Railways & Environmental Sustainability
Research activities at Vienna University of Technology, Research Center for Resource & Waste Management

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Department for highway and railway engineering
Austria, in the heart of Europe

National Railway Network
4,900 km track length
250 tunnels
6,700 bridges
6,300 train trips per day

Deregulated market
Faculty for Civil Engineering
Master: Infrastructure planning and management
Main research

1. Analysis, evaluation and design of the anthropogenic metabolism.
2. Assessing measures in the field of resource and waste management
3. Landfills and final sinks.

Funding & Cooperations

- Companies (National Railway Authority, Public Transport Provider, Waste Companies, etc.)
- Universities (external & internal)
- Science Funds (EU, national)
An anthropogenic metabolism that conserves resources and protects the environment.

\[
\Sigma_1 \sim 200 \text{ t/cap.yr}
\]

\[
\Sigma_0 \sim 193 \text{ t/cap.yr}
\]

*Daxbeck, et. al (1996): Der anthropogene Stoffhaushalt der Stadt Wien (Projekt PILOT), Technische Universität Wien. modifiziert*
# Railway & Sustainability Projects

<table>
<thead>
<tr>
<th>Title</th>
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| (1) Infrastructure Guidelines for Environmental Railway Performance | Environmental Management  
Environmental Procurement                                             | European Union                               |
| (2) Cu flows into railway tracks                                    | Cu sources, pathways and sinks along railway tracks                  | National Railway Authority                   |
| (3) From ecological footprint to resource management                | Greenhouse gas emissions of a subway line in a life cycle perspective | Public Transport Provider                   |
| (4) Christian Doppler Laboratory                                     | Identification of resource potentials in built infrastructures       | Public Transport Provider, Governmental department |
| (5) Sino-Austrian Research Center                                    | Environmental Protection & Railway Engineering                       |                                              |
Title
Infrastructure Guidelines for Environmental Railway Performance

Goal
Improving environmental performance of railways

Outcomes
- Mutual exchange of current practices through European Railway Infrastructure Managers.
- Generic guidelines for environmental management of railway infrastructure
- Guidelines for procurement of materials and services.
Contaminants in ballast

**Problem**
Disposal costs for old ballast fractions.

**Driver**
Heavy metal concentrations.

**Goal**
Identification of Cu sources, pathways and sinks.

**Approach**
1. System definition
2. Data acquisition
3. Cu flow analysis

Gerald Schöller, MA
Where does the Cu go to?

Alteration of copper stocks [Mg/a]

- Catenary wire: -9.6 kg/a
- Rolling stock components: -2.7 kg/a
- Track ballast: +2.6 kg/a
- Unknown losses to environment and others: +9.7 kg/a
Fine material, contaminated by Cu

Threshold for recycling

Copper concentrations in the fine material [mg Cu / kg TS]

Operational lifetime of track ballast [years]
Solution 1: Avoidance of contaminants

Source oriented measures to reduce copper entries

- Purchase ballast low in Cu
- Replace copper in brake pads
- New design of overhead lines
Solution 2: Separation of contaminants

Technology optimizes recycling rates

BALLAST
- 100% old ballast
- 55% recycled
- 45% contaminated

COPPER
- 100% copper
- 22% recycled
- 78% contaminated

Source: http://www.ing-k.de/gallerie.php
Problem
Greenhouse gas emissions exceed Kyoto limits

Driver
Mobility patterns (emissions +55%, from 1990 – 2011)

Research goal
Comparing 2 modes of transport (subway & cars) in a life cycle perspective

Approach
GHG inventory in a life cycle perspective

Energy and materials...
...for the provision and operation of the subway.

System „Subway line“

System „Cars“
Footprint

System "Subway":
- Ecological Footprint: 0.16 [m²/person.year]

System "Cars":
- Ecological Footprint: 0.54 [m²/person.year]
More passengers, less footprint

Ecological footprint [m²/Person-km-yr] vs occupation rate [%]

- Occupation rate: 5% to 60%
- Ecological footprint: 0.35 to 0.00

Peak at 0.16 m²/Person-km-yr for a 5% occupation rate.
Goal
Knowledge base for efficient recycling of materials in infrastructures and buildings.

Partner
Public Transport Provider (City of Vienna)
- 5 subway lines
- tram network (2nd largest worldwide)
- bus network
- office buildings, maintenance halls, etc.

Expected results
- Methods that characterize the materials in infrastructures
- Information regarding:
  - „hibernating material stocks“.
  - resources and reserves in infrastructures.
- Prediction of future recycling materials

Project started in autumn 2012

Ass. Prof. Johann Fellner
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Letter of intend
The aim is to increase the operational safety. Remote controlled interlocking and centralization of operation control are used to assist or substitute human inspection of trains, for example by hot box detectors to prevent derailments. Early recognition of future fault states allows immediate interaction and thereby increasing quality of transport due to less disturbances of traffic flow.

Dr. Norbert OSTERMANN  
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The aim is to ensure environmental protection and resource conservation by railway systems. An effective and efficient scheme for monitoring has to be developed. It enables to set measures right in time, preventing over-loadings of environmental compartments and depletion of ballast. Technical guidelines for design and operation of sustainable railway sub-systems have to be developed.

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Welcome, and let us begin to cooperate!
Central Station Vienna

The End

or the Beginning?