CA B1.: Integration, Operation and Optimization of Mobility Systems

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SCCER Mobility: 2nd Annual Conference
August 26th 2015 – ETH Zürich, ML Halle – E12
Overview

1. Reminder

2. News

3. Perspective
Scope: Wider System Aspects of Mobility

The system shells

B2: Sustainability
B1: Wider System aspects
A: components & technical systems

- B1: Wider System aspects
  - A: components & technical systems
    - A1 & A2
    - A3

- B2: Sustainability
  - B1: Wider System aspects
    - A: components & technical systems

- A3
  - Batteries and Drivetrain components
  - Energy converters
  - Advanced SotA vehicles

- B1
  - Spatio-temporal data acquisition
  - Integration, operation of mobility systems
  - New carriers & freight
  - Infra-structure
  - urban planning
Overall Context

B1: Measures for optimization of efficiency by system approach

Supply: Technologies and infrastructure integration

Demand: Users, Linking mobility, environmental data, urban planning
Abstract B1

B1 deals with

- increasing the energy efficiency in transportation from a systems point of view: integration of new technologies, overall feasibility of mobility systems in relation to grids, buildings, users....

- To this end users, technology and the infrastructure are interfaced with each other by linking mobility patterns with urban planning and environmental data.

- This includes simulating and monitoring people’s spatio-temporal behavior in near real-time with the goal of calculating and communicating energy saving options.

- Such approach will result in an optimization of mobility systems and therefore a reduction of the future energy demand.
Subtasks

- **B1.1:** Integration, Infrastructure & New Urban Transport
- **B1.2:** Spatio-temporal Data Acquisition & Analysis, Monitoring Devices and User Communication
- **B1.3:** Urban Planning & Environmental Impact
Road Map B1

Technology Roadmap 2013-2024 CA B1: Integration, Operation and Optimization of Mobility Systems

- System Dissemination
- System concepts & Realisation
- System Analysis & preparation
- Assessment
- Pilots
- Support of industrialization
- Overall system integrations
- Grid infrastructure interactions
- Personalized user energy apps
- Infrastructure and new freight, railways and urban mobility concepts
- Spatio-temporal data analysis
- Urban planning & environmental impact
- Feasibility data acquisition sensors, new freight and urban transport concepts
- Tool preparation for evaluation, simulations
- Advanced methodologies for system integration
- Short Term (2013-2016)
- Mid Term (2017-2020)
- Long Term (2021-2024)
# Research Groups in CA B1

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Overview

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CA B1.1: Infrastructure & New Urban Transport
Context B1.1

- Integrating technical subsystems: drive-chains, overhead-lines and pantographs, inductive or other power transfer devices, static storages, substations and decentralized renewable power supply hubs
- Overall benefits by reducing energy losses in the supply chain: planning of distributed and intelligent grid infrastructures, which satisfy the demand of dynamic control for handling the high power peaks by breaking and acceleration
- Overall evaluation and optimization of the most promising transport carriers and their optimal multimodal combination from an energy efficiency point-of-view
- Including advanced and new carriers: trains, LRT, elevators, escalators, people movers, cable cars...
- Taking into account operation profiles and applied in pilot transportation projects
- Lately: also topics of green ITS in the system context
**Topics IVT**

**Automatic train operation joint with centralized train management system**
Holistic optimization of energy consumption and network capacity in rail systems

**Reduction of the peak loads of energy consumption in integrated timetable systems**
Energy storage on locomotives and/or new timetables with smoothed connection systems

**Electromobility in urban public transport systems**
Decision method for the evaluation of road-bound electric public transport systems

**Enhanced flexibility and productivity in the single waggonload system**
New opportunities given by hybrid diesel-electric locomotives for multipurpose operation
Energy savings in rail freight by traffic flow optimization

**SCCER Mobility – Competence Area B 1.1 (group IVT Weidmann)**

**The Approach**

- Freight rail traffic is a non negligible % of rail traffic in Switzerland (≈ 20%)
- Energy efficiency in rail freight has not been deeply investigated so far.
- Railway operation and energy consumption aspects may benefit from energy efficiency solutions specifically dedicated to rail freight

**The Framework**

- Based on the supply design modeling approach
- Applications on speed profiles and rescheduling procedures.
- Optimization model built with MatLab and Cplex (IVT internal code). Simulation model built with a commercial tool (OpenTrack)

**Key factors for energy efficiency implementation**

- Route choice
- Optimal speed profiles
- Path assignment
- Timetable
- ... (DAS, Adaptive traffic control, Multi objective rescheduling, ...)

**First results**

By optimizing the speed profiles of the train:

- Savings up to 14% approximatively between 2 consecutive stops (ideal condition)
- With an increased running time of 5% in average.

Additional saving can be obtained with appropriate multi objective rescheduling procedures for avoiding unplanned stops.

*Currently, real trajectories with associated energy consumptions from onboard monitoring systems are under analysis.*

- De Martinis, Weidmann. “Definition of energy-efficient speed profiles within rail traffic by means of supply design models”. *Research in Transportation Economics, Elsevier (publication within the year)*
- Toletti, De Martinis, Weidmann. “What about train length and energy efficiency of freight trains in rescheduling models?”. *Transportation Procedia (publication within the year)*
Achieved in 2015

- Measurement’s on Switchbus (Louis Paler, Solar taxi)

Results:
⇒ 5 % for ancillary without HVAC
⇒ 92Wh/t*km
⇒ Autonomy: 220 km
⇒ Best Profile >300km!
Micro Mobility and Grid's Integration

E-Bike
⇒ Better Recuperation
⇒ Integration of storage
⇒ Bachelor Thesis, CTI-Check

Magic-Bike AG
CTI-Check
⇒ Optimisation of components

Mobility ⇔ Grid
FURIES WP4.5
⇒ Intelligent Control
⇒ Easy integration
⇒ High autonomy
Urban Transport and Infrastructure (IVT & IIEE)

- Support of E-buses market introduction
- Cooperation with Ceekon AG (project VBZ)

→ Specification of today’s and future busses?
→ Understanding interactions of line service and charging (Grids)
Best Practice??

Lighthouse Project: in discussion/planning
SCCER Transportation Vision & Best Practice in “Luzern-Süd” (Mattenhof)

- VVL and TUs
- Verkehrsrverbund Luzern
- Mobimo AG
- IVT Axhausen
Urban Transport and Infrastructure

- Interaction with SCCER (Grids) → Bridge to WP 4.5

1 Tag im Jahr 2030

Power Transmission / Grid  Single Home / Quarter / Region  Electric - Vehicle  Building

Claim: Grid - Living & Mobility
«Intelligente Lösungen für die Energiewende» und «Gebäude als System»

Grid & Power Transmission  Quarter / Building & Energy Storage  E-Vehicle & Charging Infrastructure
CA B1.2: Spatio-temporal Data Acquisition & Analysis, Monitoring Devices and User Communication
Context B1.2

- Novel data sources, sensors, and monitoring devices will allow us in the future to tackle the challenges of reducing CO2 emissions and energy consumption from a new perspective.
- Development of an integrative framework for utilizing ICT (Information and Communication Technologies) to acquire massive data from people regarding their daily movement patterns and energy consumption.
- Goal of calculating and communicating energy saving options, e.g., the most energy efficient route to take, through a mobile service to the individual.
- Forecasting and predicting urban traffic and corresponding energy consumption.
- Developed personalized energy mobility service/app will be tested and evaluated for a large study in the cantons of Zürich and Luzern.
Heyko Stöber
GoEco!

“How can we encourage people to engage in more sustainable mobility lifestyles?”

Gamification and Eco-Feedback (Poster Cellina et al.)

- Mobile app: Tracks trips and suggests alternative, low-impact options.
- Living Lab User Tests: Long-Term Large-Scale User study

Matching Complementary Transport Needs (Poster Bucher et al.)

- Queries are results for others with complementary needs.
- Ex: Person A looking for car-pooling partners provides result for person B who is looking for transport options.
- Model allows to automatically match such needs.

Diagram showing the relationships between transport modes and needs.
Optimization at building/district level

Energy flows

Optimization principle

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CA B1.3:
Urban Planning & Environmental Impact
Context B1.3

- The aim is to show consequences of the interaction of future (growing) mobility (public and private) on housing, settlement and community infrastructure: on life quality. The results will help communities and related organisations (public and private) to optimize urban planning and infrastructure, i.e. to optimize related opportunity costs.
- Modelling the energy demand and impacts of housing and land-based mobility for all households in Switzerland
- Cluster analysis of urban settlements: Interaction of settlements typologies and mobility behaviour in Switzerland.
- Integration of future scenarios and optimization approaches
- Economic analysis, consequences and products
- Implementation into practice
B1.3: Urban Planning and Environmental Impact

1) LCA-Household-Consumption-Model:

1.1) Modelling GHG emissions from housing and mobility of individual households (here: St. Gallen)

1.2) Studying differences of behavior patterns between individual households and different regions

![Chart showing GHG emissions comparison](chart.png)

Main life cycle GHG area and statistics per municipality:
- Housing: Energy Use
- Housing: Infrastructure
- Mobility: Motorized Private Transport
- Mobility: Public Transport
B1.3: Urban Planning and Environmental Impact

2) Urban-Structure-Analysis-Tool:

2.1) **Database**: OSM, GWR, GWS

2.2) **Tool**: Definition of all the precise parameters to filter the three main specific architectural typologies with their subcategories.

2.3) **Analysis**: Automatic analysis of all three typologies from the field of city planning. The analysis is working for whole CH and gives a graphical feedback for each household.

3) **Outlook Data-Matching**: Refined analyses of GHG emissions and mobility consumption data with regard to different urban settlement typologies and urban structures.
Industry partners
CA B1: Scientific Exchange and Knowledge Transfer
Scientific Exchange, Knowledge Transfer: Publications


Scientific Exchange, Knowledge Transfer: Publications


Scientific Exchange, Knowledge Transfer: Others

- Course unit in “Advanced Environmental Assessments“ (Hellweg)
- Poster Presentation: Assessing the Environmental Impacts from Housing and Land-Based Mobility Demand of Households on a Regional Level), Froemelt, A.; Hellweg, S. ISIE Conference 2015, Guildford, UK, 7-10 July 2015
- Courses within bachelor and MSE master modules, HSLU
- Presentations on BAV event, 23th of June 2015, ETH Zentrum (Weidmann/DeMArtinis, Raubal, Härri)
Overview

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Next Steps B1

- Definition Proposal 2015
- Increasing bridge function to other SCCER (FURIES, CREST...)
- Expanding the investigations for system aspects challenges for future transportation systems (e.g. green ITS, ..)
- Practical realization of new solutions (ligthouse projects)
- Taking part in the master course development