UIC ENERGY EFFICIENCY DAYS 2014

ANTWERPEN, 16 - 19 JUNE

PROCUREMENT OF ENERGY EFFICIENT ROLLING STOCK: TECREC100_001

WORKSHOP – 18/06/2014 – 11H30 /13H

Energy Efficiency, the best fuel to move our trains!

WORKSHOP ON PROCUREMENT OF ENERGY EFFICIENT ROLLING STOCK: TECREC100_001

Moderated by

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SUMMARY

- 1 Experiences of TecRec100_001 users
- 2 Experiences of TecRec100_001 non users
- 3 Tomorrow

1 Experiences of TecRec100_001 users

I ♥ TecRec 100_001

Technical Recommendation

SBB EXPERIENCE WITH APPLICATION OF TECREC 100_001

Presented by

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ENERGY CONSUMPTION – EXPERIENCE FROM THE NSB FLIRT PROJECT

Presented by

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EVALUATION OF ENERGY PERFORMANCE IN LIGHT RAIL PROCUREMENT

LESSONS LEARNED FROM AARHUS LIGHT RAIL TRANSIT

Presented by

- Mads Bergendorff
  - Senior energy expert
    CUBRIS - m.bergendorff@cubris.dk

2 Experiences of TecRec100_001

NON USERS

We need you!

NS EXPERIENCE

Source : http://www.railjournal.com/index.php/rolling-stock/ns-set-to-launch-virm-refurbishment-programme.html
http://ec.europa.eu/environment/ecoap/about-eco-innovation/good-practices/netherlands/20120724_en.htm

- 2010 Refurbishment of DDAR trains
  Heat pump (6%) + CO2-controlled HVAC(3,5%) + Isolation of coach (0,6%) + Automated Parking-mode (1,3%) + Flush-windows (in combination with air conditioning) (0,2%) + Reduction of air-resistance in roof-area (2%) + Improved regeneration (1%, depends on implementation of energy efficient driving) = **15%** reduction on energy consumption

- 03/2014 : "The refurbishment [of VIRMM trains] will have to meet NS' policy for sustainability, with a **20%** reduction in energy consumption. The trains will therefore be equipped with an energy efficient climate control system and LED lighting"

OTHER PROCUREMENT PROCESSES TO OBTAIN ENERGY EFFICIENT TRAINS

- Direct requirement of energy efficient solutions as:
  - Cooling and heating with CO2-controlled air exchange
  - Start-stop for diesel engines
  - Aerodynamic shapes
  - Standby modes
  - Thermal insulations of coaches
  - Low energy lighting
  - Maximal seats capacity
- Other processes ?

3 TOMORROW

TS 50 591

TOMORROW WITH TS 50 591

- NEEDS
  - Simulations tools
  - Simulations guide
  - Measurements guide or norms
  - ?

INFRABEL UIC

UIC Energy Efficiency Days 2014

Antwerpen, 16 - 19 June

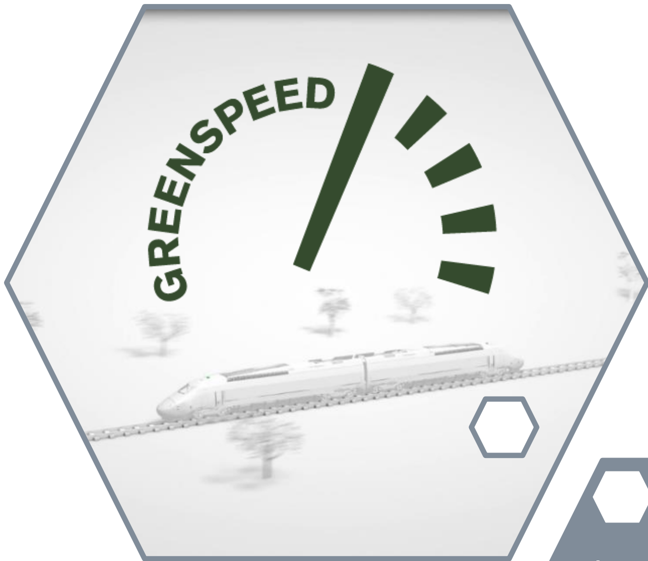
Evaluation of Energy Performance in Light Rail Procurement

Lessons learned from Aarhus Light Rail Transit

Presented by Mads Bergendorff, Senior energy expert, Cubris

Energy Efficiency, the best fuel to move our trains!

About Cubris



Innovating the railway

- Based in Copenhagen, Denmark
- An engineering company specializing in IT systems for the railway industry
- More than 7 years of experience in developing the eco-driving system GreenSpeed
- Project driven approach. We like to work with local partners to deliver high quality every time
- References:

DSB banedanmark

SOUTH WEST TRAINS NetworkRail

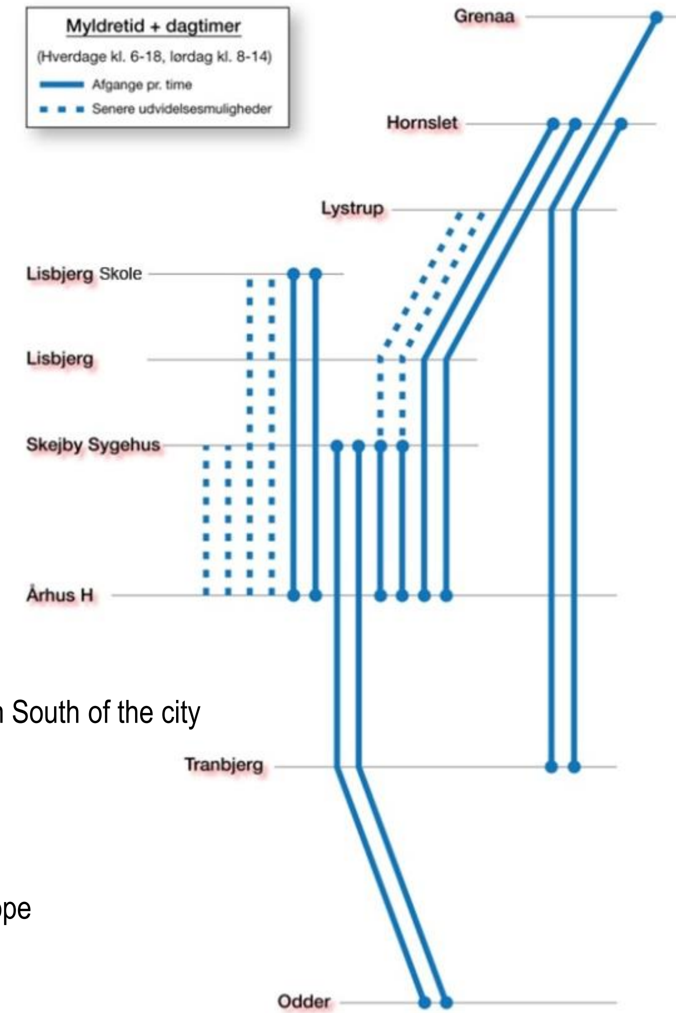
CUBRIS

Agenda

1. Introduction to the Aarhus LRT case and a Disclaimer
2. How was TecRec 100_001 applied for evaluation purposes?
3. Evaluation round 1 and 2
4. What were the lessons learned?
5. Next steps for the TecRec 100_001 (TS 50591)

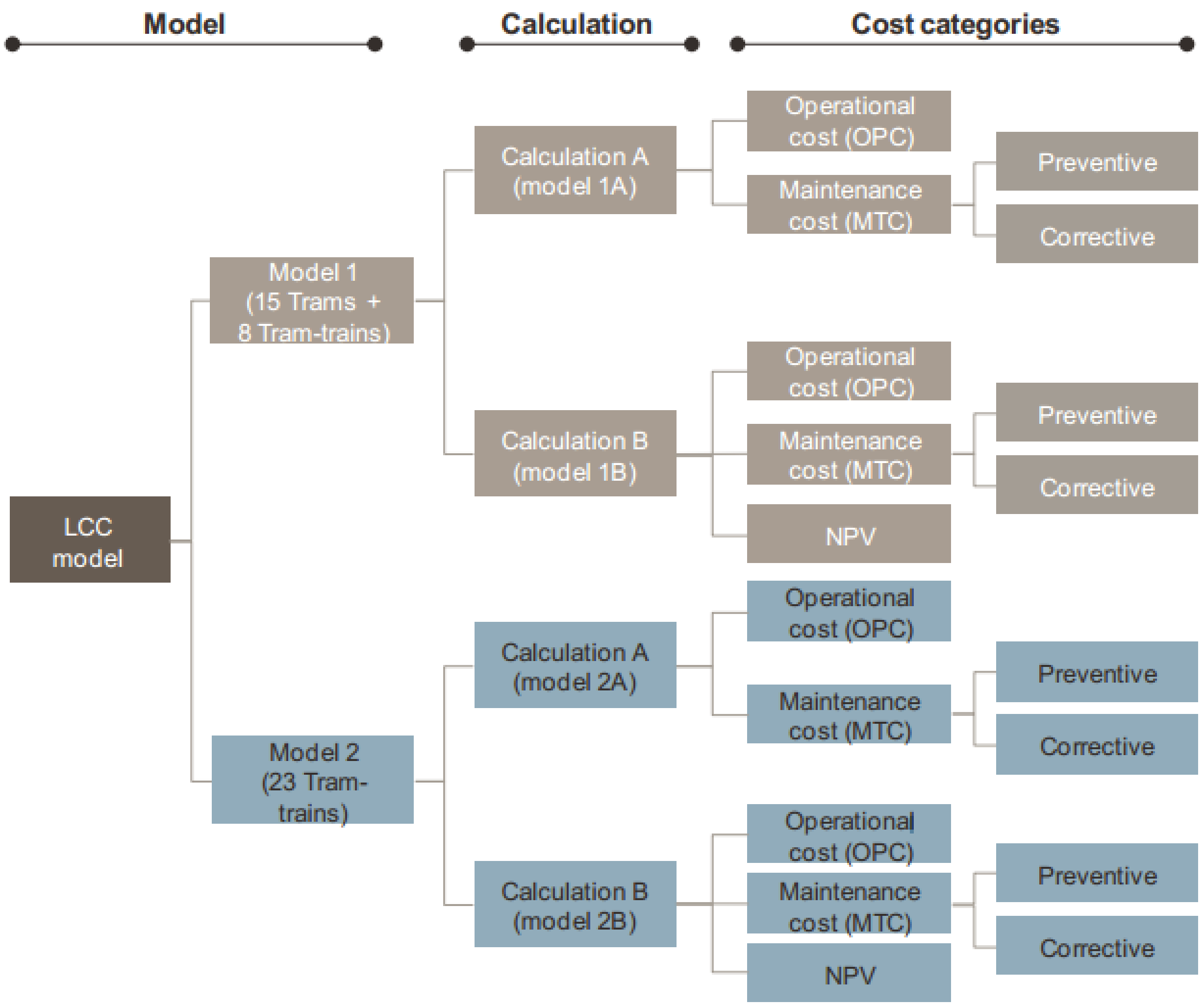
Introduction to Aarhus Light Rail Transit

Letbanen

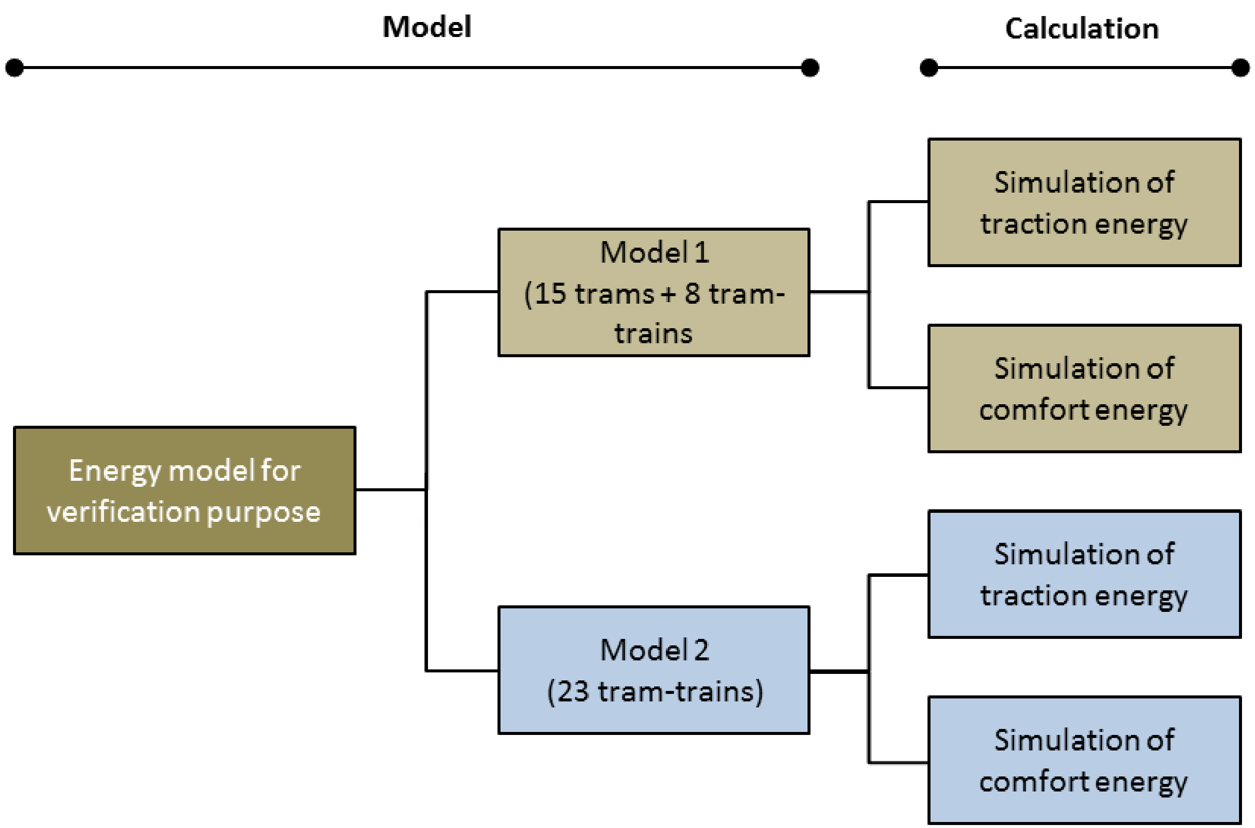


- Electric Tram-Train Service to replace existing local train service 70 km North and 27 km South of the city
- New Inner-city Electric Tram Service to be set up.
- Size of Order 15 Trams and 8 Tram Trains (option 1) or 23 Tram Trains (option 2)
- Service is due to commence early 2017 when Aarhus will be the Cultural Capitol of Europe
- Selection and negotiation process is sill ongoing (June 2014)

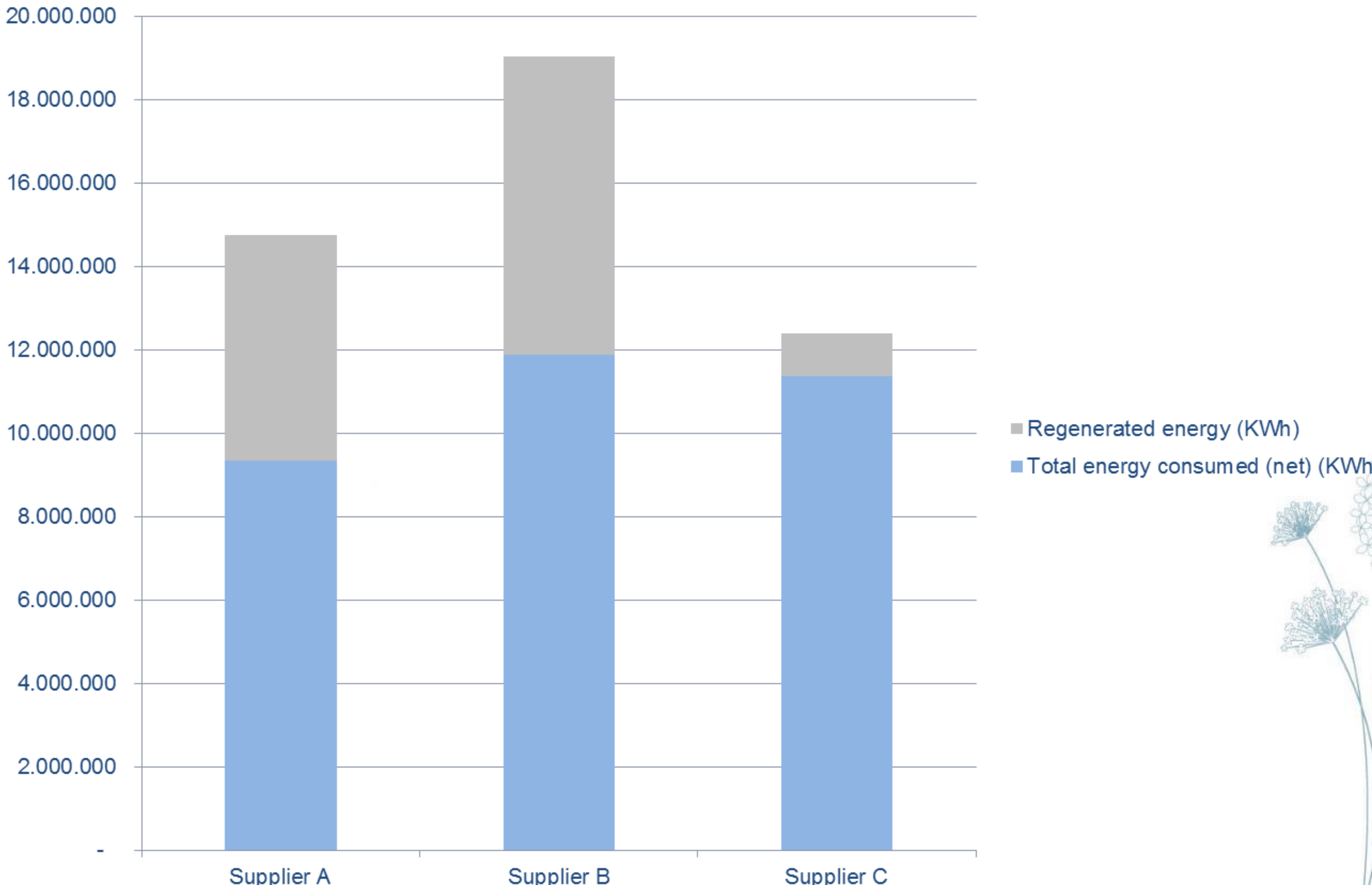
Energy efficiency as part of LCC



Scope of the energy model



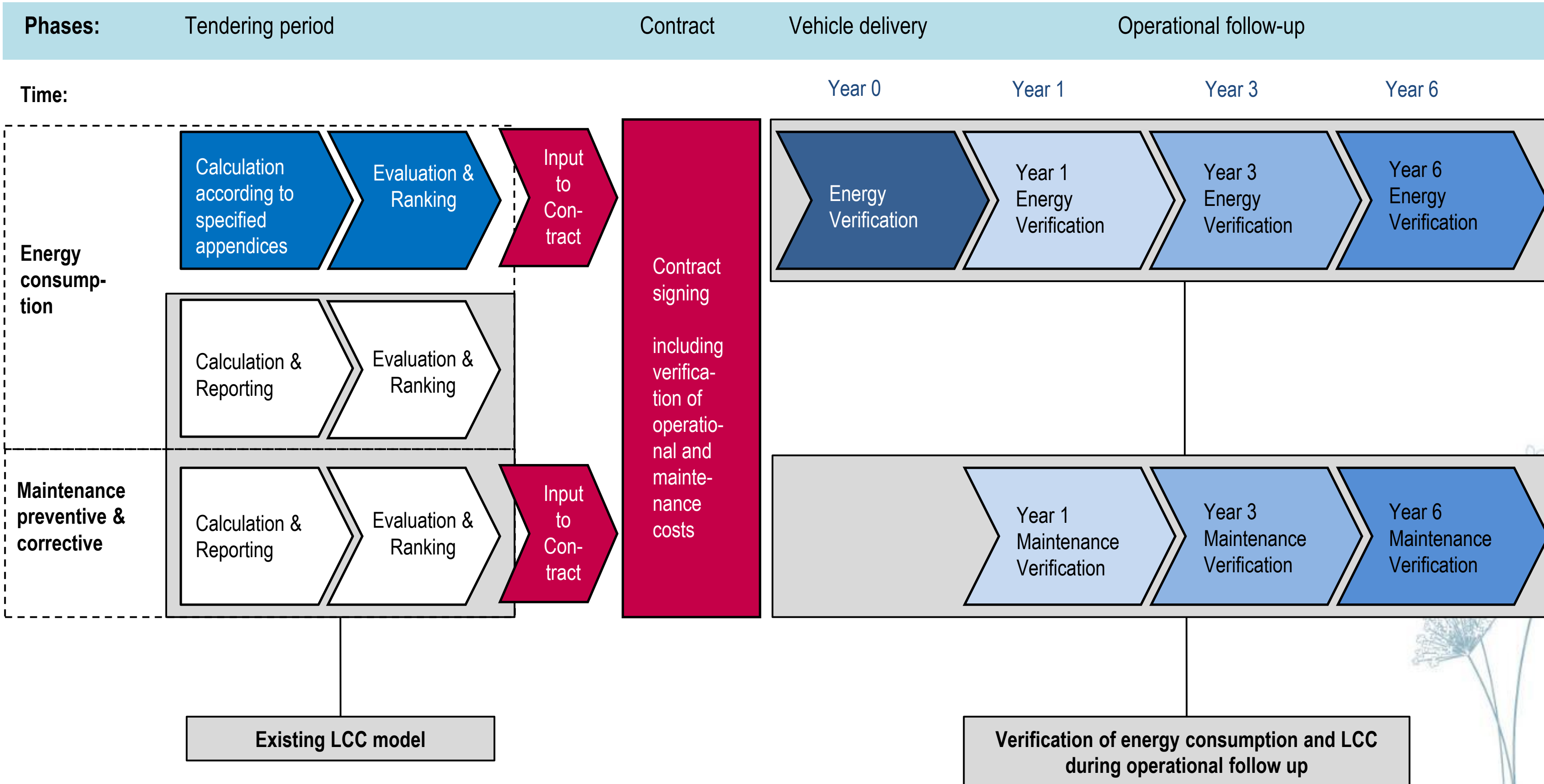
Comparison of energy consumption – First round



Lessons learned from first round of ITT evaluation

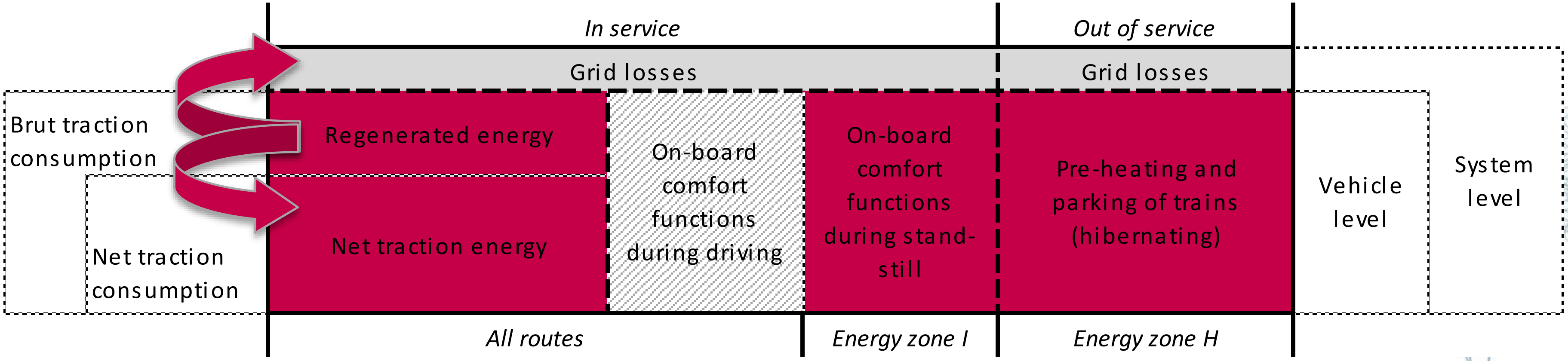
1. The definitions for calculating energy consumption were not sufficiently clear:
    - Regenerated energy
    - Ambient conditions for on board comfort functions (in and out of service)
2. The suppliers were not willing to guarantee their calculated energy consumption as part of the main contract
3. The evaluation framework had to be revised for the second round to obtain a successful application of TecRec 100_001

Revised tender evaluation and verification procedure

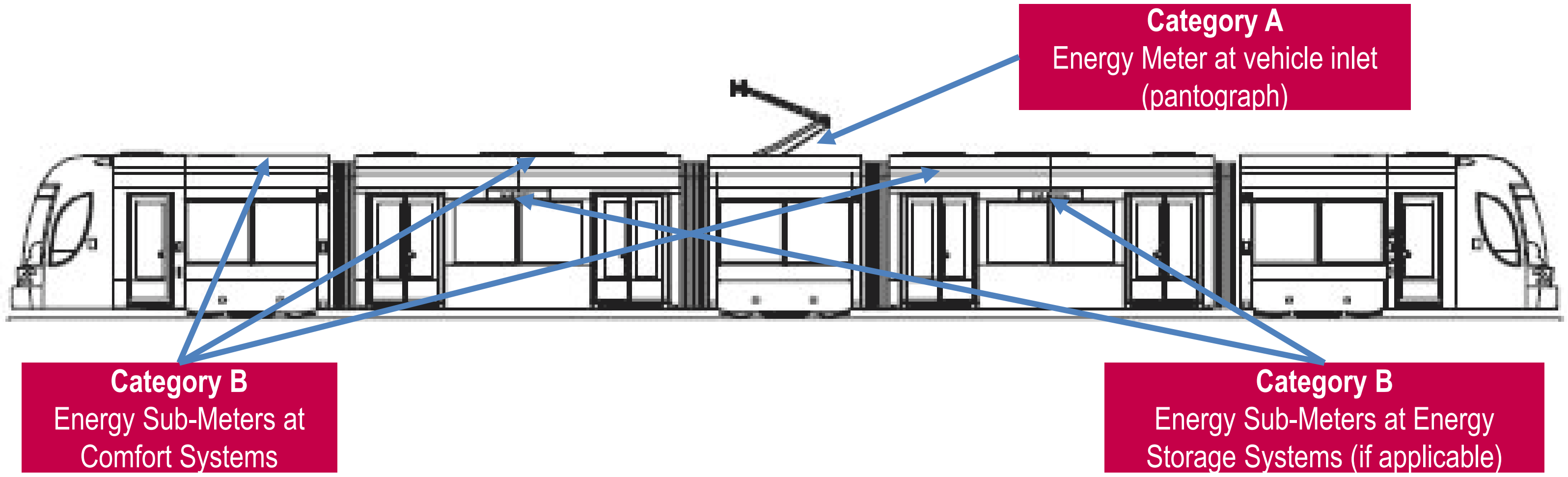


Model assumptions (I)

- The UIC/UNIFE TecRec 100_001 is the basis for application in Aarhus LRT. Relevant input data from Appendix D is used. Traction and comfort energy is however separated.
- Definition of energy consumption structure in the Aarhus LRT System:



Model Assumptions (II)



- For verification purposes the regenerated energy at vehicle level is split into two categories:
  - Category A: Regenerated energy returned from the vehicle to the OCS. This energy is measured at the inlet to the vehicle at the pantograph.
  - Category B: Regenerated energy used on board the same vehicle. This energy is measured through sub-meters at the comfort systems and energy storage systems on board to separate these from the traction and auxiliaries system.
- In cases where the OCS is not receptive to the regenerated energy returned by the vehicle, this energy will normally dissipate as heating in resistors on the vehicle's roof. In these cases the regenerated energy shall be added to (included in) the net energy consumption measured in the actual vehicle.

Example of application:
In service mode parked trains (energy zone i)

Purpose

- The purpose of this test is to simulate and later verify through measurements the “in service” comfort functions excluding passengers equal to the energy zone I (parked train service mode) as outlined in appendix B for the LCC calculations.

Specific assumptions

- The vehicle has to be in a thermally stable condition.
- Service temperature is 22°C according to Appendix D
- HVAC, lighting and passenger information systems are all up and running at normal operational conditions.
- Simulation or calculation of energy consumption for one full hour for one vehicle

Simulation values to be reported

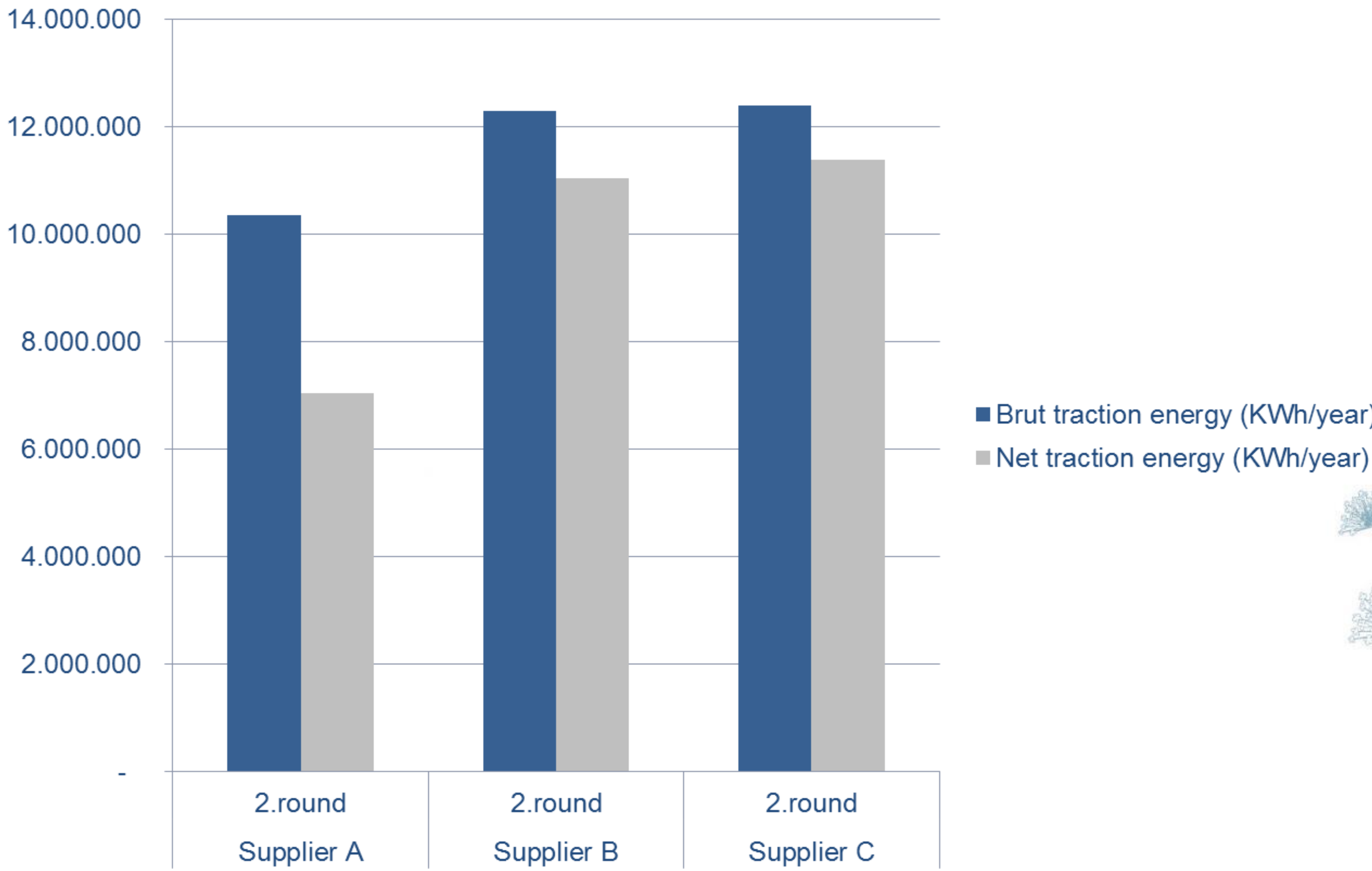
- The contractor shall produce energy consumption calculations corresponding to one full hour of “in service” comfort energy consumption for one vehicle for the temperature interval ranging from -20°C to +20°C in maximum steps of 1°C with the purpose of producing a temperature table that will be used as basis for subsequent verification.
  - For model 1 (double fleet): Table 8 (for Trams and Tram-Trains)
  - For model 2 (single fleet): Table 8 (for Tram-Trains only)

Example of application: Data input template

On board comfort energy consumption

Table 8: In service mode parked trains - energy zone I Consumed gross energy at vehicle level per vehicle for one hour	**Temperature** ° Celsius	**Tram** Energy consumption KWh/h	**Tram-Train** Energy consumption KWh/h
	-20		
	-19		
	-18		
	-17		
	-16		
	-15		
	-14		
	-13		
	-12		
	-11		
	-10		
	-9		
	-8		
	-7		
	-6		
	-5		
	-4		
	-3		
	-2		
	-1		
	0		

Comparison of energy consumption – Round 2



Lessons learned from second round of ITT evaluation

1. Much better consistency between the different offers
2. The suppliers were now willing to guarantee their calculated energy consumption as part of the main contract
3. More energy efficient solutions were proposed in the second round

Lessons learned from applying the TecRec 100_001 at Aarhus LRT

Letbanen

1. TecRec 100_001 is a good basis and reference document to demonstrate the main principles for evaluation of energy efficiency - BUT use it mainly as guideline
2. Be prepared for resistance to use it – on both sides of the table
3. Due to the learning process it was beneficial to be able to adjust the requirements between the first and second round of tender (submission and) evaluation
4. A close dialogue between each manufacturer and the operator – already in the tendering phase – is needed in order to avoid misunderstandings

Possible next steps for the TecRec 100_001 (TS 50591)

1. Enlarge the scope of the TecRec to cover also light rail and metro applications
2. Sharing of various application examples (specifications and data formats)
3. Sharing of (anonymous) reference values for the different service types
4. Register of procurement projects and contact persons where the TecRec has been applied
5. Continue the UIC/UNIFE workshops for exchange of experience

CUBRIS

Thank you for your attention

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Energy consumption – experience from the NSB Flirt project

UIC Energy Efficiency Days 17-19 of June in Antwerpen

Terje Ekrann/NSB

Background

- In 2008 NSB signed a contract with Stadler AG for the delivery of 50 EMU train sets, each with 5 coaches. First train set was delivered in 2012. The contract includes an option of 100 more trains.
- Two very important issues reflected in the technical specification was Reliability and LCC.
- As part of the LCC requirements, the Energy Consumption is of great importance.
- The Contract included a detailed requirement for the yearly Energy Consumption for the fleet og 50 EMU's

Background - continued

The contract included the following requirements/features important for the Energy Consumption:

- The train should have a heat recovery system (exhaust air is used to preheat or precool the fresh air before this is mixed to the return air of the coach).
- Heat pump function should be installed in all coaches (but not in the driver's cab).

Contract specification/verification

- The total Energy Consumption should be verified for a yearly mileage of 250 000 km per train.
- 4 different line sections were defined, with section lengths between 75 and 192 km. A multiple of these sections were defined, which in total should add up to 250 000 km.
- Energy Consumption due to HVAC in passenger compartment and Energy Consumption during parking is verified by calculations based partly on results from earlier tests in the climatic chamber in Vienna, where the k-value was determined – according to EN13129/EN14750.

Contract specification/verification – continued

Verification of Energy Consumption consists of:

1) Energy Consumption in driving operation (measured with HVAC in drivers cab on, but HVAC in passenger compartments switched off).

2) Energy Consumption due to HVAC during operation – Calculated. Verified for a defined number of hours with different outside temperatures (-15ºC, 0ºC, +15ºC and +25ºC). Set inside temperature 22ºC.

3) Energy Consumption during parking mode, that is HVAC consumption and consumption due to train control and losses. Inside temperature 15ºC to 26ºC.

Requirements

- Maximum allowed yearly Energy Consumption per train (250 000 km) was specified to: **1 841 628 kWh**.
- This original requirement was based on a maximum speed of 160 km/h. The 200 km/h option were chosen, and the requirement was adjusted accordingly to: **2 020 475** kWh. This is based on a calculated increase in Energy Consumption of approx 12 % during operation (exclusive HVAC in passenger compartments) **but still verified with a maximum driving speed of 160 km/h**.
- The total increase in Energy Consumption due to modifications for 200 km/h is calculated to 10 %.

Requirements - continued

- The increase is due to:

  - increased train weight

  - different gear ratio

  - different operation points of traction equipment

  - different driving dynamics (decreased tractive and braking effort)

- In the contract the total cost was calculated using an Energy Cost of approx 0,05Є/kWh. The total (minimum) Energy Cost is hence approx 100 000 Є/trainset and year (based on a maximum speed of 160 km/h).

Optimisations

- Pretests showed that the Energy Consumption would not fulfil the contractual requirements. A number of technical adjustments were implemented:
  - A number of aerodynamic adjustments
  - Remagnetisation and turning off the traction motors during costing
  - Improved traction motor control
  - ECO-driving mode introduced (automatic mode).

Verification adjustments

- The verifications tests (Energy Consumption during operation) was specified to be carried out with a payload equivalent to 50 % of the seats occupied. The tests were however carried out with an empty train, and the effect of payload was calculated.

Problem areas/Challenges

- How to drive during verification of the Energy Consumption in operation?
  - The normal travel time between different stations have a certain “reserve” compared to the timetable required time. Is it allowed to drive extremely “smooth” to take advantage of this “time reserve”?
  - There will usually be sections were it is temporary speed limits or the line speed for some reason is not reached. How to calculate the effect of this?
  - Energy Consumption driving through long tunnels depends on the roughness of the tunnel walls/roof (aerodynamic effects). How to take this into consideration?

Problem areas/Challenges – continued 1

- Verification with or without active cleaning brakes?
- The real length of the test sections are often not exactly as foreseen in the contract. The total test length (including the necessary multiplication factors) does not add up to the agreed yearly mileage. How to handle this?
- Is it allowed to take into consideration a theoretical optimisation of the drivers behaviour during driving?

Problem areas/Challenges – continued 2

- Most modern trains have energy counters. It may be a small difference between the measured energy through this counter and the measured Energy Consumption at the pantograph during the verification tests. Which values are to be used in the verification?

Results

The total Energy Consumption was verified to fulfil the contractual requirements:

- Energy Consumption consist of approx:
  - Driving operation: 81 %
  - HVAC during driving: 14 %
  - Parking (HVAC, train control and losses: 5 %
- Energy Consumption approx 6 to 7 kWh/km (depending on the line)
- The recovery (feeding back to the catenary) was "100%" (manual mode to avoid pneumatic braking), and recovery was approx 50% of the drawn energy.

Cost reflection

The importance of making strict requirements for the Energy Consumption and the verification process can be visualised in the following way:

The total Energy Cost for the original NSB fleet of 50 Flirt trains is approx 125 million Є over 25 years. An Energy Consumption 10 % above the target will have a quite substantial effect on the costs of operating the trains – 12,5 million Є over 25 years.

Technical Data

• Maximum speed:	200 km/h
• Weight empty:	220 tons
• Weight 50 % seated:	231 tons
• Maximum weight /suburban version):	270 tons
• Length:	105,5 m
• Width:	3200 mm
• Height:	4,38 m
• Wheel diameter:	920 mm
• Energy System:	15 kV/16 2/3 Hz
• Maximum traction force:	240 kN
• Number of traction “packages”:	3

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ANTWERPEN, 16 - 19 JUNE

ENERGY EFFICIENCY AND PROCUREMENT –

SBB EXPERIENCE WITH APPLICATION OF TECREC 100_001

Energy Efficiency, the best fuel to move our trains!

Energiemanagement Ueli Kramer

AGENDA

- Introduction
- Actual projects
- Example
- Experience
- Future / What's next?

Actual Application Example

Regional Traffic Double Deck Trains

IN-SERVICE OPERATION MODE

- Testconditions / Definition
  - Track (Brugg-Winterthur-Brugg) and Timetable
  - Driving style and Pay-load
  - Environmental conditon (16kV, 15°C, dry, …)
  - Recuperation: always possible
  - Heating and Ariconditioning : OFF ; Lighting: ON
  - Toiletsystem: OFF
  - Etc.

OUT OF SERVICE MODE

- Testconditions
  - Train in parking-mode for 6 hours
  - Heating and Airconditioning System: OFF
  - Compressed Air Supply: ON
  - No Door and no Toilet Operation
  - Environmental condition (16kV, 15°C, dry, …)

TOILET SYSTEM

- Testconditions
  - Predefined flushing interval
  - Compressing Air System: partially OFF
  - Local consumption measurement at supplying systems

HEATING AND AIRCONDITIONING SYSTEM

- Testconditions
  - Special equipped Train for measurement
  - Testing while in normal operation
  - Test period has been extended to one year

Effects due to Energy-Efficent Procurement

- **Light weight**: only 296 t for a 6 car EMU
- **Increased brake power** and **priority** in using the **regenerative brakes**
- **haptic feedback**
- **Optimized control of the converters** to reduce losses in the traction motors
- **Separate traction motors** to optimize control
- Effective and consequent optimization of the **stand-by-modus**
- Passenger dependent Airconditioning
- Etc…

EXPERIENCES AND LESSONS LEARNT

- In-service operation mode
  - Difficult to integrate into daily traffic system
  - Driving style of Driver
  - Testprocedure vs. Train-Specification
- Heating and Aircon.System
  - Ambient conditions

EXPERIENCE AND LESSENS LEARNT

- Accuracy of measurement equipment
- Clear definition of application
- It needs a good cooperation between manufacturer and purchaser
- Tendency towards overspecification

WHAT'S NEXT ?
PRESENT AND FUTURE

Evaluation of additional energy savings due to application of TecRec at Regio Double Deck Trains

→ what is additional to the state of the art in modern vehicles?

What's next ?
Present and Future

- Twindexx Swiss Express and FV-Dosto

Present and Future Application

- Phase_1: Manufacturer hands in simulated energy consumption values for
  - In-service operation mode
  - Out of service mode
  - Toilet System
  - Heating and Airconditioning System
- Phase_2: Verification after first delivery (Prototype)
  - Definition of verification scenario
  - Measurement in cooperation Manufacturer and SBB within first year
- Phase_3: optional after first verification
  - If some values can not be reached the system has to be improved and again verified
  - Improvements have to be realized within 6 months
  - Penalties in function of the additional power consumption

TO CONCLUDE…

- Is it a precise and repeatable enough method to select fairly a train manufacturer?
  - → YES: It's a clear way to decide and communicate the decision
  - → The actual projects/procurements showed that the LCC costs are a good and strong argument to decide
- Does it need special tools for measurements and simulation?
  - → NO: SBB had just to support the verification
  - → YES but: the Manufacturers are developing simulation tools to **improve** their system! This is beneficial for EMU **and** manufacturer
- Does it really save money?
  - → YES(!): the energy-costs have been calculated and this was the base for the decision while evaluating the offers
  - → YES: clear definitions and a clear process does simplify the procurement procedure

JUST USE IT AND IMPROVE IT!!!