VDV Akademie Konferenz Elektrobusse

The Future is NOW
Introduction

- A 100% private owned Dutch company
- Located at the High Tech Automotive Campus in Helmond The Netherlands
- First Electric bus manufacturer with full European type approval for a 12 meter 100% electric bus
- First official energy consumption test with TNO 2012
- ECW Award Ecology at Busworld
Why we do it

- Air Quality
- Noise
- Emissions
- Energy Security
Performance of Battery Electric Buses
Practice: Energy Consumption and Range
November 2012

<table>
<thead>
<tr>
<th>Vehicle specific information</th>
<th>SORT 1</th>
<th>SORT 2</th>
<th>SORT 3</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td></td>
<td></td>
<td>Ebusco</td>
<td></td>
</tr>
<tr>
<td>Model name</td>
<td></td>
<td></td>
<td>YTP1</td>
<td></td>
</tr>
<tr>
<td>Dutch licence plate number</td>
<td></td>
<td></td>
<td>69-BBD-3</td>
<td></td>
</tr>
<tr>
<td>Empty vehicle weight</td>
<td></td>
<td></td>
<td>11800</td>
<td>kg</td>
</tr>
<tr>
<td>Lump load</td>
<td></td>
<td></td>
<td>2610</td>
<td>kg</td>
</tr>
<tr>
<td>Total vehicle weight</td>
<td></td>
<td></td>
<td>14410</td>
<td>kg</td>
</tr>
</tbody>
</table>

| Energy consumption test                |        |        |        |      |
| Travelled distance                     | 5395,4 | 8386,2 | 11181,6 | m   |
| Energy charged after test              | 6,21   | 9,57   | 12,87   | kWh |
| Energy consumption                     | **1,15** | **1,14** | **1,15** | kWh/km |
Research Project

Table 4. Main battery energy use in different driving scenarios.

<table>
<thead>
<tr>
<th>Test case</th>
<th>Total (kWh)</th>
<th>Distance (km)</th>
<th>Time (s)</th>
<th>Average speed km/h</th>
<th>kWh/km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line 11 Espoo</td>
<td>9.214</td>
<td>9.007</td>
<td>1371</td>
<td>23.7</td>
<td>1.023</td>
</tr>
<tr>
<td>Braunschweig</td>
<td>15.962</td>
<td>10.504</td>
<td>1741</td>
<td>21.7</td>
<td>1.52</td>
</tr>
</tbody>
</table>

Figure 16. presents the influences to energy consumption in different payloads. It shows that the load influence was quite linear in these two different cycles.

Figure 16. Payload influence to energy consumption.
Daily Operation Maastricht - Veolia

EBUSCO 1.0

Date: May 14-15, 2013
Location: Maastricht Netherlands
Bus Line: 14
Operation Time: 7 AM ~ 5 PM
Operation Temperatures: 16°C
Average kWh/km: 0,93 (incl. charger loss)
Km/day: 204
Average speed km/h: 14,9
Operation Bremen - BSAG

EBUSCO 1.0

One week of operation in Bremen Germany for BSAG.
Daily Operation Helsinki

EBUSCO 1.0

Date: From Dec 4, 2013 and ongoing
Location: Helsinki (Espoo) Finland
Bus Line: 11
Operation Time: 7 AM ~ 9 PM
Operation Temperatures: -19°C ~ -4°C
Average kWh/km: 0.98 (incl. charger loss)
Km/day: 180
Average speed km/h: 18
Daily Operation Bonn

EBUSCO 2.0

Date: Oct 7~17, 2014
Location: Bonn Germany
Bus Line: 607
Operation Time: 6 AM ~ 9 PM (15 hours)
Operation Temperatures: 18°C
Average kWh/km: 1,15 (incl. charger loss)
Km/day: 235,4
Average speed km/h: 17,5
Daily Operation Jönköping Sweden

EBUSCO 2.0
Date: October, 2014
Location: Copenhagen Denmark
Bus Line: 14
Operation Time: 6 AM ~ 9.45 PM
Operation Temperatures: 0°C
Average kWh/km: 0.99 (incl. charger loss)
Km/day: 238
Average speed km/h: 14.9
Daily Operation Karlskrona Sweden

EBUSCO 2.0

Date: Nov 26, 2014
Location: Karlskrona Sweden
Bus Line: 1
Operation Time: 10.25 AM ~ 11.55 AM
Operation Temperatures: 2°C ~ 5°C
Average kWh/km: 1.06 (incl. charger loss)
Km/day: 229.4
Average speed km/h: 22.6
EBUSCO 2.0

Date: Dec 17, 2014
Location: Kalmar Sweden
Bus Line: 401
Operation Time: 8.42 AM ~ 12.57 PM
Operation Temperatures: 1°C
Average kWh/km: 0.93 (incl. charger loss)
Km/day: 99.9
Average speed km/h: 24
Daily Operation Jönköping Sweden

EBUSCO 2.0

Date: Jan 7, 2015
Location: Jönköping Sweden
Bus Line: 12/18
Operation Time: 6 AM ~ 9.45 PM
Operation Temperatures: 0°C
Average kWh/km: 0,99 (incl. charger loss)
Km/day: 224
Average speed km/h: 14,5
EBUSCO 2.0  12m 3-door City bus
Empty weight 311kW/h 12.150 kg

**Main dimensions**
- Maximum length 12,000 mm
- Maximum width 2,550 mm
- Maximum height 3,270 mm

**Battery**
- 310kW/h LFP (90%DOD)
- Energy density 160wH/kg (cell)

**Capacity**
- Seating capacity 41 (max)
- Standing room 55
- Wheelchair room (1)

TOTAL CAPACITY  90 passengers

**Performance**
- Range >300 km City conditions 14km/h average speed (excl. cooling/heating)
- Max speed >80 (70) km/h
- Max grade ability >16 % full load
- 0-30 km/h < 7 seconds
- 0-40 km/h <10 seconds

**Charging time**
- Approx. 3 hours (400 Volt 250 Amp)
- 1 hours Charging = 88 KM
Opportunity Charging

- Phantograph solution
- Weight saving for vehicle
- Space saving for vehicle
- High power transfer 200kW = 3.1km/min LFP
  
  500kW = 8.3 km/min LTO

- Price
Advantages of LTO batteries

- Ultra Fast charging (up to 8~10C)
- Long cycle life (approx. 20,000 cycles, @80% DOD)
- Wider operating temperature range (-40°C~60°C)
- Excellent consistency
- Calendar Life greater than +25 years
- Lower impedance and high specific power combined with higher 90 Wh/kg specific energy.
- Stable impedance and respectively power performance during entire cycle and calendar life
- Continuous operation at +65°C
- Continuous operation at -50°C
- Per min charging = 8 km range
Conversions  BredaMenarinibus e-Vivacity+

**eVivacity+ 8m. Full Electric Bus specifications**

**Main dimensions**
- Maximum length 8.000 mm
- Maximum width 2.350 mm
- Maximum height 3.270 mm

**Capacity**
- Seating capacity 11
- Standing room 49
- Wheelchair room 1

**TOTAL CAPACITY 61**

**Masses**
- Front Rear
- Kerb weight 9.300 kg 3.370 5930
- Gross vehicle weight 13.850 kg 5.700 8.150

**Performance of the ELECTRIC BUS**
- Capacity >180 km (Sort 1)
- max speed >80 km/h
- max grade ability >16 % full load
- Commercial speed 12-14 km/h (Sort 1)
- 0-30 km/h 1,1 m/s2
- Operation range -20/+70 °C
- Battery charger On site or/and on board
Questions?