Battery modeling requirements for stationary storage systems

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Introduction

Who I am?

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

Introduction
Introduction

Efficiency & 2nd life

Modelling & Grid-simulation

Optimization & Multi-Use

Forschungsprojekt EffSkalBatt

open_BEA

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

- **Service duration/discharge duration**
  - **Microgrid/island-grid support (multi-use)**
  - **Residential PV-home storage**
  - **UPS**
  - **Power quality**
  - **Peak shaving**
  - **Ramping**
  - **EV fast charging**
  - **Arbitrage**
  - **TCR**
  - **SCR**

- **Typical energy demand in applications**
  - **PCR**
  - **UPs**
  - **EV fast charging**

- **Seasonal Storage**
Structure Simulation software 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 Simulation software SimSES

Battery Model
- equivalent circuit model (OCV + R_i)
- Temperature-dependent resistance
- 1D thermal model

Aging Model
- Superposition Cyclic + Cal. Alterung

Battery cells
- 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?

  - 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?

- **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

Source: PhD Thesis Naumann, Maik
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
Now: Depending on the use-case we simulate with a time resolution of 1s to 15m
Which applications are relevant for you?

- Microgrid / island-grid support (multi-use)
- Residential PV-home storage
- Seasonal Storage
- UPS
- Power quality
- Peak shaving
- Ramping
- EV fast charging
- Arbitrage
- TCR
- SCR
- PCR

Typical energy demand in applications:

- <10^-4 kWh
- 10^-2 kWh
- 1 kWh
- 1 MWh
- 1 GWh

Time scales:

- <10^-4 s
- 1 ms
- 10^-2 s
- 1 s
- 10^0 min
- 1 min
- 10^2 h
- 1 h
- 10^4 d
- 1 day
- 1 week
- 1 month
- >10^6 month
Vielen Dank | Thank you | Tak

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