3IBS, THE INTELLIGENT, INNOVATIVE, INTEGRATED BUS SYSTEM

Michele Tozzi – 3iBS Project Manager - UITP
CONTENTS

- Project Overview
  Scope
  Logical Approach
- Future trends in BS
- Energy sustainability
  Eco-driving
  Advanced gearboxes
  Hybrid propulsion
  Network design
3iBS

• A step forward in the EU funded research to raise the image of urban bus systems

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≈ 50 companies collaborate to reach this goal
Logical approach

Accessibility
Bus Service during Special Events
Level of Service
Intermodality
Internal and External Modularity
Energy Sustainability
IT standards for BS

Recommendations for implementation of BS solutions
Innovative BS Roadmap

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Study Cases

- ≈ 30 SC + experiences from EU Projects

- AENEAS
- CIVITAS
- MEDIATE
- NICHE $+$
- STADIUM
- ...

Europe

- Beijing
- Shanghai
- New Delhi
- Melbourne
- Cape Town
- Curitiba

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• **Fuel & energy:** current fleet

**Survey on EU Bus Systems**
- ≈70,000 buses
- ≈63 bus fleets
- 24 countries

**Respondents distribution according to future plans to change propulsion system ratio**

- Diesel
- Biodiesel
- CNG
- Biogas
- Electricity
- Other
• Fuel & energy: future fleet

Respondents distribution according to future plans to change propulsion system ratio

- Stay with diesel: 34.0%
- More biodiesel: 18.9%
- More CNG: 28.3%
- More biogas: 13.2%
- More electric: 41.5%
- Other: 15.1%
- More hybrids: 69.7%
- More plug in hybrids: 33.3%
- More fully electric trolleys: 15.2%
- More fully electric with batteries: 45.5%
- Fuel Cell: 3.0%
ENERGY SUSTAINABILITY IN THE URBAN BUS NETWORK

Mario Canet Sabate – TMB
Objective

• Overview on different measures for increasing the energy efficiency of urban buses

Analysis of study cases on intelligent gearboxes, eco-driving and hybrid propulsion systems

New methodology for measuring energy consumption of hybrid vehicles based on a new SORT test

Characterization in a real network
Eco-driving

• Tests in 2 cities in France and the Netherlands
  ▪ 6 buses equipped with an eco-driving system
  ▪ buses running under real operational conditions
  ▪ ≈ 390,000 km
  ▪ “before/after” data an analysis
  ▪ 16 to 26 months of data collection

  ▪ fuel consumption decreases between 8 and 13.5%
  ▪ tests on a larger fleet and over a longer period needed
  ▪ variations due to driving styles place the emphasis on the need to have drivers properly trained to “ecodrive”.

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Advanced gearbox

- Tests in Cagliari (Italy) - Replacement of 70% of the fleet with vehicles with advanced equipments
  - ZF EcoLife new-generation gearbox
  - 10 and 12 m buses
  - tests procedure based on the UITP’s SORT 2 cycle

- fuel economy improvement:
  - between 6 and 14% for 10m buses
  - between 8 and 18% for 12m buses
- More tests in France confirmed advanced gearboxes efficiently influences the fuel consumption of buses (-6.8%).
Increasing the number of gear changes, the gearbox and the software strategy reduces the fuel consumption.
**Fleet renewal and network re-design**

- Barcelona study case

Impact on energy consumption and emissions of actions impacting *fleet technology* and *network design*

<table>
<thead>
<tr>
<th>Scenario</th>
<th>FLEET</th>
<th>NETWORK</th>
<th>R/H</th>
<th>HYPHOTESYS</th>
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<td>Real</td>
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<tr>
<td>9</td>
<td>2017</td>
<td>Total Orthogonal</td>
<td>Real</td>
<td>new fleet/ network totally changed</td>
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</table>
Network re-design

- Orthogonal and diagonal routes
- Easier to use
- Faster
- More frequent
- More connected
- New hybrids
- **Retrofitting buses to hybrid** (70 diesel and 13 CNG)
- **Increasing CNG fleet** (forecast 2015: 500 buses)
- **CRT and NOx filters** (from Euro 2/3 to Euro 4/5)
Fleet evolution

- Retrofit experience

- Hybrid technologies saves 20% of fuel consumption in a low commercial speeds
28.2% of reductions: only due to fleet improvements.
7.2% of reduction: only due to network improvements
33.6% both affects together (fleet and network)
## Emissions

<table>
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<th>Emissions Reduction</th>
<th>NOx 2011</th>
<th>PM 2011</th>
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</thead>
<tbody>
<tr>
<td>FLEET (2011-2017)</td>
<td>65.3%</td>
<td>73.7%</td>
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<tr>
<td>NETWORK (2011-2011)</td>
<td>10.1%</td>
<td>8.8%</td>
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<tr>
<td>FLEET + NETWORK (2011-2017)</td>
<td>68.8%</td>
<td>75.6%</td>
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**NOx 2011**

**NOx 2017**
THANK YOU FOR YOUR ATTENTION

mcanet@tmb.cat
michele.tozzi@uiotp.org