Modeling Framework for Simulating Energy Storage Systems in Grid Applications

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**Motivation**

The imminent coupling of the transport sector with the electricity sector and the possibilities of grid integrated energy storages are creating new potentials and challenges.

With open_BEA (open battery models for electrical grid applications), the following open questions are addressed:

- Which storage technology is cost-optimal for a given application?
- How must stationary storage systems optimally be positioned, dimensioned and operated in order to provide grid-related services?
- To which extend are battery electric vehicles capable to serve as a flexibility option in a future power grid?
- Which potential has an energy storage system performing active peak-shaving for future grid planning?

**Model Overview**

In open_BEA (open battery models for electrical grid applications), a holistic open-source modeling tool, which will be made open-source accessible is developed.

The simulation platform allows connecting the open-source tools SimSES for simulation storage systems and edisGo, a toolbox to analyze distribution grids [1]. Figure 1 shows the open_BEA model overview of as well as its key functionalities.

**SimSES**

SimSES (Simulation of stationary energy storage systems) is a modeling framework for stand-alone simulations stationary energy storage systems. The open-source tool is developed at the Institute for Electrical Energy Storage Technology. SimSES enables:

- A detailed simulation and evaluation of stationary energy storage systems with the current main focus on lithium-ion batteries, redox-flow batteries and hydrogen based storage systems.
- A modular and flexible structure (see Figure 2), which allows the variation of storage technologies, technical subcomponents, such as power electronic units, and aging models.

SimSES is available as an open source version and can be found here: www.simes.org. The simulation loop (flow-chart) is shown in Figure 3.

**Results open_BEA**

The open_BEA framework was used to analyze the effect of storage systems performing PS in an active role.

**Outlook**

In the future the open_BEA framework will include:

- A holistic techno-economic analysis to fully compare stationary storage systems based on lithium-ion batteries with redox-flow batteries and hydrogen based storage systems.
- The possibility to simulate and analyze buffer storage systems at (fast) charging stations.
- Real-life examples by simulating storage systems in existing grid topologies.

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[1] Stoyanov, D., Dotzauer, P., Hesse, H., [Title of the paper], [Conference or Journal], [Year] 1-10.