Improving traction system

- Higher voltages for Overhead Contact Line (OCL)
- Norwegian experience
- New Direct Current Medium Voltage railway electrification system
- Supra-conductor cable for reduced energy losses during transport

Energy storage

- Battery development and super-capacitors
- Reversible Substations
- SNCF experience

Replacing diesel traction by less emitting traction systems

- Defining best line configuration
- SBB experience
- **Hydrogen refuelling facilities – H_2 vs. batteries**
  ir.Patrick LAFONTAINE

Hydrogen : many existing applications in industry

Technology, safety standards are widely known and available

Heat Treatment

10 m3/h (batch) –

1000 m3/h (continuous)

Glass

80 to 500 m3/h

H2 Ultra pure <1ppb

50 to 500 m3/h

Chemicals

Ex: 0,067 t/ton Anilin

Petroleum refining

(desulfuration & hydrocracking)

10-100 km3/h

Ariane 5

28 t/launch

Fuel cell vehicle

1 kg for 100 km

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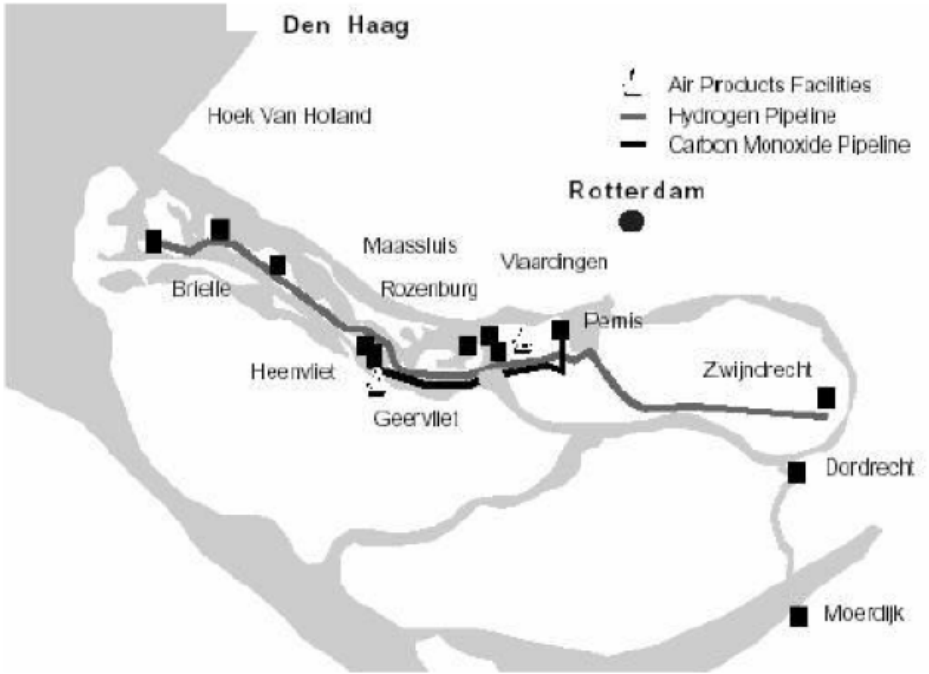
Hydrogen production units and pipelines exist in industrial areas

Current production : based on fossil fuels

Future : “green” hydrogen from renewable energy sources



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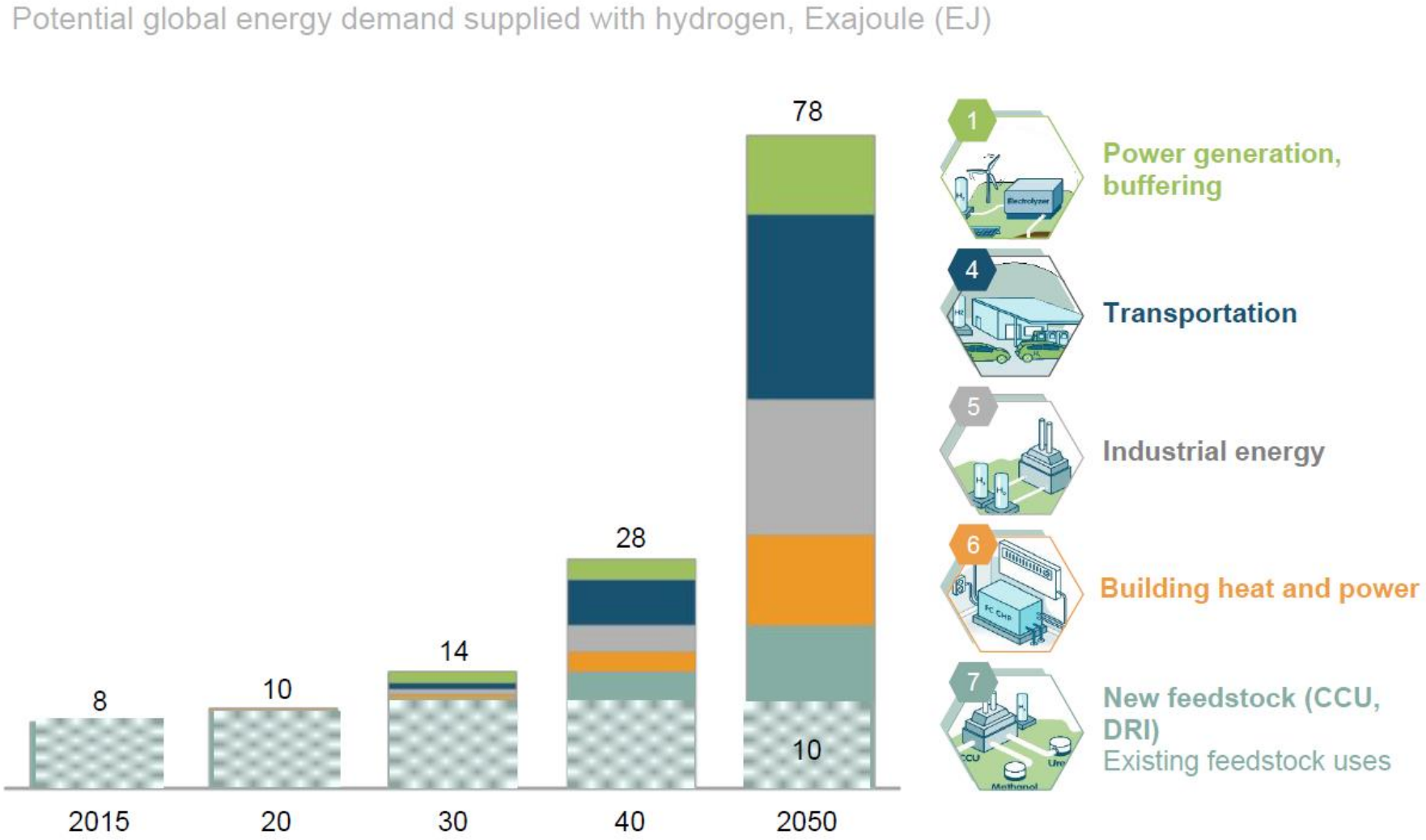
Hydrogen is about to become a major green energy vector

In view of EU climate change objectives 2030/50

Transportation segment will have a major share



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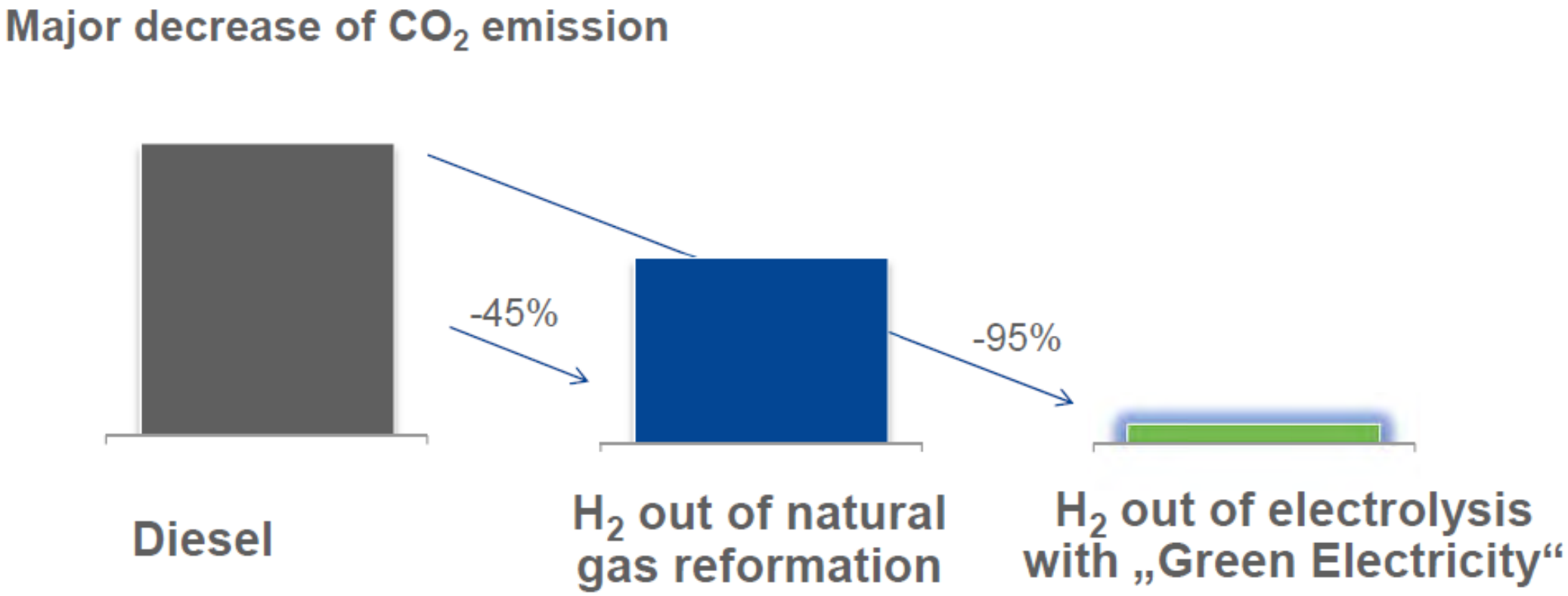
Growth of hydrogen production will come from water electrolysis process based on renewable energy sources



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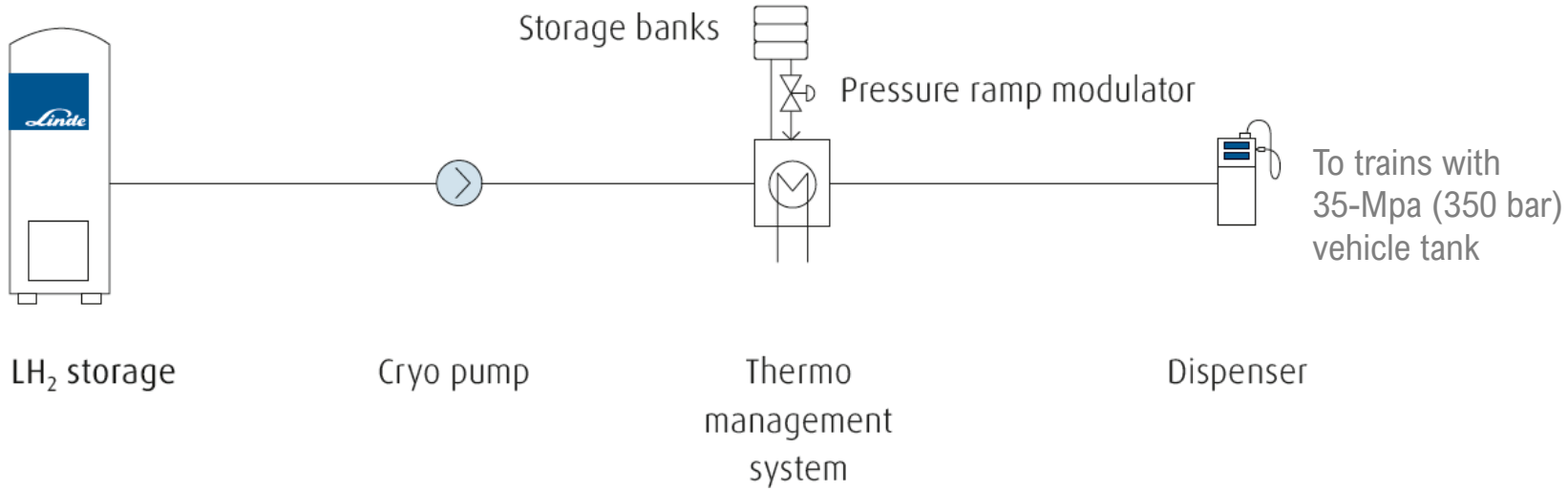
Hydrogen consumption H_2-EMU fleets

based on ALSTOM Coradia Ilint 2-car EMU

Hydrogen need per day (example)

	Network 1	Network 2
Amount of trains	10	20
Km per day	600 km	750 km
H_2 per km	0.25 kg/km	
Consumption per day	**1.500 kg**	**3.750 kg**

Typical layout for a 400 - 4,000 kg/d hydrogen fuelling station



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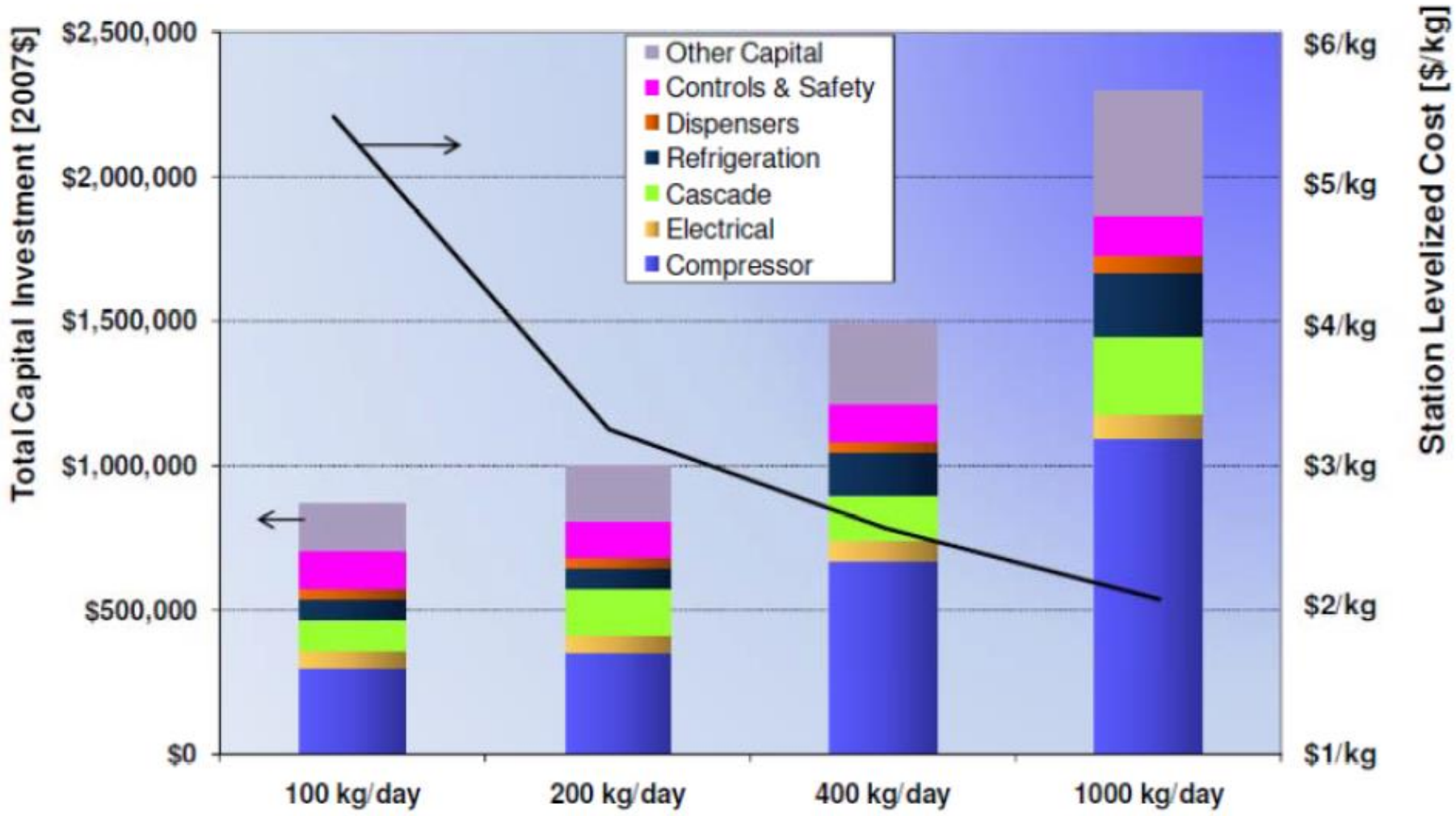
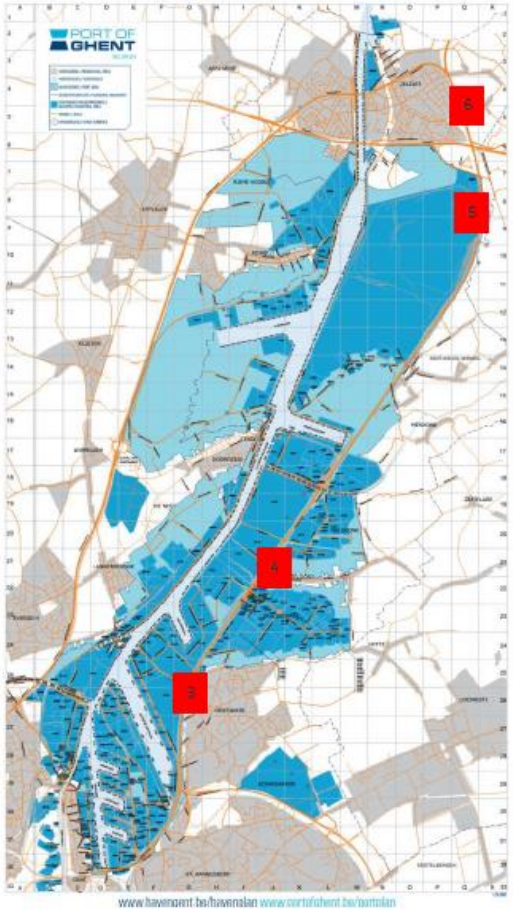
CAPEX/OPEX for hydrogen fuelling stations



Source: DOE, WHEC 2012 presentation

Case study : Gent-Terneuzen passenger line – North Sea Port

Waterstoftrein voor North Sea Port
Van alternatief tot beste keuze



« Rail North Sea Port»

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Waterstoftrein voor Gent-Terneuzen

6-10 treinstellen

½ h of ¼ h service

BAT voor >1000 pphd

ATO voor competitieve service

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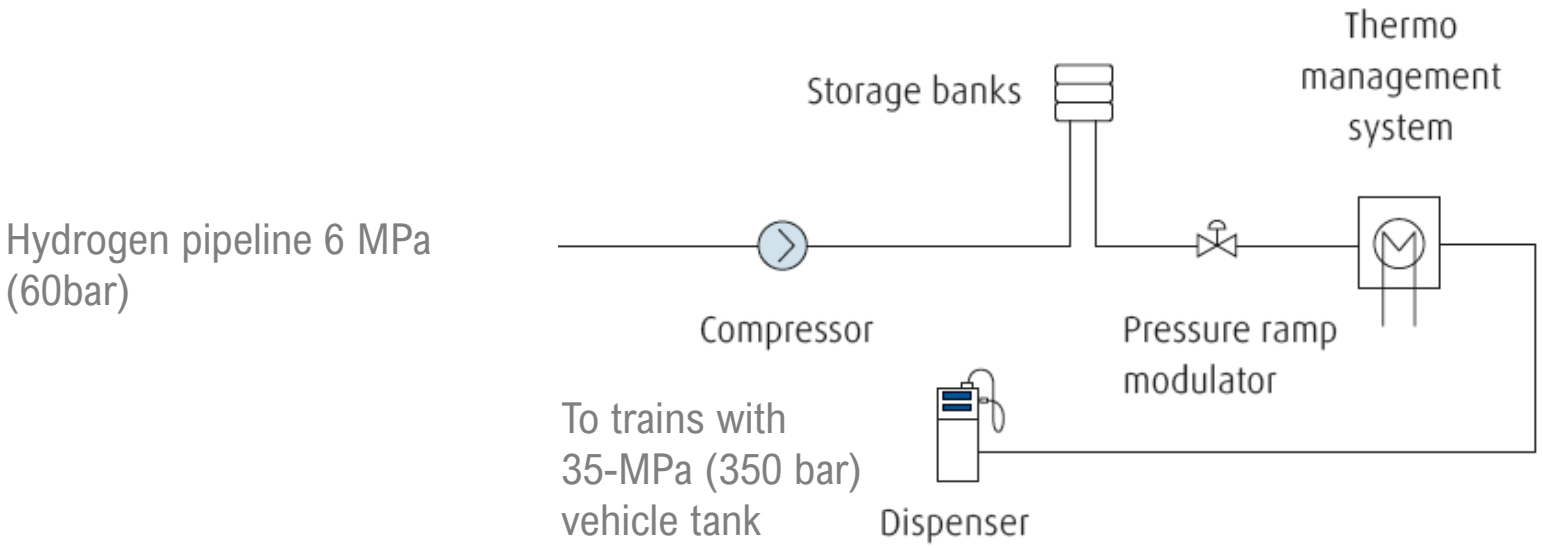
Integration in a large scale hydrogen network, as would be the case in the harbour of Gent, leads to important savings

No need for liquid hydrogen transportation and storage

Fuelling station connected to high pressure H_2 pipeline

No need for expensive cryogenic equipment



For the Gent-Terneuzen line, hydrogen is the best available technology

	Diesel hybrid with batteries	Electric train with batteries	Hydrogen fuel cell train
	 example	 example	 Coradia iLINT
Autonomy	▪ 900-1000 km	▪ 40-60 km (w/o catenary) *)	▪ > 800 km
Weight	▪ High	▪ High	▪ Low (< 18 t/axle)
Flexibility in Operation	▪ High	▪ Low	▪ High
Infrastructure	▪ Diesel re-fueling	▪ Battery charging	▪ HRS - Hydrogen Re-fueling Station
Environment	▪ Not emission-free	▪ Emission-free	▪ Emission-free

*) source Bombardier

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Any questions ?
Thank you for your attention !

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