1. A story of success … and the motivation to strike a new path
2. Coradia iLint and its technology …
3. … in passenger service
4. Production and provision of hydrogen
5. Cross-sectoral view
6. Next steps …
CORADIA Lint: A story of success …
CORADIA Lint: A story of success …

LINT 27: 47 trains

LINT 41: 688 trains

LINT 54: 203 trains

LINT 81: 72 trains

… market leadership in light regional service.
Motivation to strike a new path …

The climate protection agreement of Paris 2015

- Agreement of 195 member states of the United Nations Framework Convention of Climate Change (UNFCCC)
- Limitation of average temperature rise to well below 2 °C – if possible to below 1.5°C – compared to pre-industrial level
- Achievement of 2 °C level with 66% probability
- Lowering limits of GHG emissions
- Max. 700 Mrd. tons of CO2 until 2100
- Peak of emissions before 2020 and 50% reduction every 10 years
- Doubling of renewable energy every 10 years
- Negative emissions if turnaround cannot be finished until 2040

600 Gt after 2017

800 Gt
Motivation to strike a new path … compared to current facts

Change of GHG emissions in economic sectors in Germany

Source: Statisches Bundesamt

- Total: -28%
- Energy Supply: -22%
- Industry: -32%
- Private Households: -42%
- Other: -40%
- Transport: -2%
Motivation to strike a new path … compared to current facts

- More than 40% or 25,000 km of German rail network is not electrified.
- More than 20% of traffic in Germany is operated with diesel trains today.
- Required investment of 1.5 Mio. EUR per km
- Electrification is economically not efficient on a significant part of network due to low utilization.

Even the most environmental friendly way of transport can contribute.
CORADIA iLint
CORADIA iLint: The Technology

- Complete removal of diesel propulsion system
- Integration of a fuel cell electrical propulsion system
  - Hydrogen tank
  - Fuel cell composition
  - Battery composition
  - Converter system
  - Electrical traction motor
CORADIA iLint: The Components

Distribution at 1 MPa  Storage at 35 MPa (@ 15°C)

Mission profile for Coradia iLint battery

Spare capacity of Coradia iLint battery vs. mission profile

Energy  Type of battery  Size of battery

Power  Mission profile for Coradia iLint battery
CORADIA iLint: The power management

- Avoid low fuel cell efficiency at high power demand during acceleration
- Optimize power management during coasting
- Recuperate kinetic energy during braking
Core subjects
- Running dynamics
- Brake
- Wheelsets
- Train radio / Train protection

Technical Specification for Interoperability
- LOC & PAS
- SRT
- PRM
- NOI

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 homologation process

Notified rules on H2-systems & Li-Ion batteries on trains …
CORADIA iLint: Validation and homologation process – The strategy

Risk analysis with consideration of environmental and operational conditions

Definition of requirements

Follow-up on realization

Independent inspection and assessment

Validation of fulfillment of requirements

Combined assessment by TÜV Süd

Fire safety

Hydrogen System & Li-Ion-Battery

System with special supervision

TÜV Süd Rail

TÜV Süd Battery Testing

TÜV Süd Industrie Service

Risk analysis with consideration of environmental and operational conditions

Definition of requirements

Follow-up on realization

Independent inspection and assessment

Validation of fulfillment of requirements

Combined assessment by TÜV Süd

Fire safety

Hydrogen System & Li-Ion-Battery

System with special supervision

TÜV Süd Rail
CORADIA iLint: From homologation to passenger service

- **Homologation** 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 time table since **17.09.2018**
CORADIA iLint: … in daily passenger service!

Cuxhaven

Bremerhaven

Bremervörde (fueling station)

Buxtehude
CORADIA iLint: … and on other venue! – Roadshow January + February 2019

1. Rheinland-Pfalz / Ludwigshafen
   29.01.2019 / 10:00 to 12:00 am

2. Baden-Württemberg / Offenburg – Freudentstadt
   30.01.2019 / 11:00 to 13:00 am
   route: Offenburg – Freudenstadt

3. Sachsen / Leipzig
   01.02.2019 / morning
   route: Leipzig – Grimma and back

4. Thüringen / Erfurt
   04.02.2019 / 01:00 to 04:30 pm
   route: Rottenbach – Katzöhütte and back

5. Berlin/Brandenburg
   11.02.2018 / morning
   route: Basdorf – Berlin Gesundbrunnen

6 Bundesländer in 3 weeks
Coradia iLint can do snow, ice and steep incline
CORADIA iLint: … in daily passenger service!

Experience of more than 9 months of regular operation

- Total distance covered: > 106,000 km (pass. service) / > 130,000 (total)

- Non-availability between September 2018 and March 2019 were focused on small number of reasons for fuel cells and batteries

Trial operation of 2 pre-series trains is the optimum way to improve rigidity of new technology.
Hydrogen supply: ... as part of an overall mobility proposal

- Erection and Operation of H₂-infrastructure (with partner)
- Performing Maintenance and Repair
- Delivery of trains

We provide emission-free availability

Operator receives maintained and refilled train!

Passengers receive emission-free mobility with increased comfort!
Hydrogen supply: From by-product to regenerative energy

By-product hydrogen

Steam reforming

Electrolysis

H₂
Hydrogen supply: Use of regenerative energy
Next steps …

- **Development**
  - 07/2014: Start iLint Project

- **First Vehicles**
  - 11/2017: LNVG Contract for 14 trains
  - 09/2018: Pre-Series in Passenger Service

- **Orders**
  - 2016: Production of two prototypes
  - 2018: Homologation of first Vehicles in Germany
  - 2021/2022: Start of fleet operation

**Timeline:**
- 2014 - 2015
- 2016
- 2017
- 2018
- 2019 - 2022
Several federal states started RFQ or at least studies for emission reduced / emission free rail traffic
Further countries interested
CORADIA iLint on YouTube …