Talgo Hydrogen Train Project
Summary

1. Who we are

2. Core activities
High Speed. Conventional fleet. Maintenance Services and Products

3. Climate Change Global Framework

4. Hydrogen Traction in Railway
Hybrid hydrogen Powertrain vs Diesel

5. Talgo Hydrogen Bi-mode Technology
Hydrogen Bi-mode Commuter and Regional Train. FCH Powertrain Prototype
A mid-sized company focused about quality and with the right costs-capabilities balance.
Permanent industrial presence in some of the most relevant rail markets around the world

Global player

- Russia
- Germany
- USA
- Spain
- Kazakhstan
- KSA
- Uzbekistan
Core activities

- Design and manufacture rail vehicles
- Design and manufacture of Maintenance equipment
- Maintain and refurbish vehicles

Talga 350
High Speed proven solution

TALGO 250 / 250 DUAL
We mean full interoperability

AVRIL
Variable Gauge at 330 kph

AVRIL
Maximum capacity at 360 kph

Maintain and refurbish vehicles

Talgo is one of the five manufacturers shortlisted to supply VHS trains to HS2
Climate Change Global Framework

Targets – the industry, including some governments, support the target of net zero carbon by 2050 as proposed by the Committee on Climate Change (CCC).

Policy – the whole industry has responsibility to contribute to net zero carbon in a cost-effective manner.

*The climate target of Deutsche Bahn AG: halve the specific CO2 emissions by 2030 of 2006. There are alternatives to find more than 2,000 diesel vehicles in rail transport of the DB, where no electrification is feasible. Significant contribution to CO2 reduction through targeted use of alternative drives. With "green" hydrogen fuel cell trains are used for routes entirely without OLE
Hydrogen Technology in Railway traction

At train level (locomotive case) the efficiency of Hydrogen FC traction is higher than diesel engine!

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Vehicle</th>
<th>Power at rails</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity at Pantograph 100 %</td>
<td>Diesel Locomotive</td>
<td>Vehicle Efficiency 76 %</td>
<td>(Stein, 2006)</td>
</tr>
<tr>
<td>Feed Cable 95 %</td>
<td>Diesel Engine 40 % LHV, 37 % HHV</td>
<td>Vehicle Efficiency 30 % LHV, 28 % HHV</td>
<td>(Canders, 2007)</td>
</tr>
<tr>
<td>Transformer 95 %</td>
<td>Generator 92 %</td>
<td>Vehicle Efficiency 30 % LHV, 25 % HHV</td>
<td>(MAN Nutzfahrzeuge AG, 2006)</td>
</tr>
<tr>
<td>Control System / Power Electronics 97.5 %</td>
<td>Rectifier 98 %</td>
<td>Vehicle Efficiency 42 % LHV, 38 % HHV</td>
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<tr>
<td>Electric Motors 95 %</td>
<td>Electric Motors 92 %</td>
<td>Vehicle Efficiency 30 % LHV, 28 % HHV</td>
<td></td>
</tr>
<tr>
<td>Transmission 96 %</td>
<td>Transmission 95 %</td>
<td>Vehicle Efficiency 30 % LHV, 28 % HHV</td>
<td></td>
</tr>
<tr>
<td>Traction Auxiliaries 95 %</td>
<td>Traction Auxiliaries 95 %</td>
<td>Vehicle Efficiency 30 % LHV, 28 % HHV</td>
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<tr>
<td>Vehicle Efficiency 76 %</td>
<td>Vehicle Efficiency 30 % LHV, 28 % HHV</td>
<td>Vehicle Efficiency 30 % LHV, 25 % HHV</td>
<td></td>
</tr>
<tr>
<td>78 % LHV and HHV</td>
<td>30 % LHV, 28 % HHV</td>
<td>30 % LHV, 25 % HHV</td>
<td></td>
</tr>
</tbody>
</table>

Hybrid Hydrogen Powertrain

Boundary conditions to apply this type of solution

Facts and figures about FC:
• Required also batteries (hybrid tech)
• Efficiency > 50%
• Zero Emissions at train Level
• Hydrogen in gas condition (350-700 bar)
• 0,2-0,5 kg H₂/km
# Talgo Commuter and Regional Bi-mode Train (OLE + H₂ Fuel Cell)

## Technical Sheet

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum speed</td>
<td>176km/h</td>
</tr>
<tr>
<td>Operating speed</td>
<td>160km/h</td>
</tr>
<tr>
<td>Track gauge (mm)</td>
<td>1435-1520-1668</td>
</tr>
<tr>
<td>Floor height (mm)</td>
<td>550 from rail head</td>
</tr>
<tr>
<td>Length (m)</td>
<td>75m (4 cars)</td>
</tr>
<tr>
<td>Bodyshell width (mm)</td>
<td>2900</td>
</tr>
<tr>
<td>Unladen weight (tonnes)</td>
<td>131 tonnes (4 cars)</td>
</tr>
<tr>
<td>Number of axles</td>
<td>10</td>
</tr>
<tr>
<td>Passengers/WC</td>
<td>Depends on configuration</td>
</tr>
<tr>
<td>Power supply</td>
<td>25kV 50Hz AC, 3kV DC, Hydrogen</td>
</tr>
<tr>
<td>Power</td>
<td>2 x 1,100 kW (OLE)</td>
</tr>
<tr>
<td></td>
<td>1,600 kW (H₂ Fuel Cell + Batteries)</td>
</tr>
<tr>
<td>Brakes</td>
<td>Regenerative, rheostatic and pneumatic</td>
</tr>
<tr>
<td>Standard</td>
<td>UIC/ETI/GOST</td>
</tr>
</tbody>
</table>
Bi-mode Powertrain (OLE + H₂ Fuel Cell)

- OLE
  - HV main switch
  - Transformer
  - Converter
  - DC Link
  - DC-DC Converter
  - Batteries
  - Refrigeration tower

- Inverter + Traction Motor
- Regenerative braking system
- Fuel Cell
  - Anode
  - Electróxido
  - Cátodo
  - H₂

- Air
- Water
Bi-mode PowerTrain Prototype (OLE + H₂ Fuel Cell)

Goal of the Project
Development a Hydrogen Traction Prototype (H₂ FC + Batteries) on a existing train (Talgo AVRIL Very High speed), including Fuel Cell, batteries, tanks, converter, H₂ supply station and engineering.

The Traction Prototype will be mounted at Talgo AVRIL that will feature a ‘H₂ Commuter/Regional mode’

H₂ Commuter/Regional mode
- Power: 1600 kW (800 kW FC + 800 kW Batteries)
- H₂ Storage pressure: 700 - 350 bar
- Range: up to 800 km
- Max speed: 140 kph

OLE mode (existing performance)
- Power: 8800 kW
- Max speed: 330 kph

Talgo AVRIL Very High speed Train
Bi-mode PowerTrain Prototype (OLE + H2 Fuel Cell)

Coach for H₂ traction equipment

Mobile Hydrogen Supply System

Preliminary Integration Study
Thank you for your kind attention

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