

Fourth International Hydrail Conference

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Valencia, Spain

***The Role of Hydrail In
Meeting Environmental
Commitments***

ENEA

ENTE PER LE
NUOVE TECNOLOGIE,
L'ENERGIA E L'AMBIENTE



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From steam to diesel.....from

From mass transportto mass&fast transport.....
to fast&clean transport



Great Northern locomotives William Crooks, 4-8-4 Class S2 steam locomotive and diesel locomotive Class E7

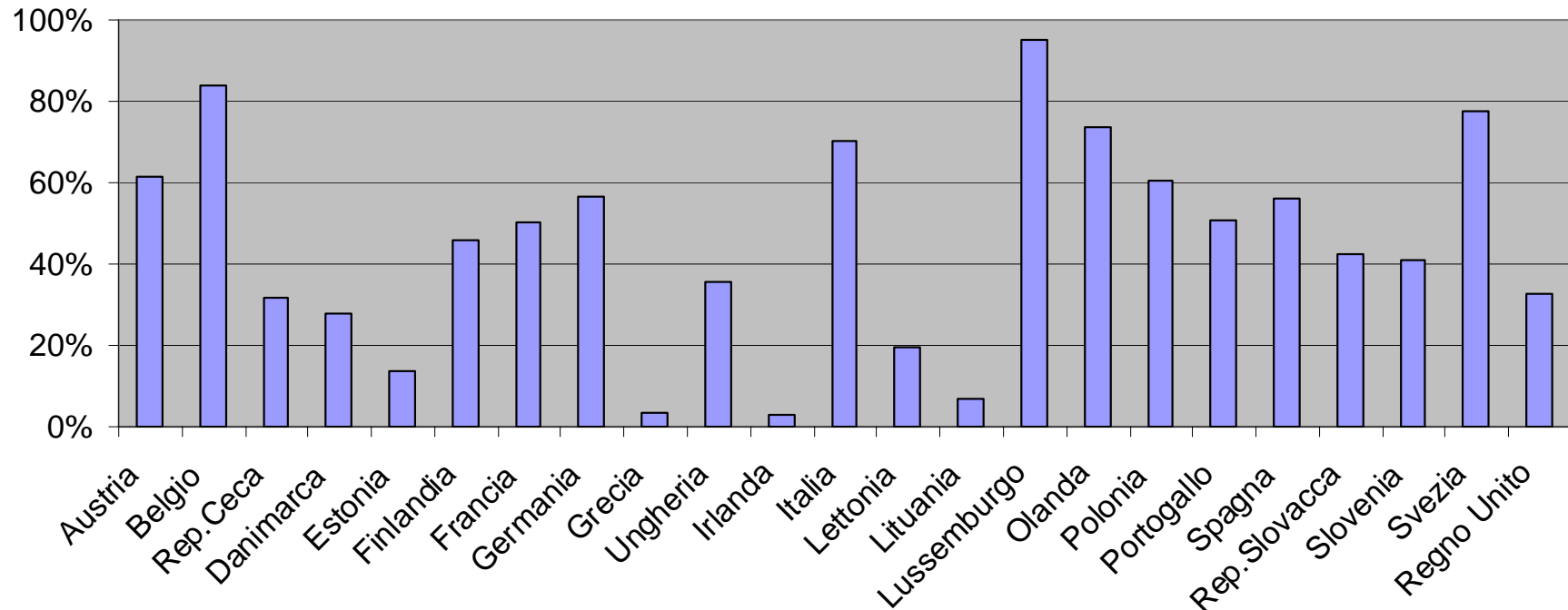


Bombardier B81500 (dual mode train)

Electric traction:

1. more power,
2. less energy consumption
3. zero-emission on-site,
4. less CO2 emissions (it depends on the Well-to-wheel energy pathway)

Electrified lines in the EU Countries



Power source

Peculiarity

Cost

Electric trains

Fossil/Nuclear/Ren.

E.E. gener./distr.

Hydrogen trains

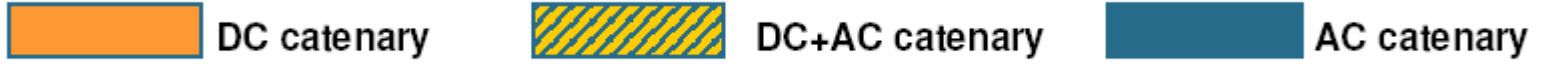
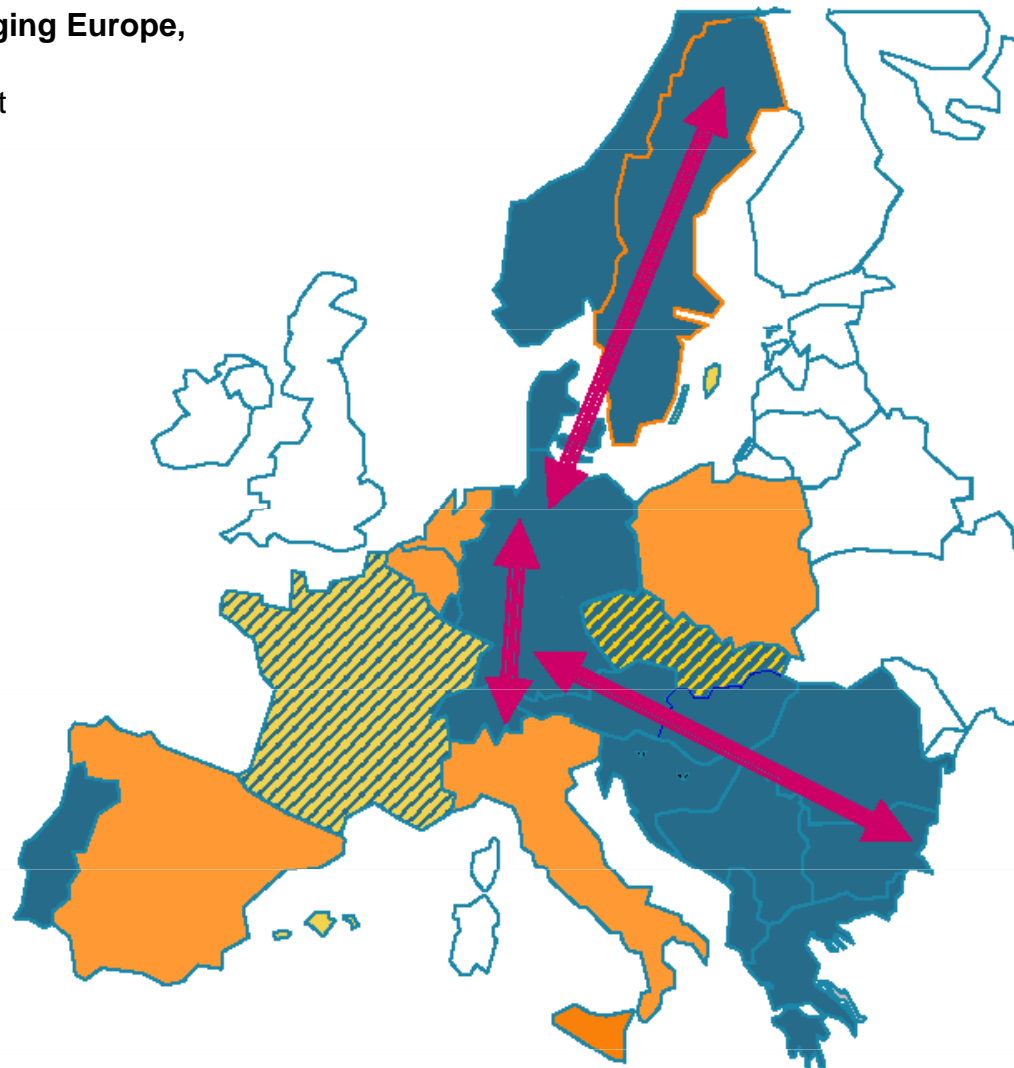
Fossil/Nuclear/Ren. **interoperability / no overhead lines**

H2 prod./ distr./ use

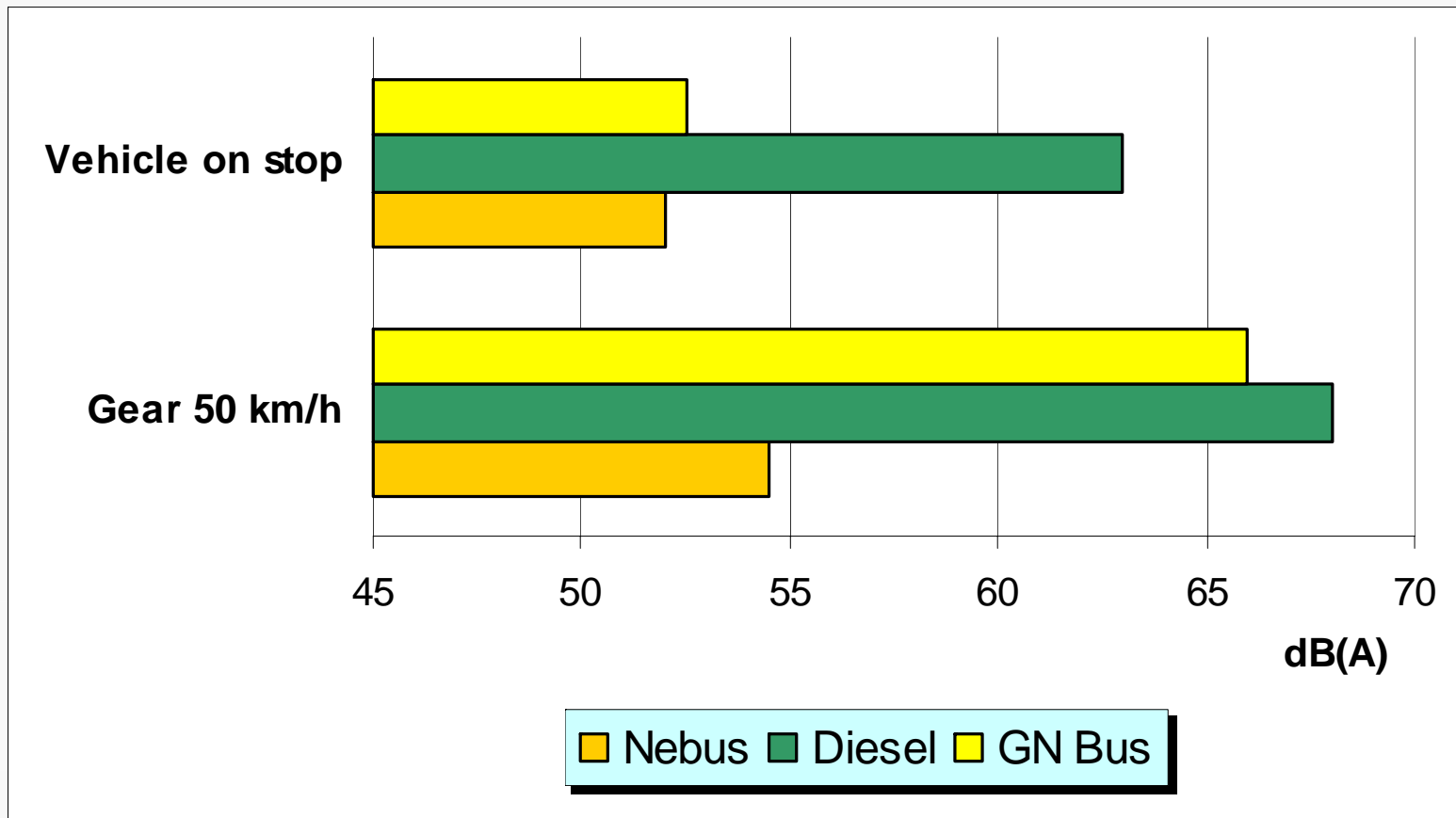
- ◆ In general terms, autonomous electric traction in rail vehicles could avoid electrification costs (2-3 MEuro/km) and represents an appropriate answer to promote interoperability throughout the EU.
- ◆ If diesel powered rail vehicles suffer from environmental problems like noise and air pollution, fuel cells systems represent an innovative solution for the on-board energy source, offering clean and efficient energy without sacrifice operational performance.

- ◆ High power generation units (8 MW) as high temperature FC could provide dual-mode locomotives for long-distance transport independently on different national solutions (25.000 AC, 3000 DC, etc)
- ◆ Innovative on-board generators (4-500 kW) as automotive derived fuel cell systems could provide dual-mode railcars for short-distance transport and tram-trains operating in urban and extra-urban areas
- ◆ Switcher locomotives retrofitted with 150-200 kW fuel cell systems could operate in silent and zero-emission mode in the urban areas, where they are often used.
- ◆ Auxiliary power units (50 – 70 kW) for emergency and service (light and hotel) use, reducing emissions at enclosing stations.

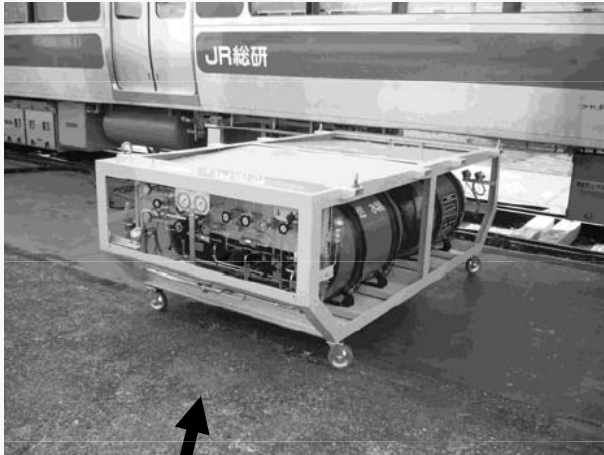
Locomotives for a changing Europe,
Janis Vitins, Bombardier,
Infratrans 2007, Bucharest



In urban areas, low noise and zero-emissions are of outmost importance.



T T R R T R I



The composite cylinders can store 18 kg of hydrogen at 350 bar

120 kW	Start-up time	Within 5 min.
Pure hydrogen	Weight	2000 kg
Air	Outside dimension (Without Radiator)	1.65(L) × 1.25(W) × 1.50(H) m
900~600 V		

Vehicle platform is based on Green Goat™ diesel-battery hybrid switcher



FC systems (n.2)
corresponds to the Citaro
Bus power plant

1. Engineering design; project manager
 2. Fuelcell manufacturer
 3. Industry funder; vehicle integrator; railyard demonstrator
 4. Adviser on military applications; power-to-grid demonstrator
 5. Hydrogen storage manufacturer
 6. Refueling system
 7. RailPower Hybrid Technologies
1. Vehicle Projects LLC
 2. Ballard Power Systems
 3. BNSF* Railway Company
 4. Defense Gen. & Rail Equipment Center (DGRC)
 5. Dynetek Industries
 6. University of Nevada – Reno
 7. Manufacturer of Green Goat platform

*Burlington Northern Santa Fè

The (no more experimental) railcar 'NEtrain'



East Japan Railway Company (JR-East) and Hitachi, Ltd. in the last years developed a diesel hybrid system. Commercial railcars with the developed diesel hybrid system have been put in service this year (2007).

	System	Configuration
(1)	Diesel hybrid system (developed)	<p>The diagram shows a Diesel hybrid system configuration. On the left, an Engine (331kW) is connected to a Generator (230kW rating). The generator is connected to a Traction converter, which consists of an AC/DC Converter and a DC/AC Inverter. A Battery (15kWh) is connected to the DC link between the AC/DC Converter and the DC/AC Inverter. The DC/AC Inverter is connected to a Motor (95kW x 2 rating), which is connected to a Wheel.</p> <p>Engine (331kW) 300kW (operating)</p> <p>Generator (230kW rating)</p> <p>Traction converter</p> <p>AC/DC Converter</p> <p>Battery (15kWh)</p> <p>DC/AC Inverter</p> <p>270kW (max)</p> <p>Motor (95kW x 2 rating)</p> <p>Wheel</p>
(2)	Fuel cell hybrid system (developing) TESTED!	<p>The diagram shows a Fuel cell hybrid system configuration. On the left, two Fuel Cell Systems (A) and (B), each rated at 65kW, are connected to a Traction converter. The Traction converter consists of a DC/DC Converter and a DC/AC Inverter. A Battery (19kWh) is connected to the DC link between the DC/DC Converter and the DC/AC Inverter. The DC/AC Inverter is connected to a Motor (95kW x 2 rating), which is connected to a Wheel.</p> <p>Fuel Cell System (A) (65kW)</p> <p>Fuel Cell System (B) (65kW)</p> <p>Traction converter</p> <p>DC/DC Converter</p> <p>Battery (19kWh)</p> <p>DC/AC Inverter</p> <p>340kW (max)</p> <p>Motor (95kW x 2 rating)</p> <p>Wheel</p>

Taking account of the commercial mission profile to be assumed by the railway and the technology state of art, critical points, besides costs, for hydrogen use in railway application are:

- ◆ the energy autonomy to assume for the mission,
- ◆ the reliability level required by the railway applications,
- ◆ Infrastructure issues that require safety approach with hydrogen storage system, in depot for refuelling and in running line in tunnel.

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