Hydrogen train development

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ALSTOM
Designing fluidity

EVERSHOLT
UK RAILS GROUP

About Alstom

- **34,500 employees** working on **105 sites** in **60 countries** serving **200 customers**

Solid orders backlog

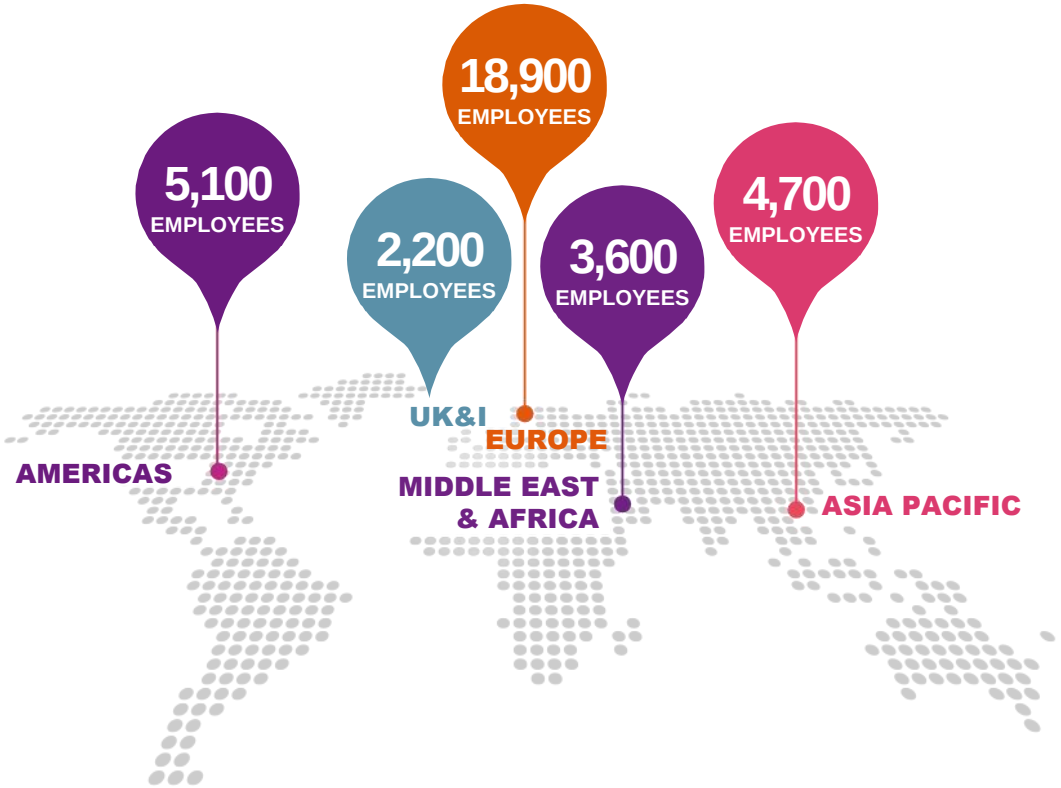
€34.2bn

Sales at outstanding growth

€8bn
+9%

Continued profitability improvement

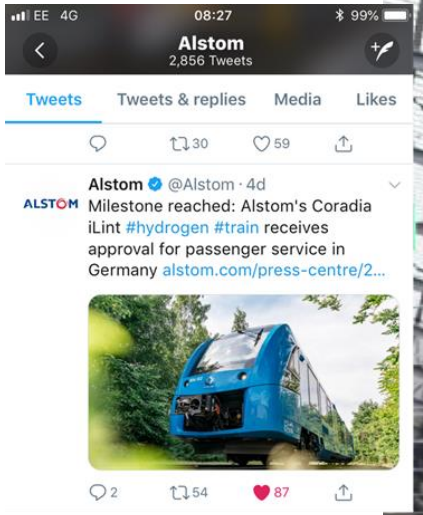
€514m Adjusted EBIT
+22%



A rail system supplier with global reach

Hydrogen trains – a new reality

- Alstom has built the world's first hydrogen fuel cell trains and last month they entered service…



Hydrogen trains – why has Alstom developed this technology?

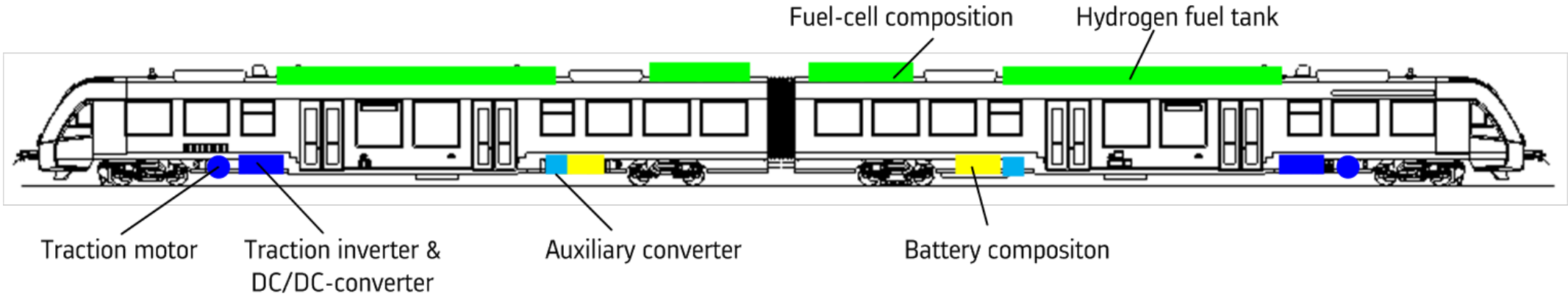
- Alstom is also a leading supplier of rail electrification equipment
- And Alstom builds electric trains, we even build diesel trains…

- So why build hydrogen trains? And why now?

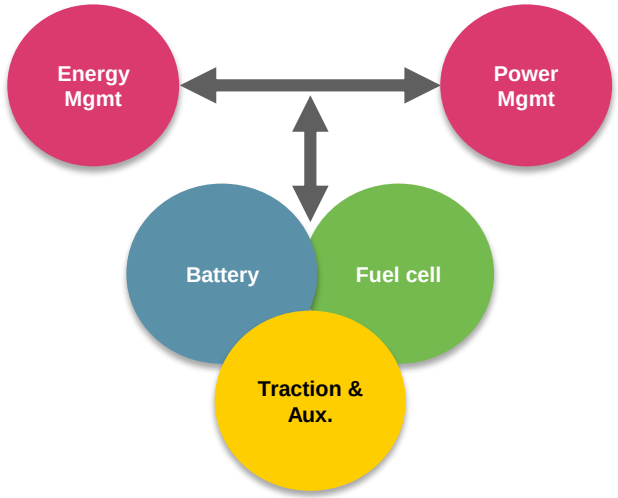
Why we build hydrogen trains

- First and foremost, because our customers want them in order to provide a cleaner, more environmentally efficient mode of rail transport.
- Because they are complementary to the other sustainable mobility products and technologies that we supply.
- Because they *do* offer a very effective alternative to electrification in certain situations, a cost effective and sustainable solution to the need to decarbonise rail transport.
- But not as an alternative to electrification in *all* circumstances.
- They do offer an ideal solution for the ~50% of the UK network that is not electrified, nor is it ever likely to be so.
- Our hydrogen trains have not been designed to bridge shortfalls in planned electrification.
- They are a solution to the greater need to provide environmentally sustainable, cost effective alternatives to diesel. Self-powered, long range trains where electrification really never made sense.

The Coradia iLint – putting theory into practice

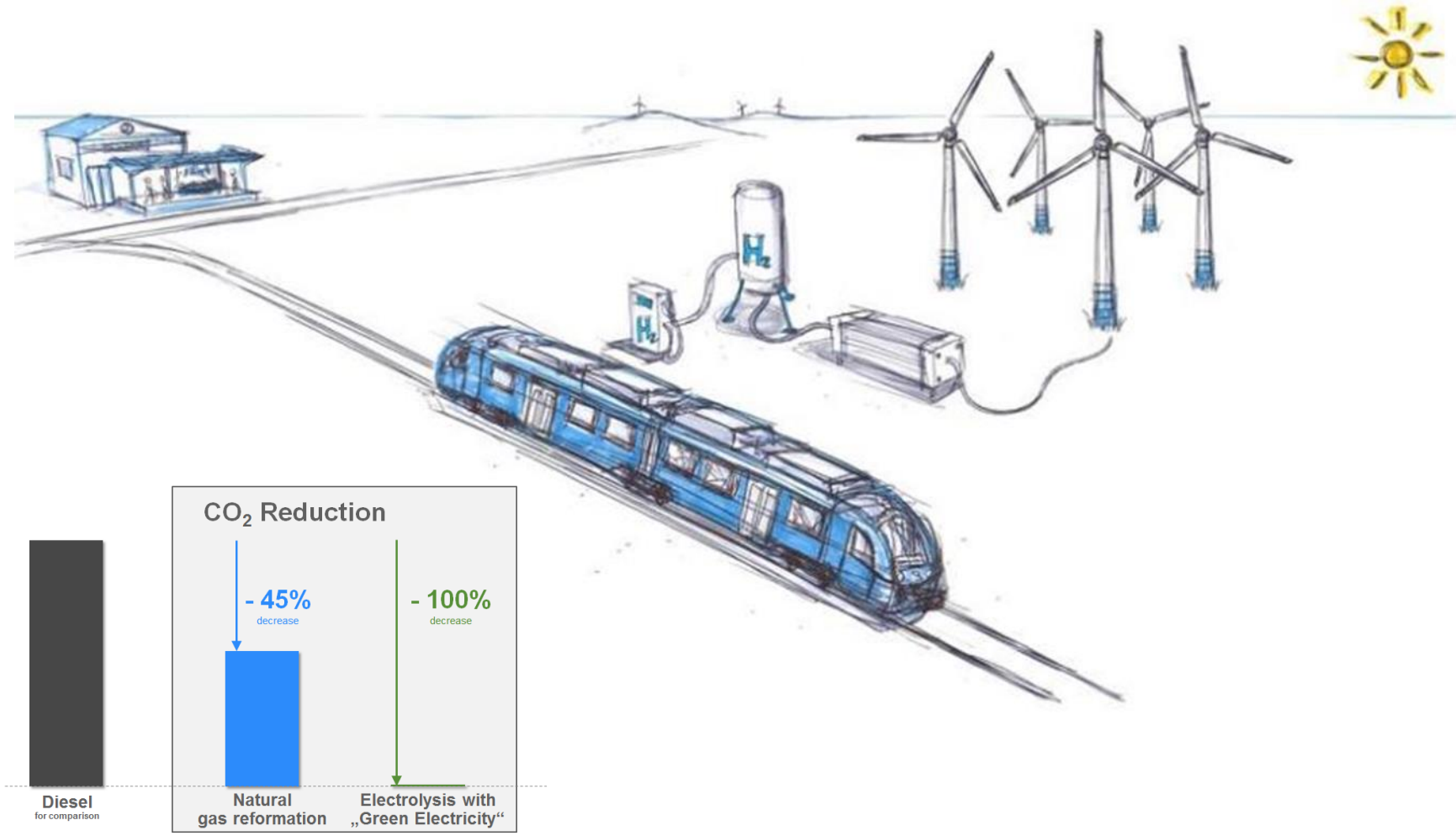


- Diesel traction replaced with electric traction system
- Primary energy supply from hydrogen fuel cells
- Intermediate energy storage from Li-Ion batteries
  - to boost during acceleration
  - to recover kinetic energy during braking
- All electric auxiliary supply



Modern energy supply and storage system combined with intelligent energy management

Achieving zero emissions



Our vision: Single sourced emission-free availability

Operator receives a maintained and tanked vehicle

Delivery of the **trains**

Construction and operation of the **H2 infrastructure** (with partners)

Maintenance and **service**

We provide emission-free availability

ALSTOM

Meeting the challenge closer to home

“I would like to see us take all diesel-only trains off the track by 2040. After all, we’re committed to ending the sales of petrol and diesel cars by 2040. If we can achieve that, then why can’t the railway aspire to a similar objective?”

“As battery technologies improve we expect to see the diesel engines in bi-modes replaced altogether with batteries powering the train between the electrified sections of the network. Or maybe in the future we could see those batteries and diesel engines replaced with hydrogen units.

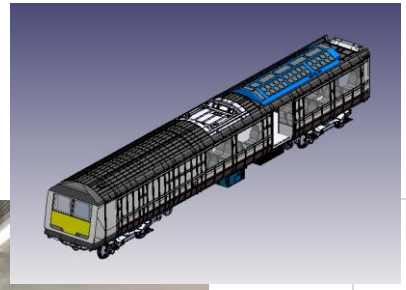
“Alternative-fuel trains powered entirely by hydrogen are a prize on the horizon and I’d like to see hydrogen train trials on the UK railway as soon as possible because hydrogen offers an affordable and potentially much cleaner alternative to diesel.”

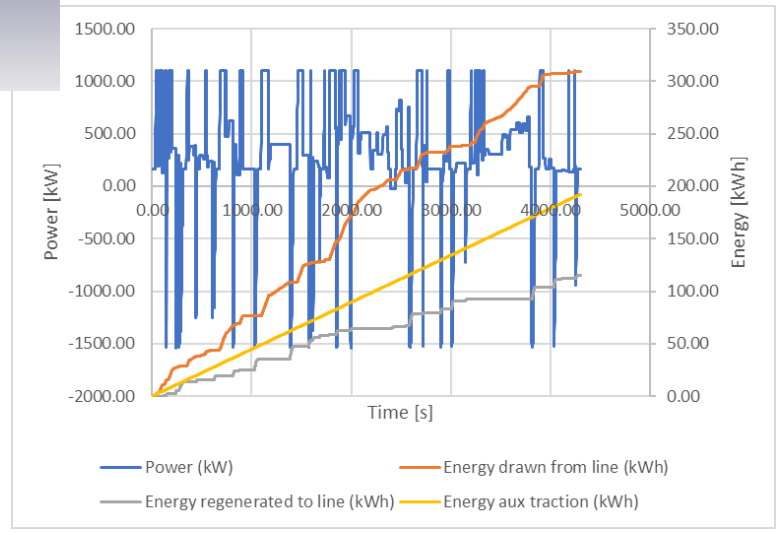
Jo Johnson, UK Minister of State for the DfT, 12 February 2018

#Dieselgate

The next steps are in the UK…

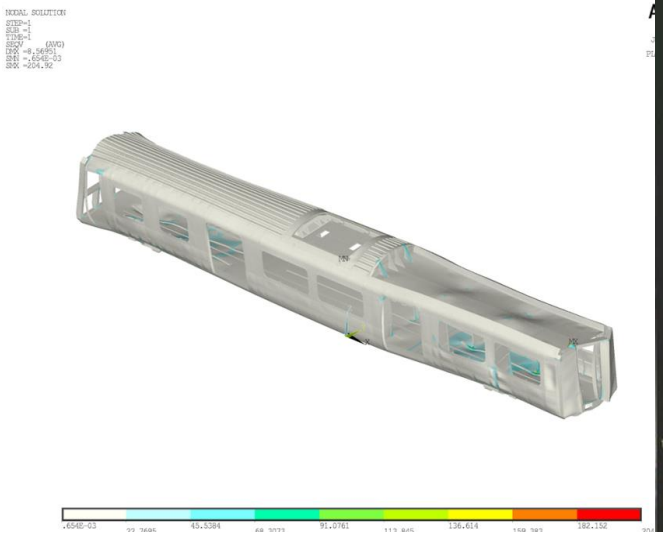
- For the UK, we are planning the conversion of Class 321 electric trains to create the first UK gauge, UK built, zero emission trains and to deploy them across Britain.
- We are exploiting the proven know-how from Coradia iLint, repackaging it for the UK and pioneering the homologation process to establish the basis for product and system approval.

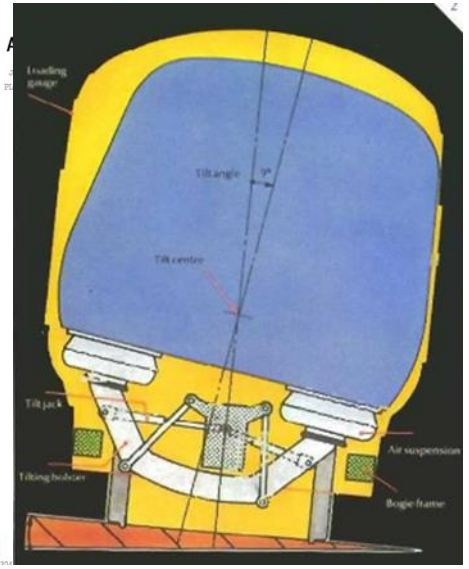


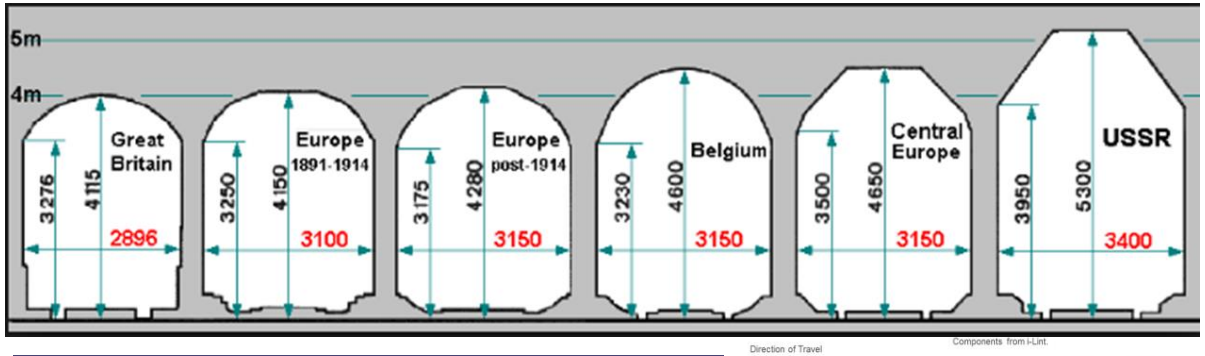


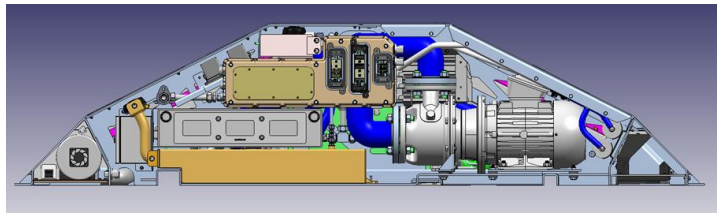
The next steps are in the UK…

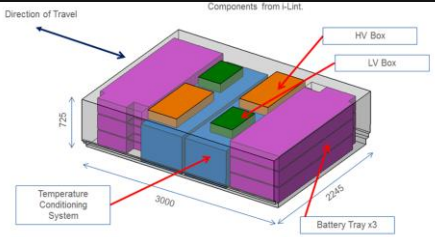
- It cannot be done alone, we shall work with partners, the first of which is Eversholt Rail, owners of the Class 321 fleet.
- Any first fleet introduction will need similar, visionary partners capable of collaborating to create the full-system proposition required to launch and support a fleet for its life.
- Collectively we can then rise to the challenge set by government to eliminate diesel from the network by 2040…











Coradia iLint: Alstom's *first* HFC train…

"Disruptive technologies are those that significantly alter the way businesses or entire industries operate. Often times, these technologies force companies to alter the way they approach their business, or risk losing market share or becoming irrelevant."

Investopedia

www.alstom.com

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