Used Lithium ion battery: State of health data for its second life

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Used batteries from EVs

Electric vehicles used batteries retain significant capacity (~80%) for its **second life**. Reuse of these batteries is a better choice than recycle because recycling needs an additional cost as well as have potential waste.

Motivation

- **No performance data** available from the previous user
- **Classify** the used batteries for second life applications
- **Analysis of SOH** data of used batteries can classify the applications

Advantages of used LIB

- Used lithium ion batteries (LIB) for **stationary applications**
- Reuse of used batteries is beneficial in terms of **economic and environmental values**
- Reuse of LIB can **reduce the battery** price
- The **cost for recycling** a LIB is already included in the price

BMS and Balancing

Balancing

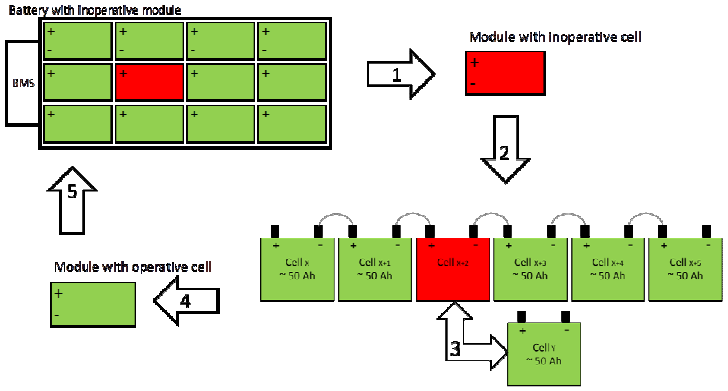
- Equal cell voltage in serial connection
- Passive balancing by a bypass resistance
- Voltage difference of 20 mV

BMS Limits

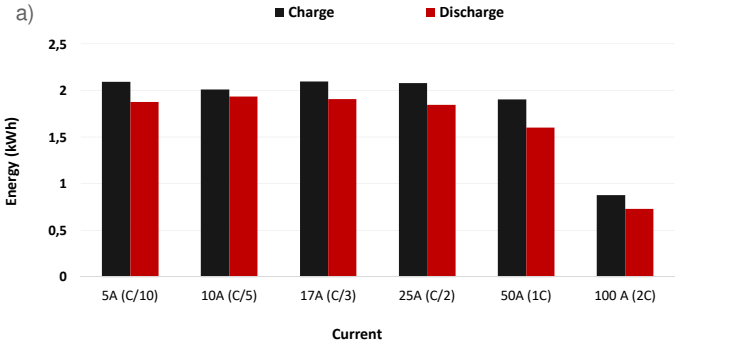
- Cell-temperature ≥ 40 °C
- Upper cut-off voltage 4.1 V
- Lower cut-off voltage 3.0 V

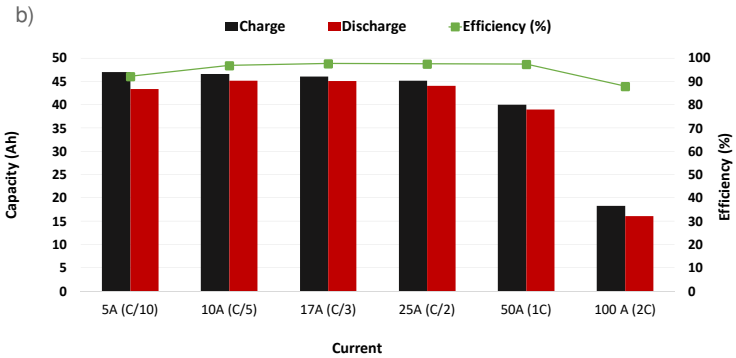
Conclusion

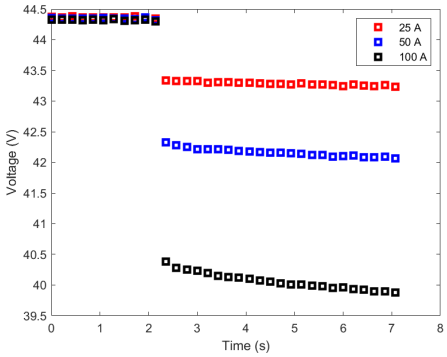
1. **Identified** (voltage drop, inner resistance) damaged cells
2. **Replaced** with active cells
3. SOH data (cycling data): Applications for **C-rates at C/20 to C/3**
4. Used batteries are suitable and an inexpensive option to **store the energy form renewable sources** and backup power for homes



Charge and Discharge data of a second life battery module with replaced active cells:
a) Energy in [kWh] b) Capacity in [Ah] and the coulomb efficiency







Voltage drop test with different current pulses:

The higher the current, the higher the voltage drop. It indicates that the battery can deliver the significant capacity only up to C/3 C-rate

Exp: Regatron TC.GSS.32.130 (max. 130V, max. 308A) was used to charge-discharge the battery module. A LabView program (National Instruments ®) was introduced to communicate with the module BMS and the measurement systems. The functions of balancing as well as the data collection were controlled by the program.

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