



Coradia iLint

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Agenda



1. Motivation to strike a new path
2. Coradia iLINT and its technology ...
3. ... in operation
4. Hydrogen: Demand & Opportunities
5. Next steps ...

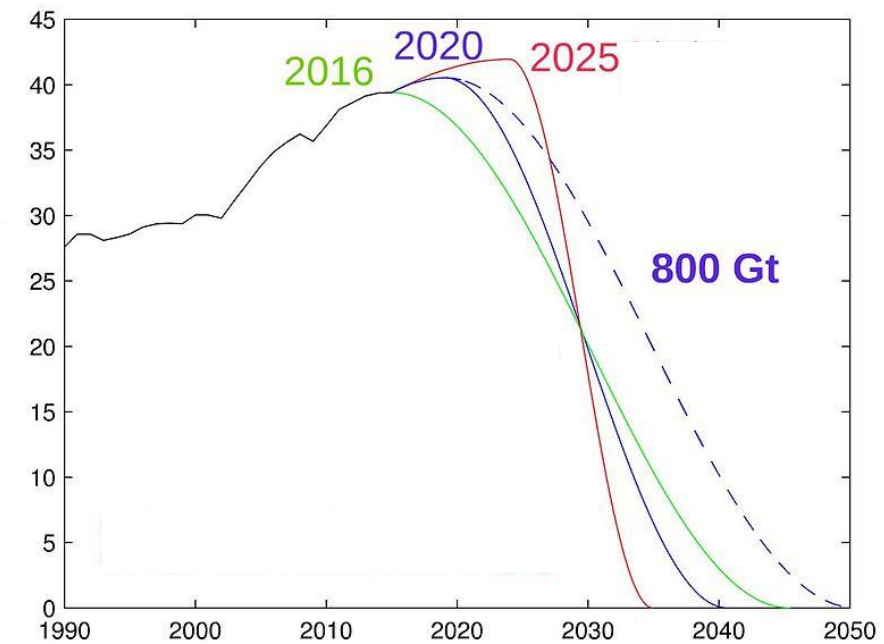
01

Motivation to strike a new path ...

Motivation to strike a new path ...

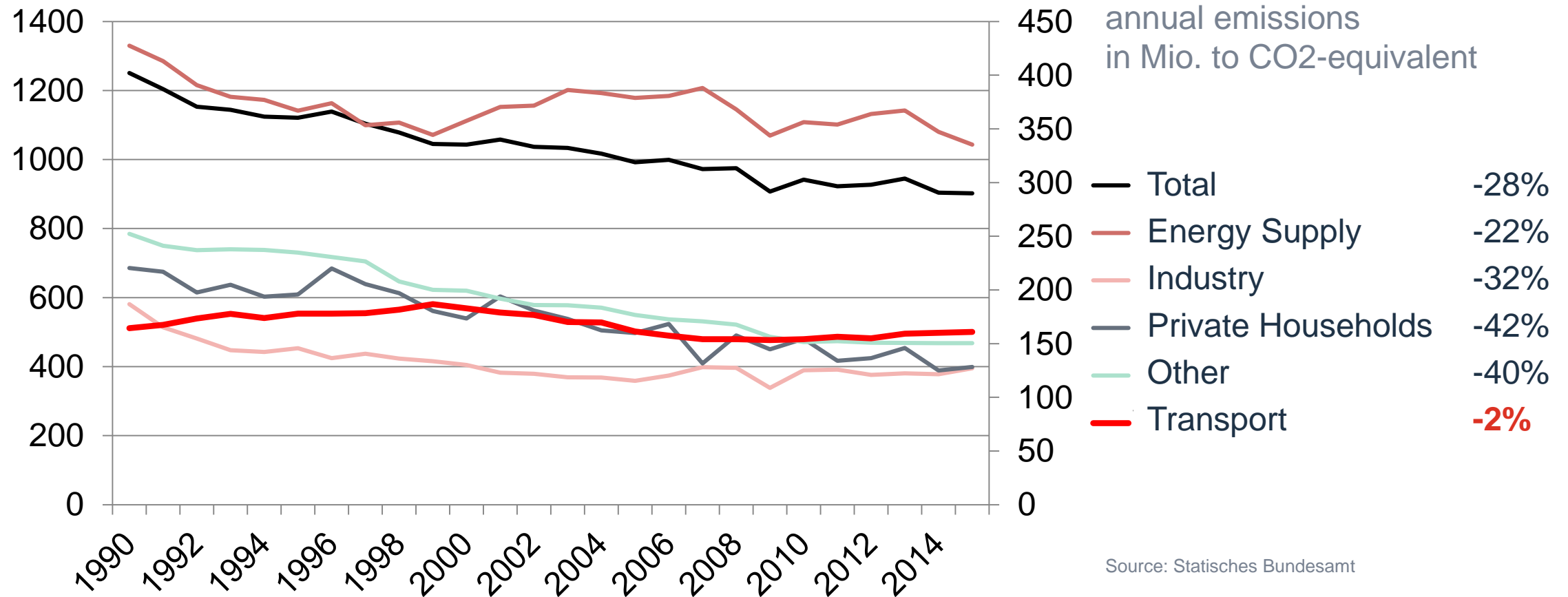
The climate protection agreement of Paris 2015

- 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 bn. 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

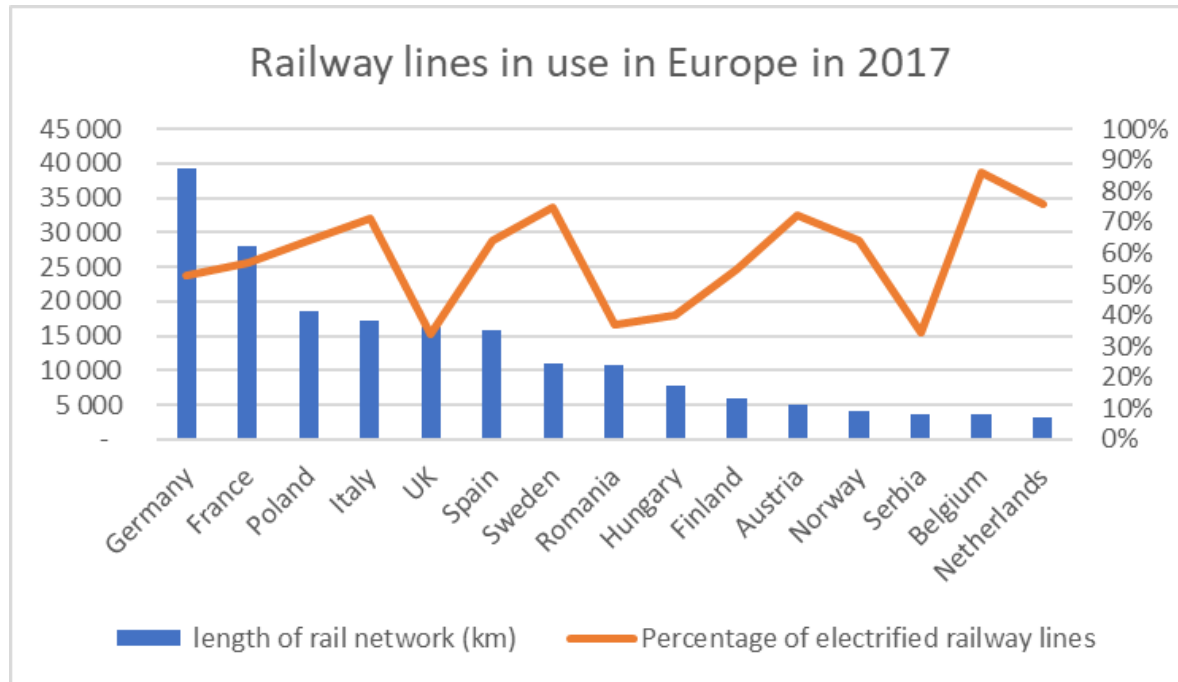


Motivation to strike a new path ... compared to current facts

Change of GHG emissions in economic sectors in Germany



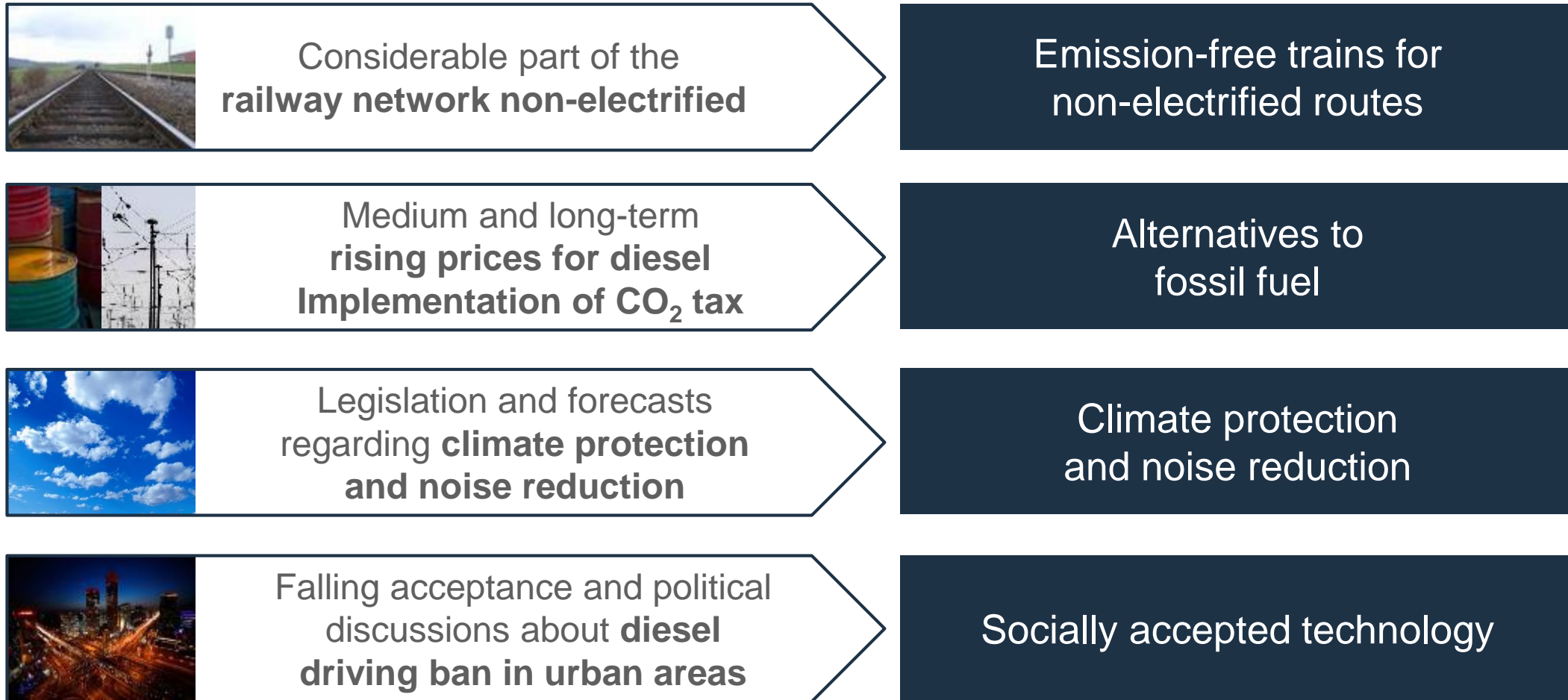
Motivation to strike a new path ... compared to current facts



- Total length of European rail network: 226.000 km.
- Approximately 46% is not electrified.
- Even more non-electrified lines in the rest of the world.

A major market in Europe and beyond.

The motivation: Need for alternative propulsion technology



02

Coradia iLint and its technology ...

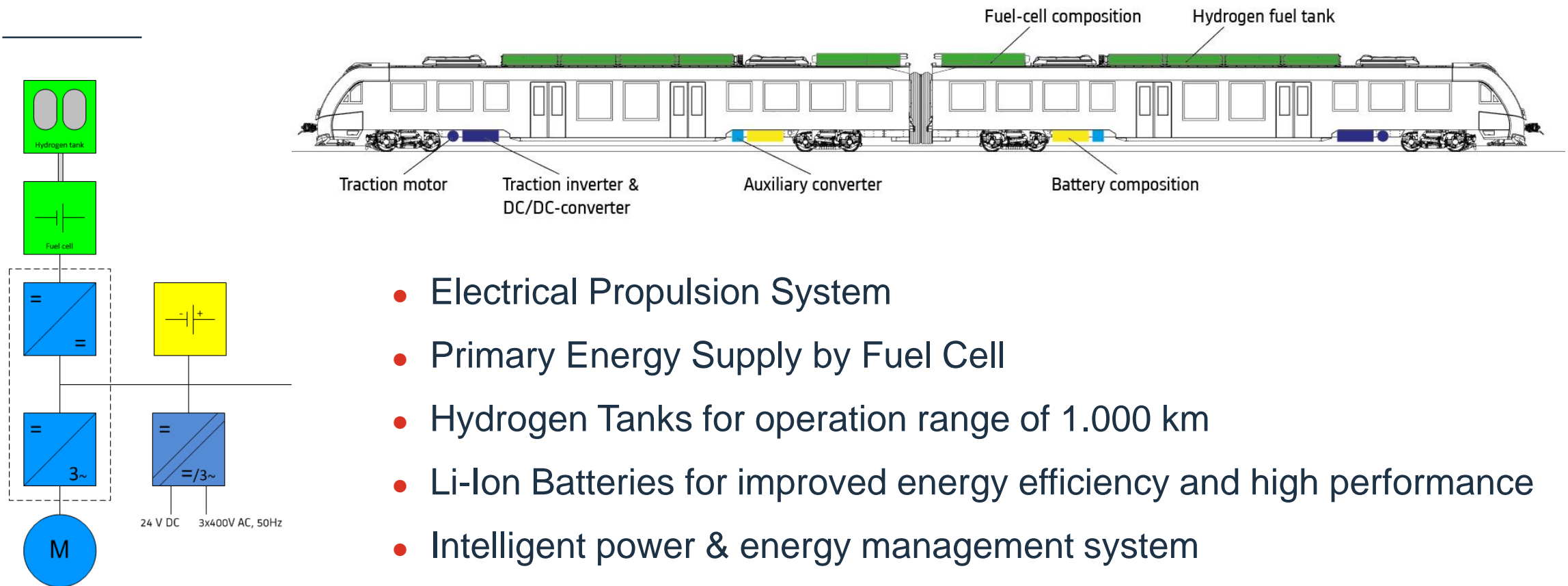
Coradia iLint



Coradia iLint



Coradia iLint: The technology

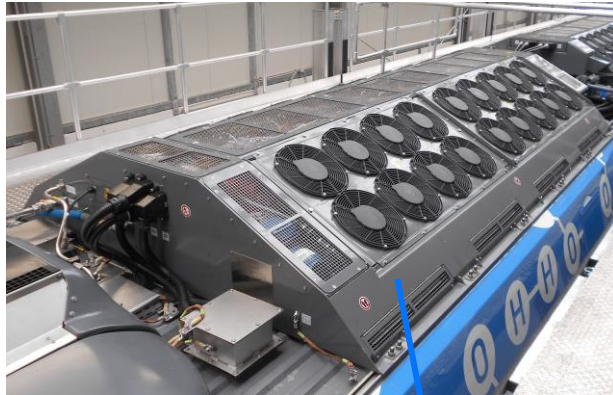


- Electrical Propulsion System
- Primary Energy Supply by Fuel Cell
- Hydrogen Tanks for operation range of 1.000 km
- Li-Ion Batteries for improved energy efficiency and high performance
- Intelligent power & energy management system

Electrical propulsion without overhead line!

Coradia iLint: The components

Fuel Cell Composition



Hydrogen storage



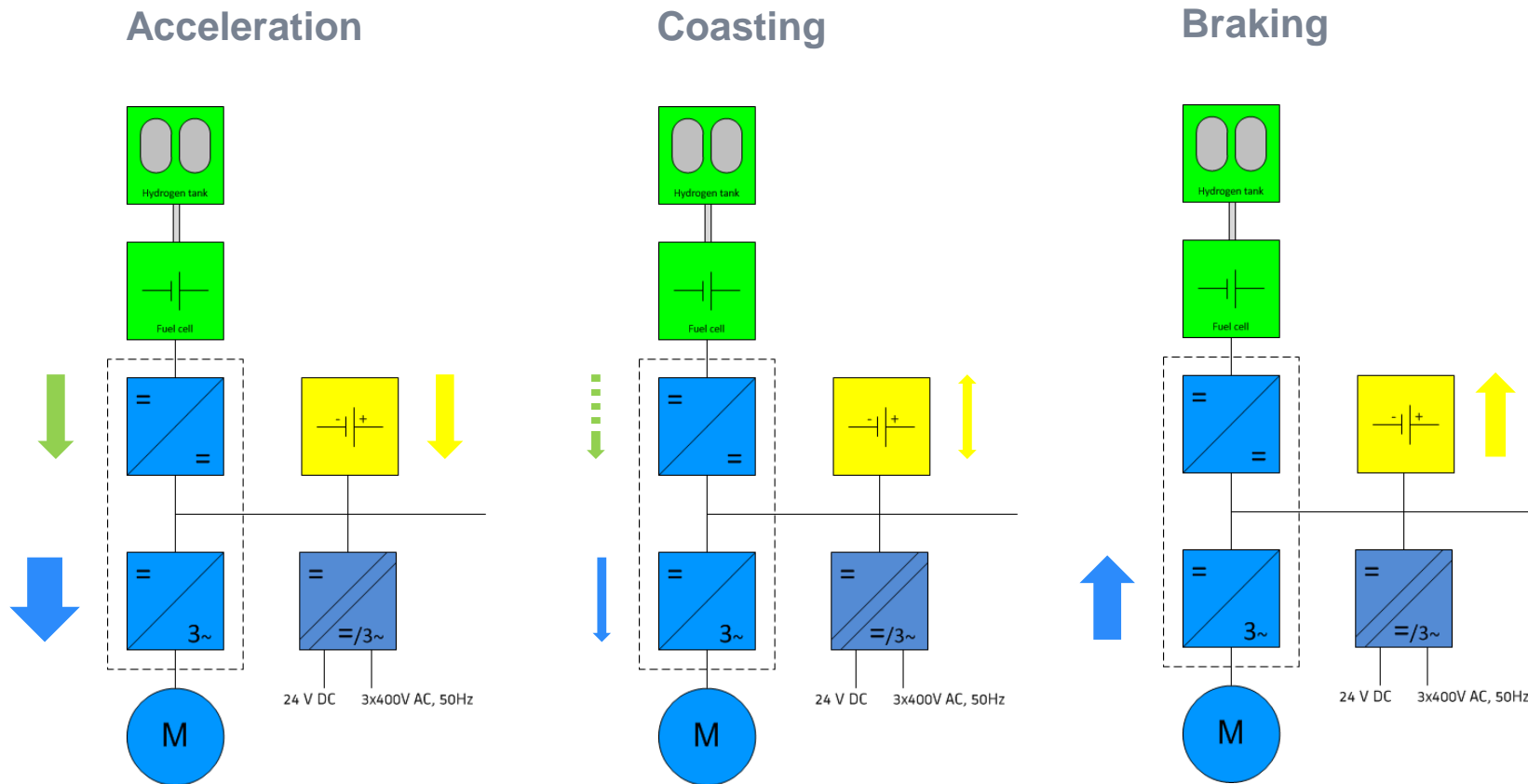
Nominal pressure at 350 bar @ 15°C



Lithium-Ion Battery Composition



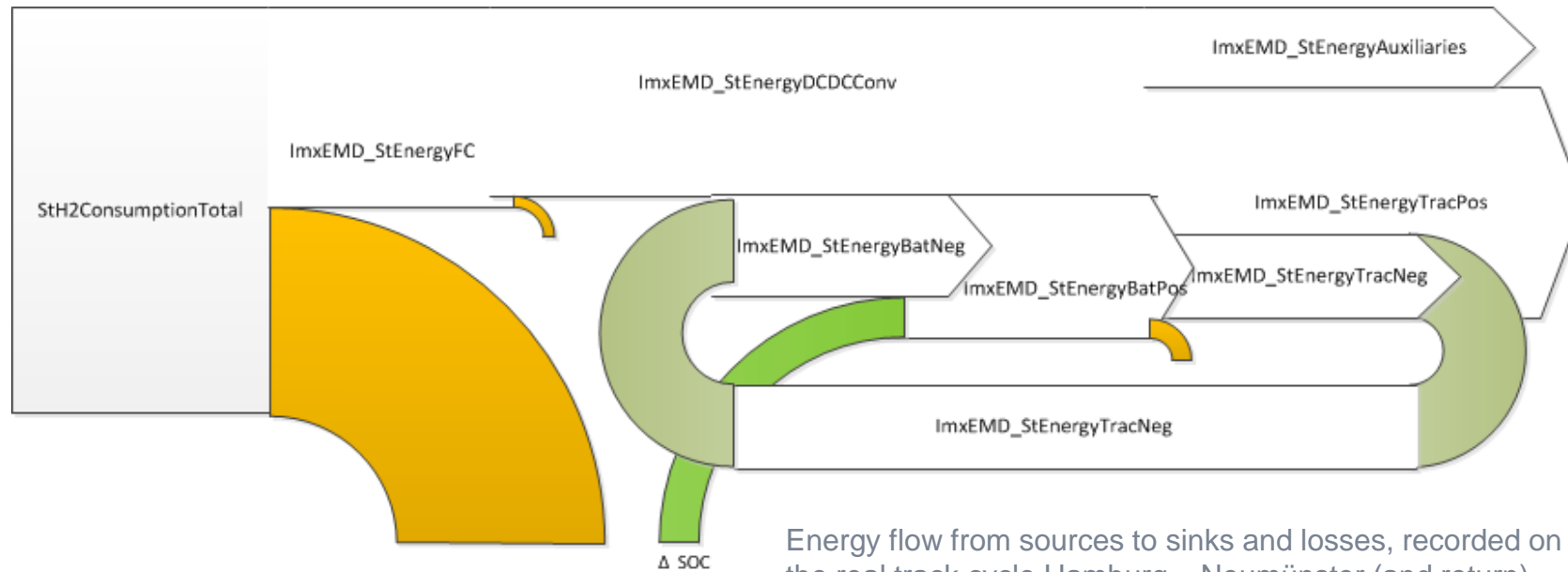
Coradia iLint: The power & energy management



- **Avoid of low fuel cell efficiency** at high power demand during acceleration
- **Optimize power management** during coasting
- **Recuperate kinetic energy** during braking

Coradia iLint: The efficiency

Energy supply, consumption and recuperation for a typical real track cycle



Energy flow from sources to sinks and losses, recorded on the real track cycle Hamburg – Neumünster (and return).

High overall efficiency due to appropriate combination of fuel cell and battery.

Coradia iLint: An economical comparison

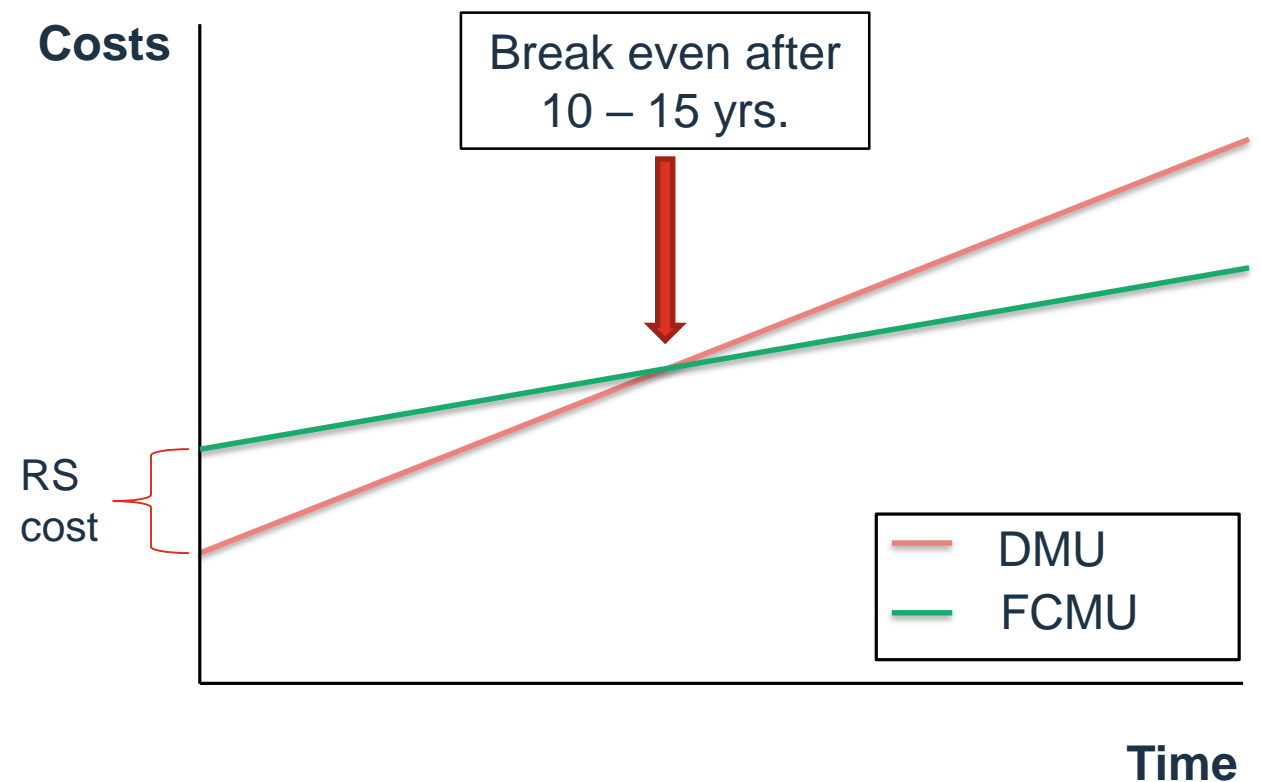
TCO Analysis DMU vs. FCMU

TCO	DMU	FCMU
Train costs	100%	125 - 135%
Maintenance costs	100%	85 - 90%
Energy costs	100%	90 - 100%

Break even point depends on

- Annual fleet mileage
- Fuel price (hydrogen & diesel)
- Labor costs
- Cost of Infrastructure

Total Cost of Ownership for a given fleet



03

... in operation

Coradia iLint in operation

**Homologated July 18
by EBA (Germany)**



**Passenger service
Bremervörde Sept 18 - Feb 20**



**Test operation in NL
27.02.20 – 11.03.20**



**Passenger service
Austria since 11.09.2020**

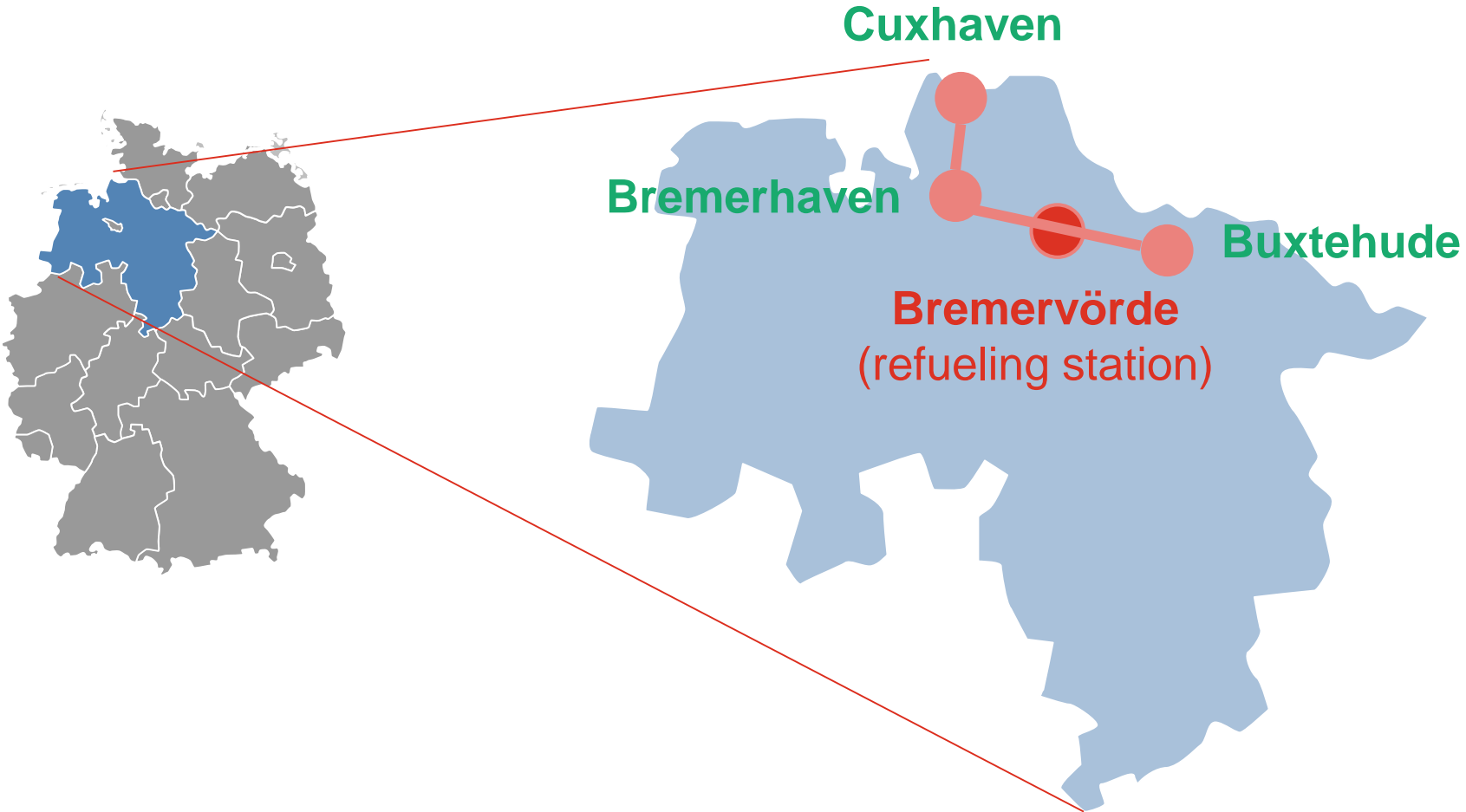


- Further (test) operations under preparation

**Homologation acc. to §32a EisbG
received on 28.10.2020**

Results from revenue service are highlighting stable availability of the technology!

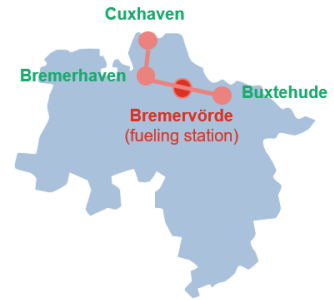
Coradia iLint in operation: Passenger service Bremervörde (Sept. 18 to Feb. 20)



Coradia iLint in operation: Passenger service Bremervörde (Sept. 18 to Feb. 20)

Experience of 18 months of regular operation

- Distance covered: > 180.000 km (pass. service) / > 200.000 (total)
 - Total distance covered by one train > 115.000 km
- Availability of trains: > 95 % (operational)
- Experience from operation phase used to improve technology and further reduce consumption for series projects – before any other train supplier brought a fuel cell or battery train into regular service



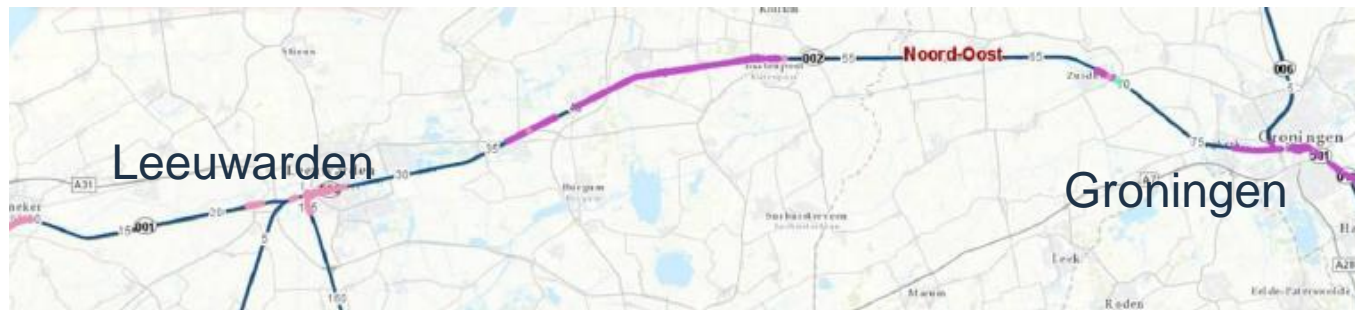
Rigidity of new technology was improved thru 18 months / 200.000 km operation!

Coradia iLint in operation: The Netherlands



Operation Set-up

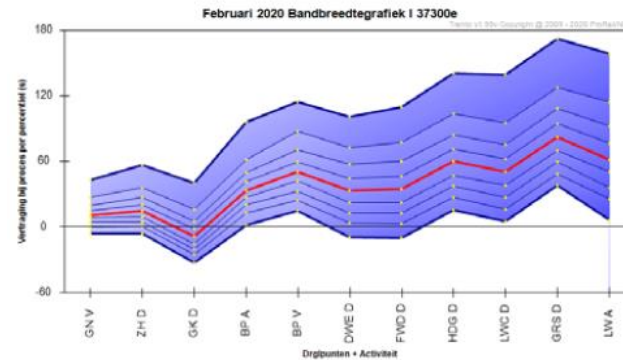
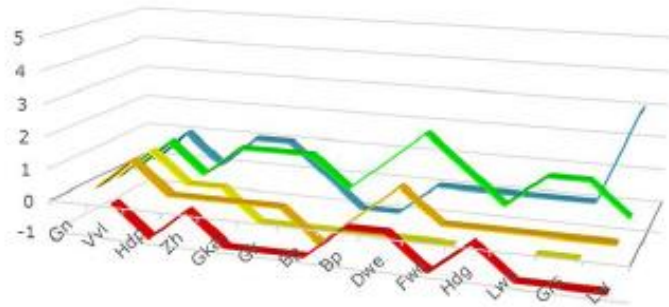
- Operation on regular track between Leeuwarden and Groningen from 27.02.2020 to 11.03.2020
- Simulation of regular operation of Intercity Train (“Sneltrain”) and Local Train (“Stoptrein”)
- No homologation for passenger service since limitations regarding local / national signaling and train radio equipment
- Operation of HRS with local partner



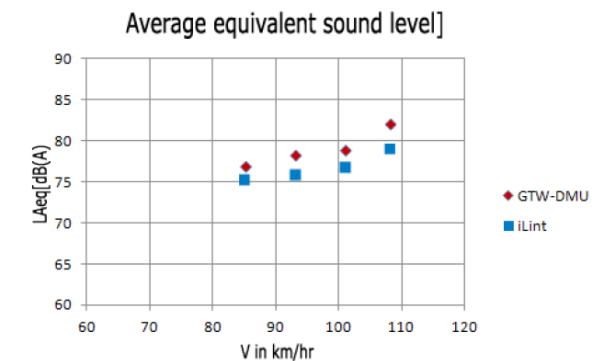
Coradia iLint in operation: The Netherlands

Results

- Full compliance with requirements of demanding timetable



- Significant reduction in noise level at standstill and during movement
- Compatibility to infrastructure needs proved
- Drivers very satisfied: “comfortable and easy to drive”

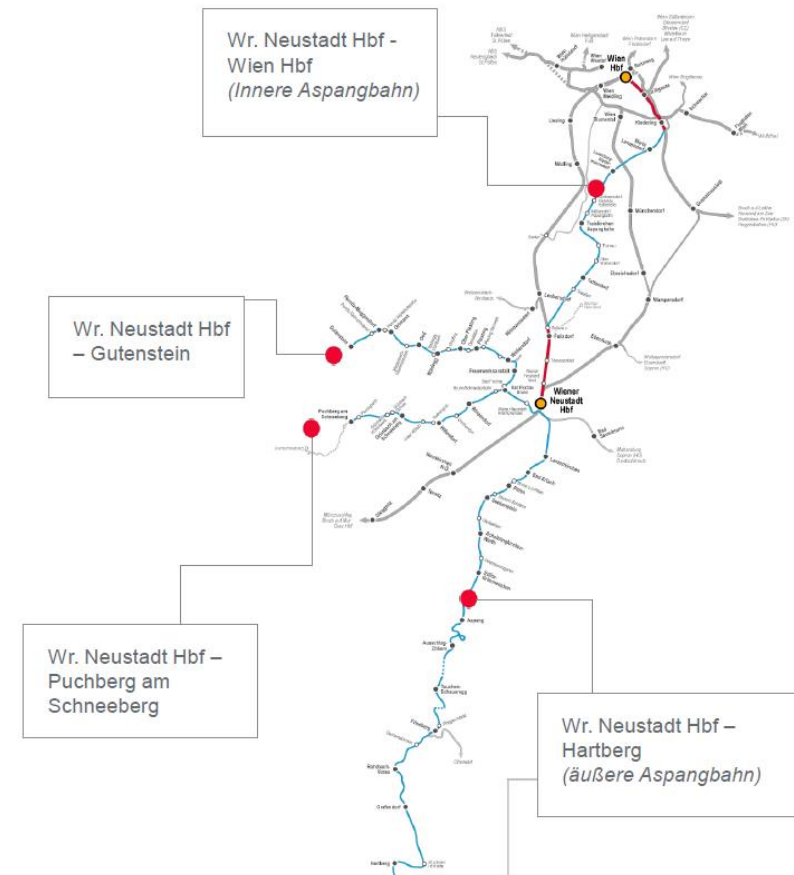
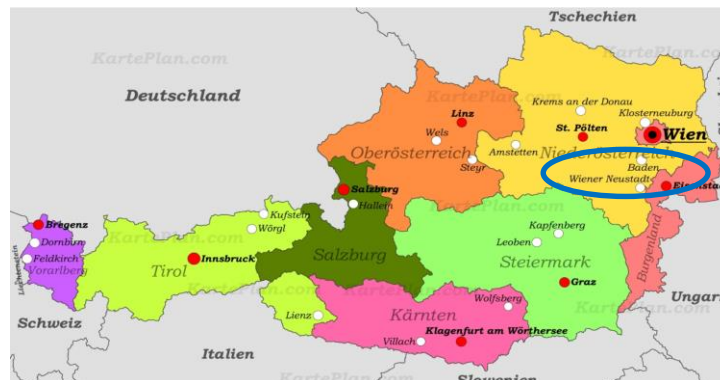


Coradia iLint in operation: Austria



Operation Set-up

- Operation on 4 lines in the area of Wiener Neustadt between September and end of November 2020
- Regular operation acc. to time tables with passengers (mixed with standard DMU)
- Ambitious tracks in alpine area with slopes of regular 2,0 to 2,5 % and maximum to 4,4 %



Coradia iLint in operation: Austria



Status

- Inauguration event on 11.09.2020 at Vienna main station
- Successful validation of operation regarding track infrastructure
- Homologation acc. to § 32a EisebG
- Already > 16.000 km covered with positive results in hydrogen consumption



04

Hydrogen: Demand & Opportunities

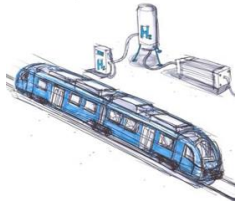
Hydrogen: Demand & Opportunities

a full fleet

1 iLint train



30 – 55t H₂
per year...



... minus
700t CO₂
per year...

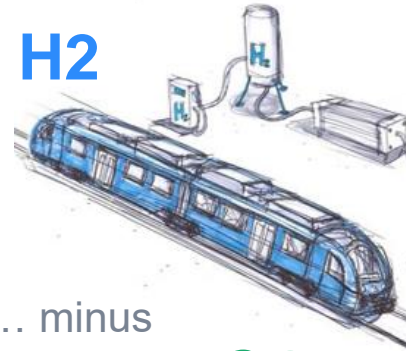
...equals annual
emissions of
400 cars



any small network



500 – 800t H₂
per year...



... minus
11.000t CO₂
per year...

...equals annual
emissions of
6.000 cars



4.000 – 6.600t H₂
per year...



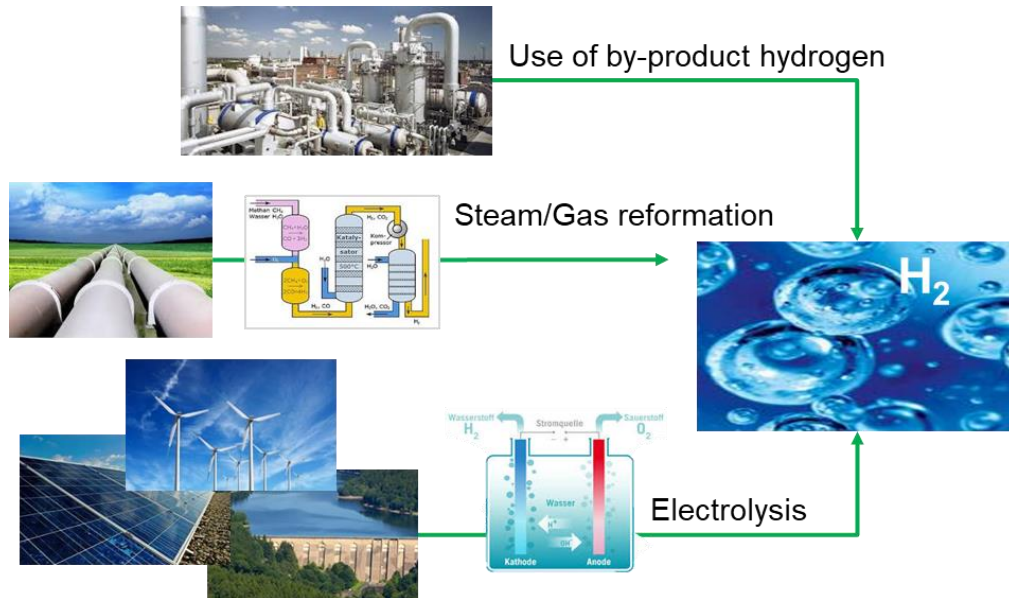
... minus
84.000t CO₂
per year...

...equals annual
emissions of
48.000 cars

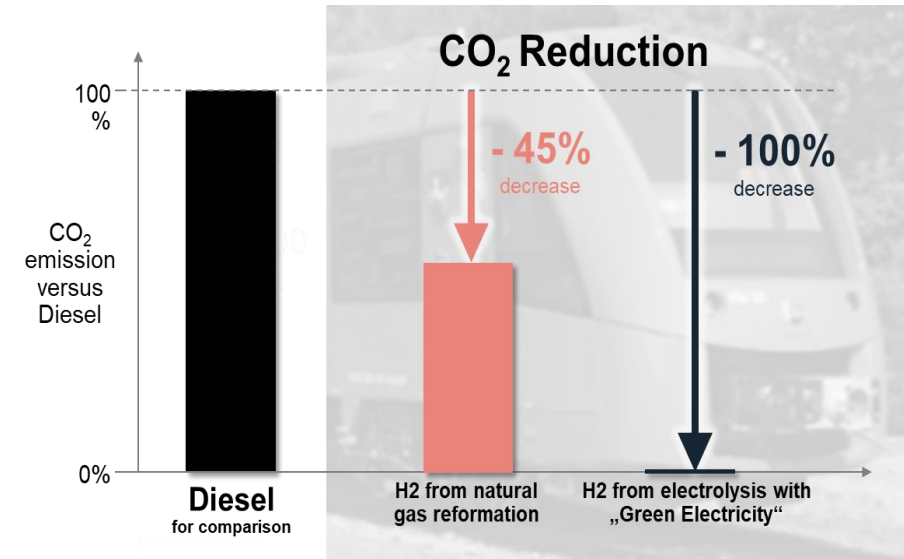


Hydrogen: Demand & Opportunities

- Different sources to produce hydrogen: from by-product to regenerative energy

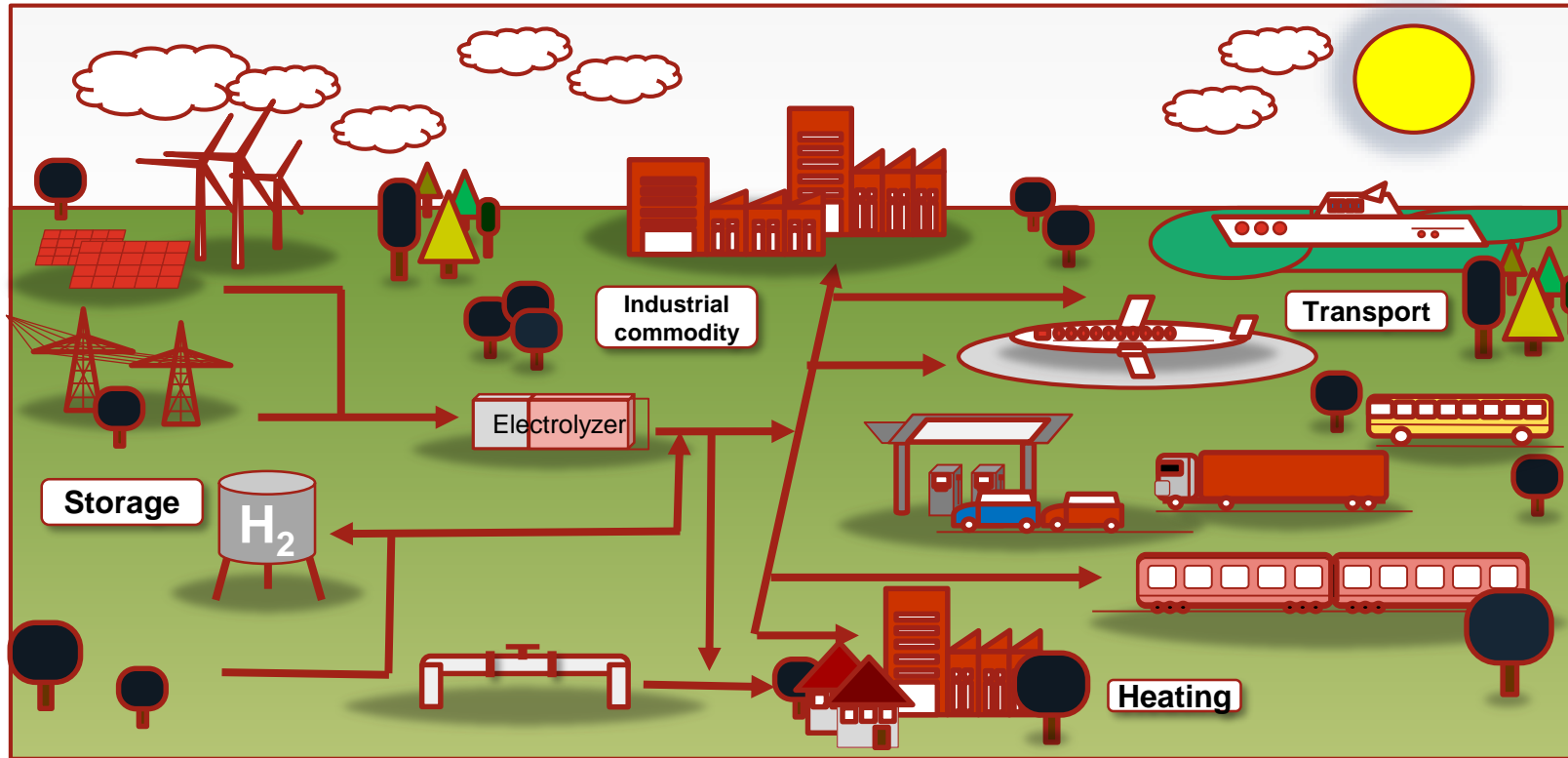


- The hydrogen production method determines the reduction of CO₂



Hydrogen trains will open the door. – The step thru it is done by the hydrogen source!

Hydrogen: Demand & Opportunities



Successful implementation of hydrogen applications within a „hydrogen society“!

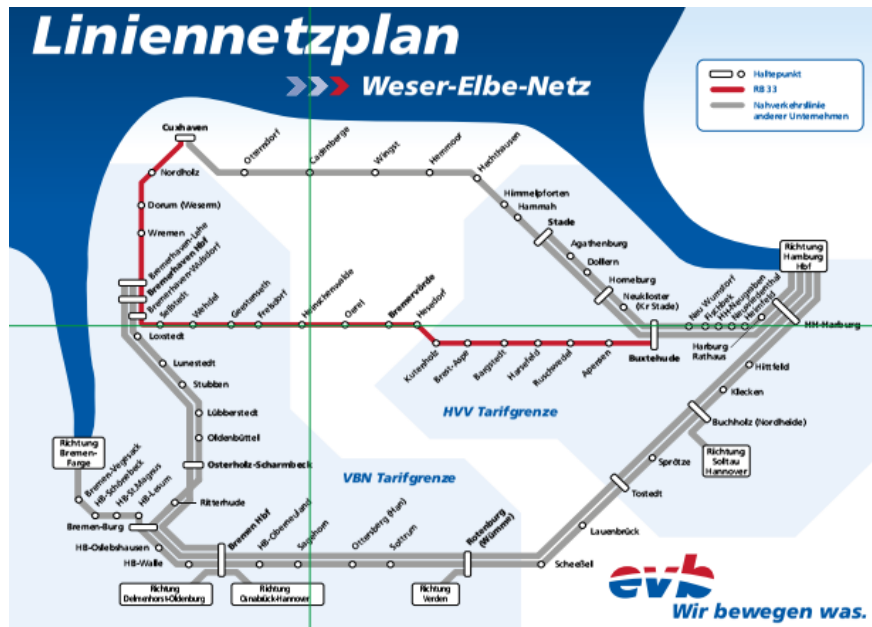
05

Next steps

The future starts now ...

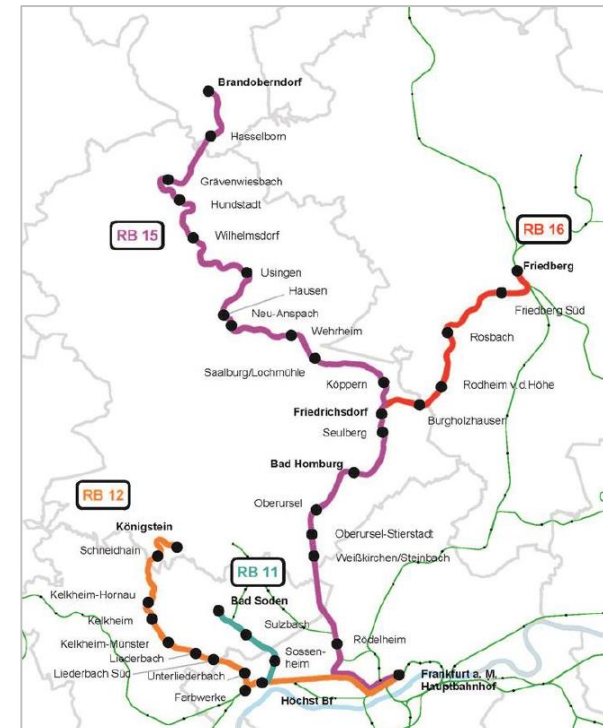
Weser-Elbe-Netz (LNVG)

- 14 Coradia iLint
- Start of operation 2022
- 30 years of maintenance and hydrogen supply



Taunusnetz (RMV / FAHMA)

- 27 Coradia iLint
- Start of operation 2022/23
- 25 years of maintenance and hydrogen supply



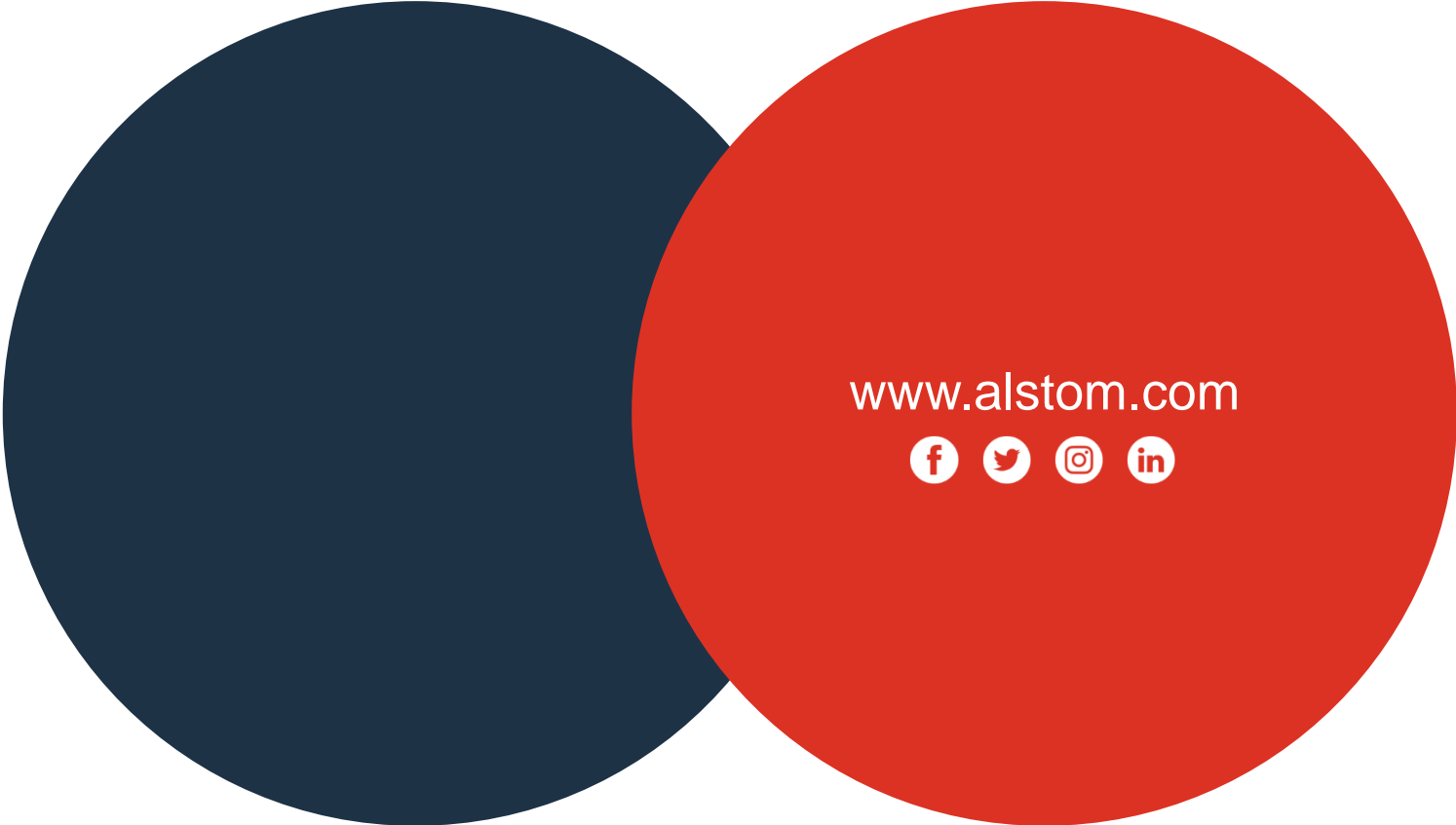
The future starts now ... everywhere?

Optimal conditions for emission-free rail transport in Europe and North-America



Coradia iLint in Austria





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