Tutorial Proposal

1. Tutorial Title

Smart Battery, a new technology

2. Instructor Team: name(s), affiliation(s), and contact information

Remus Teodorescu, ret@energy.aau.dk
Dr. Abhijit Kulkarni
Pallavi Bharadwaj
Xin Sui

3. Abstract (No more than 500 words. Accepted abstract will be published through the conference website, program, and proceedings.)

Lithium-ion batteries are extensively used in a wide range of applications from electric vehicles to energy storage systems. Although the performance parameters in terms of energy density and cost have already met the targets, the remaining challenges are improved safety and longer lifetime. Especially for battery packs with many cells, the degradation process is accelerated due to the difference between cells electrical characteristics leading to a limited lifetime and reliability issues. This lecture introduces the novel concept of Smart Battery that combines batteries with advanced power electronics and artificial intelligence (AI) with the purpose to develop a new generation of battery solution for transportation and grid storage with extended lifetime. The key feature is the bypass device, a half-bridge parallel to each cell, that can control individual cell-level load management without affecting the load. An advanced AI-based lifetime controller is trained to recognize the signs of stressed battery cells and decide to insert relaxation time, resulting in a pulsed current operation and extended lifetime with up to 100%. The smart battery unique architecture is capable of on-line retraining of AI lifetime controller using data streaming from cells and cloud computing. The smart battery technology is currently at proof-of-concept stage. We believe that the concept of smart batteries can revolutionize the distributed generation by giving a robust support to balance the stochastic renewable energy generation to fast changing loads including electric vehicles. We will further demonstrate the increased feasibility and efficiency of bi-directional vehicle to grid energy exchange using smart batteries technology for a green, efficient and robust multi-energy nexus.

4. Tutorial Outline (Outline shall only define the topics and subtopics. No detailed descriptions please. Time allocation and instructor breakdown by topics is recommended.)

Time schedule: 26.06.22

14:00 – 14:30 Smart Battery. Concept and Structure – Remus Teodorescu

14:30 – 15:00 Hardware Architecture – Abhijit Kulkarni

15:30 – 16:00 SOH Estimation and Prediction using AI – Xin Sui

16:00 – 16:30 Applications of Smart Battery – Pallavi Bharadwaj

5. Lecture Style and Requirements (Briefly describe the tutorial format, which may include traditional lecture, software/hardware demonstration, interactive audience polls/quizzes, worksheets, discussion, etc. Note any equipment or space requirements beyond a laptop and projector. Also list the targeted audience and tutorial difficulty level, including any pre-requisite knowledge.)

This tutorial would be a traditional lecture and would interact with audiences through Q&A

6. Instructor Biography

Remus Teodorescu received the Dipl.Ing. degree in electrical engineering from the Polytechnical University of Bucharest, Bucharest, Romania, in 1989, Ph.D. degree in power electronics from the University of Galati, Romania, in 1994 and , Dr.HC in 2016 from Transilvania University of Brasov. In 1998, he joined the Department of Energy Technology at Aalborg University where he is currently a Full Professor. Between 2013 and 2017, he has been a Visiting Professor with Chalmers University.

He is IEEE/PELS Fellow since 2012 for contributions to grid converters technology for renewable energy systems.

In 2022 he became a Villum Investigator and leader of Center of Research for Smart Battery at Aalborg University.

His main current research areas are: Modular Multilevel Converters (MMC) for HVDC/FACTS, Li-Ion battery SOH Estimation with AI and Smart Batteries.

Pallavi Bharadwaj is an Assistant Professor at the Department of Energy Technology at Aalborg University. She completed her Postdoctoral Research at Massachusetts Institute of Technology (MIT) in 2021 after receiving her Ph.D. from Indian Institute of Science (IISc), Bengaluru, India in 2019. Pallavi is a Gold Medalist for her industrial training and has received several awards including Posoco Power System Award, Bhaskara Advanced Solar Energy Indo-US fellowship and serves in several IEEE Committees since 2016.

She is very passionate about sustainability and strives towards engineering optimized solutions for global energy needs. Her research interests broadly include: design and control of renewable power conversion systems; modelling and optimization of energy storage solutions; physics inspired AI for smart power electronics towards net zero transition

Xin Sui received the B.Eng. degree from Northeast Electric Power University, Jilin, China, in 2015, and the M.Sc. degree in from Institute of Electrical Engineering, Chinese Academy of Sciences, Beijing, China, in 2018, both in electrical engineering, and the Ph.D. degree from Aalborg University, Aalborg, Denmark, in 2022. She is currently a postdoctoral researcher with the Center for Research on Smart Battery (CROSBAT), AAU Energy, Aalborg University. Her research interests include battery state of health estimation, lifetime extension, and machine learning.

Dr. Abhijit Kulkarni is working as Assistant Professor at Aalborg University in the Department of Energy since March 2022. He was working as a Senior Scientist at Honeywell prior to this.
He received his M.E. and Ph.D degrees in Electrical Engineering from IISc Bangalore in 2011 and 2016 respectively. He has been a gold medalist in his B.Tech, M.E., and received POSOCO Power System Award for Doctoral Excellence for his Ph.D work. He worked at the University of Illinois at Chicago as a Postdoctoral Research Associate between 2016 – 2017 where he also taught a graduate level course on Advanced Power Electronics.
His research interests include power electronics for electric vehicles, battery management systems, power converters for photovoltaic applications, control design, motor drives.