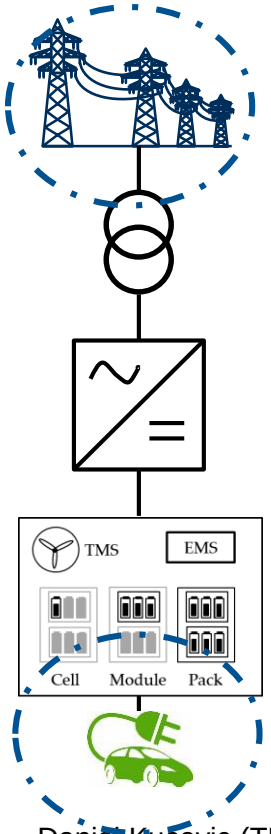




Batterycells

- LFP Sony US26650
- NMC Molicel IHR18650A
- (NCA Panasonic NCR18650PD)
- (All-Vanadium RFB)
- Alternative: literature values / data sheet information

Structure Simulationsoftware SimSES

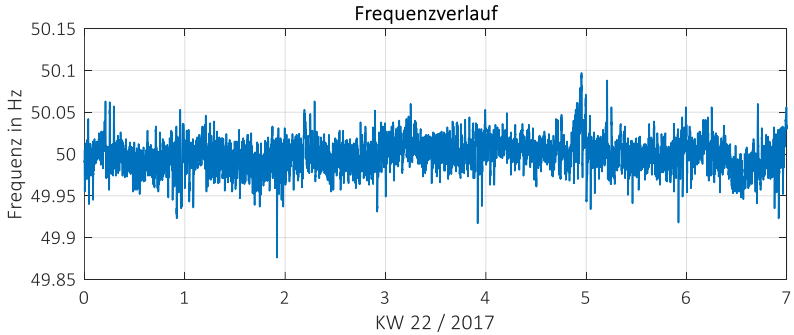


Inputprofiles

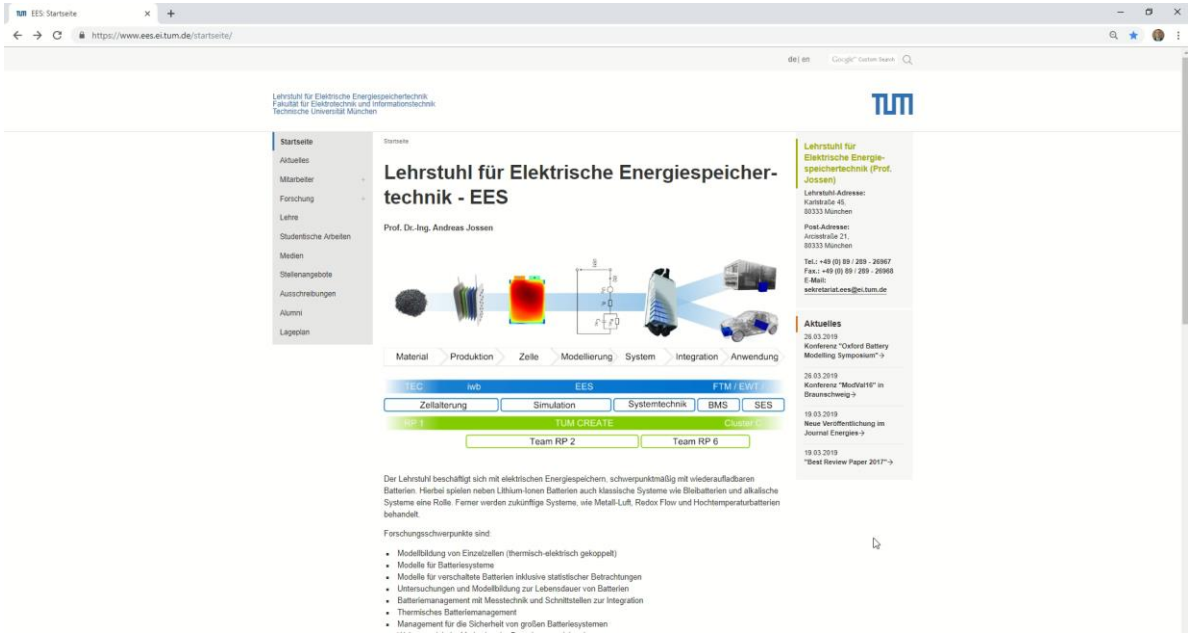
- Frequency 2012 – 2018
- PV-Profiles TUM
- Economic data
  - FCR prices
  - IDM prices
- (FRR profile 2017-2018)

Loadprofiles

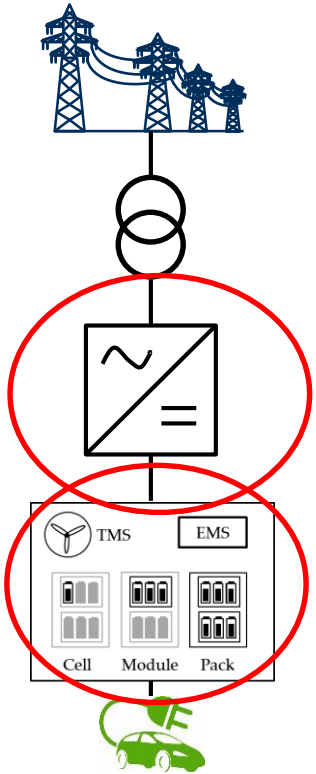
- ~150 Household loadprofiles
- ~ 50 Industryprofiles
- Charging behavior for E-mobility



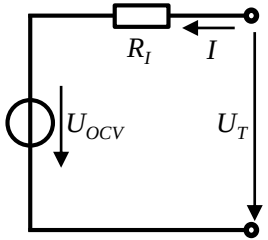
Simulationsoftware SimSES

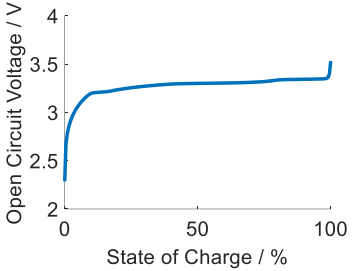


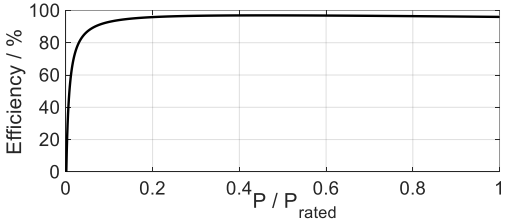
Battery modeling requirements for stationary storage systems



- Why I'm here?



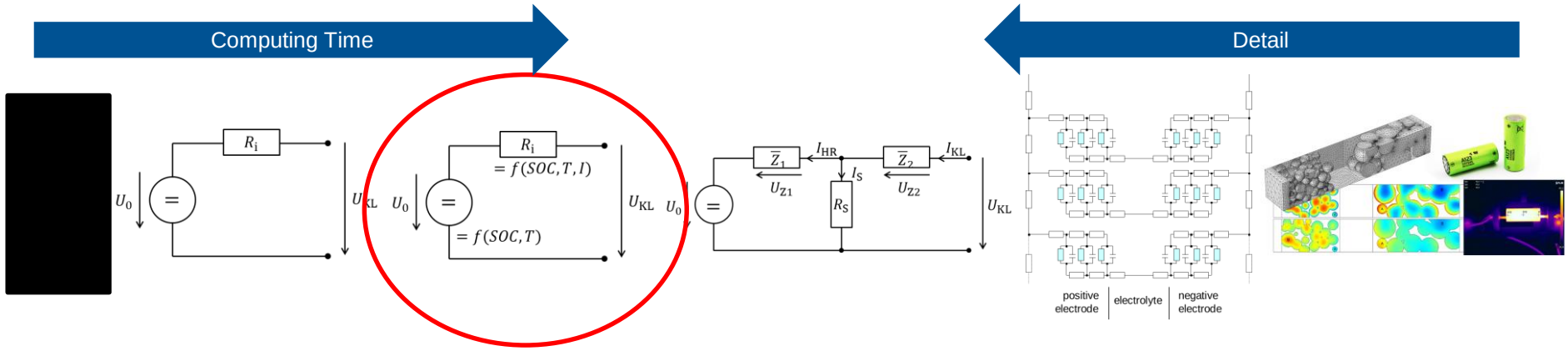


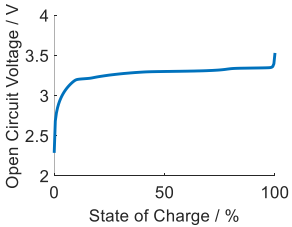


Why I'm here?

- ***How much can we go into the modeling of the battery in detail, that remains useable for other tools in the energy sector?***
  - Is aging a factor that is relevant to your tool/purpose?
  - Is variable efficiency a factor that is relevant to your tool/purpose?
  - Is variable efficiency a factor that is relevant to your tool/purpose?
  - What time resolution is relevant to your purpose?
  - Which applications are relevant for you?
- SimSES2Python - Betatest? (Friday - running and testing open-source models)

Abstraction level battery modeling

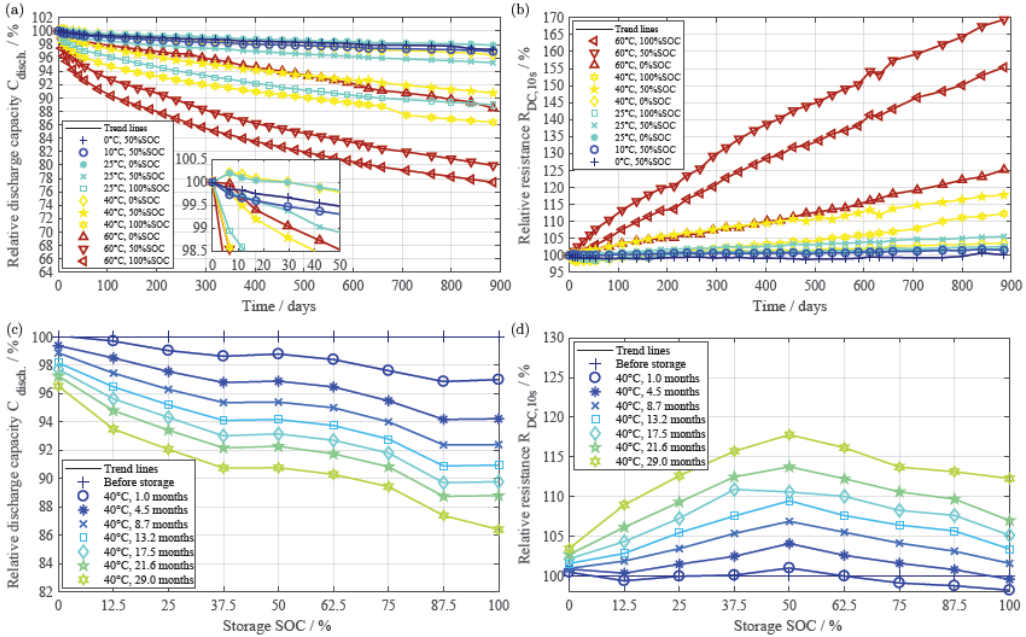




OCV curve dependent on SOC, (Temp)

R_i dependent on SOC, Temp and Current

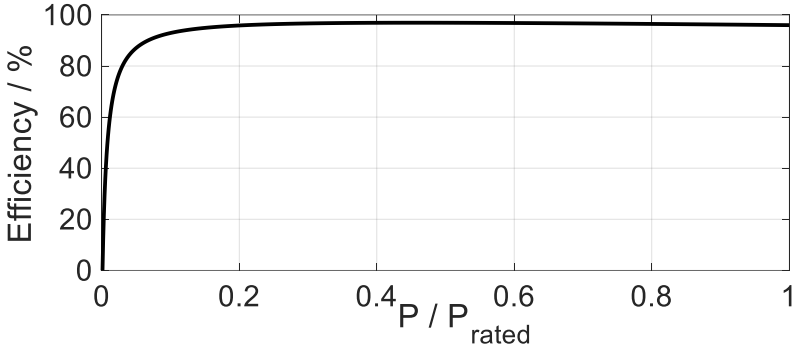
Is aging a factor that is relevant to your tool/purpose?

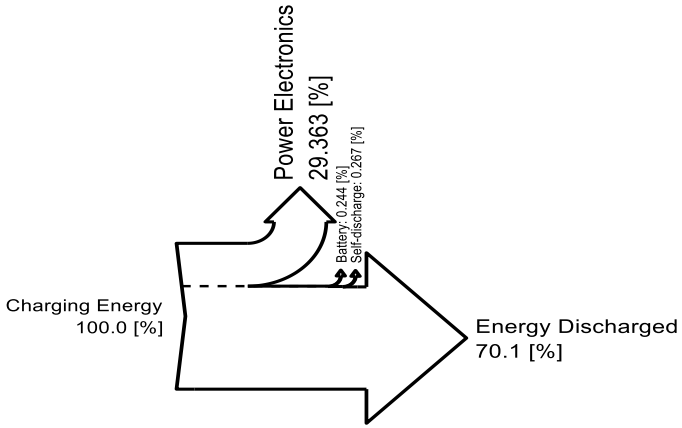


Source: PhD Thesis Naumann, Maik

- **Now**: Semi empirical models
- **Options**:
  - Fixed aging (10 years)
  - Linear aging
  - Simplified Models (1 year 95 %, 2 years 90 %, …)
  - Noaging
  - Data sheet specifications
  - Physiochemical models

Is efficiency a factor that is relevant to your tool/purpose?



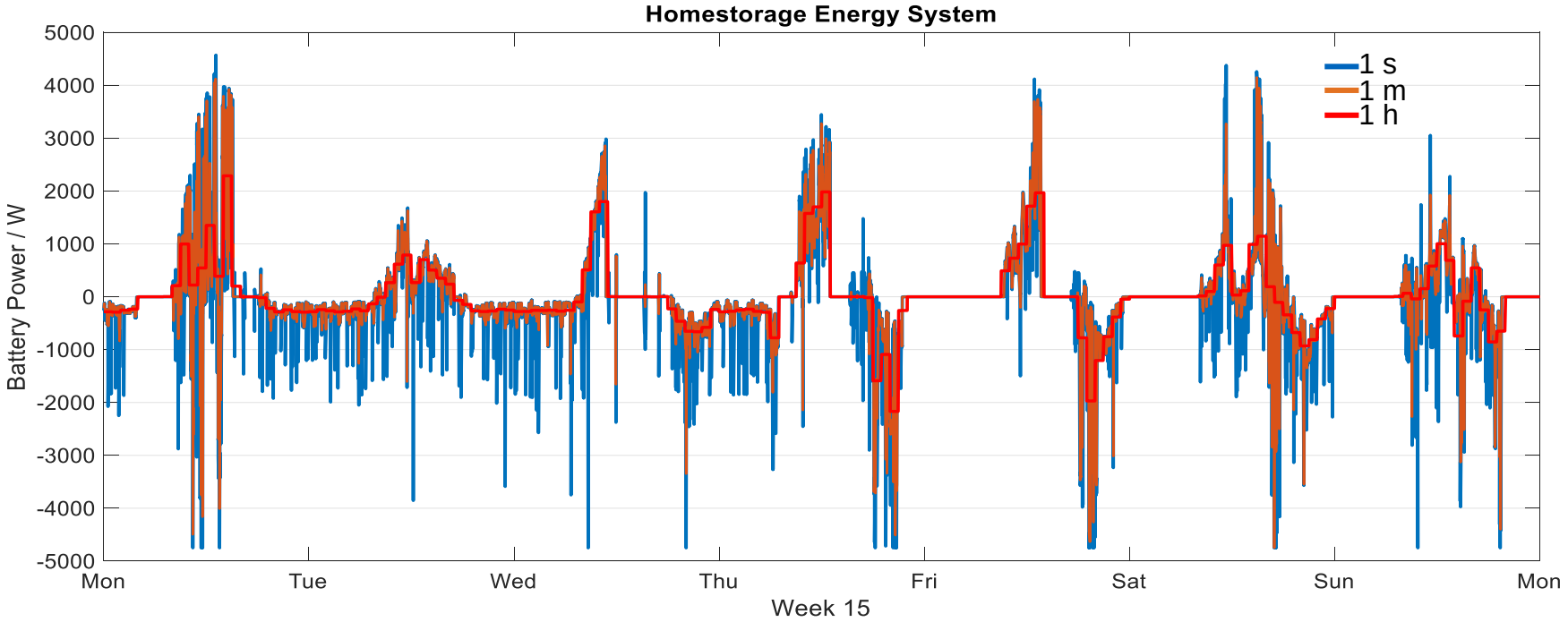


- **Now**: Detailed efficiency curves for battery cell and power electronics unit

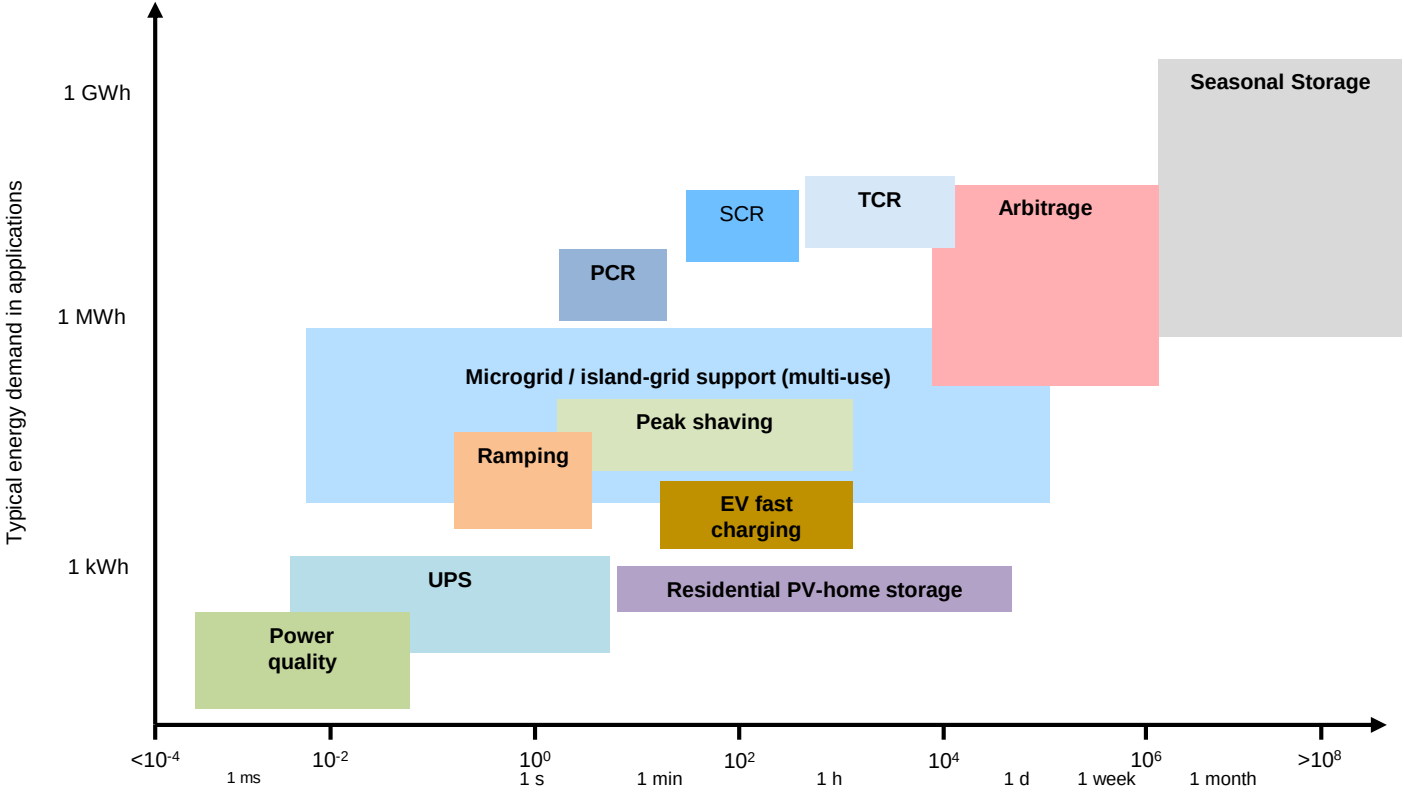
- **Options**:
  - Fixed efficiency for the whole system
  - Fixed efficiency for each component
  - Simplified Models (1 year 95 %, 2 years 90 %, …)
  - No Efficiency
  - Data sheet specifications

What time resolution is relevant to your purpose?

- **Now**: Depending on the use-case we simulate with a time resolution of 1s to 15m



Which applications are relevant for you?



Vielen Dank | Thank you | Tak

Daniel Kucevic, M.Sc.

Technical University of Munich

Institute for Electrical Energy Storage Technology

Tel.: +49 (0) 89 / 289 – 26986

E-Mail: daniel.kucevic@tum.de

Visitor address: Karlstraße 45, 80333 München

Postal address: Arcisstraße 21, 80333 München

Homepage: http://www.ees.ei.tum.de/en/

open_BEA

(FKZ: 03ET4072)

Gefördert durch:

Bundesministerium für Wirtschaft und Energie

aufgrund eines Beschlusses des Deutschen Bundestages

ZAE BAYERN

REINER LEMOINE INSTITUT