Trolleymotien 1.12.2010 :

Alternative elektrische Antriebssysteme im öff.Busverkehr

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Innovativer Einsatz von Energiespeichern, Ladesystem und Management

1. Introduction, background
2. Public transport drive chains
3. e.g. TR-bus with SCAPs
4. Energy storages for trolleys
5. Discussion, outlook

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1. Introduction, Background

Direktion Hochschule Luzern

- Hochschule Luzern – Technik & Architektur
- Hochschule Luzern – Wirtschaft
- Hochschule Luzern – Soziale Arbeit
- Hochschule Luzern – Design & Kunst
- Hochschule Luzern – Musik

Architektur, Bau, Elektrotechnik, Gebäudetechnik, Informatik, Innenarchitektur, Maschinentechnik, Wirtschaftsingenieur

CC IIEE

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Strategy CC IIEE

IIEE means: „Integral, Intelligent, Efficient Energy Systems

Integral:

Innovation by combinations, compact solutions

Intelligent:

Management, communication, regulation

Efficient:

Our motivation is the ecological and economical responsability for the ressource „energy“

Energy Systems:

Emphasis on system integration rather than components

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Team CC IIEE

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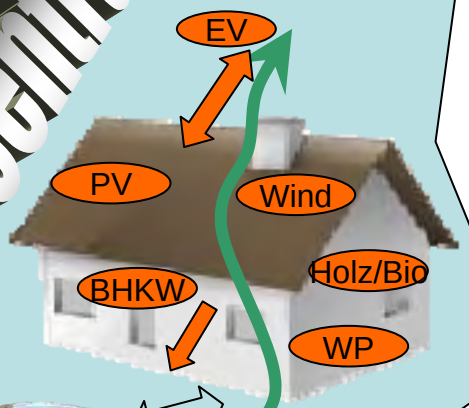
3 Main Paths of Strategy

Efficient Lights & Devices

Future Light!

Integral Drives & Storages

Decentral Power Supply



Living & Mobility

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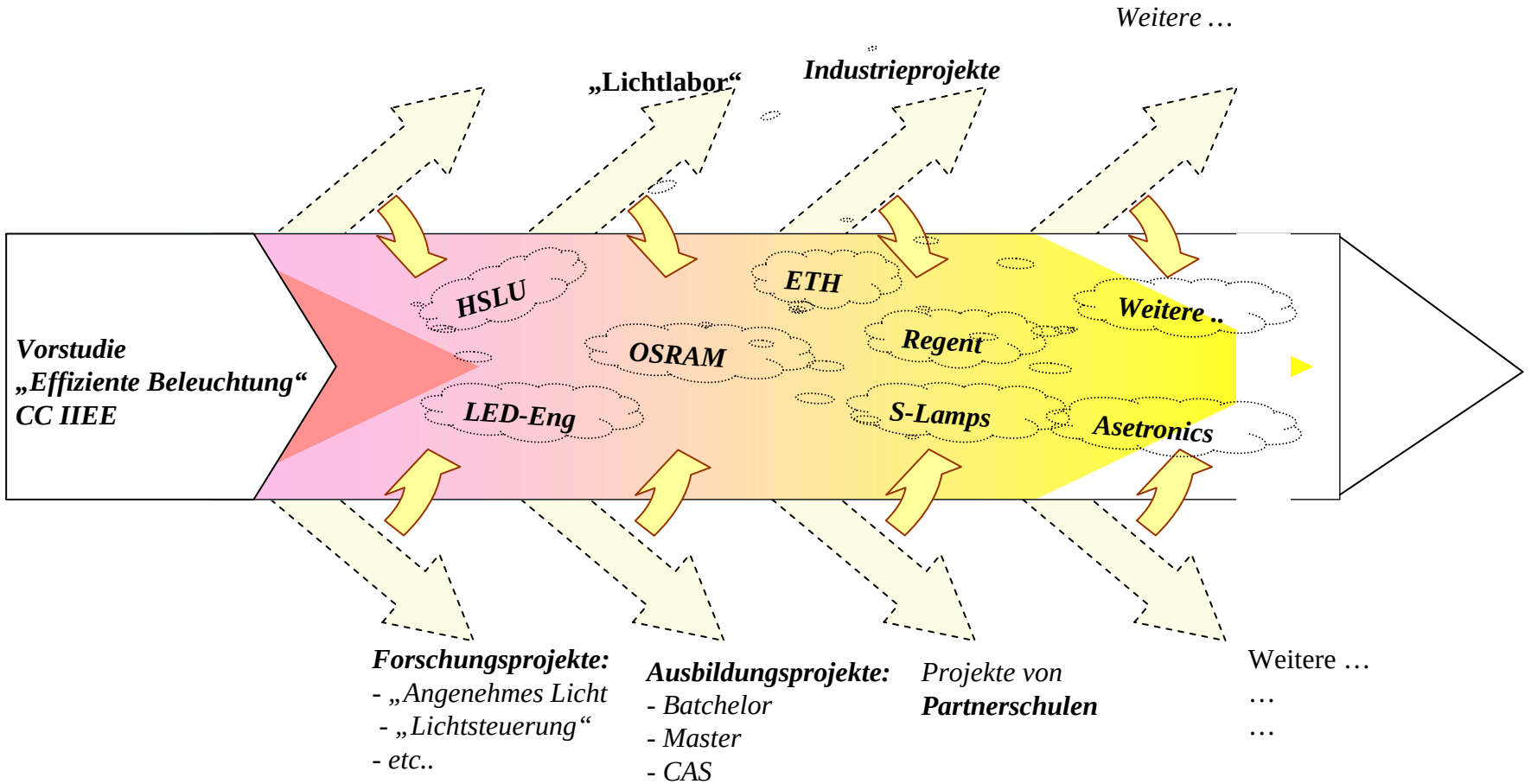
Future Light Network



- Thematik Beleuchtung schweizweit mit Netzwerk fördern (FutureLight!)
- Interdisziplinäres Lichtlabor (Abt. Gebäudetechnik, Architektur, Elektro)
- Forschung auf dem Gebiet von LEDs

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Blue-Angle 1992-1997, 94: 2.4l/100km, ULEV

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Swiss Ecco-Tour 1994: At the Top of Furka

→ Looking for the 3 liter vehicle !

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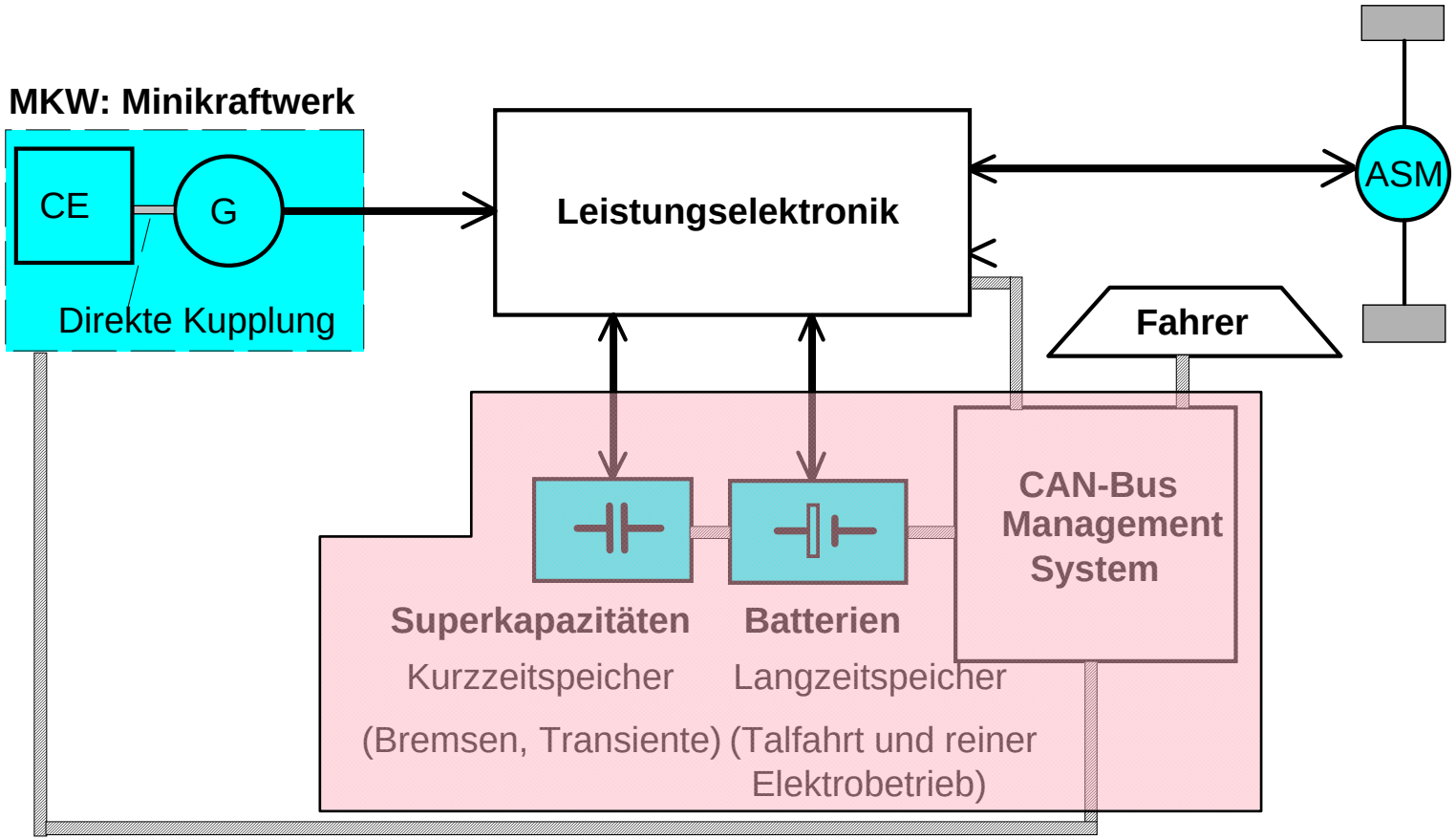
Understanding of SAM

APU, ICE or
Fuel Cell

Power Electronics

Motor



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Introduction: Blue-Angel III today

2010: Blue Angel III in CC IIEE Laboratory

Battery modul for Blue Angel III

SAM box for Blue Angel III

SCAP modul for Blue Angel III

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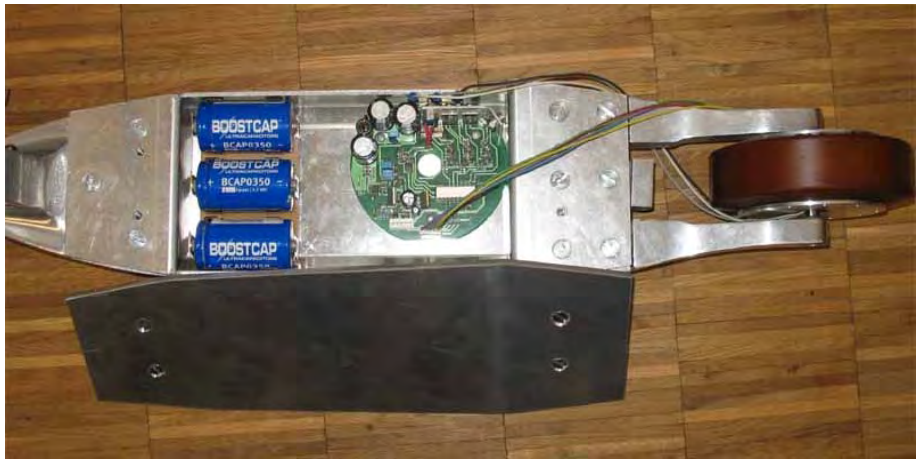
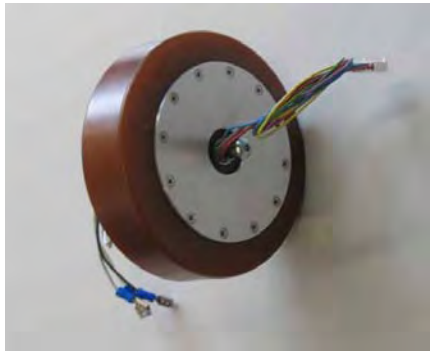
Kickboard Project

- 1st Solution 2001, ST7
- Updates 2003, 2006 SCAPs in handlebar
- 2008, PIC, sensorless, simplified power-electronics





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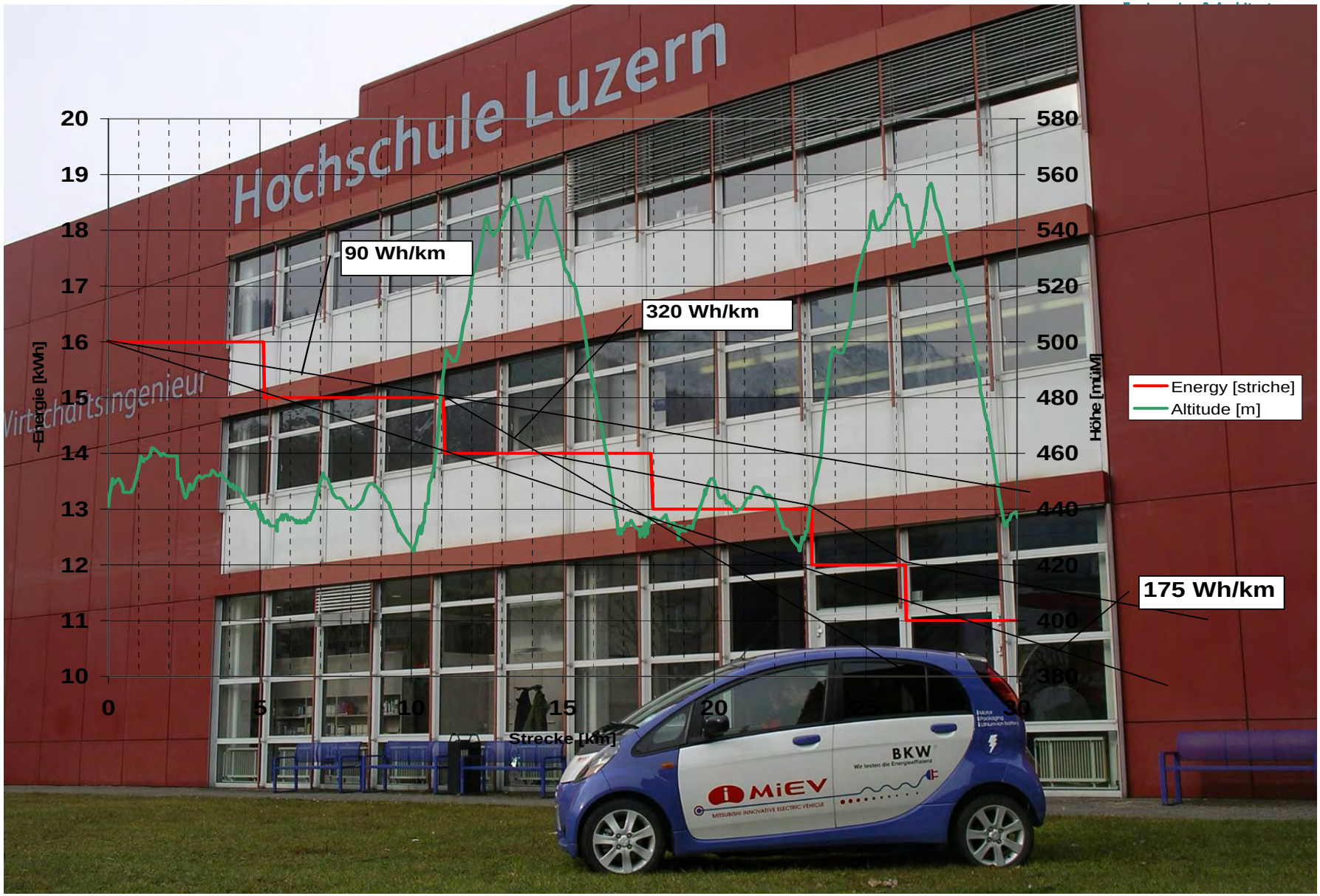
Mitsubishi IMIEV tested in Lucerne



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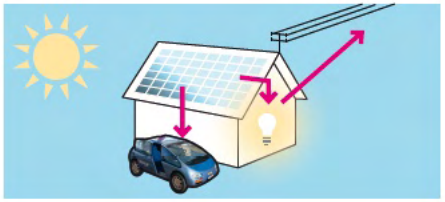
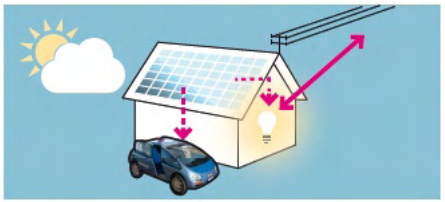
Idea of V2G

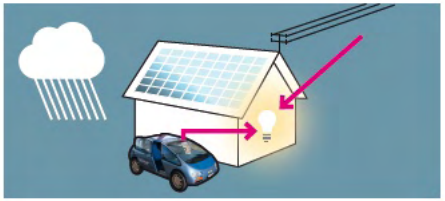
Function Principle of V2G e.g. for PV & Vehicle



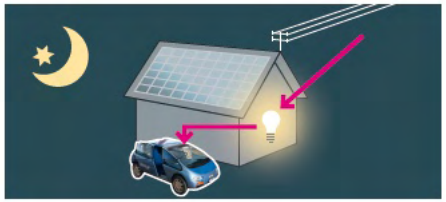
sunny day:
- PV charges Blue Angel
- PV powers elecrical appliances of building
- PV feeds back to grid



cloudy day:
- PV charges Blue Angel intermittent
- PV powers elecrical appliances intermittent
- PV feeds back to grid when possible
- grid feed when needed



rainy day:
- no PV energy
- V2G: Blue Angel privides power to building to reduce peak loads on the grid



at night:
- no PV energy
- building supplied by grid
- Blue Angel battery charged from grid in off-peak time

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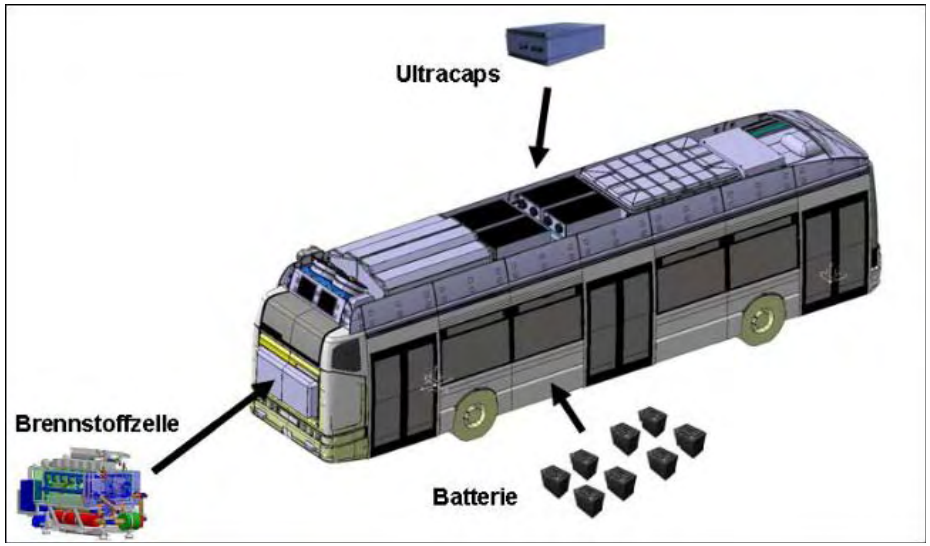
Proton Motor& Skoda: TryHyBus

TryHyBus- serial hybrid with:

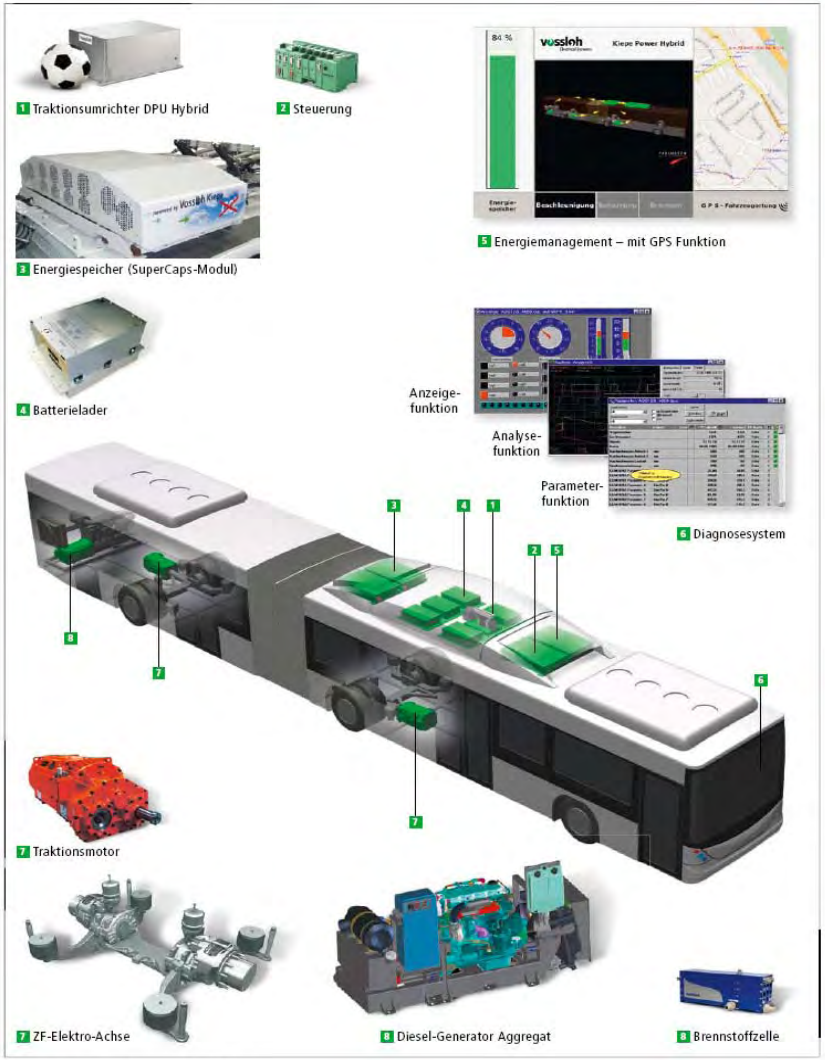
- Fuelcells 48kW PEM as a primary energy source
- Li-ion battery storage 26kWh and ultracapacitors 0.32 kWh as a secondary energy source

Range: 250km Max. speed:65km/h



Carrosserie HESS & Vossloh-Kiepe 24m Hybrid Bus

- Hybrid technology in 24m bus
- Capacity for more than 200 passangers
- ESS- energy storage system from Vossloh-Kiepe GmbH based on double-layer capacitors
- Energy management system developed in cooperation with CC IIEE



Vossloh Kiepe Hybrid System – Übersicht

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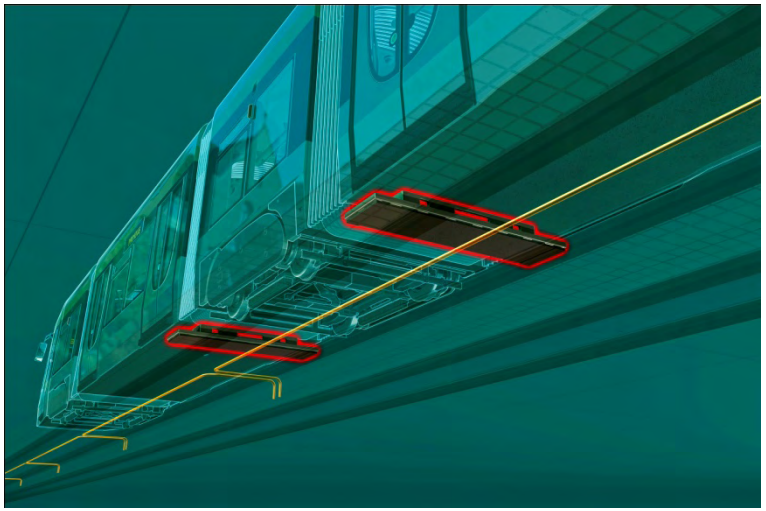
Bombardier Transportation: Primove-Inductive Power Transfer

- Eliminates overhead wires and increases city‘s attractiveness
- Safely transfers inductive power
- Eliminates wear on parts and components
- Operates in all weather and ground conditions



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Siemens SITRAS: E. S. S. for Mass Transit Systems

- Energy saving up to 30% of the suplied energy
- Stabilizing the line voltage
- Enabling operation without overhead contact line

- SES: static energy storage system
- MES: mobile storage system
- HES: hybrid energy storage system that combines powerful double-layer capacitors and traction batteries
- Up to 2.5km without wires by energy storage

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ALSTOM Citadis System

Citadis trams can be powered by:

- Overhead wires
- APS: ground-level power supply (alimentation par sol), sections put on and off
- Flywheel or fuel cell
- Hybrid with disel motor for Regional traffic

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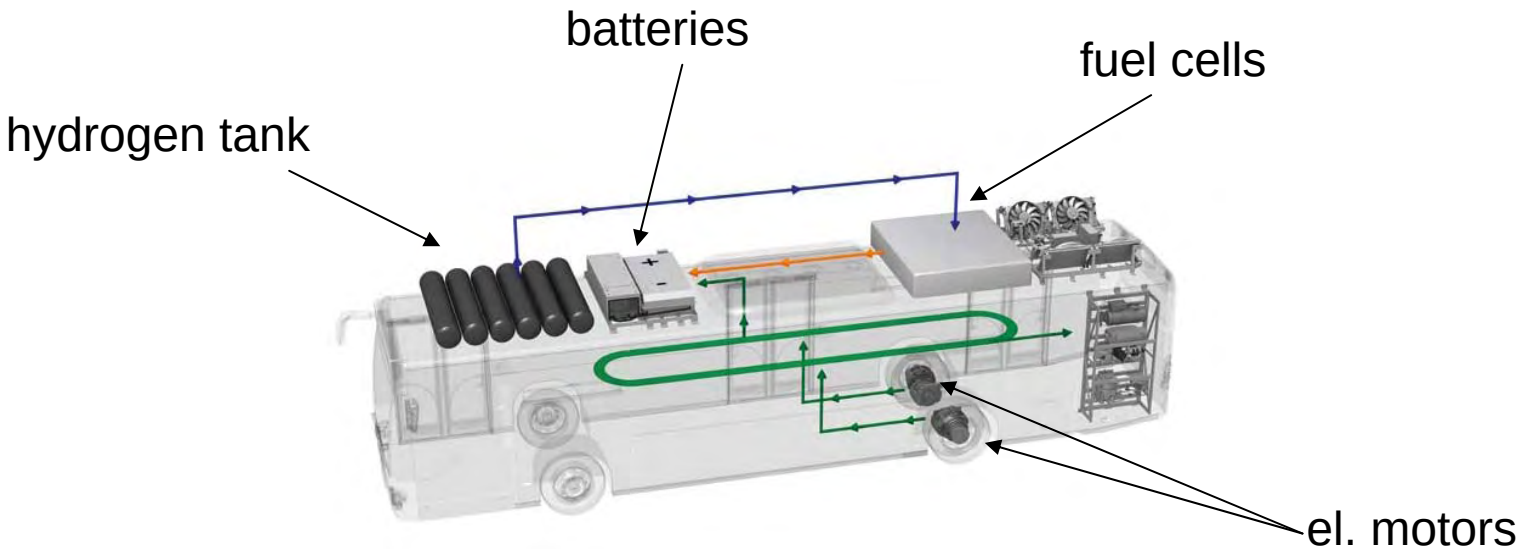
Mercedes Benz Citaro Fuel-cell Hybrid System

- 18m articulated hybrid bus, later
- 12m bus with fuel cells and Lithium-ion battery pack
- Shoulkd be extrely efficient



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Anasaldo STS: Tram Wave System

- A ground-level power supply where the contact line is embedded in the permanent way
- A modular system that assures safety
- Tram is equped with magnetic „pick up shoes“
- **Only one part of track under the tram is electrified**
- Typically 3m to 5m
- Retrofit of existing systems possible

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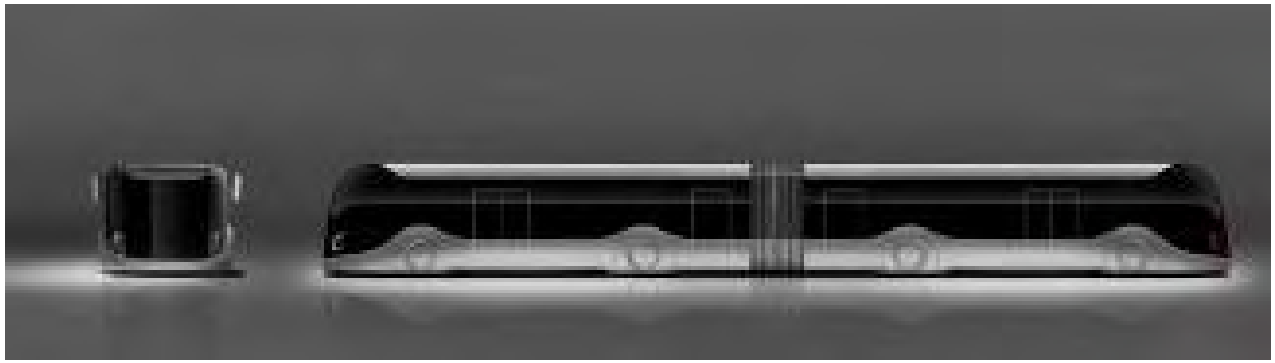
Frauenhofer- Institut: Auto Tram

- A modular vehicle with a flywheel energy storage system
- Can be operated as a single bus or a uni- or bidirectional high-capacity vehicle
- A hybrid drive concept with fuelcells and a flywheel energy storage system
- rubber wheels and optically guided



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Conductix-Wampfler: Inductive Power System (IPT)

- Contactless power supply without mechanical contact
- Used for fast fast battery charging in Lucerne, Genova, Turin
- Safety- safe operation and charging under all weather conditions
- Automated and optimized charging process
- Pick-up

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Solaris: Trollino with Batteries in Roma

- Solaris Ganz Trollino 18 with NiMH batteries on board
- Can operate at regular traffic speed on battery power
- Feed in system

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Ultracapacitor Buses in Shanghai

- The bus is powered entirely by electricity, which is stored in ultracapacitors and batteries onboard
- When the bus stops at passenger stops, the overhead charger quickly recharges the ultracapacitor onboard
- Ultracap hybrid bus: 2.25kWH from Ultracapacitors and 60kWH from batteries

Overview

Alternative transport systems can be sorted according to

- type of drive system (hybrid, electrical)
- type of guidance (1-2 rails, 1-2 wires, inductive in the floor, by colour line)
- energy source (continously, storage, by APU or fuel cell, changing storage)
- energy storage (batteries,supercaps, flywheel)

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TOHYCO bus with Supercaps and IPT

TR-Bus Drive Profile 2004 / 2006

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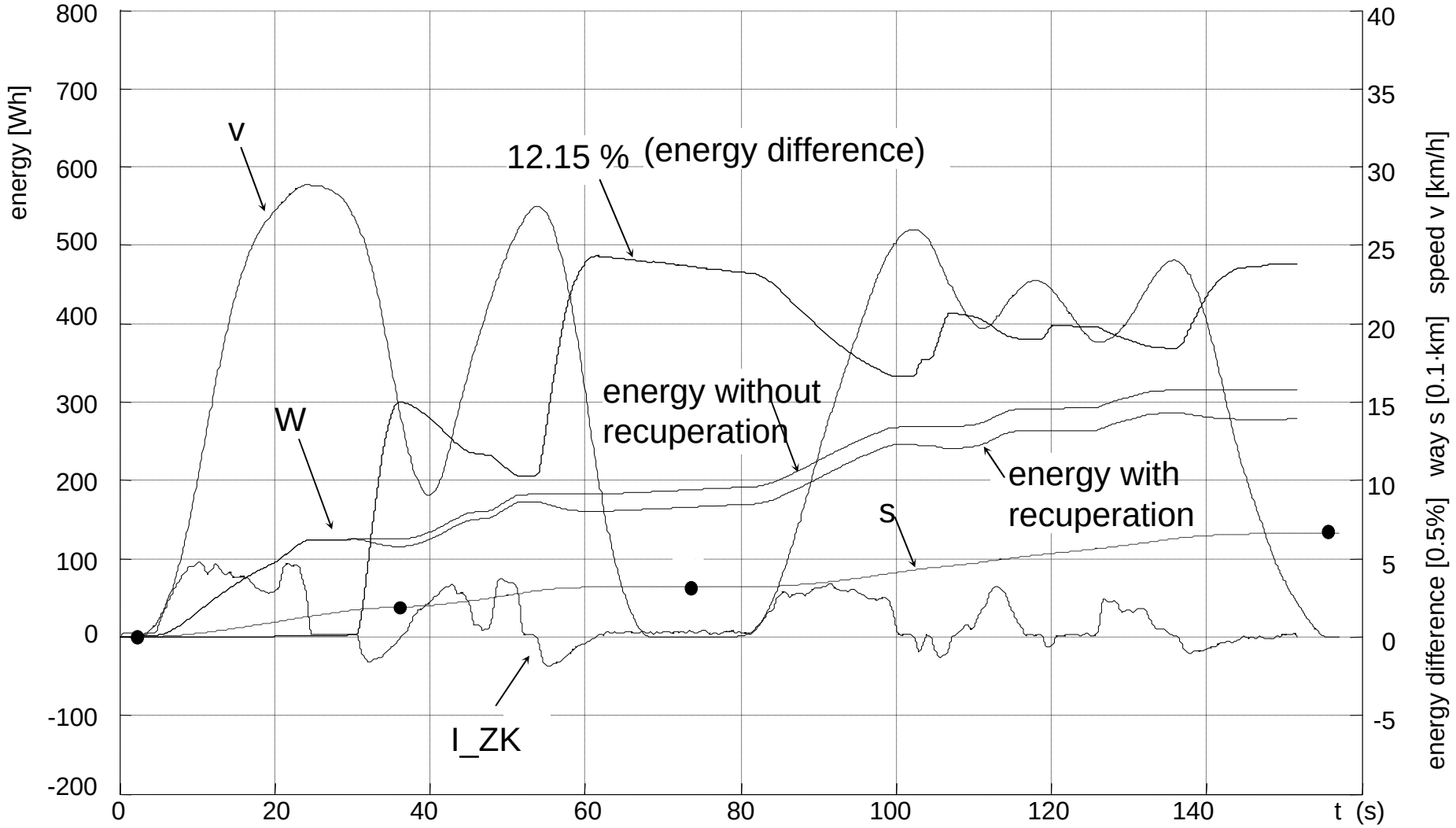
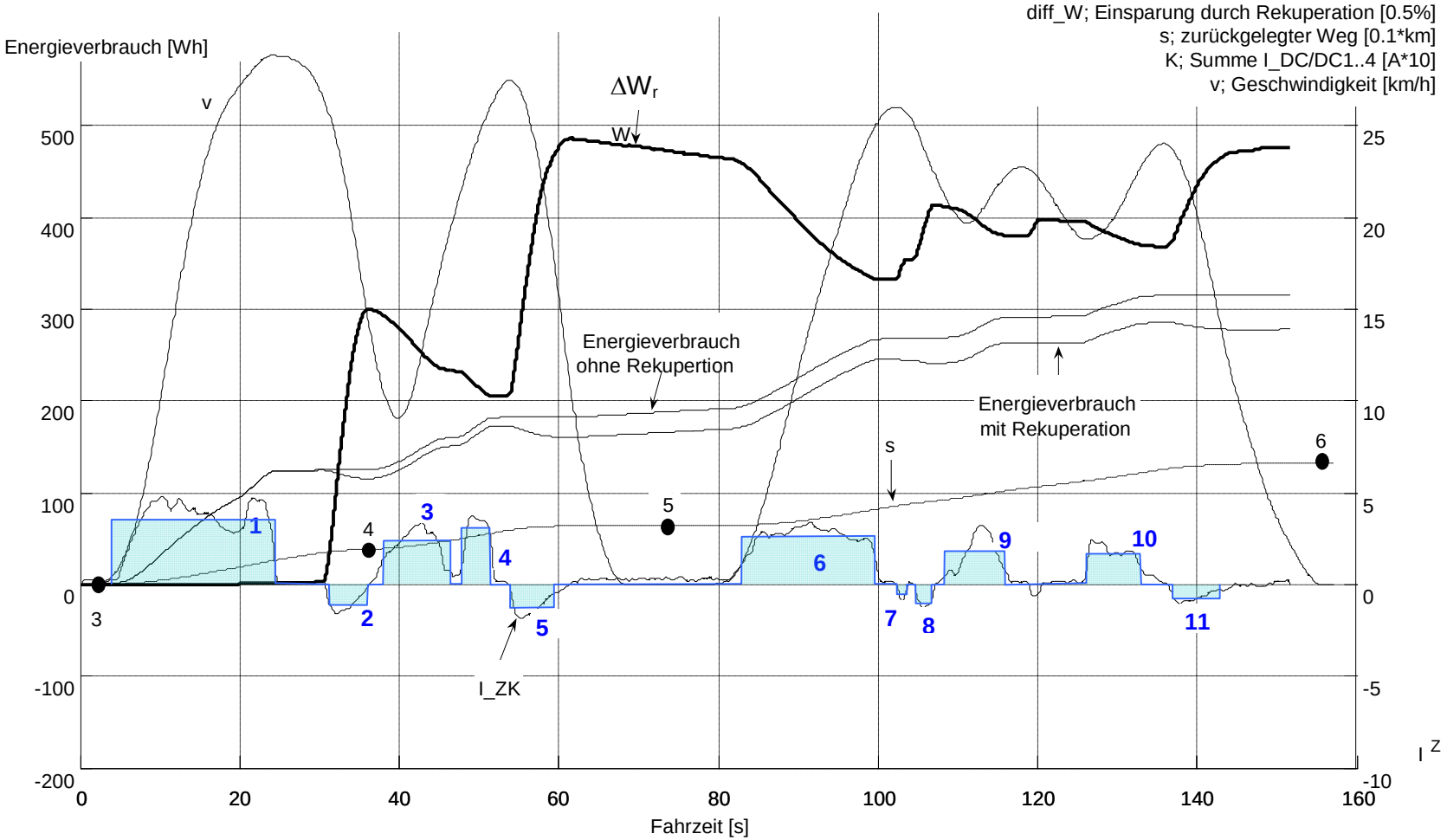


Measured losses of SCAPs



TR-Bus: storage losses of supercaps for this section only about **0.4%** !

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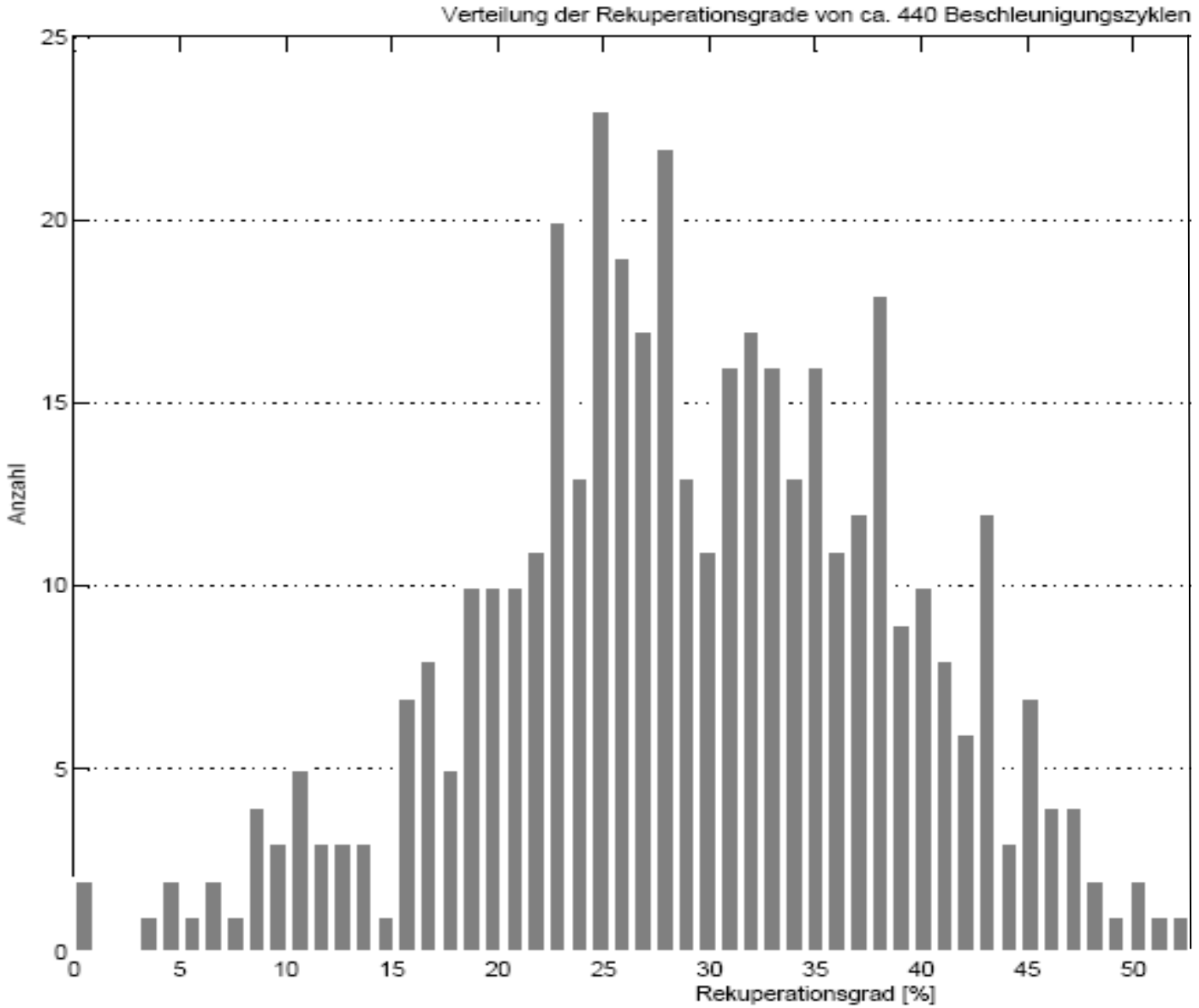
TR-Bus Analysis of 440 Rides



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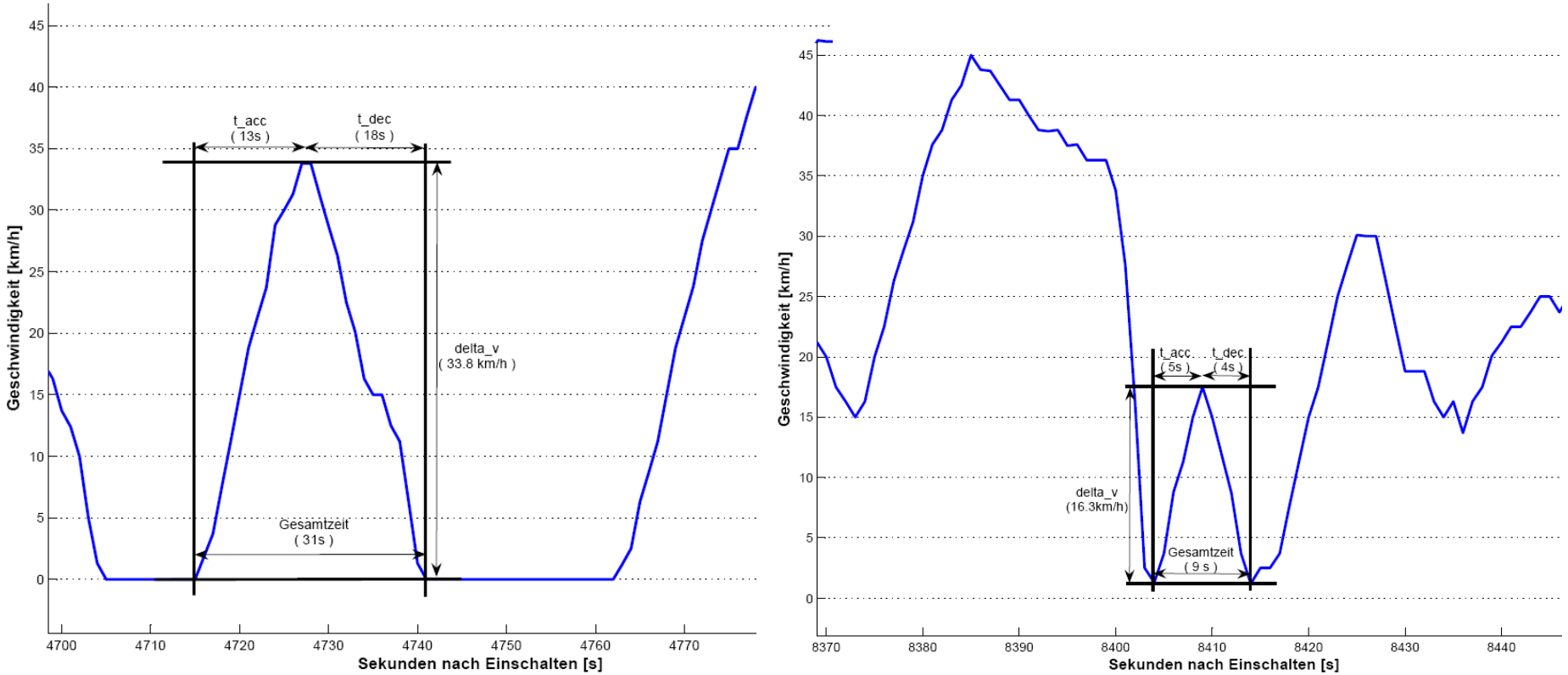
Efficiency with SCAPs



Looking for the best efficiency: left 10%, right 49%

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Result: when SCAPs are useful ?

1. The faster the acceleration or the braking and the shorter the ride with constant speed, the better the recuperation degrees
2. High recuperation degrees are only possible with a very good efficiency (supercaps). Due the high power for fast speed changes, this becomes here very important.
3. With the TR-bus the very small internal resistances of the supercaps are responsible for the good efficiencies of over 90%.

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Significance of teh Energy Management

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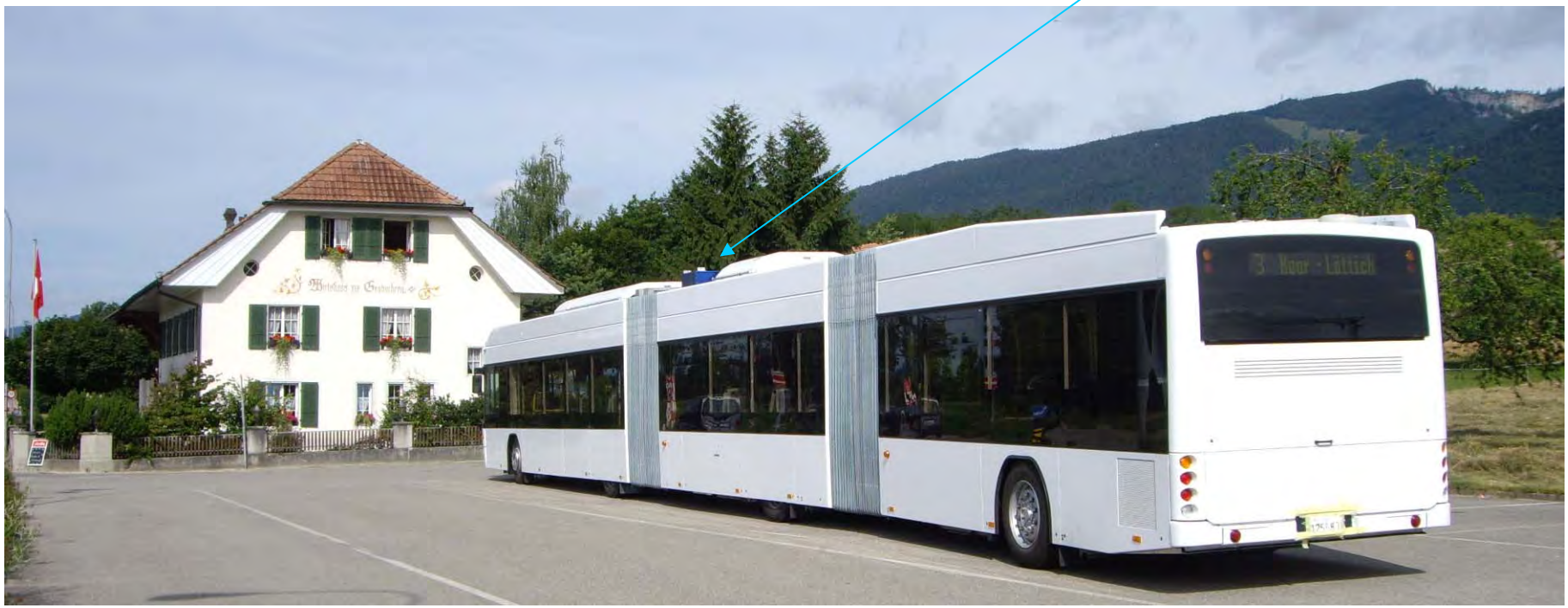
CC IIEE realized energy-management for

2 axel driven, double articulated, 24m Hybrid-Bus with supercaps

by HESS/Vossloh-Kiepe



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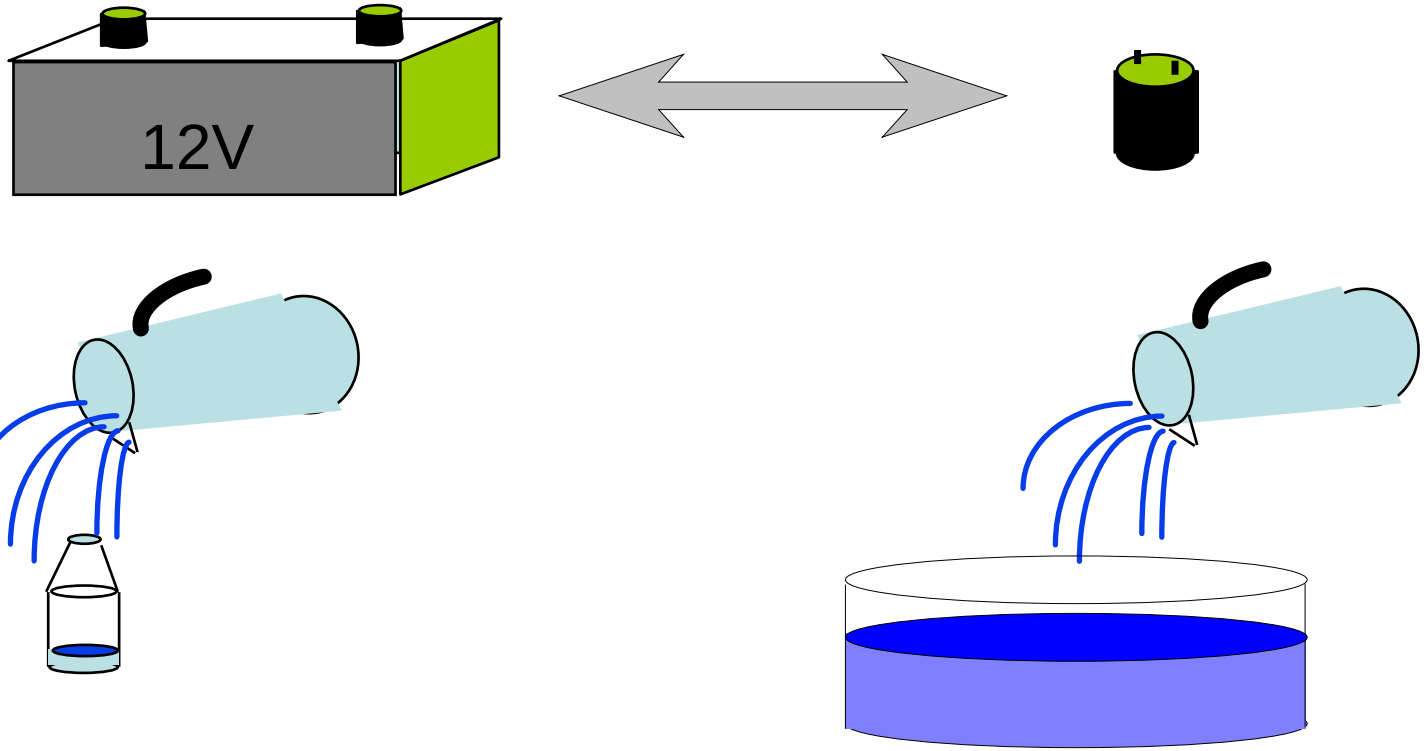
Advantage of SCAPS: Higher Power



energy spread out **whole energy is taken**

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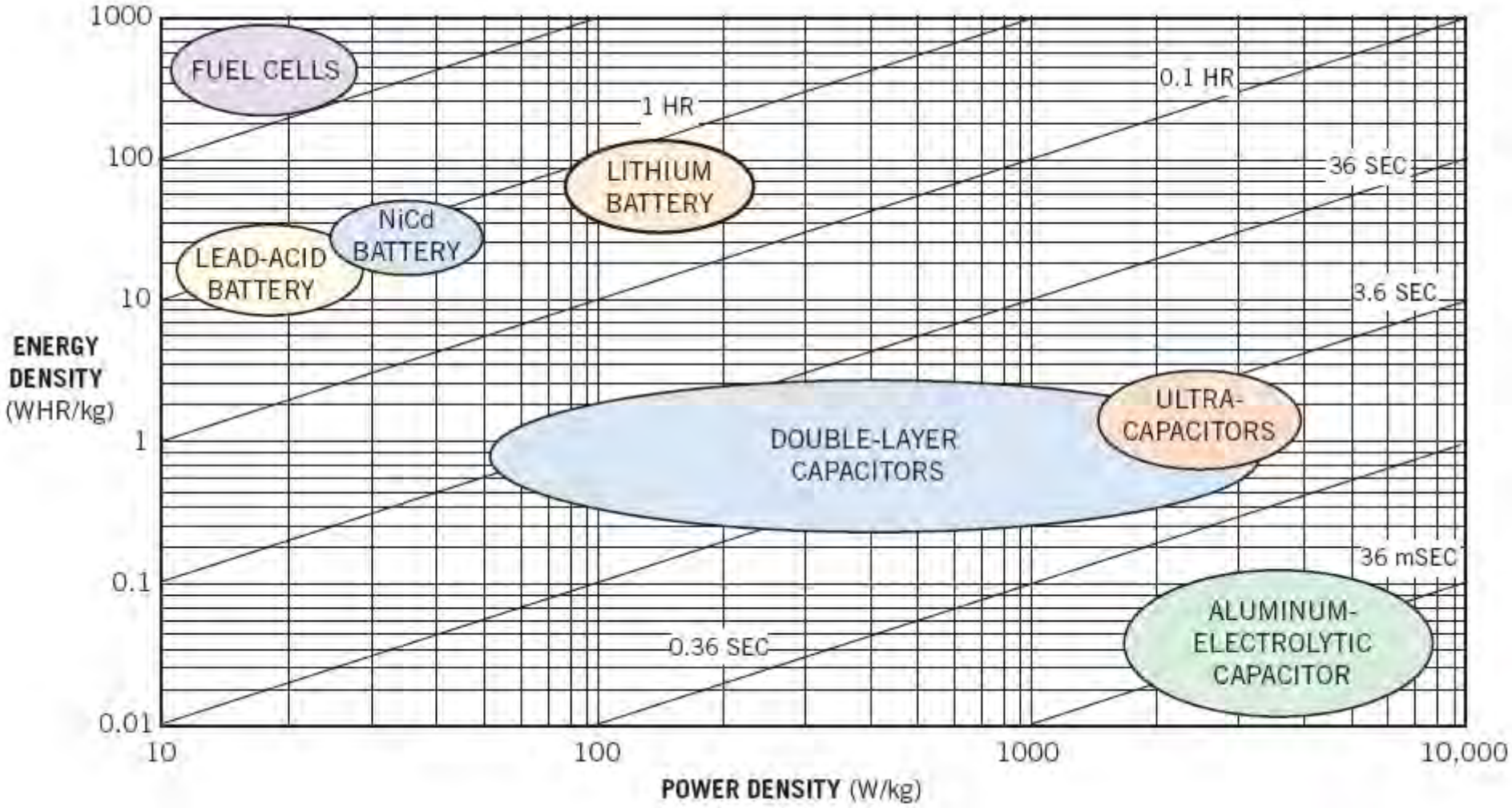
Energy versus power density (ragone)



Quelle: Maxwell (EDN 9.1.03)

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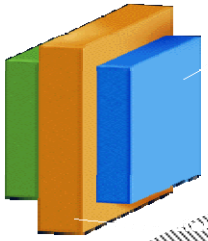
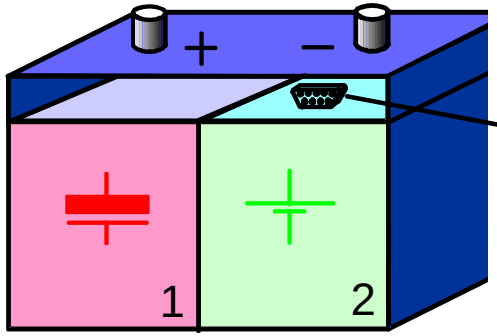
Concept "SAM"
Super Accumulator Module





3

Intelligenz /
Management

SAM for

1. accumulators &
2. supercapacitors &
3. intelligence (management of power system)

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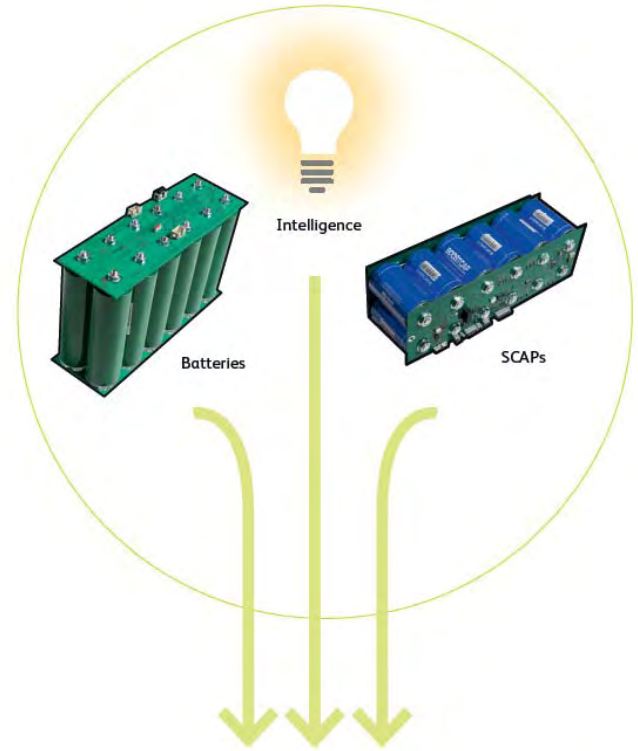
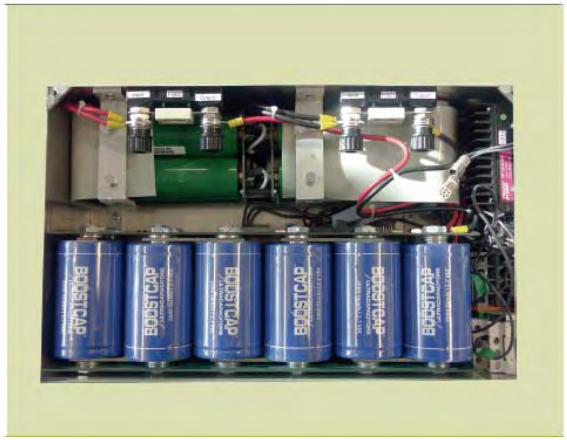
SAM today



SAM



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Additional Adv. Specification for SAM 3rd Gen.

1. connected together very easily by a special plug
2. SAM should be easily exchangeable for maintenance reasons
3. should communicate with most popular communication systems (CAN..)
4. different types of power converters should be possible
5. SAMs with specific sizes according to customers wishes
6. SAM should fulfil the relevant standards, generally for EMC and
7. Self check utility
8. Today 2 main parts: process adaption and intelligence

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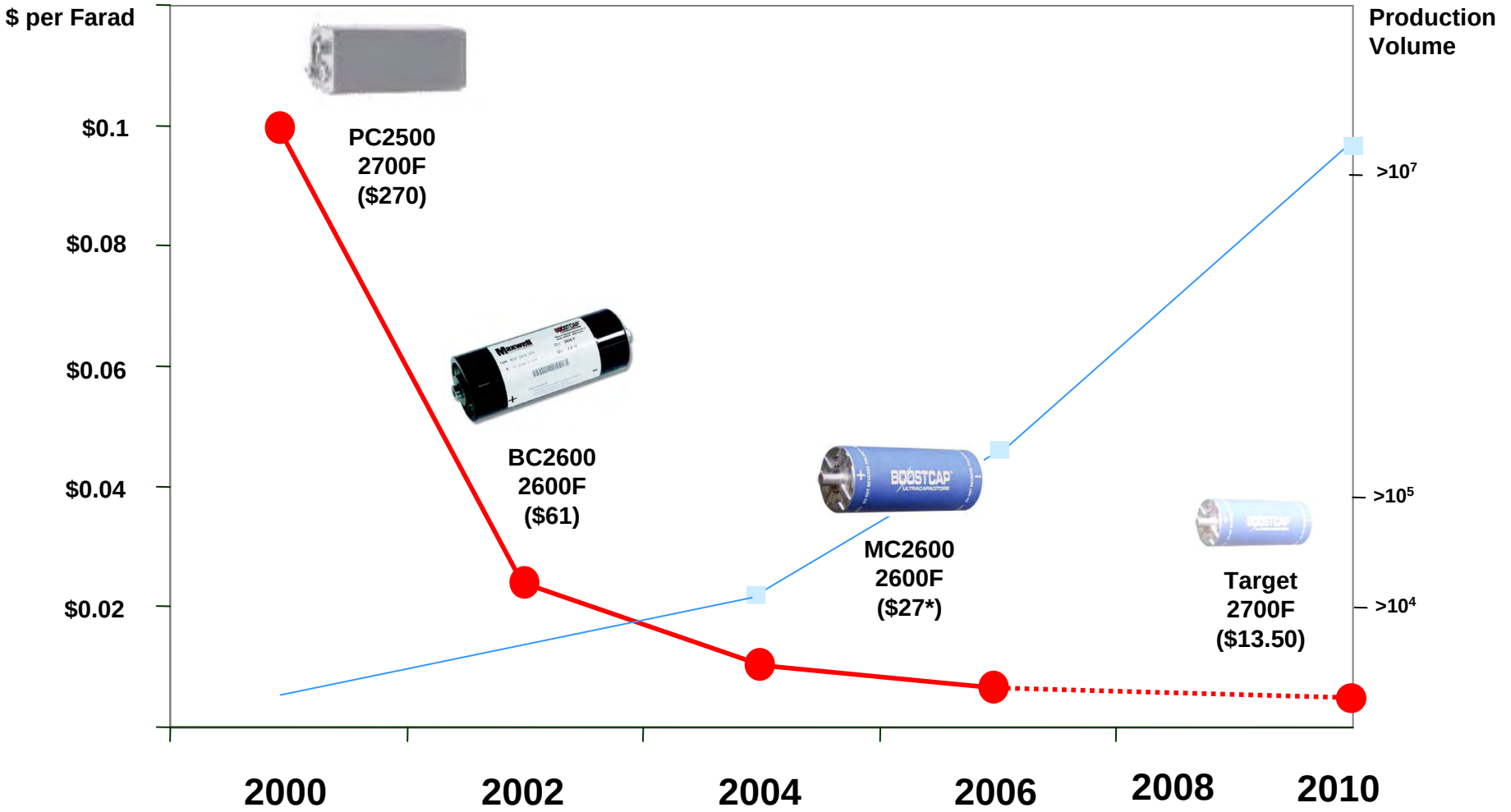
Encouraging: Cost Decrease of SCAPs



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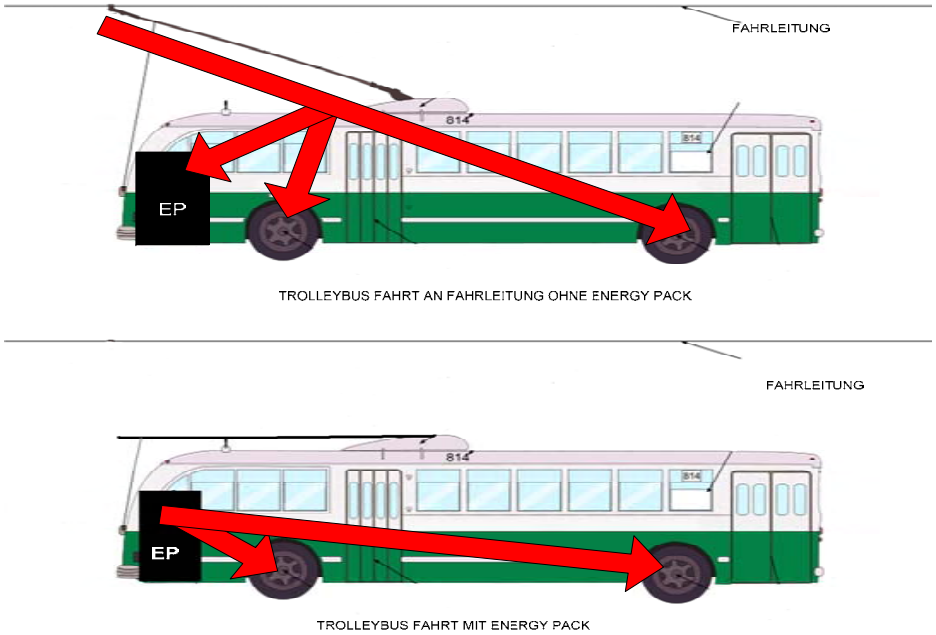
Energy Pack – the way to the E-Bus ?



Looking for a multifunctional use of an energy pack:
grid stabilization, autonomy, and so on...?

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Boundary Conditions

System view and large political act:

- Basics: 2050 oil? Only EVs?
- Faisibility is given, solutions are ready, we have only politically to realise it.
- Detaching from the simple question about the quality of the battery! Further solutions?
- Consider the cross connections: „Living & Mobility“ (view of total energy, building and infrastructure, apsects of V2G, and so on ...)
- Not public transport for public transport‘s sake

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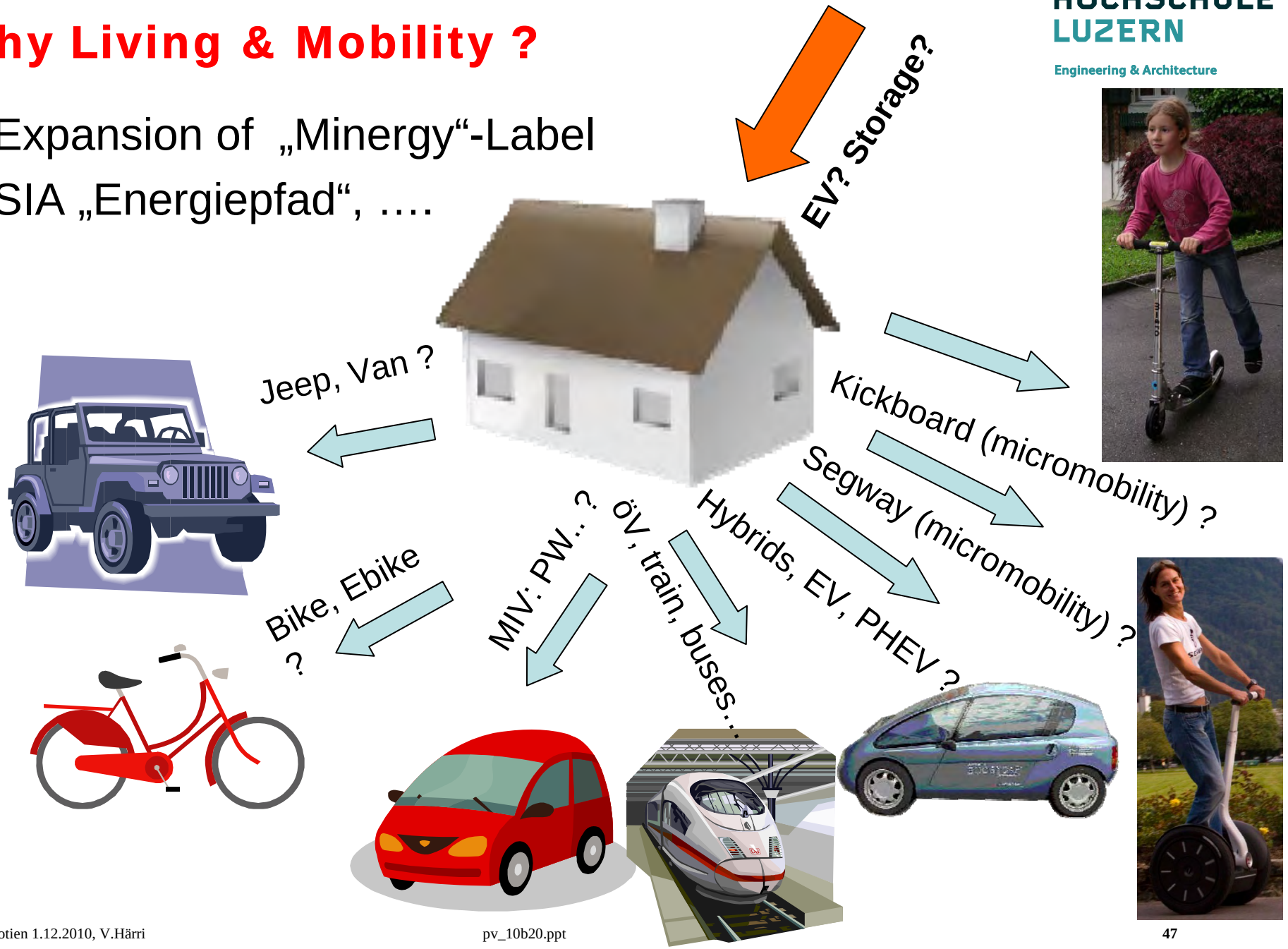
Why Living & Mobility ?

- Expansion of „Minergy“-Label
- SIA „Energiepfad“, ….



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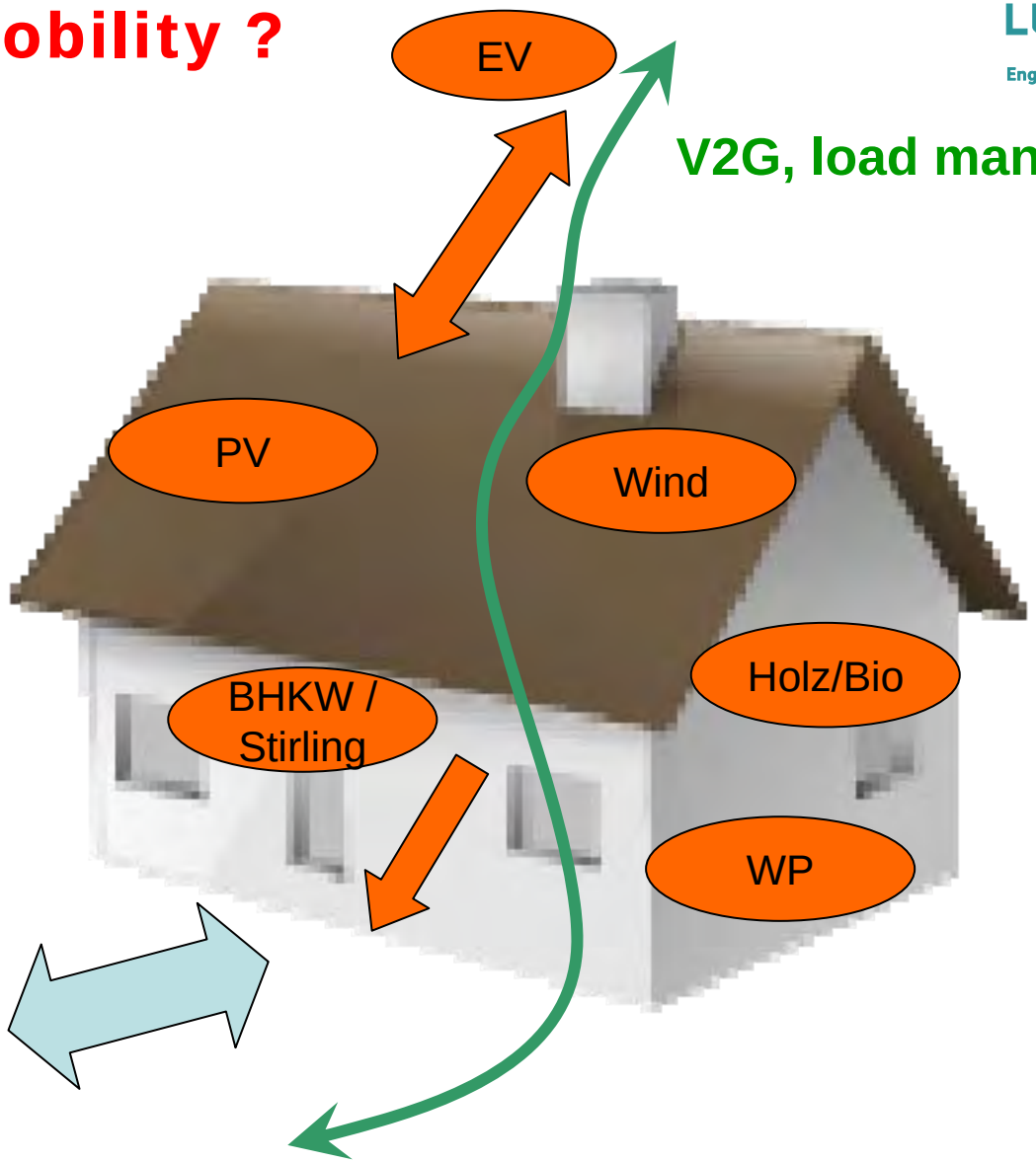
Why Living & Mobility ?

- different sources
- grid stability



PHEV at minergy home:

3x400V oder 3x230V
power link ??

with supercap fast storage

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Discussion

- Acting with system view is important, mobility is only a part
- Public transport may become the role of a pioneer for electromobility (small number, simple dissemination)
- Reduction to technical questions is not correct

  → Solutions are present! Political act!
- Networking: all are involved for the responsibility
- No delegation of the responsibility to single persons, groups
- Creating incentives, promote alternatives
- Different types of mobility, playing together in the context of „Living & Mobility“