Coradia iLint – Hydrogen Fuel Cell Train
Agenda

• Motivation to strike a new path
• Coradia iLint and its technology
• Safety and certification
• Production and supply of hydrogen
• Efficient Utilization of grid capacity
• Next steps ...
Motivation to strike a new path...

- Significant part of the rail network is not electrified and high cost of traditional electrification
- Achieve greater resiliency and address increasing prices of diesel fuel
- Need to improve air quality and reduce noise
- Overload of roads and need to reduce pressure on grid at peak times

Hydrogen: the ideal alternative energy source
HFC Rolling Stock – comparison with electric alternatives

**H2**

**+** Performance, operating range and refueling duration comparable to that of diesel trains (900 to 1,100 km range, refueling from empty tank takes 15 minutes)

- higher investment in infrastructure

**+** lower investment in infrastructure

- suboptimal relationship between operating range and cost / weight / re-charging duration (200 km range: ~33 t of batteries / 45 minutes recharging)

**BEMU**

**BEMU+**

**HMU**

**+** optimal only if electrification infrastructure is already in place

- Operating range of sections without overhead line very low (approx. 40 to 70 km)

*Based on a regional railcar with 150 seats / 150 standees and 140 km/h maximum operating speed*
Motivation to strike a new path...

Coal: 34 MJ/kg, 1801

Diesel: 43, 1925

Hydrogen: 120 MJ/kg, 2018
CORADIA Lint: the Diesel platform from which HFC train developed...

LINT 27: 47 trains

LINT 41: 688 trains

LINT 54: 203 trains

LINT 81: 72 trains

More than 1000 LINT Diesel Trains sold worldwide, including in Ottawa, Canada

... a reliable and service proven base for the first hydrogen HMU
Fuel Cell Trains: The Technology – transformation from Diesel to HMU

- Removal of diesel propulsion system
- Integration of electrical propulsion system

- Diesel powerpack
- Diesel tank

- Hydrogen tank
- Fuel cell pack
- Battery pack
- Converter system
- Electrical traction motor
Fuel Cell Trains: Design criteria

• Retain the same train dimensions
• No significant changes in weight/point of gravity
• Re-use of main components (eg. bogie)
• Maintain excellent performance (availability, reliability, acceleration, range, etc)
• Avoid adding equipment in passenger areas
• No adverse impact on passenger experience and comfort
• High energy efficiency
• Scalability – technology can be scaled and used to retrofit existing fleets, can be used on passenger locomotives, bi-level multiple units (of varying lengths) etc.
• Interoperability (mixed fleet)
CORADIA iLint: The fuel cell composition
CORADIA iLint: Hydrogen storage

Storage at 35 Mpa (5000 psi) (@ 15°C)

Distribution at 1 Mpa (145 psi)
CORADIA iLint: The lithium-Ion battery composition
Fuel Cell Trains: CORADIA iLint - energy management

Energy management is the key to achieve highest efficiency

- Operates fuel cells at optimal efficiency
- Optimizes energy management during acceleration, coasting and braking
- Recuperates kinetic energy during braking (>30% recuperation of traction energy used)
CORADIA iLint: Validation and certification process (example for Germany)

Core subjects
- Running dynamics
- Crash
- Brake
- Wheelsets
- Train radio / Train protection

Technical Specification for Interoperability
- Infrastructure
- Energy
- Rolling Stock
- Train Control / Communications

Notified National Technical Rules
- Running dynamics
- Fire Safety
- EMC
- Functional Safety
- Labeling
- and some others

Safety assessment on Common Safety Methods (CSM)
CORADIA iLint: Validation and certification process – the strategy

- Risk analysis with consideration of environmental and operational conditions
- Definition of requirements
- Independent inspection and assessment
- Validation of fulfillment of requirements
- Follow-up on realization
- Fire safety
- Combined assessment by TÜV Süd
- System with special supervision
- Validation of fulfillment of requirements
- TÜV Süd Rail
- TÜV Süd
- TÜV Süd Industrie Service
- Battery Testing
- Hydrogen System & Li-Ion-Battery
CORADIA iLint: Certification ... 
Hydrogen safety

- Certification of pressure vessels in accordance with EC 79/2009
- Certification of overall system in accordance with 2014/68/EU (PED)
- Validation of structural safety (frame / vessels / piping) by S&V-test in accordance with EN 61373
- Certification of railway conditions (Environment, EMC, Fire Safety)
  - Fire safety - EN 45545-2
  - Environment - EN 50125/IEC 60077
  - EMC - EN 50121-3-2
CORADIA iLint: From certification to regular passenger service

- **Certification** for passenger service in Germany received on **11.07.2018**

- **Inauguration** of passenger service at Bremervörde on **16.09.2018**

- **Daily passenger service** according to regular time table since **17.09.2018**
CORADIA iLint: ... in daily passenger service!

- Daily passenger operation
- Operation in mixed fleet
- 75 miles of tracks
- One mobile refueling station in Bremervörde
CORADIA iLint - entrance into daily passenger revenue service on Sept. 16, 2018

Hydrogen-powered trains begin service in Germany.
In a breakthrough for a green fuel, two hydrogen-powered trains are expected to go into commercial service Monday on a rail line in northern Germany near Hamburg. The trains, which will serve cities including Bremerhaven and Cuxhaven, will be powered by hydrogen fuel cells that generate electricity through a chemical reaction. The trains are being promoted as a cheaper alternative to stringing wires on rail lines that are not electrified. Hydrogen-powered vehicles produce no emissions of carbon dioxide, which is blamed for climate change, or other pollutants...
Hydrogen supply: From by-product to regenerative energy

- By-product of other processes
- Steam reforming
- Electrolysis
Hydrogen supply: Mobile refueling station
Hydrogen supply: An ecological comparison

minus 700t CO₂ per year…
…equals annual emissions of 400 cars

minus 11,000t CO₂ per year…
…equals annual emissions of 6,000 cars

Reduction per iLint vehicle

Reduction per iLint fleet
Two windmills and One 5mw electrolyzer can provide the H2 for the Fourteen 2-car iLint trains for Lower Saxony.
Electrical mobility and effects on other sectors: Load on transmission grids

As the share of renewable energy is increasing...

... the transmission networks are more and more overloaded – hydrogen can be produced in off-peak.

One solution: Local use of green electricity for electrolysis.
Next steps: Introduction of HFC Rolling Stock in...
Thank you!!!

CORADIA iLint on YouTube ...