sccer mobility

Swiss Competence Center for Energy Research
Efficient Technologies and Systems for Mobility

In cooperation with the CTI

Energy funding programme
Swiss Competence Centers for Energy Research

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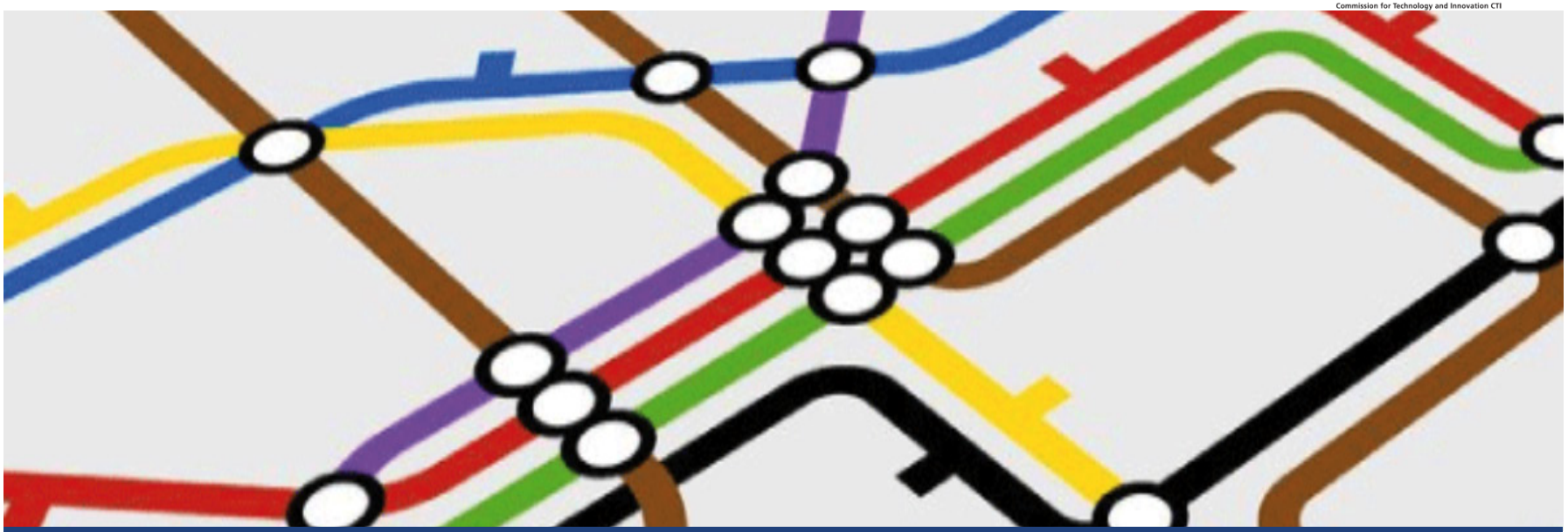

Systems and Components for E-Mobility

Overview and Selected Topics from the Capacity Area A1

Prof. Andrea Vezzini , BFH Bern, Deputy Head SCCER Mobility

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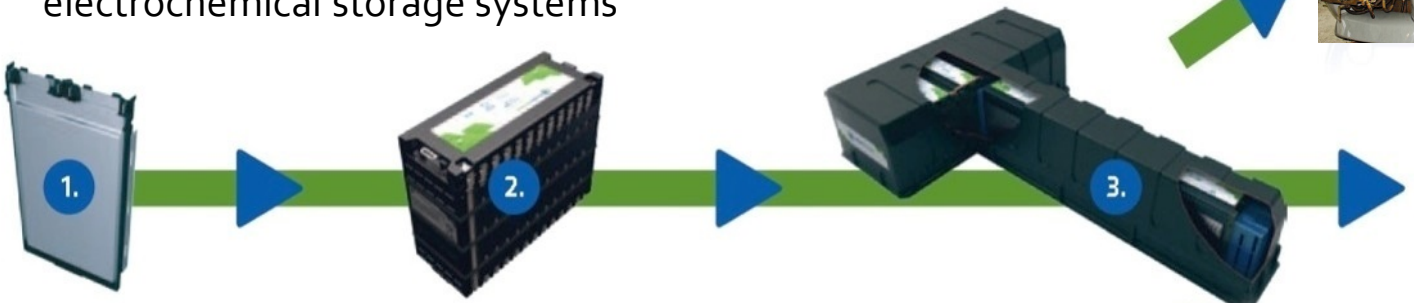
CA A1: Technology Research Platform for Battery Systems for Rail, Bus, Construction, Agricultural and Utility Vehicles

- CA A1 embraces ETH, PSI, EMPA, BFH, FHO and HSLU
- Electrification of drive train and auxiliaries in mobile markets with low production numbers but specific requirements demand customized electrochemical storage systems



- Create a research and technology platform for mobile battery systems providing cell, module and system know-how for Rail, Bus, Construction, Agricultural and Utility Vehicles industry partners
- Establish cross-industry research activities to allow low production volume markets to develop customized battery system solutions

Roadmap: Systems and Components for E-Mobility

Swiss Battery Research Platform

BFH IEM/B, Empa EMRL, ETHZ-HPE, HSLU-IIEE, NTB-EMS

Organization (A1.1)

D-A1.1.1

Characterization and Testing methods and Capacity extension (A1.2)

D-A1.2.1

D-A1.2.2

Battery System Development and Integration (A1.3)

D-A1.3.1

D-A1.3.2

System Integration in Test Beds (A1.4)

D-A1.4.1

Manufacturing technologies for battery assembly

Charging Stations for Infrastructure Expansion

Charging strategies and technologies incl. bidirectional chargers

Certification of Components and Modules

Systems with Increased energy and power densities

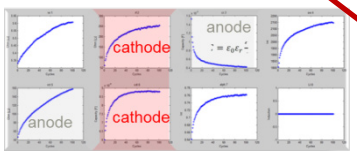
2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020

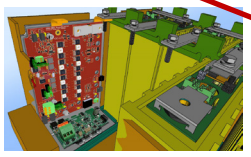
TRL 1-4

TRL 5-7

TRL 8

TRL 9





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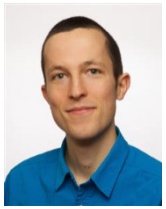
Capacity Expansion


Prof. Sébastien Mariéthoz


Dr. Alejandro Santis


Dr. Neeta Khare


Christian Vögtli (MSc. El. Eng.)


Patrick Haldi (BSc. El. Eng.)


Patrick Wälti (BSc. El. Eng.)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Christoph Giger (BSc. Mech. Eng.)


Patrick Habermacher


Olivier Duvanel


Manuel Neumaier


Dr. Gerhard Rizzo

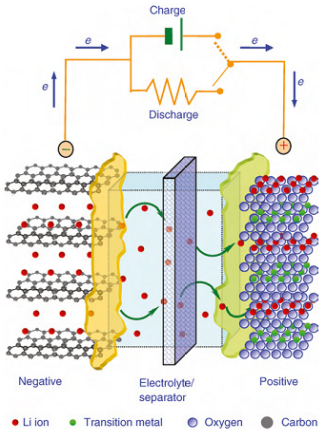

Mathias Schön (Dipl. Ing. FH)

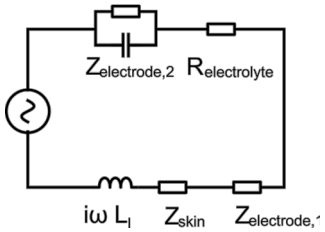

Rouven Christen (MSc.Mechatronik)


Alfred Gadola (BSc. Sys. Eng.)

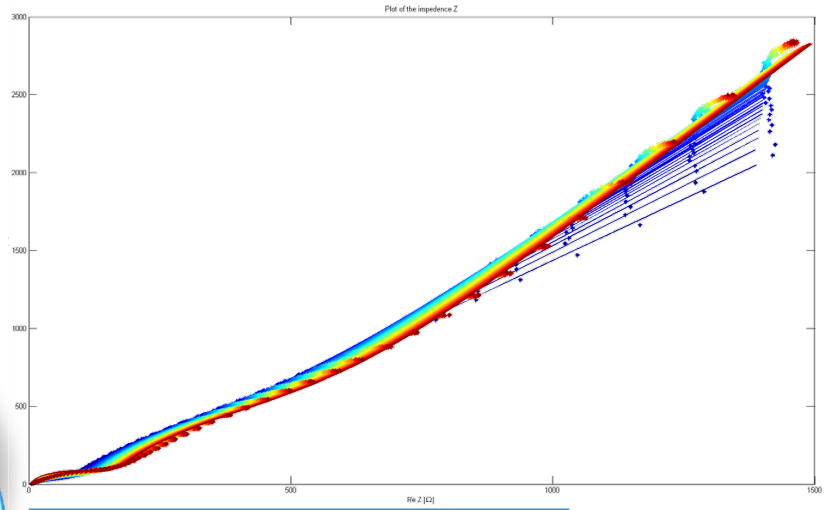
Cuervo-Reyes, E., Scheller, C. P., Held, M., & Sennhauser, U. (2015). A Unifying View of the Constant-Phase-Element and Its Role as an Aging Indicator for Li-Ion Batteries. *Journal of The Electrochemical Society*, *162*(8), A1585-A1591.

In Situ Battery Analysis: Frequency response Analysis





Battery models

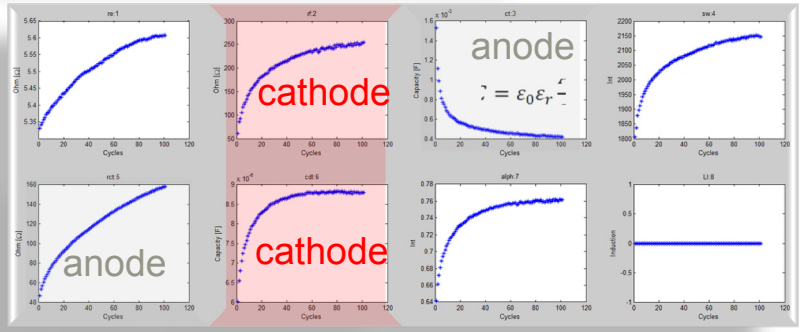


Interpretation

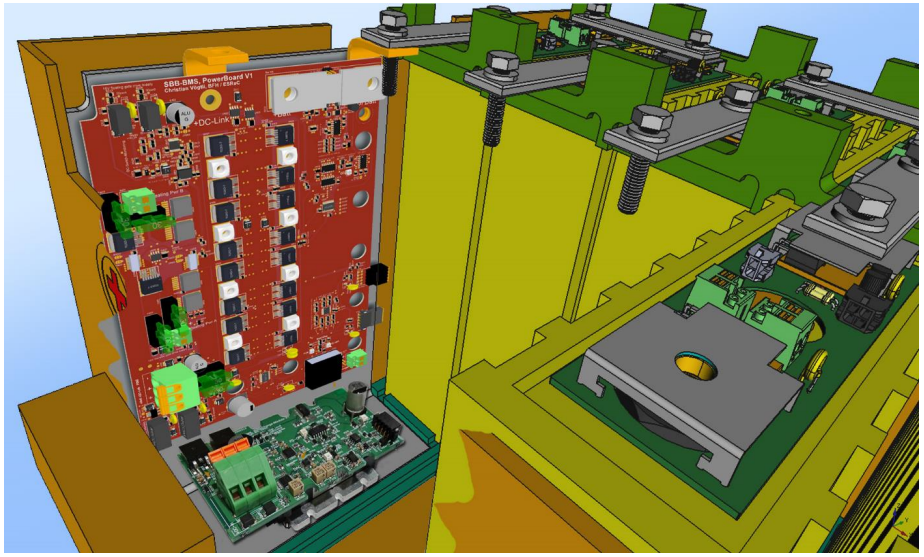
- in terms of cell components
- E.g. localization of degradation on cathode (red) and anode (green)

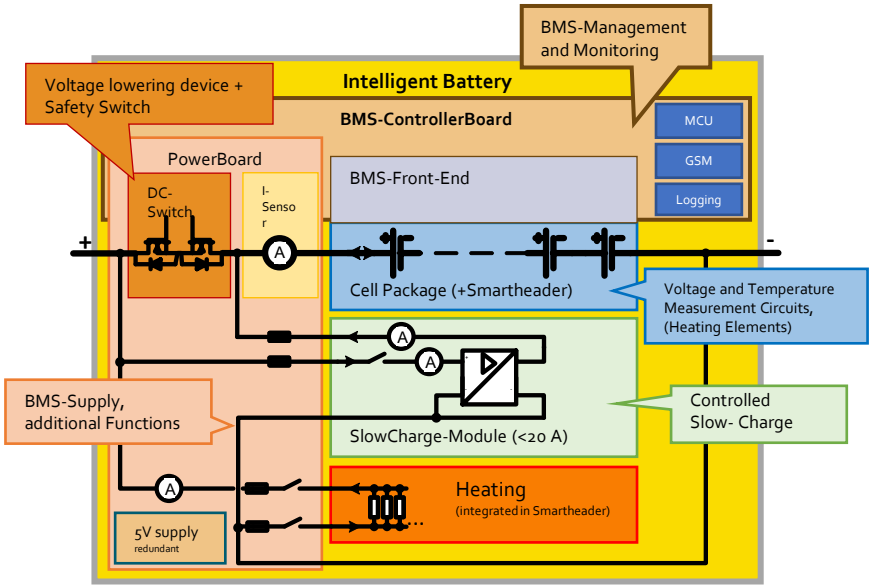
Optimization (on supercomputers)

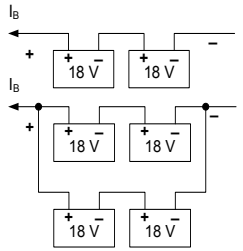
- Measurment of impedance spectra
- Battery model (Equivalent circuit)
- Modelling of batteries: optimization of equivalent circuit
- Gives insight into degradation in intact and operational batteries



Battery technology for passenger coaches of SBB







- Replacing 36V Lead Acid Batteries with an intelligent Li-FePO4 battery for SBB passenger coaches
- Annual Energy Saving Potential: 1.1 GWh
- Deep temperature performance proved with continuous life cycle testing
- Prototype testing in the lab and on the passenger coach till end 2015 / field trials in 2016

SUNCAR Project – E-Excavator

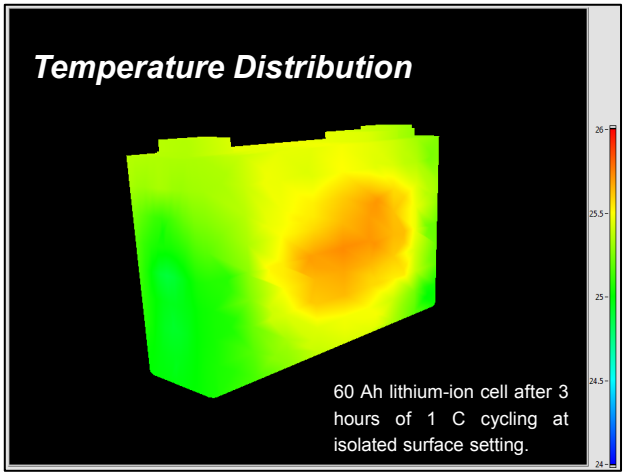
Re-Design of Excavator Battery

- Concept of electro-excavator has been proven successfully in praxis – reduction of 40 t CO_2/a
- first feedback of the battery available
- re-design with integrated thermo management to enlarge the lifetime of the battery

NTB — Cell- / Module-Test-Rig

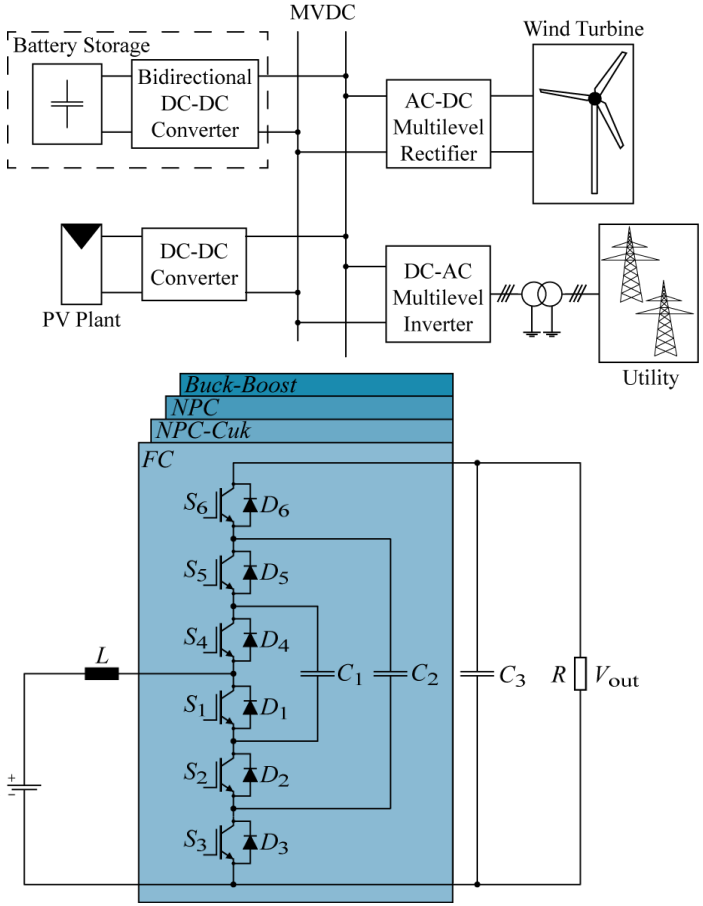
With Unique Measurement Modes

- **Detection of local heat flux distribution**
  - (Mode: Const. Surface Temp.)
- **Detection of local surface temperature distribution**
  - (Mode: Const. Heat Flux)
- **Analysis of a discrete cooling strategy**
  - (Mode: Partial Ideal Isolated with Locally Cooled Areas)

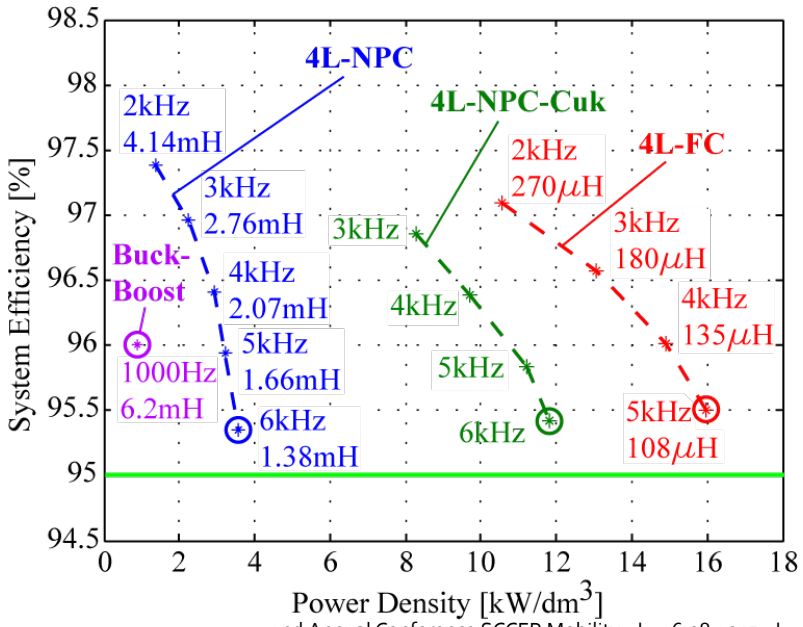


Comparison of Multilevel DC-DC Converter for Battery Storage Applications (2nd life application)

- Medium-Voltage Battery Interface



Battery Voltage V_{in}	530V..980V
DC Link Voltage V_{out}	2800V
System Power	4 MW



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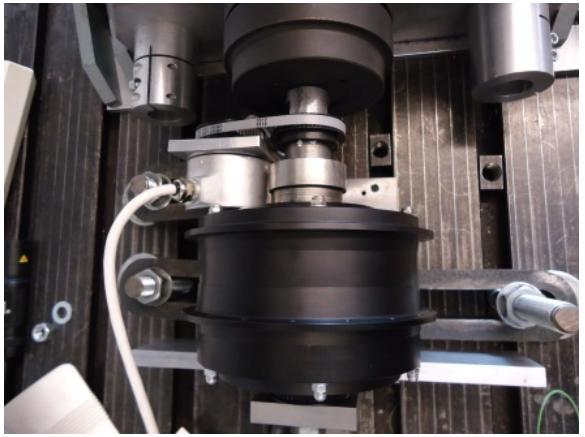
Integrating SCAP-Storages for E-Bikes

- CTI project and bachelor thesis investigate the energy storage system of an electric bike
- The idea is to supplement the lithium-ion battery with a super capacitor pack with a continous braking control lever

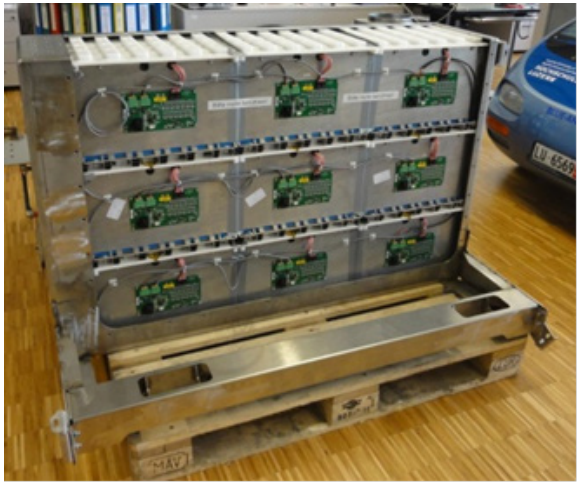


Innovation Check CTI

- Ebike storage system for stepless regeneration in combination with an additional SCAP-Storage in work

Interior Permanent Magnet Synchronous Motor

- for a High End E-Bike Drive Chain Development of a new IPMSM with a top torque of 45 Nm and a better heat dissipation in compared to similar motors
- project completion with industrialization of the motor

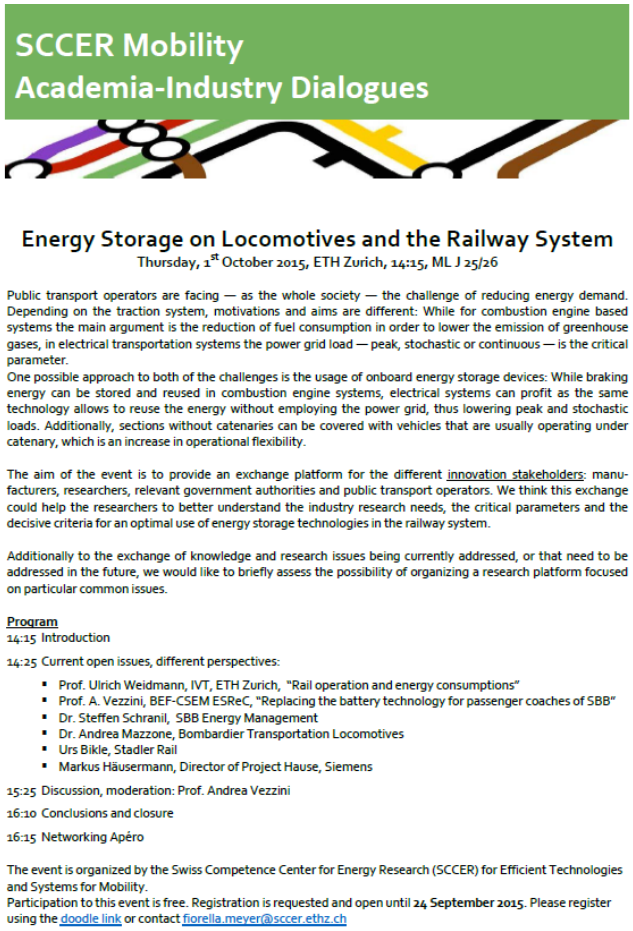


Publications at the EDPC Conference 2015, Nürnberg

- The Energy-Pack APU-Replacement for Catenary Free Operation of Overhead Wired Buses
- A Novel Interior Permanent Synchronous Motor for a High End E-Bike Drive Chain

Scientific Exchange and Knowledge Transfer

- 2014 EMPA Akademie, June 17th 2014: "Lithium-Ionen-Akkus: Zuverlässigkeit – Lebensdauer – Sicherheit
- 2015 SCCER Mobility Academia-Industry Dialogues, October 1st 2015: "Energy Storage on Locomotives and the Railway System"
- 2016 PhD Summer School with SCCER HaE, June 11th -15th 2016 (planned): "From Materials to Battery Systems"



SCCER Mobility
Academia-Industry Dialogues

Energy Storage on Locomotives and the Railway System

Thursday, 1st October 2015, ETH Zurich, 14:15, ML J 25/26

Public transport operators are facing — as the whole society — the challenge of reducing energy demand. Depending on the traction system, motivations and aims are different: While for combustion engine based systems the main argument is the reduction of fuel consumption in order to lower the emission of greenhouse gases, in electrical transportation systems the power grid load — peak, stochastic or continuous — is the critical parameter.
One possible approach to both of the challenges is the usage of onboard energy storage devices: While braking energy can be stored and reused in combustion engine systems, electrical systems can profit as the same technology allows to reuse the energy without employing the power grid, thus lowering peak and stochastic loads. Additionally, sections without catenaries can be covered with vehicles that are usually operating under catenary, which is an increase in operational flexibility.

The aim of the event is to provide an exchange platform for the different innovation stakeholders: manufacturers, researchers, relevant government authorities and public transport operators. We think this exchange could help the researchers to better understand the industry research needs, the critical parameters and the decisive criteria for an optimal use of energy storage technologies in the railway system.

Additionally to the exchange of knowledge and research issues being currently addressed, or that need to be addressed in the future, we would like to briefly assess the possibility of organizing a research platform focused on particular common issues.

Program
14:15 Introduction

14:25 Current open issues, different perspectives:

- Prof. Ulrich Weidmann, IVT, ETH Zurich, "Rail operation and energy consumptions"
- Prof. A. Vezzini, BEF-CSEM ESReC, "Replacing the battery technology for passenger coaches of SBB"
- Dr. Steffen Schranil, SBB Energy Management
- Dr. Andrea Mazzone, Bombardier Transportation Locomotives
- Urs Bikle, Stadler Rail
- Markus Häusermann, Director of Project Hause, Siemens

15:25 Discussion, moderation: Prof. Andrea Vezzini

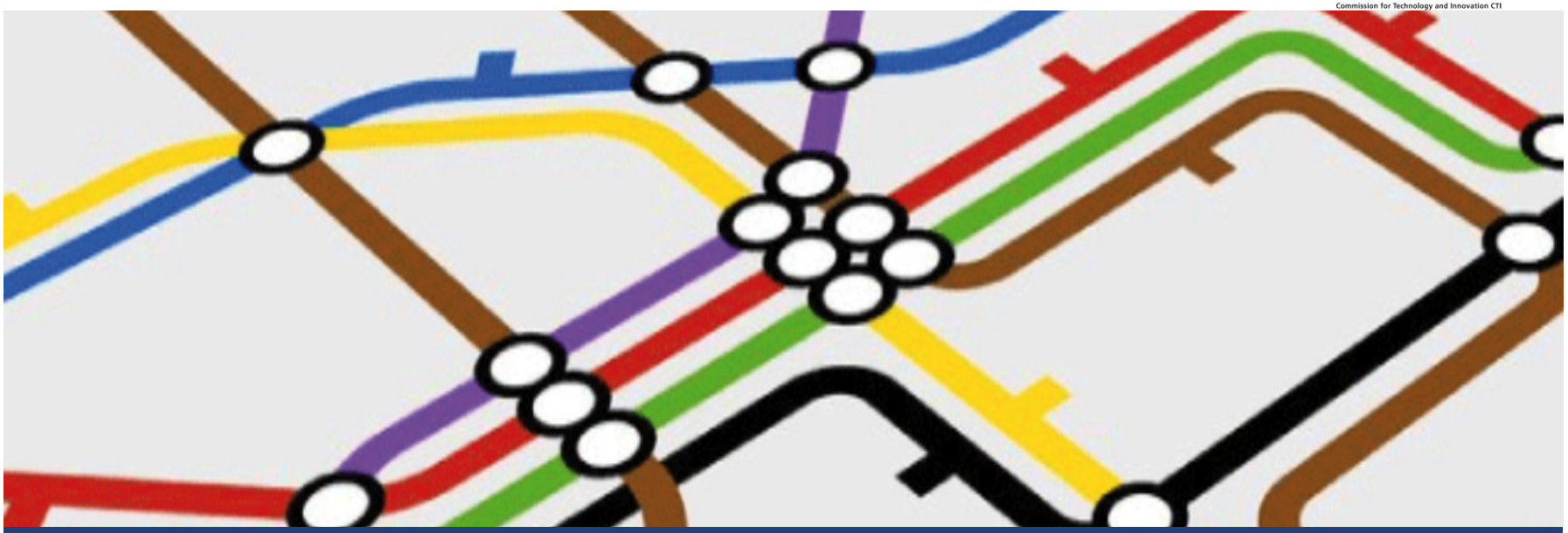
16:10 Conclusions and closure

16:15 Networking Apéro

The event is organized by the Swiss Competence Center for Energy Research (SCCER) for Efficient Technologies and Systems for Mobility.
Participation to this event is free. Registration is requested and open until **24 September 2015**. Please register using the doodle link or contact fiorella.meyer@sccer.ethz.ch

SCCER Mobility: 2017-2020 Proposal

- Continuation of roadmap 2013-2016 with minor changes
- Intention to add two research topics:
  - Use of second life batteries from automotive application for High Voltage energy storage application: technical requirements, battery performance, joint demonstrator project with SCCER FURIES
  - Charging technology: from algorithm to charging station with special emphasis on bidirectional charging and inductive (fast) chargers, demonstrator project with Capacity Area B1
  - Additional Ideas are welcome



Questions?

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