The End of fossil Fuels
ÖBB-Personenverkehr AG

13.11.2019

Martin Prießnitz
Thomas Gerstenmayer
Contents

Alternative Propulsion
General aspects

Cityjet ECO
Pilot-Project of ÖBB-Personenverkehrs AG

Discussion
## Climate targets in Europe & Austria

Reduction of greenhouse gas emissions Development and share of transport and ÖBB

### Target 2020

<table>
<thead>
<tr>
<th>EU</th>
<th>-20 % greenhouse gas EU-weit (related to 1990)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT</td>
<td>-16 % GHG (related to 2005)</td>
</tr>
</tbody>
</table>

### Target 2030

<table>
<thead>
<tr>
<th>EU</th>
<th>-40 % greenhouse gas EU-weit (related to 1990)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT</td>
<td>-36 % GHG (related to 2005) #mission2030</td>
</tr>
</tbody>
</table>

### Ambition 2050

| EU | -80 bis 95 % greenhouse gas EU-weit (related to 1990) |

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**THG Emission in Mio. t.p.a.**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>79.6 Mio. t</td>
<td>23.7 Mio. t</td>
<td>Add. Increase CO2 Emissionen 2018+</td>
</tr>
<tr>
<td>2017</td>
<td>82.3 Mio. t (v. 2.7 Mio. t /+3.3%)</td>
<td>23.5 Mio. t</td>
<td>&gt;-7.2 Mio. t</td>
</tr>
</tbody>
</table>

**Mission 2030**

- **Traffic share (2017)**: 29%
- **Traffic total (2017)**: 23.7 Mio. t
- **Rail (2017)**: 0.21 Mio. t
- **Bus (2017)**: 0.16 Mio. t

**CO2 traffic Equivalents**: +0.37 Mio. t
The 6 elements of the ÖBB climate strategy

The climate is changing...
The ÖBB Climate Protection Strategy 2030 makes a significant contribution to achieving climate targets:
ÖBB climate protection strategy has 6 central levers

The ambition of the climate strategy, aligned with the government’s climate and energy strategy (#mission 2030) is:

- CO2-neutral ÖBB mobility sector by 2030
- Complete CO2 neutrality of ÖBB (incl. buildings) by 2050
- Modal shift through system attractiveness and innovative capacity expansion
- Substitution diesel vehicles
Electrification of ÖBB lines:
cornerstone of climate protection strategy

The use of alternative drives (H2, rechargeable battery) as a supplement to electrification is gaining in relevance.
Alternative drives: What is available on the market?

- Battery train
- Hydrogen train
- Electrification
Comparison of alternatives:
Total cost comparison of diesel routes in Austria

- D: Diesel
- DP: Diesel-Panthograf
- DPA: Diesel-Panto-Battery
- H2: Hydrogen
- AP: EMU with Battery
- ETW: Electrification
Total Lifetime CO₂-Emissions: Target 2030

- 100 % Grünstrom aus erneuerbaren Energieträgern
- 100 % Bio-Diesel
- H₂-Herstellung aus Elektrolyse

- Entsorgung (Anteil der Emissionen < 0,5 %)
- Betrieb
- Energiebereitstellung (inkl. Herstellung Energieinfrastruktur)
- Herstellung Triebfahrzeug

1 D
2 DP
3 DPA
4 H₂
5
6 AP
7 ETW
### Alternative use of vehicles / electrification:

#### Advantages / disadvantages

<table>
<thead>
<tr>
<th></th>
<th>Electrification</th>
<th>Battery Train</th>
<th>H₂ Train</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>advantages</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environment-friendly, Communication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low-cost operation (Energy / Maint.)</td>
<td></td>
<td>No need for line conversions</td>
<td></td>
</tr>
<tr>
<td>Energy-efficient operation</td>
<td></td>
<td></td>
<td>Range of vehicles</td>
</tr>
<tr>
<td><strong>Neutral</strong></td>
<td>Limited range</td>
<td></td>
<td>Adaptation of maintenance locations + equipment</td>
</tr>
<tr>
<td></td>
<td>Fleet standardisation</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>disadvantages</strong></td>
<td>High investment for electrification</td>
<td>Development of charging infrastructure</td>
<td>Development of tank infrastructure</td>
</tr>
<tr>
<td></td>
<td>Maintenance costs line</td>
<td>Power supply available</td>
<td>High operation cost</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Charging times</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Influences on circulation plan</td>
<td></td>
</tr>
</tbody>
</table>
Comparison of CO2 emissions:
DMU, EMU, HMU

<table>
<thead>
<tr>
<th>Mode</th>
<th>Germany</th>
<th>Austria</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMU</td>
<td>3,08</td>
<td>3,08</td>
</tr>
<tr>
<td>EMU</td>
<td>0,99</td>
<td>1,89</td>
</tr>
<tr>
<td>Hydrogen MU</td>
<td>3,41</td>
<td>6,52</td>
</tr>
</tbody>
</table>

Quelle: Umweltbundesamt
Contents

Alternative Propulsion
General aspects

Cityjet ECO
Pilot-Project of ÖBB-Personenverkehr AG

Discussion
Cityjet eco – Project timeline

Integration of the battery-system
Activities for Homologation
regular commercial operation
deconstruction of the battery-system
Homologation for an conventional EMU

the Project is a cooperation between the ÖBB Personenverkehr und Siemens Mobility
Implementation of the battery components

The Desiro ML Cityjet vehicle concept is predestined for extension to a battery-powered vehicle.

**Advantage:** the complete battery equipment can be accommodated on the centre car.

The battery system includes:
- 3 battery containers
- 2 DC/DC controllers
- 1 chiller (for cooling/heating)
visualization of the battery-system

In the project, importance was attached to ease of use and little training effort.

Additional, a Driver-Assistance-System was developed in the project to signalize the range forecast and to give recommendations for the most energy-efficient driving style.
## Cityjet eco – Technical Data

<table>
<thead>
<tr>
<th>Technical Data</th>
<th>AC mode</th>
<th>Battery mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheel arrangement</td>
<td>Bo'Bo'+2'2'+Bo'Bo'</td>
<td></td>
</tr>
<tr>
<td>Track gauge</td>
<td>1,435 mm</td>
<td></td>
</tr>
<tr>
<td>Maximum speed</td>
<td>140 km/h</td>
<td>120 km/h</td>
</tr>
<tr>
<td>Traction power</td>
<td>up to 2,600 kW</td>
<td></td>
</tr>
<tr>
<td>Installed battery capacity</td>
<td></td>
<td>528 kWh</td>
</tr>
<tr>
<td>Starting acceleration</td>
<td>1.0 m/s²</td>
<td>0.77 m/s²</td>
</tr>
<tr>
<td>Power supply</td>
<td>15 kV AC / 25 kV AC</td>
<td></td>
</tr>
<tr>
<td>Length (over coupling)</td>
<td>75,152 mm</td>
<td></td>
</tr>
<tr>
<td>Floor height</td>
<td>600 mm</td>
<td></td>
</tr>
<tr>
<td>Entrance areas</td>
<td>6 on each urban train</td>
<td></td>
</tr>
<tr>
<td>Capacity</td>
<td>244 seats on urban train</td>
<td></td>
</tr>
<tr>
<td>Maximum axle load</td>
<td>&lt; 17 t including traction battery pack</td>
<td></td>
</tr>
<tr>
<td>Crashworthiness</td>
<td>TSI and EN 15227 conform</td>
<td></td>
</tr>
<tr>
<td>Fire protection</td>
<td>CEN / TS 45545 and DIN 5510</td>
<td>Fire protection level 2</td>
</tr>
</tbody>
</table>
### Social benefits

| 1 | **Lower costs**  
The total cost of ownership (TCO) of a battery train is lower compared to conventional diesel trains |
|---|---|
| 2 | **Reduced emissions**  
Reduction of CO2, NOx and particulate emissions |
| 3 | **Noise reduction**  
Compared to diesel vehicles, the noise level is reduced. Especially in the station, for example in preheating mode |

### Benefits for operators and passengers

| 4 | **More flexible operation**  
through battery railcars and conventional EMUs, fleet standardization, new connections can be offered |
| 5 | **Avoidance of infrastructure costs**  
Avoidance of expensive, uneconomical electrification projects through the use of battery trains |
| 6 | **Greater comfort and fewer transfers**  
Direct connections, shorter travel times and greater comfort  
→ increased passenger numbers |
potentials of battery-electric trains in Austria

- Currently 2.1 million train-km in diesel traction “under contact wire”.
- Reduction by 0.5 million km through electrification
- Remaining potential of 1.6 million km for battery trainsets (+ replacement of diesel traction on non-electrified lines)
Results of Operation

<table>
<thead>
<tr>
<th>Route</th>
<th>Length (1 Direction)</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herzogenburg - Krems</td>
<td>20 km</td>
<td>✔</td>
</tr>
<tr>
<td>Hadersdorf - Horn</td>
<td>35 km</td>
<td>✔</td>
</tr>
<tr>
<td>St.Pölten - Hainfeld</td>
<td>31 km</td>
<td>✔</td>
</tr>
<tr>
<td>Pöchlarn – Scheibbs</td>
<td>27 km</td>
<td>✔</td>
</tr>
<tr>
<td>St.Valentin – Nikola/Struden</td>
<td>40 km</td>
<td>✔</td>
</tr>
<tr>
<td>Wels – Sattledt</td>
<td>13 km</td>
<td>✔</td>
</tr>
<tr>
<td>Attnang Puchheim - Schärding</td>
<td>64 km</td>
<td>✔</td>
</tr>
</tbody>
</table>
### Outlook in the future

#### Implementation Desiro Mainline

- **3rd Railway Package**
  - **Baseline 1.0**
    - Homologation for **battery Prototype**
  - **Baseline 2.0**
    - Homologation for **24 (+11) pre-equipment battery trains**
  - **Baseline 3.0**
    - Homologation for the **final concept for 24 (+11) battery trains**
  - **Baseline 4.23**
    - Homologation for conventional Desiro ML

#### 4th Railway Package

- **Baseline 3.0**
  - Homologation for **battery Prototype**

#### 3rd Railway Package

- **Baseline 1.0**
  - Homologation for **battery Prototype**

#### 4th Railway Package

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  - Homologation for **24 (+11) pre-equipment battery trains**

#### 4th Railway Package

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### Homologation

**4th Railway Package**

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**3rd Railway Package**

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### Extension of Homologation

**4th Railway Package**

- **Baseline 3.0**
  - Homologation for the **final concept for 24 (+11) battery trains**

**Baseline 4.23**

- Homologation for conventional Desiro ML

### Fulfillment of all TSI’s and NNTR’s

**TSI = Technical specifications for interoperability**

**NNTR = notified national technical rules**

- **AUT**
  - Class 4746 & 4744
  - PZB & ETCS

- **AUT**
  - Class 4746 & 4744
  - PZB & ETCS

- **AUT**
  - Class 4746 PZB

- **AUT & GER**
  - Class 4744 PZB & ETCS
  - Class 4746 PZB & ETCS

- **ERA-TV**
  - Desiro ML cityjet BL04.23a
    - Class 4744
    - Class 4746
Thank you for your attention

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