Lifetime Evaluation of a Battery Storage System used for Residential Electricity Supply in East Africa

Stroe, Daniel-Ioan; Schaltz, Erik

Publication date:
2019

Document Version
Accepted author manuscript, peer reviewed version

International Renewable Energy Storage Conference
IRES
WCRE
EUROSOLAR The European Association for Renewable Energy

IRES 2019 Poster Exhibition
13th International Renewable Energy Storage Conference

ID: 260

Lifetime Evaluation of a Battery Storage System used for Residential Electricity Supply in East Africa

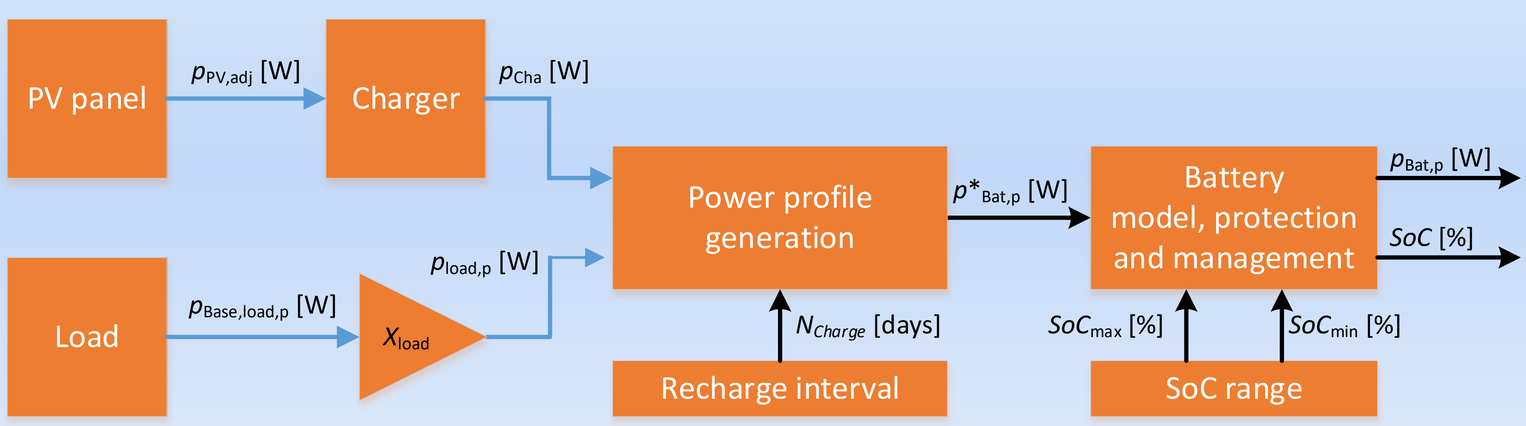
D.-I. Stroe (dis@et.aau.dk), E. Schaltz

Department of Energy Technology, Aalborg University, Aalborg, Denmark

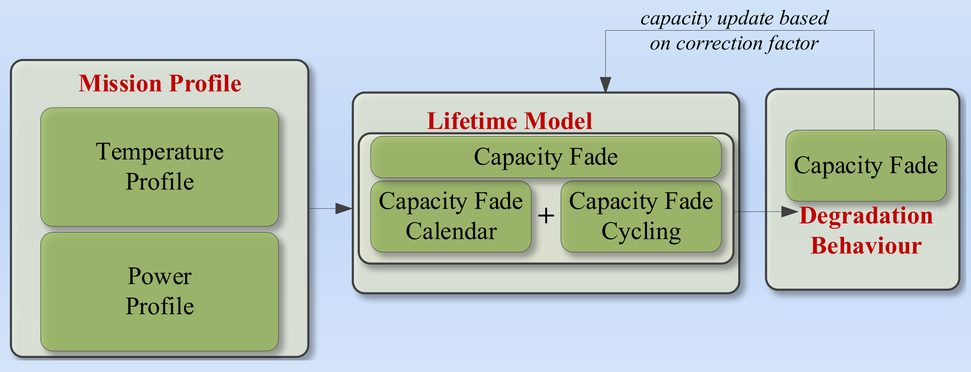
Introduction

- The lifetime is a key indicator for the battery performance in every application
- The battery lifetime is greatly influenced by the operating conditions to which the battery is subjected
- In this work, we have evaluated the lifetime of a Lithium-ion (Li-ion) battery, which is used for providing electricity for a residential home located in East Africa. The battery is recharged at least once per week from a photovoltaic panel.
- Different operating scenarios were used to evaluate the battery lifetime, by varying the battery recharging interval, the load profile, and the minimum and maximum allowed battery SOC → 23 study cases
- The battery capacity was selected as the indicator for the battery lifetime; a 20% decrease in battery capacity = end-of-life reached
- Li-ion batteries based on LCO chemistry are used

Battery Mission Profile Generation



Battery Lifetime Calculation

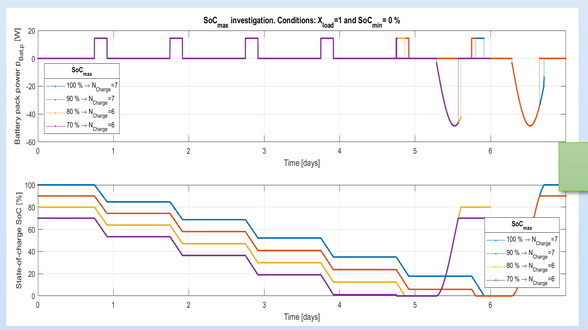


$$Cf_{cal} = 0.5169 \cdot e^{0.007388 \cdot SOC} \cdot t^{0.8}$$

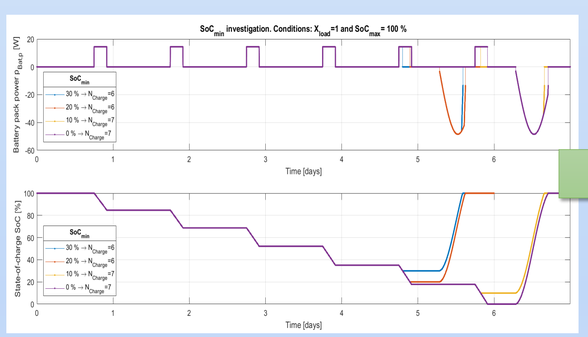
$$Cf_{cyc} = 0.0839 \cdot e^{-0.01943 \cdot SOC} \cdot cd^{0.7162} \cdot nc^{0.5}$$

Study Cases

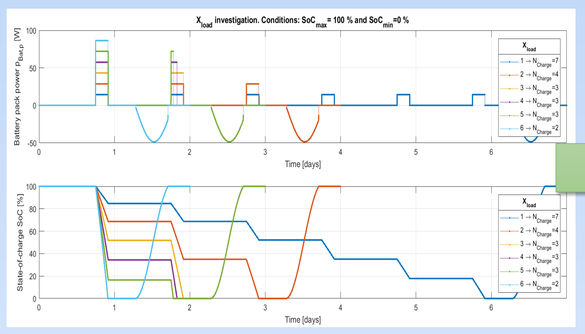
Max. SOC



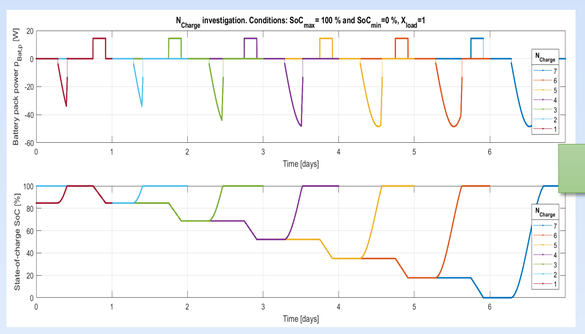
Min. SOC

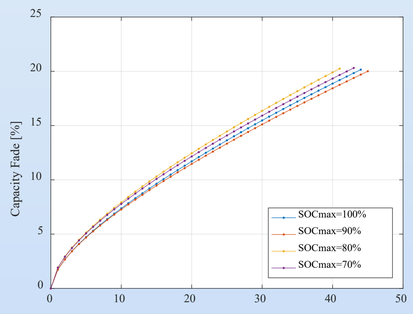


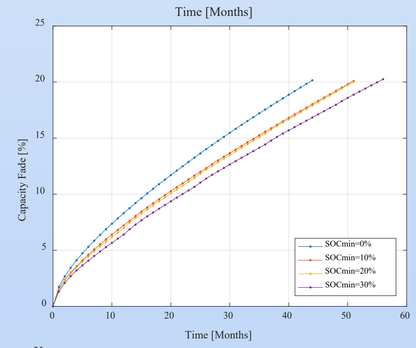
Load Power

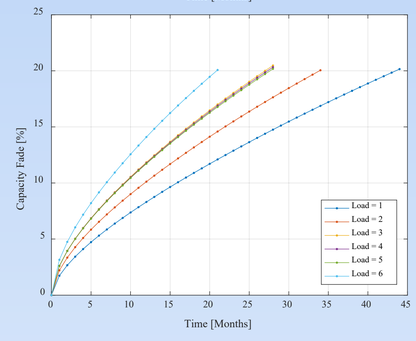


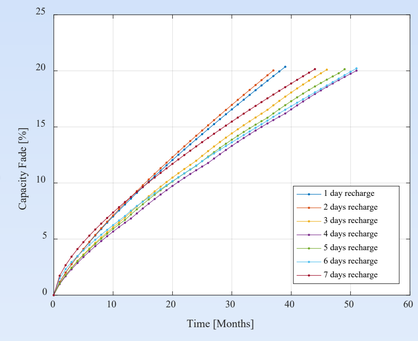
Recharge Time











Lifetime Evaluation

SOC interval	Lifetime	Cap. fade - idling	Cap. fade - cycling
100% - 0%	44 months	12.90 %	7.24 %
90% - 0%	45 months	12.34 %	7.66 %
80% - 0%	41 months	11.63 %	8.61 %
70% - 0%	43 months	11.38 %	8.92 %

SOC interval	Lifetime	Cap. fade - idling	Cap. fade - cycling
100 % - 30%	56 months	17.65 %	2.59 %
100 % - 20%	51 months	14.88 %	5.50 %
100 % - 10%	51 months	14.60 %	5.50 %
100 % - 0%	44 months	12.90 %	7.24 %

X_load	Lifetime	Cap. fade - idling	Cap. fade - cycling
1	44 months	12.90 %	7.24 %
2	34 months	10.63 %	9.41 %
3	28 months	9.83 %	10.63 %
4	28 months	9.65 %	10.66 %
5	28 months	9.46 %	10.71 %
6	21 months	8.27 %	11.80 %

Recharge	Lifetime	Cap. fade - idling	Cap. fade - cycling
1 day	39 months	19.60 %	0.75 %
2 days	37 months	19.67 %	0.36 %
3 days	46 months	17.25 %	3.06 %
4 days	51 months	15.85 %	4.32 %
5 days	49 months	14.78 %	5.25 %
6 days	51 months	15.98 %	4.23 %

- For the considered scenarios, lifetime expectances between 21 and 56 months were obtained.
- The maximum and minimum allowed battery SOC interval and the battery recharging interval have a non-linear effect on the lifetime of the considered battery