

# ACTUATE

## Advanced Training and Education for Safe Eco-driving of Clean Vehicles

Final Event  
Brussels, 12 December 2014



Co-funded by the Intelligent Energy Europe  
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# ACTUATE

## Eco-driving for clean vehicles – project results and lessons learnt

Wolfgang Backhaus, Rupprecht Consult  
Brussels, 12 December 2014



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## Background



### ACTUATE - Advanced Training and Education for Safe Eco-driving of Clean Vehicles

- **Safe eco-driving** has the potential to reduce energy consumption, emissions, operating costs and to increase passenger safety, but is so far only available for diesel-engine vehicles.
- The ACTUATE project develops concepts for professional drivers of different clean vehicle types (trolleybuses, hybrid buses, e buses with "supercapacitors" and trams), which will be developed, tested and evaluated.

- Project duration: 05/2012 to 01/2015 -



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## ACTUATE – Project Partners

- **Rupprecht Consult – Forschung & Beratung GmbH (RC)**, Cologne, Germany
- **Salzburg AG für Energie, Verkehr u. Telekommunikation (SAG)**, Salzburg, Austria
- **Leipziger Aus- und Weiterbildungsbetriebe GmbH (LAB)**, Leipzig, Germany
- **Leipziger Verkehrsbetriebe GmbH (LVB)**, Leipzig, Germany
- **Barnimer Busgesellschaft mbH (BBG)**, Eberswalde, Germany
- **Dopravní podnik města Brna a.s., (DPMB)**, Brno, Czech Republic
- **Trasporti Pubblici Parma S.p.A. (TEP)**, Parma, Italy
- **TrolleyMotion (TM)**, Austria
- **Van Hool NV (VH)**, Lier, Belgium



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## Objectives and Main Steps

- **Integrate ACTUATE trainings for safe eco-driving into formal bus driver qualification** of PT companies;  
*- trainings in accordance with EU Directive 2003/59/EC -*
- **Enhance the quality of bus driver training** and expand the training to the **special requirements of clean vehicles**;  
*- definition of minimum quality criteria & learning outcomes -*
- **Demonstrate the energy saving potentials** on the basis of capacity building in energy efficient driving of clean vehicles;  
*- evaluation of training sessions with more than 1.500 drivers -*
- Upscale the outcomes for **wider up-take at European level**.  
*- test of trainings at additional PT companies & “starter kits” -*



# Definition of minimum quality criteria & learning outcomes



## Developed according to learning outcomes:

- **Skills:**  
E.g. „to be able to use hybrid bus drive train most efficiently when braking or accelerating”.
- **Knowledge:**  
E.g. „about the ideal drive-cycle between stops incl. topographic conditions of local network/lines”.
- **Competencies:**  
E.g. “to recuperate highest possible amount of energy in operation based on knowledge about topographic conditions”.

## Basic requirements:

|              |   |
|--------------|---|
| Requirements | Trainings shall maximise energy savings by eco driving  |
|              | Training material for safety aspects of clean vehicles  |
|              | Training material for specific bus types and tram control technology  |
|              | Pre-instruction and briefing of trainers and technical experts by bus and tram manufacturers about specifica of vehicle types |
|              | Training only for drivers that are on duty on clean vehicles  |

**Minimum 40% of training sessions should be realised as practical driving session!**



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# Influences on energy consumption

What can be influenced by the driver?



e.g. Public Transport planning

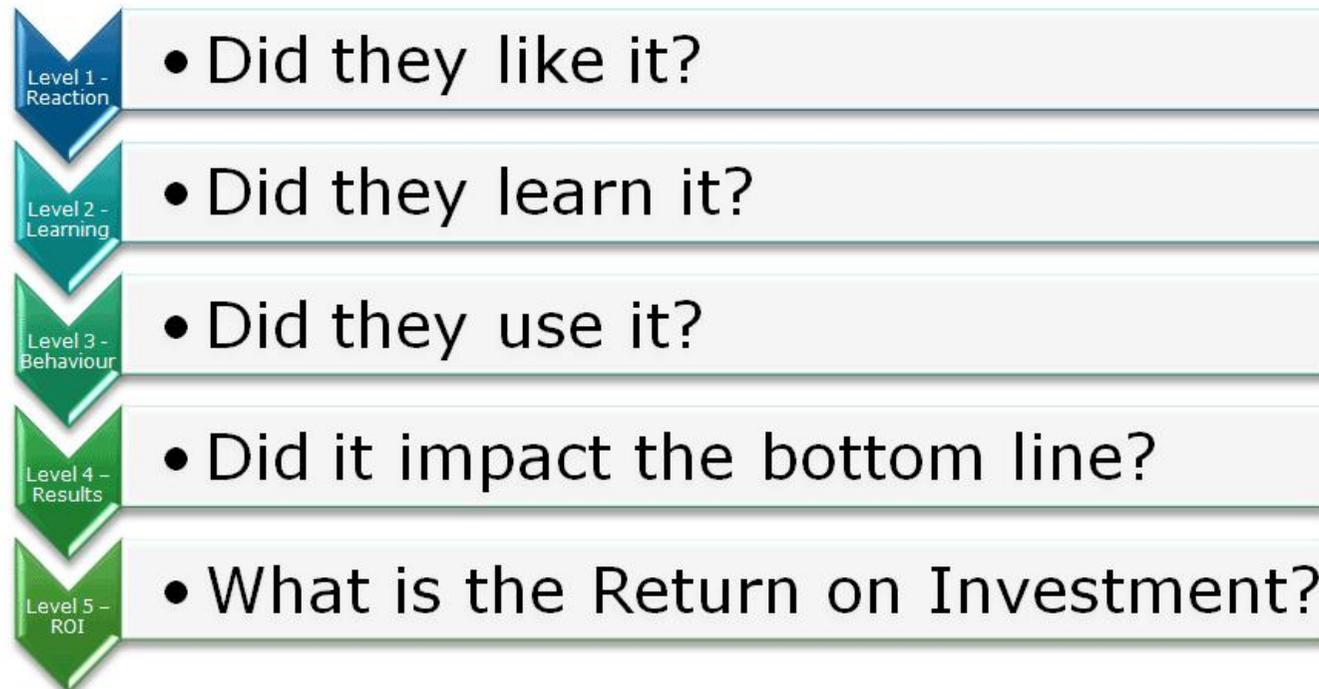


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## Training programme evaluation

**ACTUATE evaluation levels for safe eco-driving training programmes for clean vehicle drivers (according to Kirkpatrick's model 1994):**



# Training programme evaluation

Level 1 -  
Reaction

## • Did they like it?

- **Measurement focus:** Drivers reaction and perception to/of trainings
- **Question(s) addressed:** What did drivers think of the safe eco-driving training programmes?
- **How do we measure that:** Questionnaires after training sessions
- **Results:** e.g. for trolleybus drivers training in Salzburg (273 drivers trained):
  - about 90% of all trained 1.574 tram and bus bus drivers rate the overall quality of the ACTUATE training as either 'excellent' or 'very good (especially the practical part of the trainings received very positive feedback by the drivers)
  - 89% rate the topic of safe eco-driving as 'very important' or 'important' for their daily work



# Training programme evaluation



## • Did they learn it?

- **Measurement focus:** Knowledge and skills gained by drivers
- **Question(s) addressed:** Was there an increase in knowledge and/or skill level of the trained drivers?
- **How do we measure that:** energy consumption measurements during trainings
- **Results:** e.g. for trolleybus (258, Salzburg) and hybrid bus (about 650, Leipzig) drivers trained:
  - about 75% per cent of trained hybrid and trolleybus drivers were able to cut down energy consumption by applying safe eco-driving techniques during training
  - E.g. 13% (up to 17%) reduction of diesel fuel consumption / 18% energy consumption reached by hybrid-/trolleybus drivers from Leipzig/Parma on average



# IT-support to optimise, evaluate and monitor driving behaviour



- Simple displays to present „eco-status“ of driving style
- (Mobile) on-board devices for monitoring of driving style & vehicle energy consumption
- Driving-Style tutor client devices to give feedback to the drivers about driving behaviour



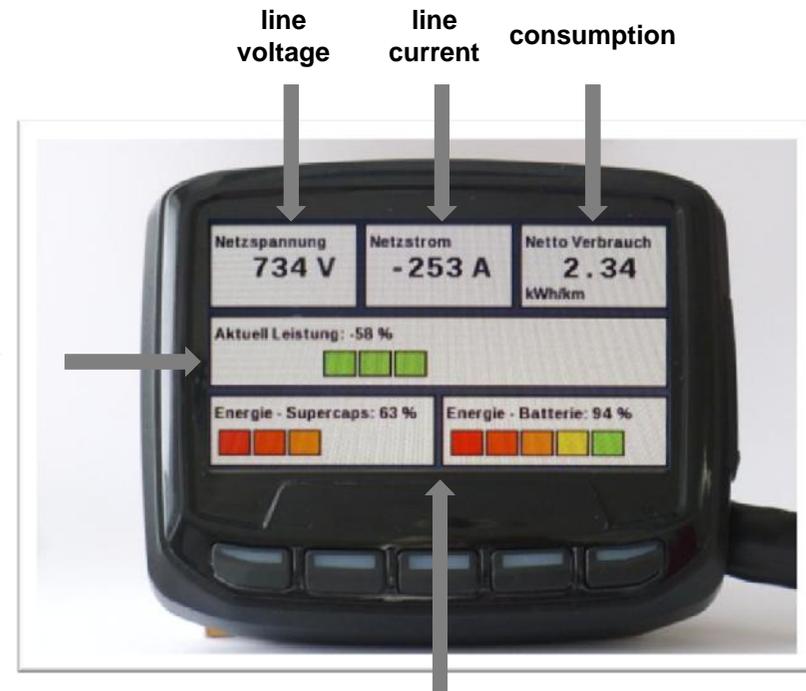
Source: TELEPARKING Srl



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# IT-support to optimise, evaluate and monitor driving behaviour – different approaches



power

energy  
supercaps & battery



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# Training programme evaluation



## • Did they use it?

- **Measurement focus:** Worksite (the driver's workplace, line operation)
- **Question(s) addressed:** Is the new knowledge/skill being used on the job? What effect did the training have on energy consumption of clean vehicles?
- **How do we measure that:** pre- and post-training energy consumption measurements, driving behaviour observation
- **Results:** e.g. measurements for trolleybuses in Brno (3 months before and after training) and tram operation (driving behaviour analysis during single days):
  - about 7,5% per cent energy consumption reduction by trained trolleybus drivers (10 drivers observed for long-term measurements) in Brno
  - Comparison of "driving curves" of single drivers in Leipzig



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# Training programme evaluation

Level 4 –  
Results

• Did it impact the bottom line?

Level 5 –  
ROI

• What is the Return on Investment?

- **Measurement focus:** Business impact on organisation, return on investment
- **Question(s) addressed:** What effect did the training have on energy consumption of clean vehicles?; Return on Investment (RoI)?
- **How do we measure that:** Impact/RoI calculations etc.
- **Results:**
  - Assuming the “realistic” scenario of 3% energy consumption reduction; this would lead to **annual budgetary savings of 210.000 EURO for tram operation** in Leipzig (ca. 7 Mio. EURO annual cost for traction current; 420.000)



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# Training programme evaluation

Level 4 –  
Results

- Did it impact the bottom line?

Level 5 –  
ROI

- What is the Return on Investment?

- **Results:**

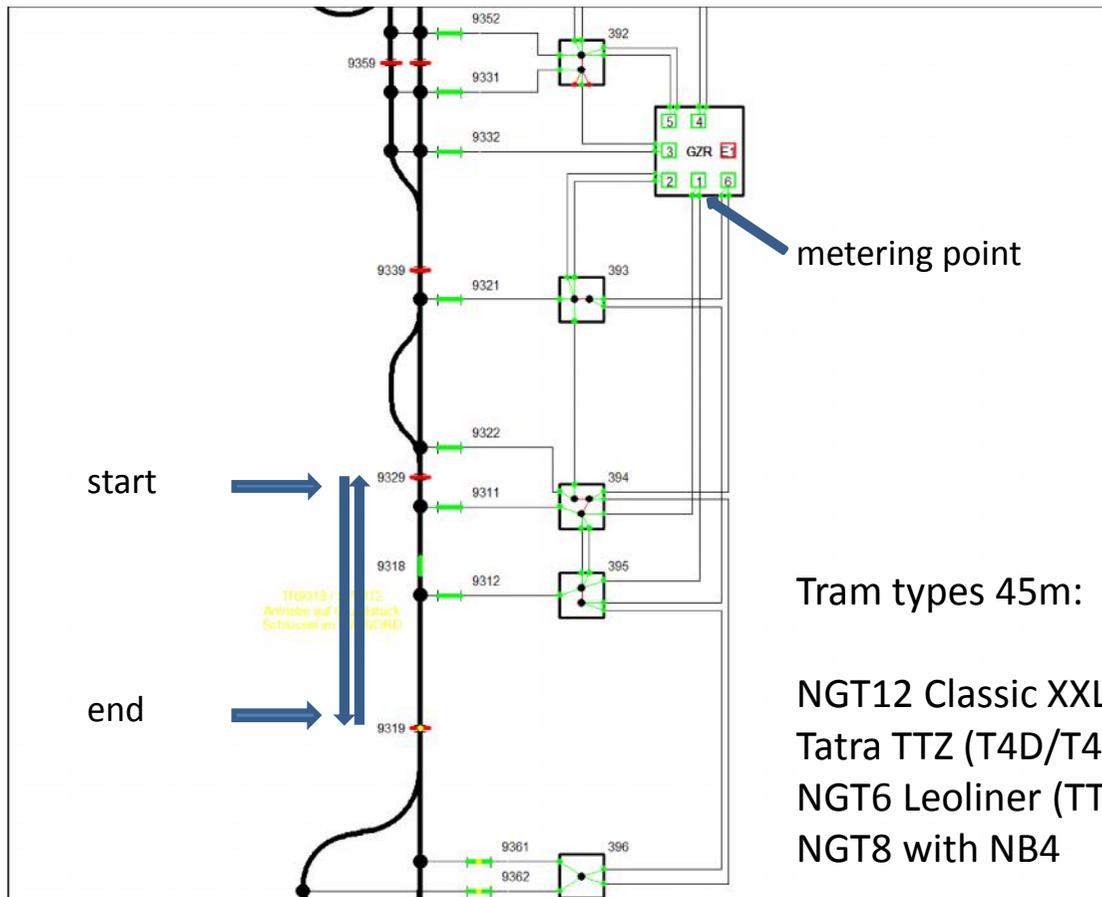
- Assess further (monetary) benefits of the trainings incl. the **reduction of abrasion** effects on clean vehicles (which have high unit cost) & on needed infrastructure in case of trolleybus/tram systems, **reduced status of drivers' illness** due to less stress etc.
- Assuming the “realistic” scenario of 3% energy consumption reduction; primary **energy savings of about 4.700 tons** of oil equivalent and **25.000 tons of CO<sub>2</sub>** reduction could be reached **by 2020 for the clean vehicle fleets of the ACTUATE partners**



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# Tram Evaluation – Measurements in Leipzig



## Overview

Part of  
LVB-tram-network

prepared for Measurement

Length of section: 874,5 m  
2 tram-stops in each direction

Tram types 45m:

- NGT12 Classic XXL
- Tatra TTZ (T4D/T4D/NB4)
- NGT6 Leoliner (TT)
- NGT8 with NB4



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# Tram Evaluation T4D/T4D/NB4 Tatra/Bombardier

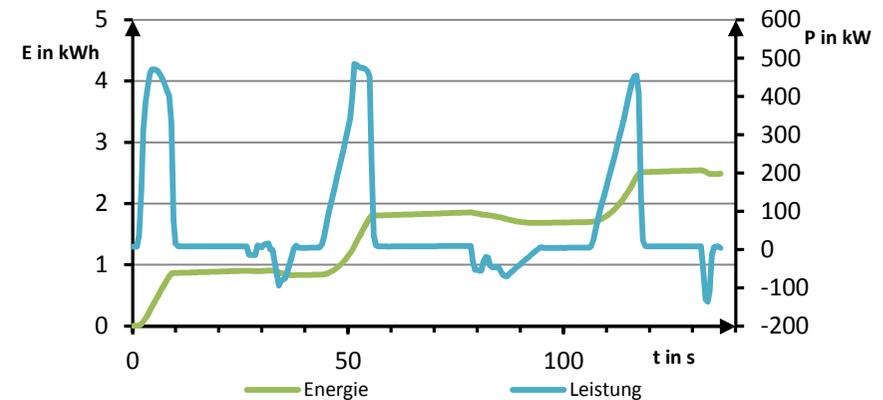
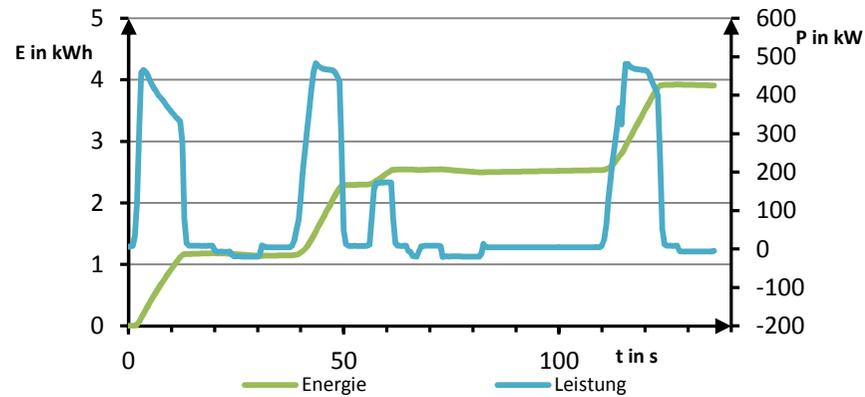
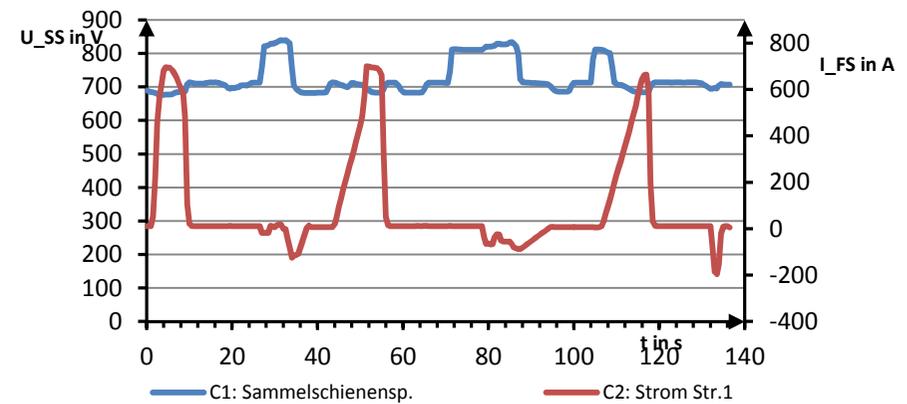
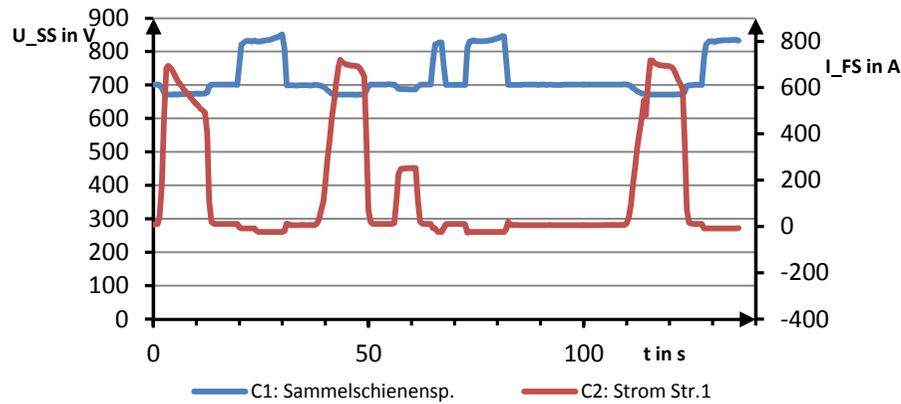


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# Tram Evaluation T4D/T4D/NB4 before and after trainings



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## Tram Evaluation

# Energy consumption T4D/T4D/NB4 Comparison

|                 | kWh  | kWh/km | t/s   |
|-----------------|------|--------|-------|
| before training | 3,98 | 4,55   | 137   |
| after training  | 2,49 | 2,98   | 138   |
| effects         |      | -44,5% | +0,7% |



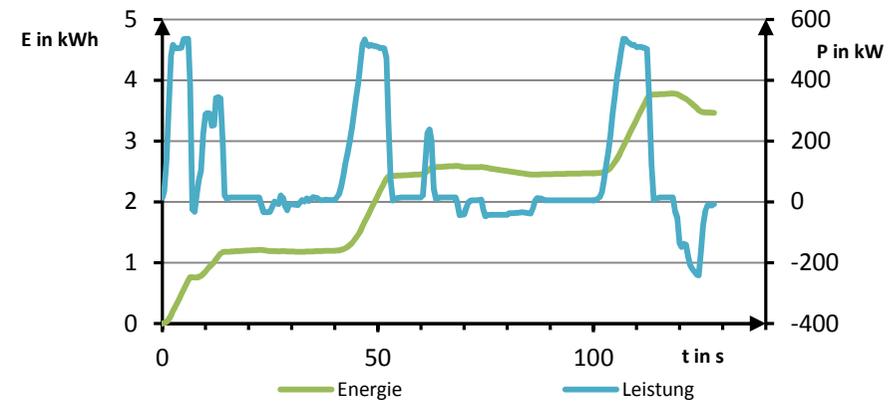
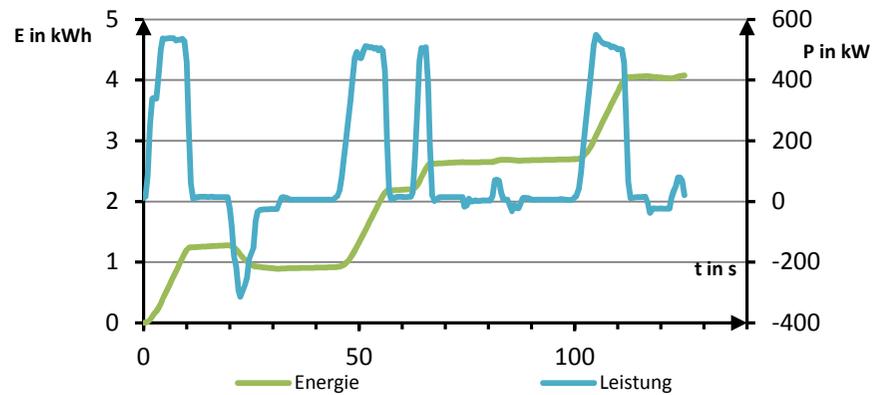
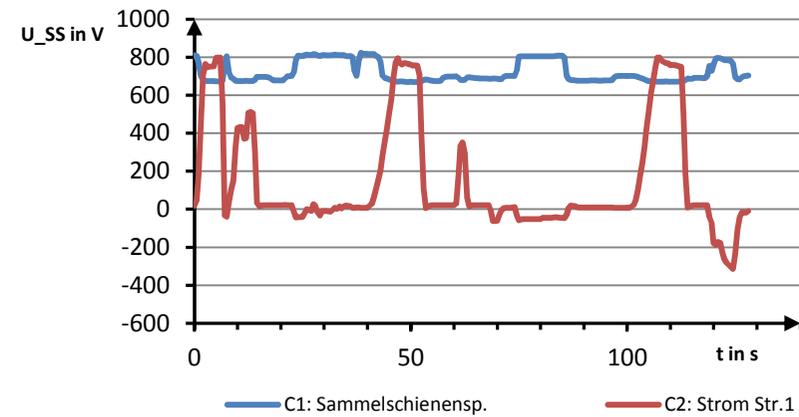
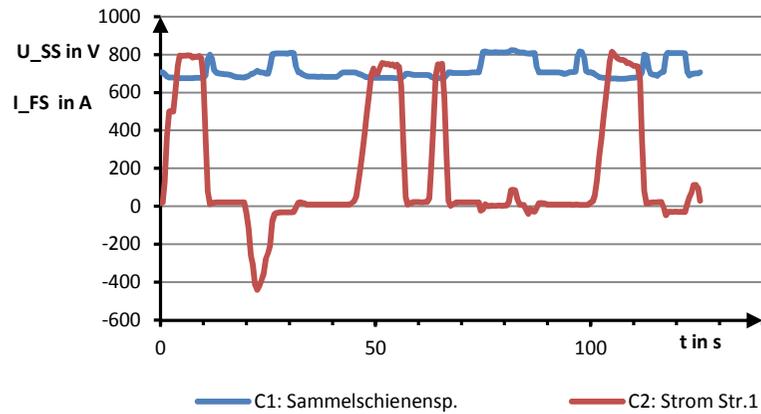
# Tram Evaluation NGT12 Bombardier Classic



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# Tram Evaluation NGT12 before and after trainings



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## Tram Evaluation

# Energyconsumption XXL

## Comparison

|                 | kWh  | kWh/km | t/s   |
|-----------------|------|--------|-------|
| before training | 4,02 | 4,60   | 127 s |
| after training  | 3,48 | 3,98   | 128 s |
| effects         |      | -14,5% | +0,8% |



# Support for the long-term impact



## Motivational in-house campaigns:

- To support the introduction of safe eco-driving trainings and to motivate drivers to apply and retain their newly acquired eco-driving skills and knowledge
- Comparison of different approaches:
  - bonus schemes (still to be decided for Leipzig)
  - competitive schemes
  - image campaign schemes



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# In-house & public campaign in Parma

**i nostri autisti hanno il piede ecologico**



**TEP INVESTE IN FORMAZIONE PER UNA GUIDA CHE RISPETTA L'AMBIENTE.**

Una guida corretta può ridurre i consumi energetici e le emissioni gassose nocive per l'ambiente. Gli autisti TEP frequentano corsi di formazione per migliorare lo stile di guida. **Salite a bordo: vi accompagniamo verso un futuro sempre più ecosostenibile.**



**rispettiamo l'ambiente con una guida virtuosa**



**TEP INVESTE IN FORMAZIONE PER UNA GUIDA CHE RISPETTA L'AMBIENTE.**

Cinzia, conducente TEP da 18 anni, ha partecipato ai corsi di formazione per l'ecoguida. Un viaggio più confortevole per i suoi passeggeri e un'aria più pulita per tutti. **Salite a bordo: vi accompagniamo verso un futuro sempre più ecosostenibile.**



**rispettiamo l'ambiente con una guida virtuosa**



**TEP INVESTE IN FORMAZIONE PER UNA GUIDA CHE RISPETTA L'AMBIENTE.**

Roberto, conducente TEP da 25 anni, ha partecipato ai corsi di formazione per l'ecoguida. Un viaggio più confortevole per i suoi passeggeri e un'aria più pulita per tutti. **Salite a bordo: vi accompagniamo verso un futuro sempre più ecosostenibile.**



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# eLearning for awareness raising / sensitisation of drivers?



## eLearning



() Halten Sie die Möglichkeit des eLearning zur Bewusstseinsbildung für eine wirtschaftliche Fahrweise für sinnvoll?

- Ja: 19 (90,48 %)

- Nein: 2 (9,52 %)

() Würden Sie die eLearning Einheit insgesamt als gelungen bewerten?

- Ja: 19 (90,48 %)

- Nein: 2 (9,52 %)

() Würden Sie an weiteren eLearning Einheiten teilnehmen, um das Thema „wirtschaftliche Fahrweise“ dauerhaft in Erinnerung zu behalten?

- Ja: 20 (95,24 %)

- Nein: 1 (4,76 %)

() Würden Sie diese eLearning Einheit zur „wirtschaftlichen Fahrweise“ anderen Fahrern und Fahrerinnen Ihrer Organisation zur Auffrischung des Themas empfehlen?

- Ja: 20 (95,24 %)

- Nein: 1 (4,76 %)

() Falls Sie noch generelle Kommentare zur eLearning Einheit „wirtschaftliches Fahren mit dem Obus“ haben, können Sie diese hier mitteilen:



rope  
nion





## How can you benefit from ACTUATE?

- **Training materials (concept, presentation & brochure for safe eco-driving training available for:**
  - Tram (LVB & LAB)
  - Hybrid bus (LVB & LAB)
  - Trolleybus (Salzburg AG) und
- **Download of a „Starter-Kit“ for eco-driving of clean vehicles (coming soon)**
- **Download of „in-house“ campaign elements**
- **Lessons Learnt brochure with main project findings fo training introduction, implementation and evaluation**

# Thank you for your attention!

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