



HYDROGENICS

SHIFT POWER | ENERGIZE YOUR WORLD

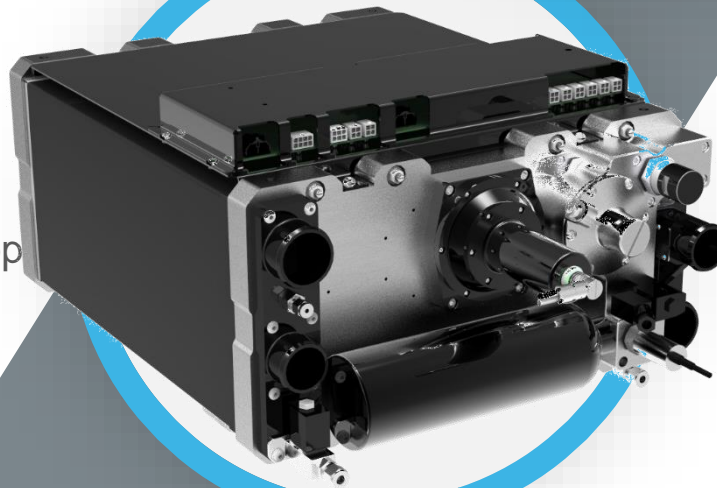


Workshop Fuel Cells and Hydrogen In the Railway Environment

Technology Status prior to railway developments

Hydrogenics HD Power Modules provide a robust and flexible platform for zero-emission heavy mobility applications.

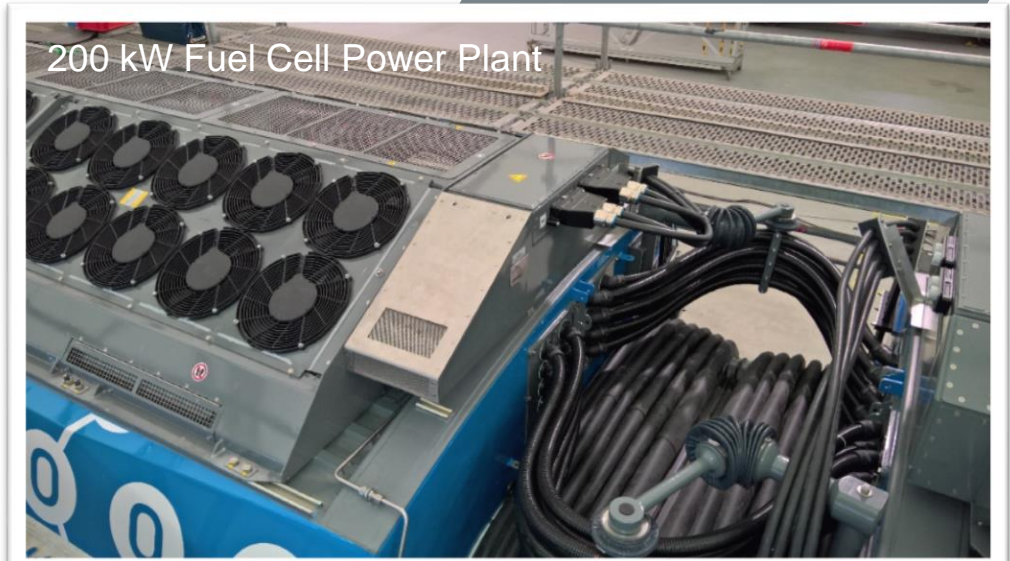
- ▶ Proven track record for superior performance, durability and reliability in bus, truck, and other heavy and light mobility since 2002
- ▶ Robust stack architecture: low pressure, dry/dry features (no humidifiers since 2009)
- ▶ High durability high cycle life components, ruggedized,
- ▶ > 10,000+ hour stack lifetime since 2009 with unlimited start/stop cycles since 2005
- ▶ Modularity enables wide and flexible kW range



Current Technology Status for Passenger Rail

The Alstom Coradia iLINT has received Certification Approval by the EBA and has started regular Regional Bahn service.

- ▶ 2014/2015 Technical Specifications defined
- ▶ 2014/2015 Applicable Codes and Standards identified
- ▶ 2015/2016 Prototype hybrid system run in the test bench (fuel cell, power electronics, battery, electric drive and controls)
- ▶ 2017 Fuel cell systems integrated into two Pre-Series Trains for test track and testing on the public rails
- ▶ 2018 Certification by the German Railway Authority (EBA)
Awarded ~ TRL Level 8
- ▶ Two trains in regular Regional Bahn service – Weser Elbe Netz (RB33: Cuxhafen - Bremerhafen - Bremervörde - Buxtehude)





Challenges for Rail Applications

- ▶ The Rail Application is one of the most demanding in terms of **Reliability**, **Availability**, **Maintainability** and **Safety**
- ▶ Demanding Duty cycle.
Vehicle operation for 30+ years
- ▶ Railway Codes, Standards, etc., extremely demanding
(EMC, Shock & Vibe, Ingress Protection, Welding, QA Requirements ...)
- ▶ Key Constraints:
Reliability, Durability, Fuel Efficiency, Weight, Compactness and **Noise**

Gen 3.0 Enhancement examples

G2.0
2011



- ▶ External coolant strainer no longer required
- ▶ Advanced cold start routine
- ▶ High isolation resistance
- ▶ Long life H2 recirculation unit
- ▶ Simplified H2 supply system
- ▶ New H2 purge architecture

G3.0
2019



Released 2019-03... HD50

Rated Power: 50 kW

- ▶ Increased power in a monolithic stack module
- ▶ Increased power density

And for modular combinations:

- ▶ reduced weight
- ▶ less interconnection
- ▶ increased simplicity
- ▶ Integration space gains

HD50
G 3.0



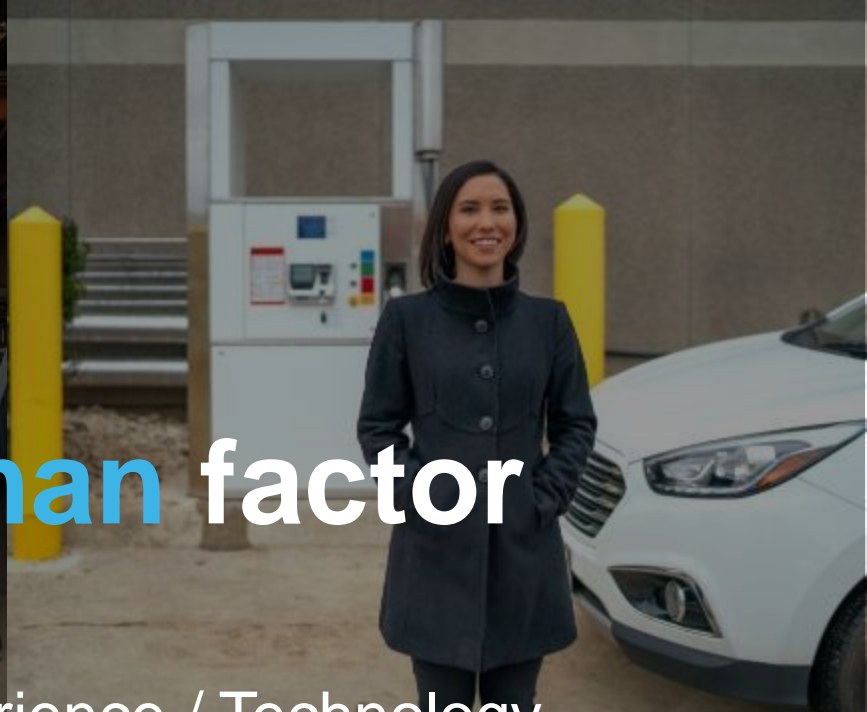
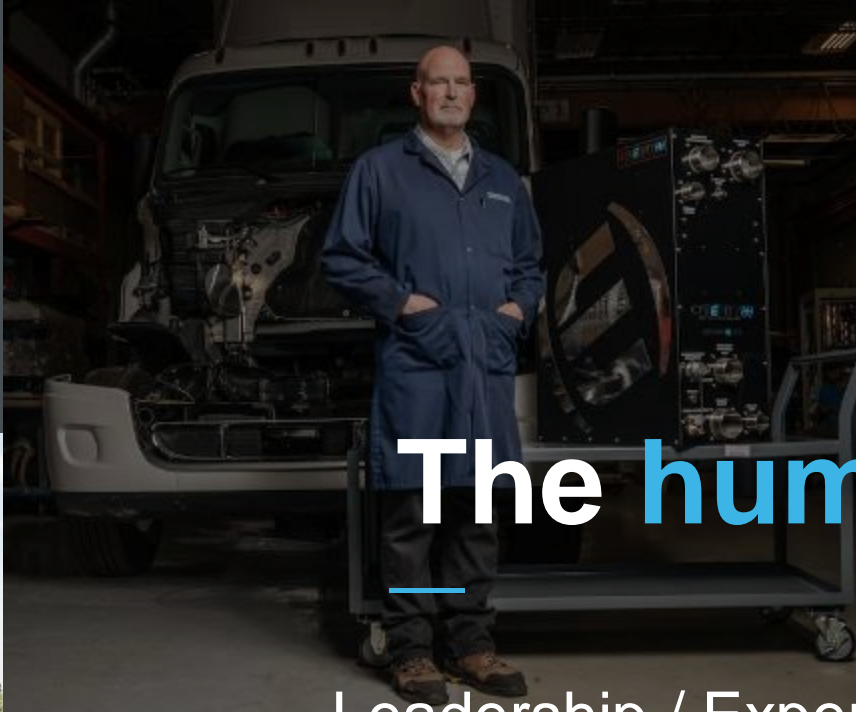
Ongoing & Future

Continuous improvement:

- ▶ Technical
- ▶ R A M S
- ▶ Production
- ▶ Costs
- ▶ TRL 9

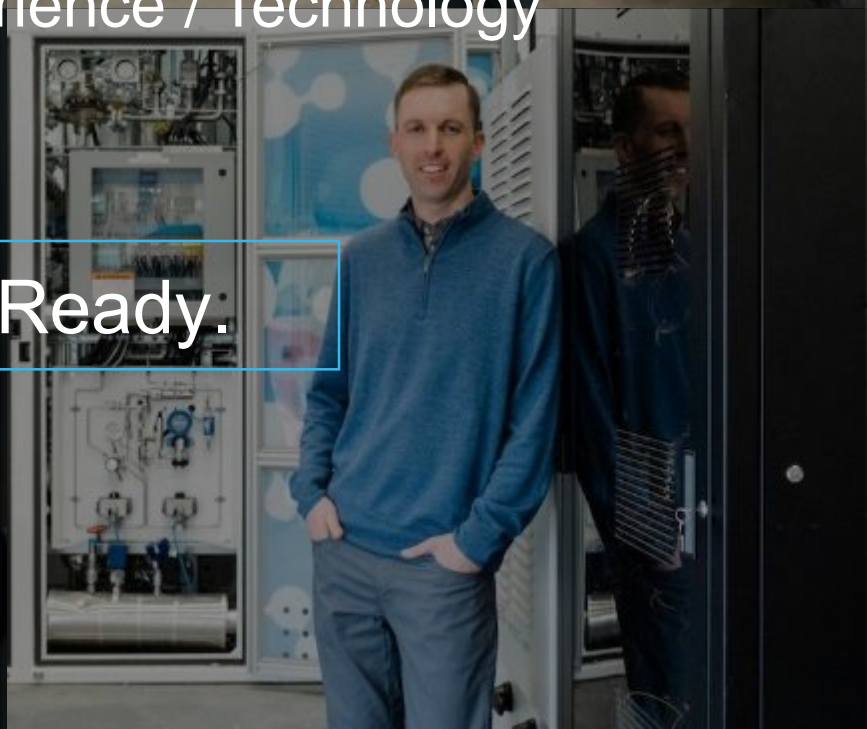
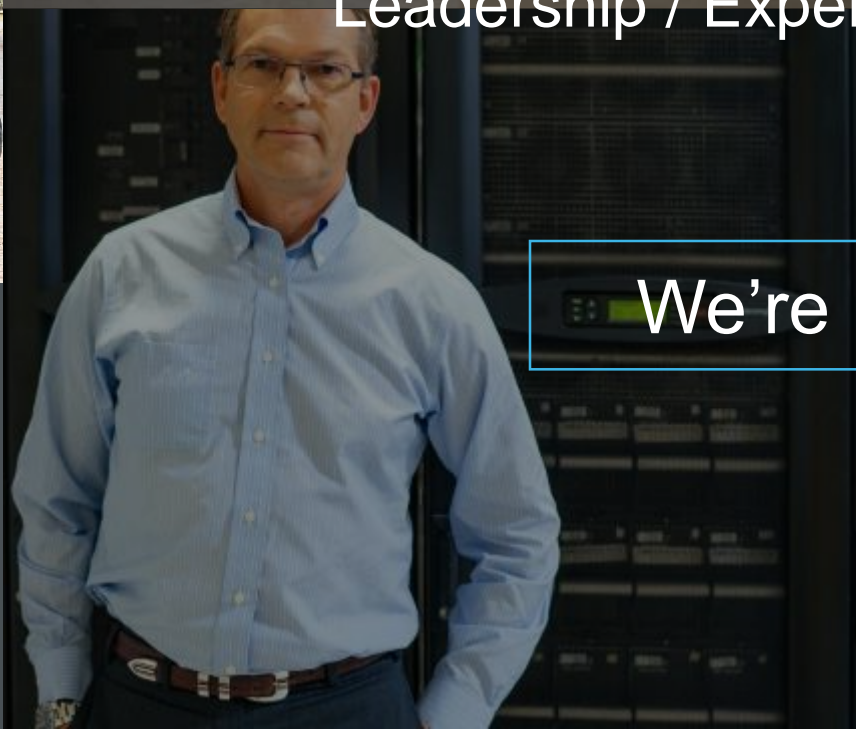


Thank you
for your
engagement



The human factor

Leadership / Experience / Technology



We're Ready.

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