



# CA A1: Systems and Components for E-Mobility

Prof. Dr. Andrea Vezzini

SCCER Mobility: 1<sup>st</sup>. Annual Conference

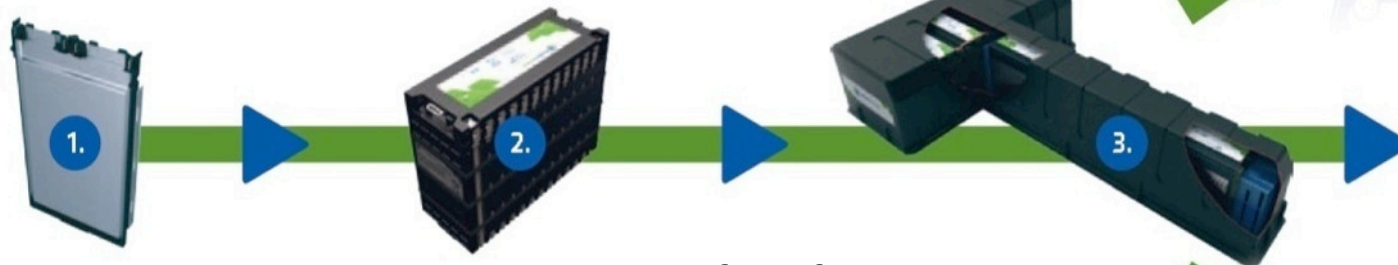
September 11<sup>th</sup> 2014 – ETH Zürich, ML Halle – E12

# Agenda

- Capacity Area A1: Systems and Components for E-Mobility
  - Goals
  - Members
  - Milestones
- Capacity Expansion Progress by our Research Partner
- Ongoing and planned Projects
- Conclusions

# 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



# Swiss Battery Research Plattform



Prof. Dr. A. Vezzini  
 Battery & Battery Management  
 Systems and Testing



Prof. Dr. Max Stöck  
 Thermal Management  
 and Packaging of Batteries



Prof. Dr. V. Wood  
 Electrochemical Simulations



Materials Science & Technology

Dr. U. Sennhauser  
 Dr. D. Adams  
 Safety & Reliability



Prof. Dr. J. Biela  
 Power Electronics



Prof. Dr. K. Wegener  
 Prof. Dr. D. Dyntar  
 Application



Prof. P. Novak  
 Dr. C. Villevieille  
 Cell Chemistry and  
 Materials

Lucerne University of Applied Sciences and Arts



Prof. V. Härri  
 Super Capacitors &  
 System Integration

# State of Deliverables

Milestones to be reached by the end of 2014 based on application (keywords)	Achievement of milestones by end of September 2014		Main comments/explanation concerning achievement of individual milestones
	Reached	Not reached	
D1-A1.1: Running website and collaboration platform, participation on 3 different battery-related events	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Running website and collaboration platform, participation on 3 different battery-related events_ The group is present on the SCCER Mobility Website and several members have set up dedicated websites. Several conferences have been visited and the work of the Swiss Battery Research Platform was presented
D2-A1.1: Organization of 1 seminar/conference event per year as battery research platform	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Organization of 1 seminar/conference event per year as battery research platform: EMPA Seminar on the 17.06.2014: Lithium-Ionen-Akkus Zuverlässigkeit -Lebensdauer - Sicherheit
D3-A1.1: atabase with test method procedure (white paper) and basic research results (cell database)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Database with test method procedure (white paper) and basic research results (cell database). Ongoing discussion shows that standardization between members is required. Several batteries have been tested. Public database not yet realized
<b>Additional milestones to be reached by the end of 2014 (keywords)</b>			
Opening of the BFH-CSEM Energy Storage Research Center	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Increase of testing capability and cooperation with CSEM PV Center. Operational in new facilities from October 1 <sup>st</sup> , opening ceremony October 23 <sup>rd</sup> .





# Capacity Area CA A1

Capacity Expansion

# BFH-CSEM Energy Storage Center

- The biggest energy storage research center for academic R&D activities available to the Swiss industry



Testing and characterization of large capacity cells and modules



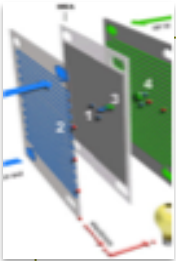
Battery Management Systems



Manufacturing Technologies for Large Scale Lithium-Ion Cell



Testing of PV integrated energy storage systems



Management and integration of fuel cell systems



Power quality measurements, modeling and analysis of grids with decentralized energy storage

# Battery Research at Bern UAS: Lithium-ion and NaNiCl

- Advanced Battery Parameter Extraction and Life Cycle testing for Lithium-ion and NaNiCl-Batteries
- Modeling of lithium-ion cell performance for the development of advanced model based battery management systems
- Battery Management System performance verification tests (including BMS communication interface)





# Infrastructure Expansion at BFH-CSEM ESReC

- Fully programmable cell and module tester FuelCon (5 channels 5 V/200 A, and one channel 100 V/100 A and 35 V/200 A each)
- Fully programmable cell tester Peccorp (40 Channels 5V/50A, which can be connected in parallel)
- Fully programmable module tester Peccorp (12 channels 100V/50A which can be connected in parallel)
- 1 impedance Spectrometer
- 3 temperature chambers (Voetsch) for cell testing
- 3 temperature chambers (ESPEC) module testing
- 1 temperature controlled freight container for large size and quantity testing

# NTB – Battery Research & Test Center at EMS

- **Infrastructure Existing and Expansion**
  - **Cell Test-Rig – CTR** – for Single Battery Cells
    - fully programmable, computer controlled test arrangement
    - max. discharging current 400 A
    - max. charging current 220 A
    - local detection of surface temperature and heat flux (by 25 x 25 mm matrix)
  - **Module Test-Rig – MTR** – for Battery Modules (up to 50 V)
    - fully programmable, computer controlled test arrangement
    - max. discharging current 385 A
    - max. charging current 385 A
  - High-Precision Heating Plate & High-Resolution IR-Camera (FLIR-T65osc)

# NTB – Battery Research & Test Center at EMS

## ■ Infrastructure Existing and Expansion

### • Shaker TIRAvib TV56263 / LS-340

- shock max. 12 kN
- sinus/random max. 6 kN
- load max. 150 kg
- frequency DC ... 3 kHz

### • Sliding table TGT MO12M

- load max. 100 kg
- frequency DC ... 2 kHz





# Ongoing and planned Projects

September 2014

# Energy Project: Ultra Fast Charging Buffer Battery

- 100kWhr / 250kW stationary battery used in a ultra fast charging station for electric vehicles
- 240 Cells (3.2V/130Ahr)
- Development of all electronic ,mechanical and thermal systems
- Project financed through SCCER/SER in cooperation between EPFL, ETHZ, EMPA and BFH

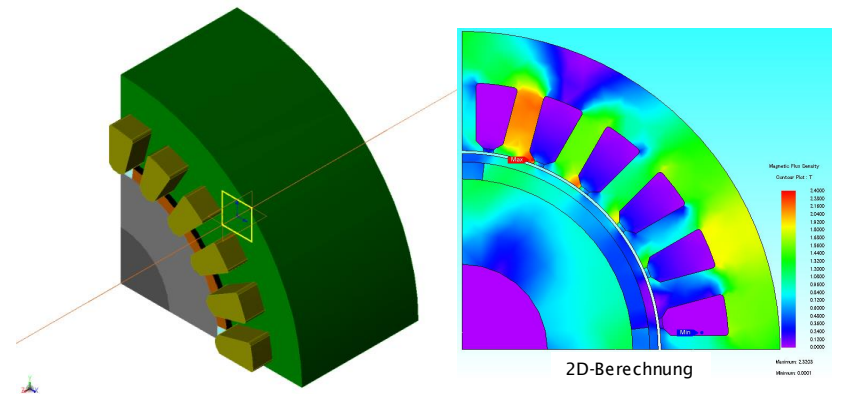




# BAZL Proposal Decision Pending: “evolaris” a full electric acrobatic plane



- 100% student run project organized as foundation
- high power density electric motor and battery system are being developed
- 10 minute flight at full power of 220kW possible
- Cooperation between MSW and Swiss Battery Research Plattform, funded by BAZL



# Small, semi-autonomous, hybrid tractors for weeding and seeding

## CONCEPT

### SMALL



Conventional

Ours

- Lower soil pressure
- More maneuverable
- Easy to store & transport

### SEMI-AUTONOMOUS

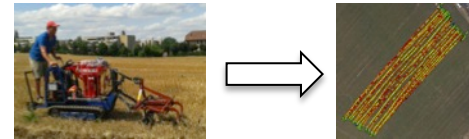
- Reduces man hours required
- Removes mundane tasks
- Increases quality of farming
- Saves time & money with "swarms" of vehicles

### HYBRID

- Reduces fuel consumption and CO<sub>2</sub>
- All-electric tools with HV system
- Quieter
- Enables new design architectures

## RESULTS

### TRACTION MEASUREMENTS



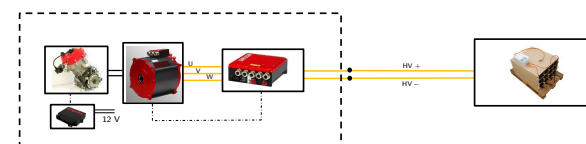
- Designed & built a miniaturized grubber
- Measured pull-force ~5 kN

### PROTOTYPE VEHICLE



- GPS-RTK
- Gas-hydraulic with e-valves
- 32-bit processor
- Line following algorithms

### BENCH-TOP HYBRID DRIVETRAIN



# SunCAR Project – Electro-Excavator

- Substitution of fossil fuel by solar energy
- Zero-Emission
- Noise reduction
- Efficiency 96%
- Battery cap. 190 kWh
- Cooperation between Affentranger Bau, Huppenkothen Bau-maschinen, ETHZ, NTB, HSLU







# CA A1: Systems and Components for E-Mobility

Conclusions

# Conclusions

- The integration of efficient energy storage technologies in the Swiss mobility system infrastructure is essential for lowering CO<sub>2</sub> emissions ...
- We address the challenge of storing electrical energy as the main barrier for the introduction of electric propulsion for automotive applications.
- Our main goal is to lower the entry barrier of rechargeable batteries for the introduction of electric propulsion and auxiliaries for automotive applications.
- Since the launch of SCCER Efficiency in Mobility, Research Partners have experienced an increasing demand for R&D projects from industrial partners
- We foresee a high short and middle term potential for the efficient integration of battery based systems in Swiss vehicles and Swiss' mobility system (e.g. inductive charging)



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- Vita
  - Professor for Industrial Electronics since 1996 at Bern University of Applied Sciences
  - Deputy Head of the Swiss Competence Center for Energy Research “Mobility”
  - Co-founder and President of the Board of drivetek ag since 2002
  - Inventor/Co-Inventor of 8/23 patents in the field of electric motor design and lithium-ion battery technology



# Questions?

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