



Running the World's First Commercial Hydrogen Train Fleet

Challenges & Lessons Learned

Christoph Grimm, CEO
evb – Eisenbahnen und Verkehrsbetriebe
Elbe-Weser GmbH, Germany

Rail: On Track for Decarbonization
May 16-17, 2023 | Denver, CO

On August 24, 2022, a German regional railroad wrote H₂istory



World's first HEMU fleet
in regular scheduled service

Mission:

- ensure reliable
day-to-day operation
- establish **processes & standards**
- gather **knowledge for future development** & next generation of HEMUs



Welcome to Bremervörde!

(Video)



Nearby and far ahead: introducing evb



- **Serving the entire production chain for organizing + operating public transportation with 5 units:**
rail | bus | freight / logistics |
infrastructure | maintenance & engineering
- **Agile size:** 660 employees in evb group
- **Annual turnover:** \$130 million USD
- **State-owned** by Lower Saxony, public entity
- evb is a tool for **regional economic development**
- Climate-friendly **mobility provider**
in predominantly **rural region**
- **Rooted in the region** and close to the customer
- **Competing** with other railroads and service providers /
freight companies
- Highly innovative – and
perfect for pioneering new technology

Infrastructure

Freight & Logistics

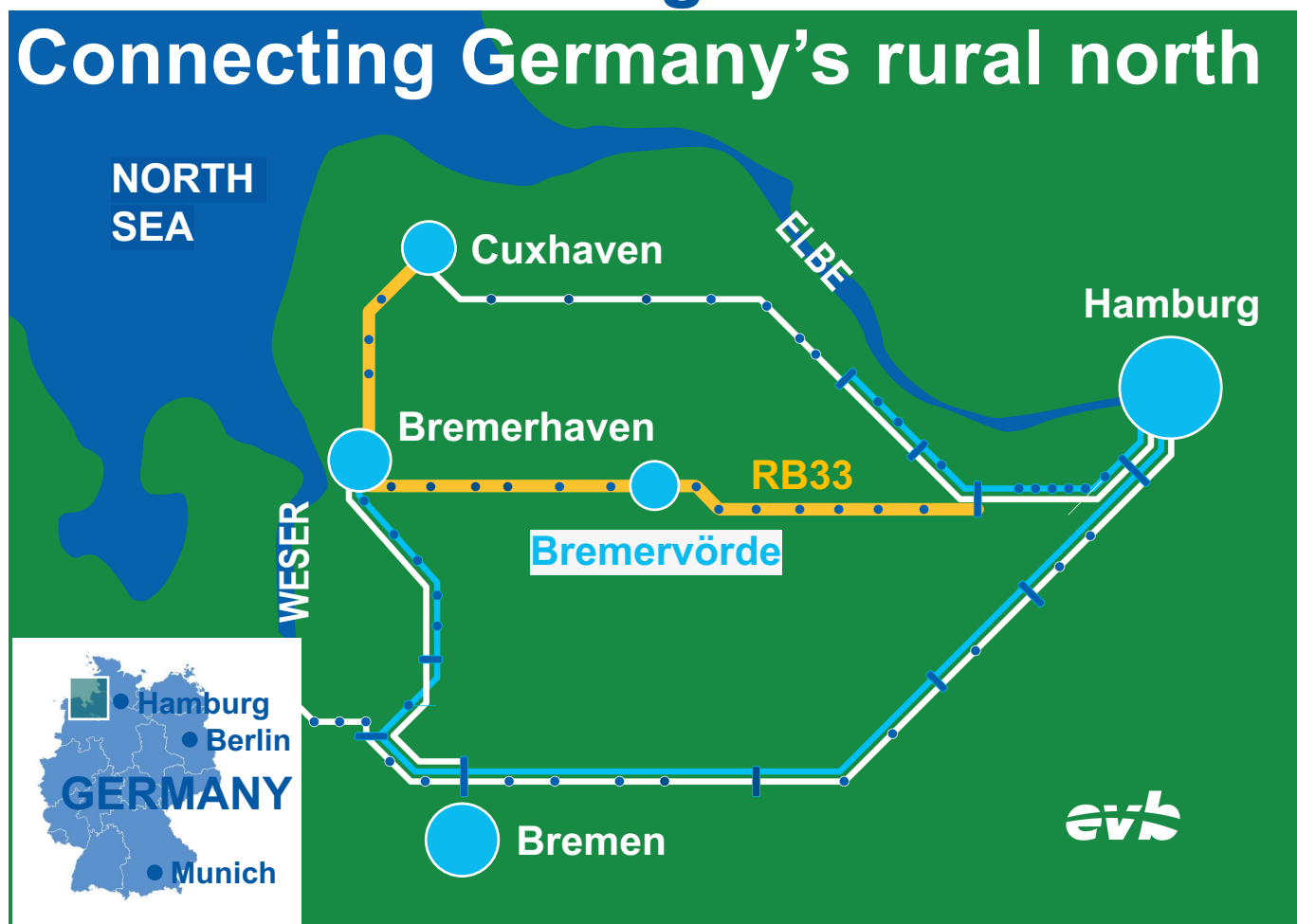


Maintenance & Engineering

Rail & Bus



A lifeline to the region: Connecting Germany's rural north



- Central line of “Elbe-Weser Triangle” (marked orange)
- Connection to metropolises Hamburg (pop. 1.8 Mio) and Bremen (pop. 600 K), vital for daily commuting
- 79 miles long, 2 hours 50 minutes travel time
- Hourly service, 7 days a week
- Non-electrified, single track
- 1.5 Mio annual passengers
- Established line, previously operated with DMUs

Why hydrogen?

- **Climate protection**
- **Noise reduction**
- **Need to phase out Diesel**
(price, CO₂ charges, shrinking public acceptance)
- **Non-electrified track**
(electrification commercially not viable)
- **Keep DMU flexibility**
with less environmental impact:
wide range
few fueling stops
quick refueling
- **Enables green H₂ production on site**
via **local electrolysis**
boosts **local economic cycles**
ensures **price stability**
100% fossil free

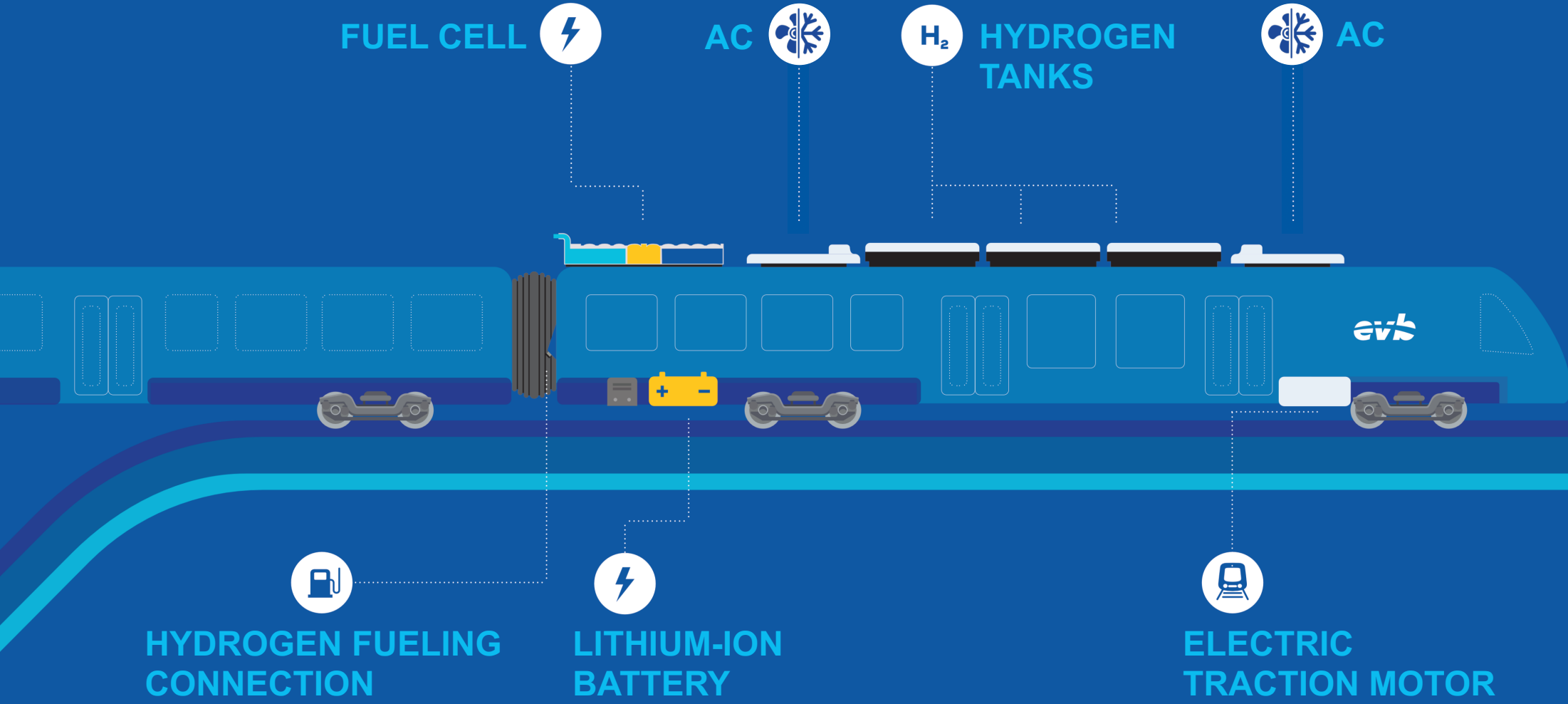


Alstom Coradia iLint



- **World's first hydrogen-powered passenger train**
- **Based on DMU platform LINT**
- **2 hydrogen tanks** of 130 kg / 287 lbs each (pressure approx. 350 bar / 5076 PSI, refueling times approx. 20 to 60 min)
- **2 fuel cells** with 210 kW power each
- **Additional battery** for energy management:
Recuperation of braking energy
Boost acceleration
Supply of on-board equipment and auxiliaries
- **Top speed:** 87 mph
- Up to **157 seats** per unit
- **World record range** (on September 15, 2022):
730 miles with one H₂ tank filling (exceeds standard range)

Alstom Coradia iLint



Fueling station

- World's first H₂ fueling station for passenger trains
- Location: close to evb workshop in Bremervörde
- 574 lbs H₂ capacity per HEMU
- Station volume: up to 2 US t H₂ per day (average consumption for 14 iLint: 1.8 US t)
- H₂ = byproduct of nearby chemical plant
- Coming soon: production of **green hydrogen** on site

Project partners



Landesnahverkehrsgesellschaft Niedersachsen (LNVG):

- **Agency**
- **Plans, organizes and finances** regional passenger train services in Lower Saxony
- **Acquires rolling stock** and provides **rolling stock pool**



- **Train operator**
- Performs **maintenance** (subcontracted by Alstom)
- Provides **workshops, track infrastructure** and **fueling station site**



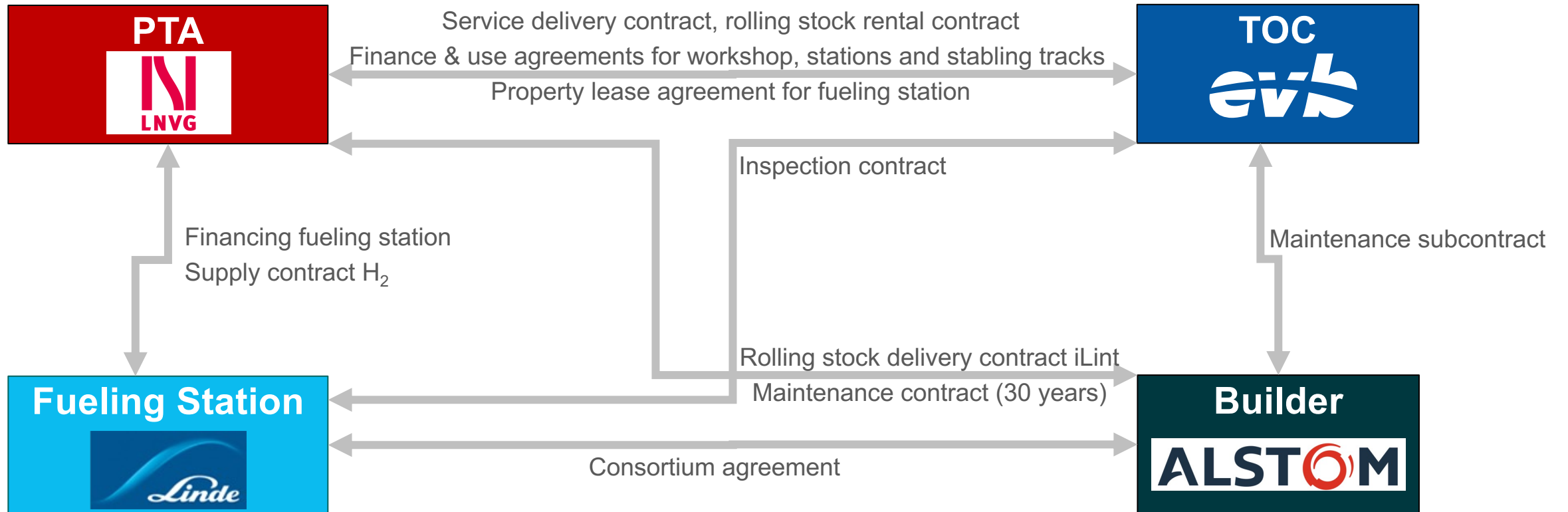
- Builds **trains**
- Responsible for **maintenance** over life span
- **Consortium partner** of Linde for H₂ fueling station



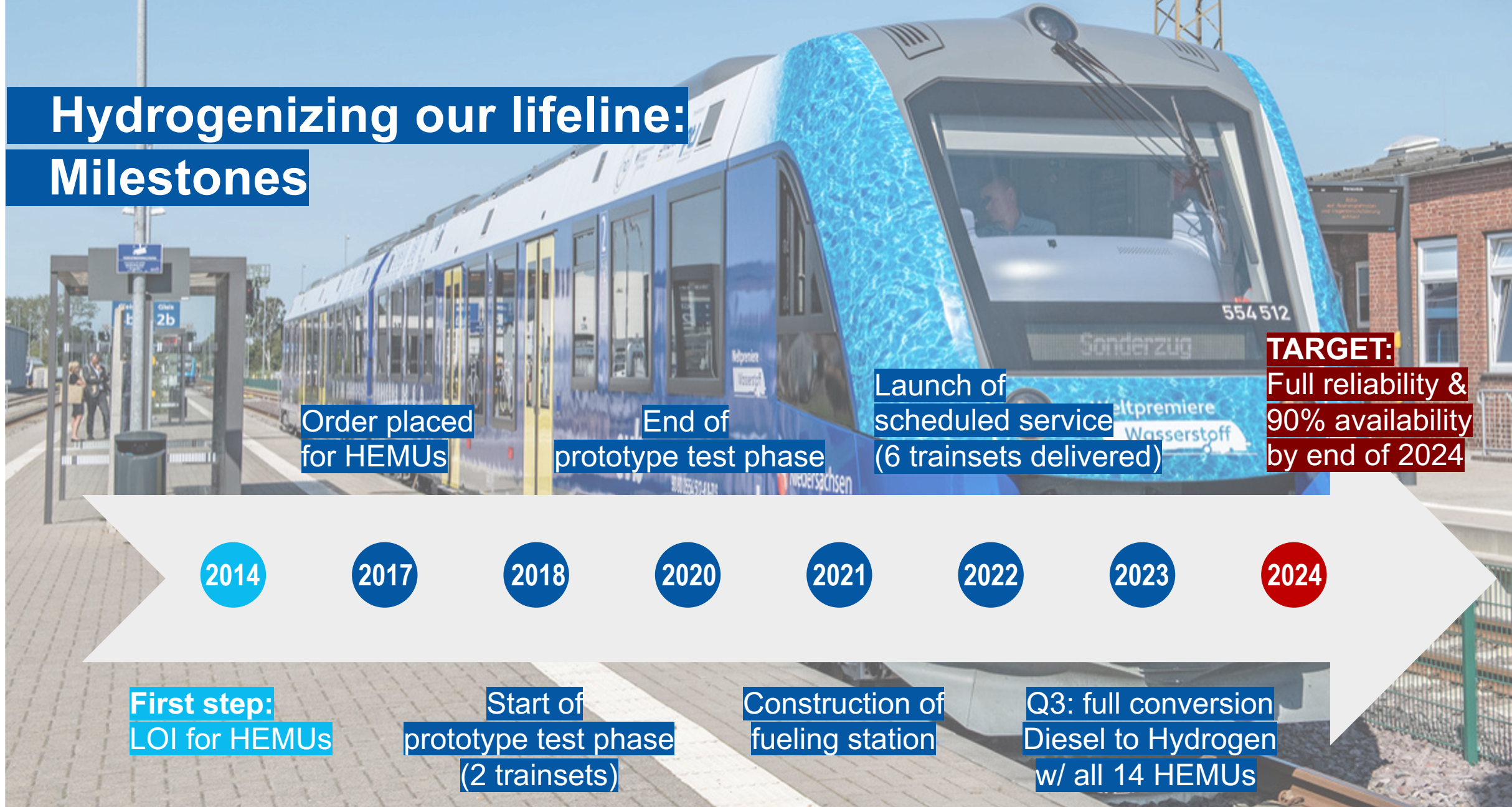
- Builds and maintains **H₂ fueling station**
- Provides **hydrogen**



Selected contracts



Hydrogenizing our lifeline: Milestones



Order placed
for HEMUs

End of
prototype test phase

Launch of
scheduled service
(6 trainsets delivered)

TARGET:
Full reliability &
90% availability
by end of 2024

2014

2017

2018

2020

2021

2022

2023

2024

First step:
LOI for HEMUs

Start of
prototype test phase
(2 trainsets)

Construction of
fueling station

Q3: full conversion
Diesel to Hydrogen
w/ all 14 HEMUs

Project challenges



- **Availability**
trains, components:
about 20% during first few months
- **Processes & standards**
best practices not established –
or non existing
- **Range**
limited by AC, auxiliaries and temperature
(total cons. about 0.89-1.06 lbs H₂ per mile)
- **Resources**
extra management capacity,
workforce / staff
- **Budget**
unexpected additional cost

Learning by doing – and breaking new ground



- **All-new risk assessments and safety standards**
possible blueprint for future projects
- **Determining range** needs real-life experience
influence of weather, timetable, passenger load etc.
- **All-new refueling process**
no shutdown of fuel cells required
cooling beneficial for speed
- **Maintenance of roof-based H₂ components**
construction of dedicated workshops not necessarily required (depends on circumstances)
- **H₂ detection** in workshop
far more marginal problem than expected,
as yet no false alarms
- **Training staff and stakeholders**
including external partners,
e.g. training 100 firefighters in handling hydrogen
in case of emergencies

Lessons learned: It's worth it – but remember ...



- **High level of dedicated resources** needed for success
- Ensure **fallback solution** to avoid service interruptions: backup fleet or possibility to push back launch
- Expect **additional cost & delays** and accept **preliminary data**: It's still early days, no full data set
- **Reduce complexity** where possible (e.g. contractual scheme)
- Be aware of **range restrictions** due to standards (min. tank pressure) and energy consumption of auxiliaries
- **Establish processes** for overall evaluation and knowledge assessment early on
- Think big and **leverage synergies** (e.g. trucking companies) using a **holistic approach**

Key message: It's all about the concept

- Key for major carbon reduction:
winning new customers for public transport
- Decisive factor:
increase overall attractiveness of public transport, independent of propulsion technology

Thank You!

evb | Eisenbahnen und
Verkehrsbetriebe Elbe-Weser GmbH
Bahnhofstr. 67
D-27404 Zeven

info@evb-elbe-weser.de
evb-wasserstoffzug.de



nearby and
far ahead