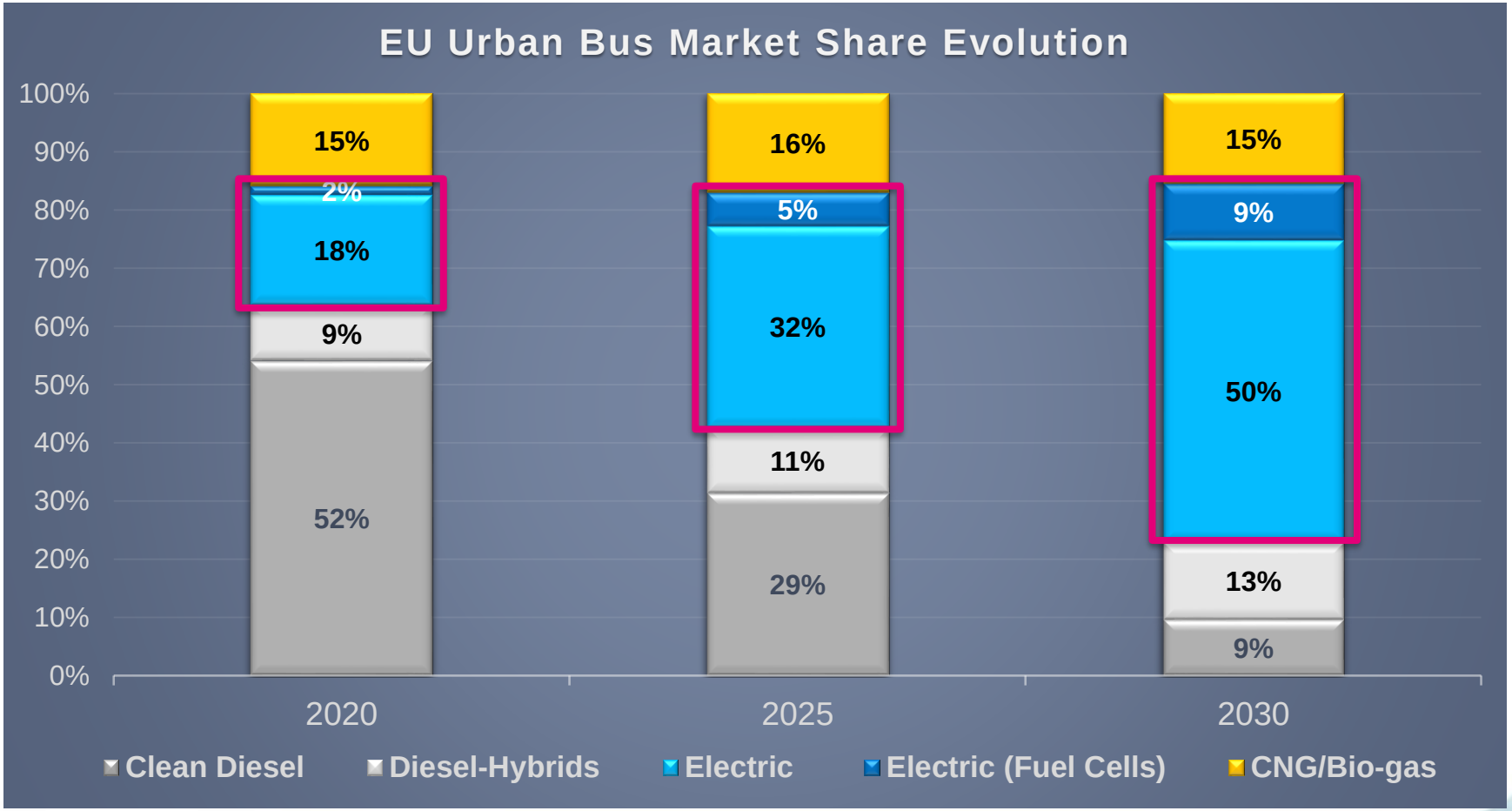
5. Fachkonferenz Elektromobilität vor Ort
Leipzig, February 27th 2018

Making electric buses a reality

Dr. Michael Faltenbacher, thinkstep AG

Urban bus: market share projections by propulsion technology in Europe



Source: ZeEUS/UITP(VEI) - 2017

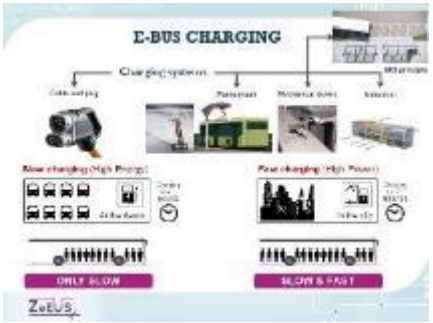
5 challenges to address for eBus deployment in Europe

High upfront cost

New challenging operations

UITP tender structure document

New ways to procure:
- Vehicles & Equipments
- Operation services



Standardisation / Interoperability

Reinforcing cooperation energy/bus

High Upfront cost

E-bus = 2 x the price of a conventional bus

- battery=45% cost
- Lifetime is a key (battery, body)
- Disposal of batteries

Charging infrastructure cost and deployment

- Fast charging infrastructure
- Or…More buses (spare)

Local Depreciation rules

Very local TCO models

- Different maintenance cost

Procurement & contracts

New technology risk: prevention and management

Functions sharing between stakeholders

- Project governance including ALL actors
  - PTA, PTO, Industry, Grid Owner, Electricity Supplier, etc.
- clear definition of roles & responsibilities:
  - Who pays? Who owns rolling stock/infra?

Tender of a system (not only a vehicle)

- Modelling the tender evaluation criteria
- UITP Tender Structure document can be a basis

Service/operation provider contract length & extensions

- Equipment ownership: what happens at the end of a contract?
- Think about decommissioning of harmful components

Positive externalities

- Emissions linked to air quality
- Noise

Interoperability

Standardisation of charging infrastructure is key

- Different implementations of the charging philosophy

Slow charging / overnight

- CCS easy to be adopted
- Plug or same than opportunity

Fast charging / opportunity

- Many charging solutions
- Industry joint effort & agreements

Use Cases for standardisation –
www.zeeus.eu

Energy sector: building trust & cooperation

Different market / service models in cities

Joint collaboration x optimal location of charging points

- Reduction of cabling
- Quality of the electricity distribution network

Electricity cost

- Urban vs industrial areas

Exploring opportunities

- Smart charging
- Use of PT power network (trams, metro)

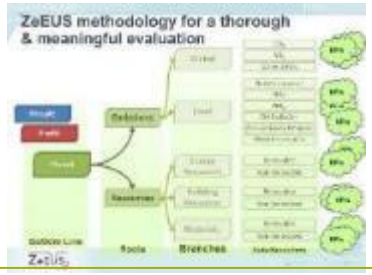
ZeEUS: a project to support electric bus deployment (2013-2018)

40 Consortium Partners
20 User Group Members
50 Observatory Members
Coordinator: UITP

European Commission
Mobility & Transport

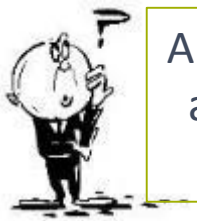
22,5 million€
EU funding: 13,5 million €

10 demo cities
~70 electric buses
90 observed cities
800 eBuses



1 evaluation methodology

If?
When?
What?
How?



A set of tools and guidelines to accompany bus stakeholders in ebus deployment

ZeEUS Demo Cities (10 cities,70 eBuses)

LONDON
3 plug-in hybrid (induction)
Double deck
Alexander Dennis

PARIS
10+ full electric
BOLLORE 12m

BARCELONA
2 full electric
IRIZAR 12 m
2 full electric
Solaris 18m

CAGLIARI
12 m Battery Trolleys
4 VOSSLOH /VAN HOOL
2 SOLARIS

EINDHOVEN
43 full electric
(opportunity)
VDL 18m

STOCKHOLM
8 plug-in hybrid
VOLVO 12m

BONN
6 full electric
BOZANKAYA 12m

WARSAW
10 full electric
SOLARIS 12m

PLZEN
2 full electric
SKODA 12m

MÜNSTER
5 full electric
VDL 12m

Ebus deployment

IF – Know & Decide

- Develop clean-buses deployment strategy
- Exchange of experiences
- Define own operation needs

The **Bonn** vision to 2030: the complete conversion from diesel to ebuses

- Market exploration
- Feasibility study
- Fields tests
- Technical specifications
- Charging concept
- Operational concept

SWB Bus und Bahn

→ **Complete Conversion of all conventional diesel buses to full electric propulsion until 2030 by decision of the Executive Board**

ZeEUS eBus Report

An overview of electric buses in Europe

Zero Emission Urban Bus Systems – second edition

- BEV, PHEV & Battery Trolleys
- 90 cities, 800 vehicles
- 32 bus manufacturers
- 8 electric charging solutions providers

www.zeeus.eu

Second Edition
October 2017
UITP Bus Conference

UITP ADVANCING PUBLIC TRANSPORT

ZeEUS Zero Emission Urban Bus Systems

Operational needs

- **Service Design according to today's reliability of the technology**
  - Trade-off = flexibility vs autonomy
- **ebus performance = conventional bus performance?**
  - **A good analysis of the operational needs is key**
  - Define the right type of eBus solution for the operational needs
  - Influence of driving style
  - Influence of on-board auxiliaries

A chosen technology performs well **if** put in its "***best operational conditions***"

Source: EBSF Project (DG-R&I)
Study by VDV and *Prof. Dr. Ralph Pütz (Landshut University)*

Ebus deployment

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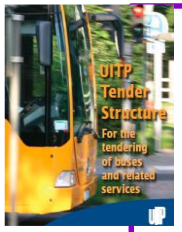
WHEN – Plan & Regulate

- System approach
- Urban policies
- Funding & Financing
- Project governance



WHAT – Select & Procure

- Standardised/ interoperable solutions
- Procurement process principles
- Indicators for procurement evaluation
- Relationship with energy providers

WHEN: Plan, Regulate, Finance

- Ensuring **support** from competent Authorities
  - *Ask for **Urban policies** to get maximum advantage by using Clean (electric) Buses in the city*
  - *Possible use of **PT power network** for charging eBuses*
- Analyse the different **legislation** impacting eBuses
  - *Ex. emissions regulations…*
- Most suitable **funding & financing schemes**
- Embrace **system approach**
- Set up **project governance**
  - *Optimise the relation between PT, Energy and ITS in cities, with mutual convenience*
  - *Possible contribution of eBuses to smart-grid*
  - *Define best contractual conditions for energy provision*

Don’t rush, it is all about planning

WHAT: Specify, Procure, Deploy

- Define **risk sharing** schemes between Municipalities, Authorities and Operators according to their role
- Open table with industry, procuring entity, regulators and financing actors – **Develop partnerships**
- Stimulate and support procuring entities to **adapt tender process** to eBuses peculiarities
  - *Develop the culture of "**system**" procurement (like*
  - *Specs, Indicators, Evaluation Methodology*
  - ***UITP Tender Structure** document*
  - ***E-SORT:** reproducible test cycles for on-road tests of buses (consumption oriented)*
- Facilitate **infrastructure deployment** processes for
  - *Building permits, depot upgrade, energy cable connections, roadworks...*

Expect the unexpected!

Being prepared …

Gaspipe – not shown on any city map!

The pantograph pole has to be entirely redesigned to respect the snow clearance regulations

IT communication test!

EMC test

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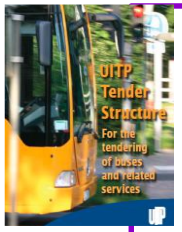

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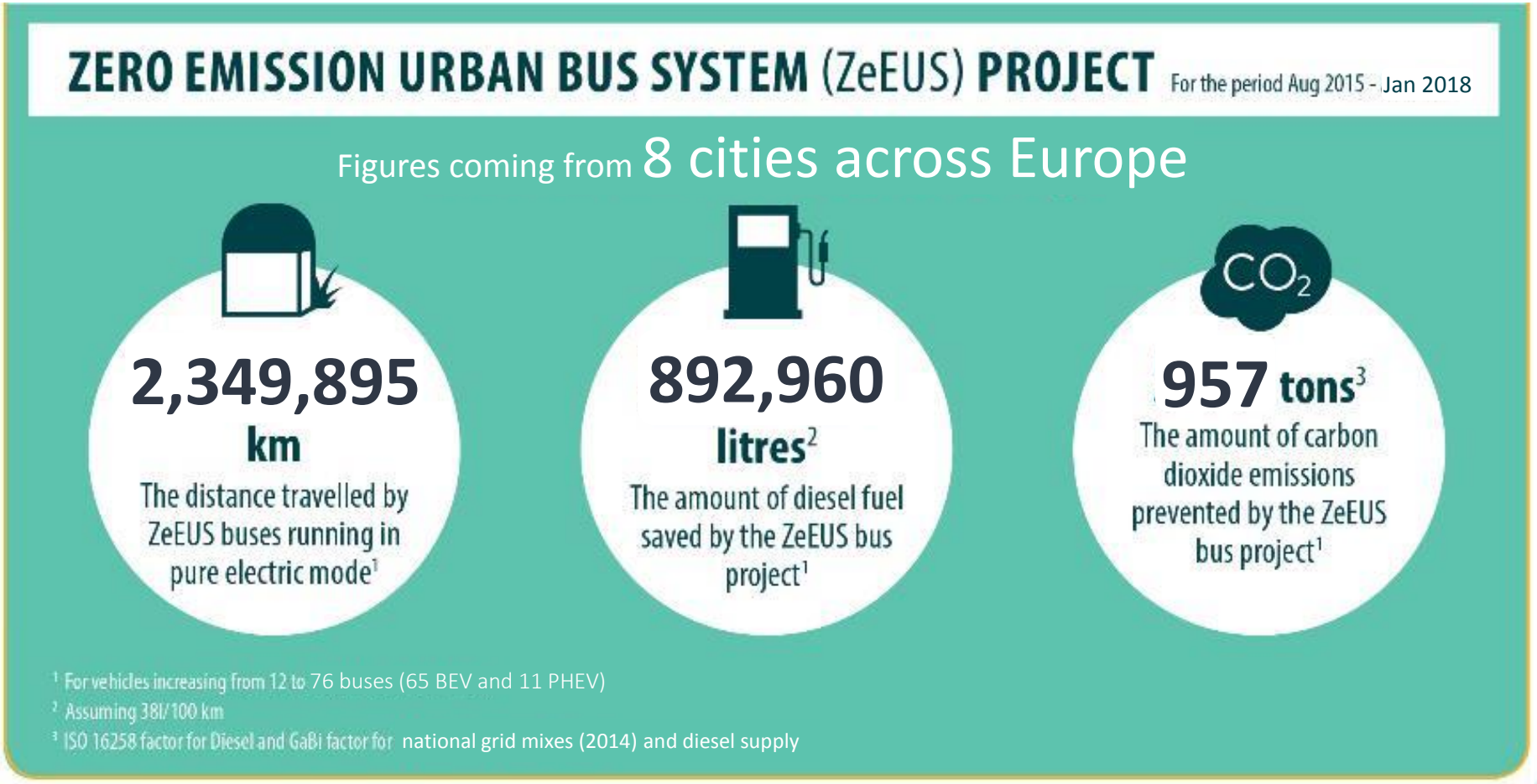
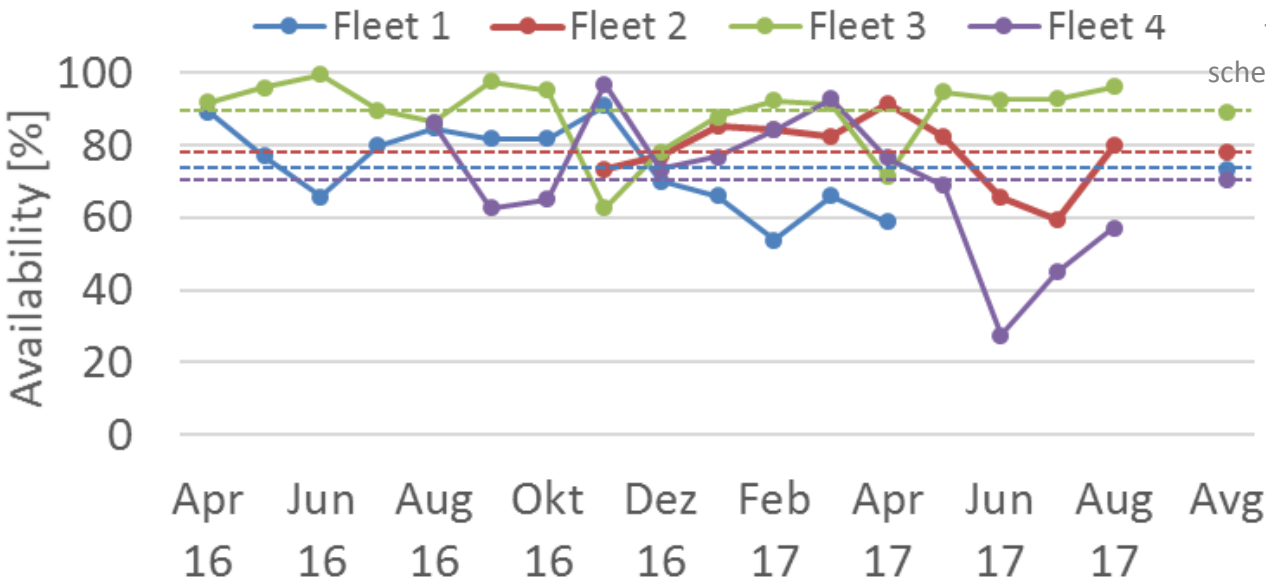
HOW – Operate & Maintain

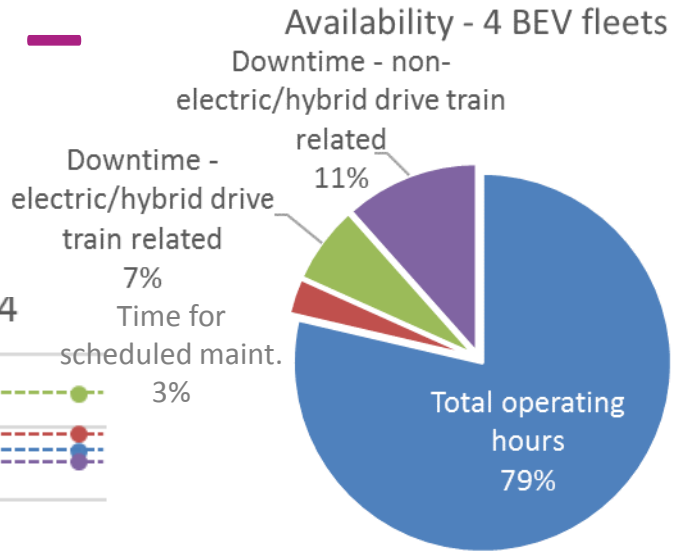
- Training (new competencies, processes)
- Operations (including charging operations)
- Maintenance (new garage settings)
- Decommissioning (battery after-life)

ZeEUS eBus Performances



ZeEUS eBus Performance – Vehicle availability





Definition of availability:

$$\frac{\sum operating\ hours}{\sum op.hours + hours\ sched.\ maint. + hours\ broken\ down}$$

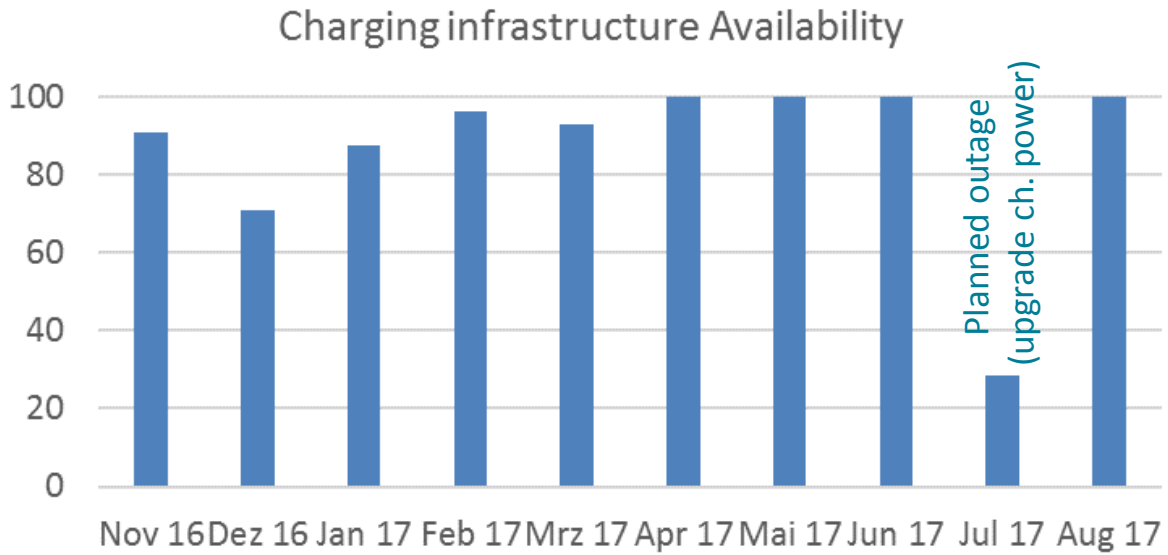
- Av. vehicle availability 4 fleets ~79% (70 – 89 %, 2-4 buses per fleet)
- Share of downtime for non-electric drive train related is lower

→ Battery electric busses are a maturing technology

→ Plan for higher vehicle reserve at the beginning

ZeEUS eBus Performance – Infrastructure availability

- E-bus based public transport is a system (vehicle + charging infrastructure)



Definition of availability:

$$\frac{\sum operating\ hours}{\sum \begin{matrix} op.hours + hours\ sched. \\ maint. + hours\ broken\ down \end{matrix}}$$

- Example Fleet 2: Average infrastructure availability of 87% with positive trend (Jul 17 was a planned upgrade)

HOW – Operate & Maintain

- **New skills** for workers (drivers and maintenance): **training**
- Changes in the **Bus Depot**
  - *Design, operations, cleaning, safety aspects…*
- Optimised **operation design** and **integration in bus network**
  - *Improvement of driving style*
  - *Keep service performance while reducing infrastructure*
- Coordination with **other services**: firefighters, police…
- Optimisation of **charging operation** at bus depot & opportunity chargers (operation vs costs)
  - *Smart charging*
  - *Optimisation of auxiliaries' energy consumption*
- Facilitate **update** technology & standard
- **Evaluate** operations and measure staff and passengers' satisfaction
- **Decommissioning** of buses, recycling batteries

"If you compare the noise level with that of other buses, it's an enormous difference". Kristina Book, driver on route 55.

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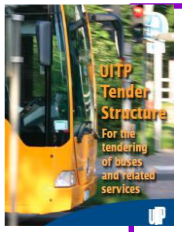
Joint Effort of Institutions Stakeholders Cities



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CONCLUSION:
Is electrification a Revolution?

Electrification already produced a revolution in public transport

From horse-powered to electric trams

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