



Utilization of Fuel Cells for Trains

Coradia iLINT

Wolfram Schwab/Andreas Frixen
Tokyo, 21st January 2018

ALSTOM
Designing fluidity

AGENDA

1 Alstom Transport

2 Coradia iLINT

A complete range of transport solutions



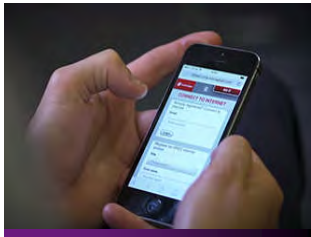
ROLLING STOCK

- Tram, metro, suburban/regional, high speed, very high speed, locomotive
- E-bus
- Components: traction, bogie, motor



SIGNALLING

- Signalling solutions portfolio for urban, main line, freight and mining and digital mobility
- Sold as products or solutions



SERVICES

- Maintenance
- Modernisation
- Spare parts, repairs & overhaul
- Support services



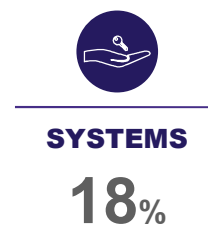
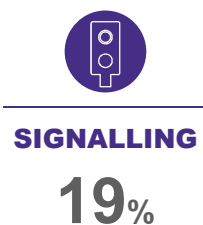
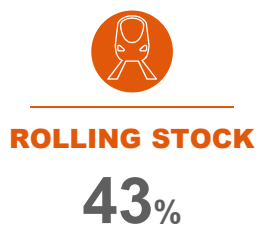
SYSTEMS

- Integrated solutions
- Infrastructure



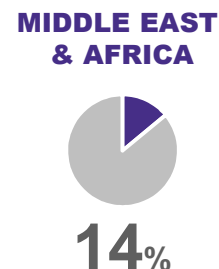
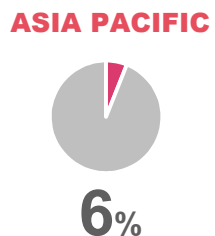
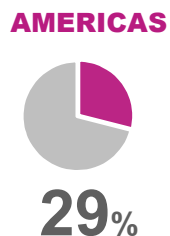
2016/17, a sound performance for Alstom

ACTIVITY (% of sales)



€7.3
BILLION
SALES

ORDERS (% per region)



€10.0
BILLION
ORDERS

5.8%

OPERATING MARGIN*

€208

MILLION
NET DEBT

All figures at 31 March 2017
* Adjusted EBIT margin

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ALSTOM

An ambitious strategy for 2020



1 Customer-focused organisation with a global presence

- **32,800 employees** working on **105 sites** in **60 countries** serving **200 customers**

- **Regions:** close to customers, in charge of execution
- **Operational functions:** global cohesion, processes and platforms
- **Support functions:** finance, legal, HR, global efficiency



Objective: becoming No.1 or No. 2 on every continent

Clear political objective: drastic reduction of CO₂ Our railway sector can be a pioneer!



The head of the Paris Conference, France's foreign minister Laurent Fabius, said this "ambitious and balanced" plan is a "historic turning point" in the goal of reducing global warming

Hydrogen as key towards Emission-free Mobility

Alstom's contribution

Coradia iLINT

Key drivers for public transport

- **Environmental needs**
- **New regulations**
- **New technology**
- **Economical solutions**
- **Sustainable public transport**



* Source: UN Sustainable Goals

It's all about Energy and Weight

Energy density(in MJ/kg)

Coal



34 MJ/kg



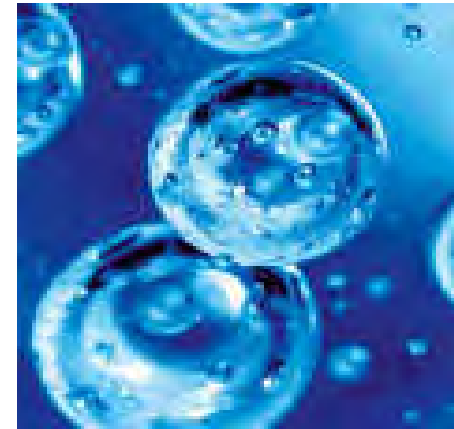
Diesel



43 MJ/kg



Hydrogen

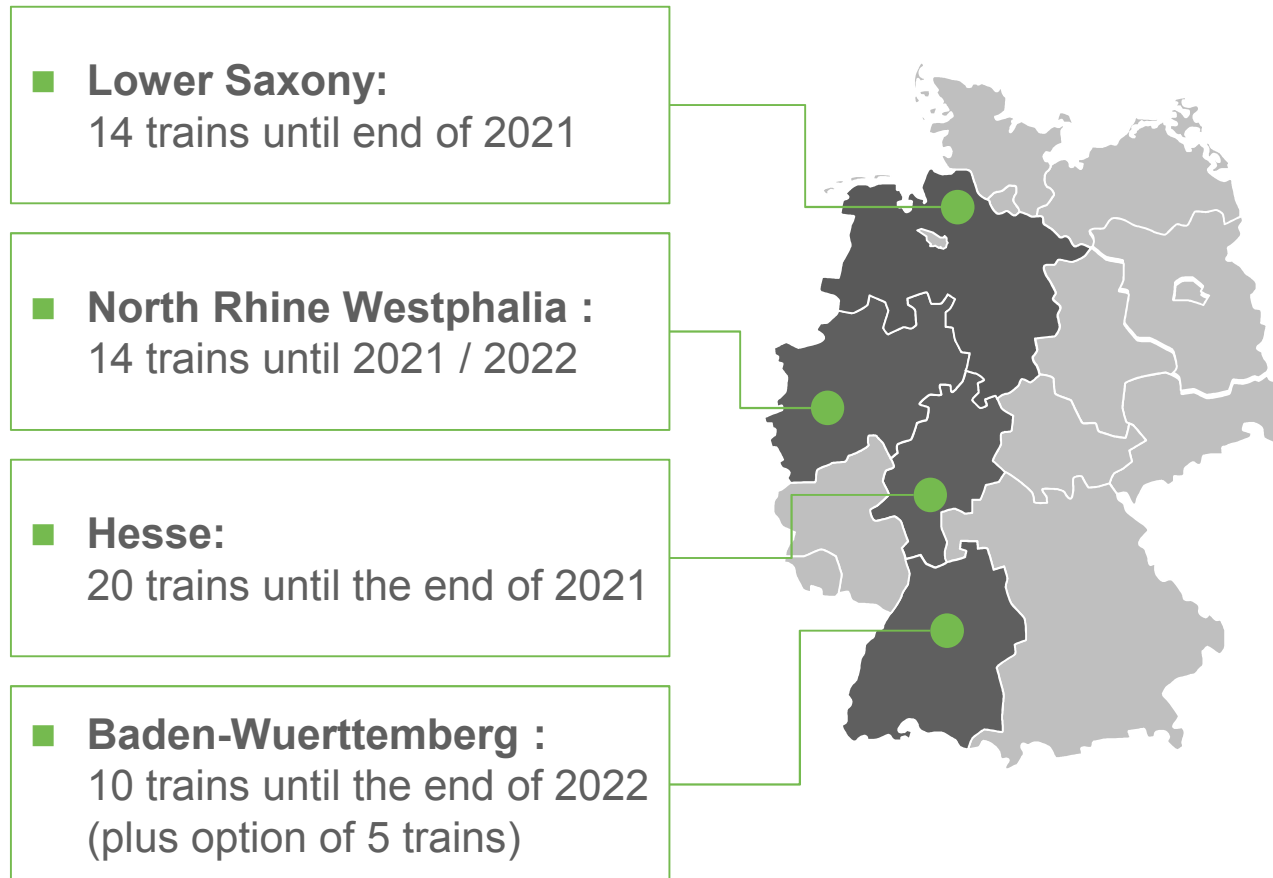


120 MJ/kg



Coradia iLINT

4 LOIs signed with 4 German PTA's in 2014



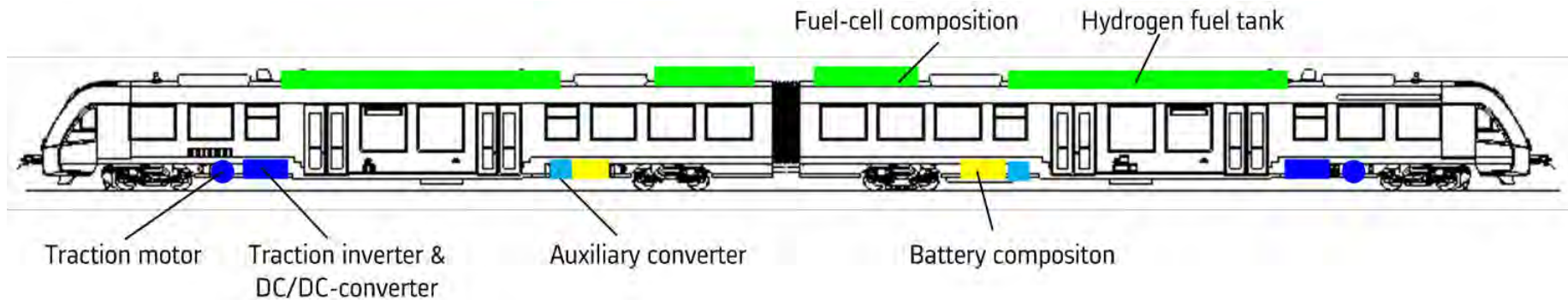
Coradia iLint with hydrogen as fuel

Premiere at the InnoTrans 2016



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The diesel technology is replaced with hydrogen and fuel cell technology

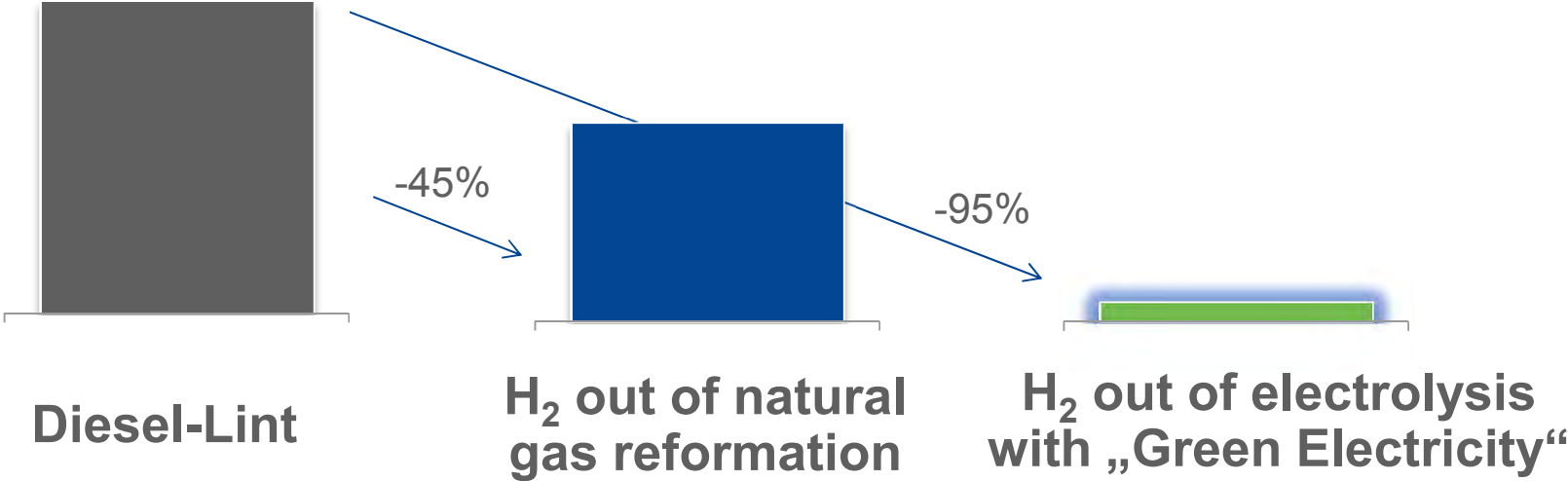


- Electric drive system
- Primary energy by fuel cells
- Intermediate storage by li-ion batteries...
 - ...for additional acceleration
 - ...for the recovery of braking energy
- **Combined propulsion and energy storage system**

Video

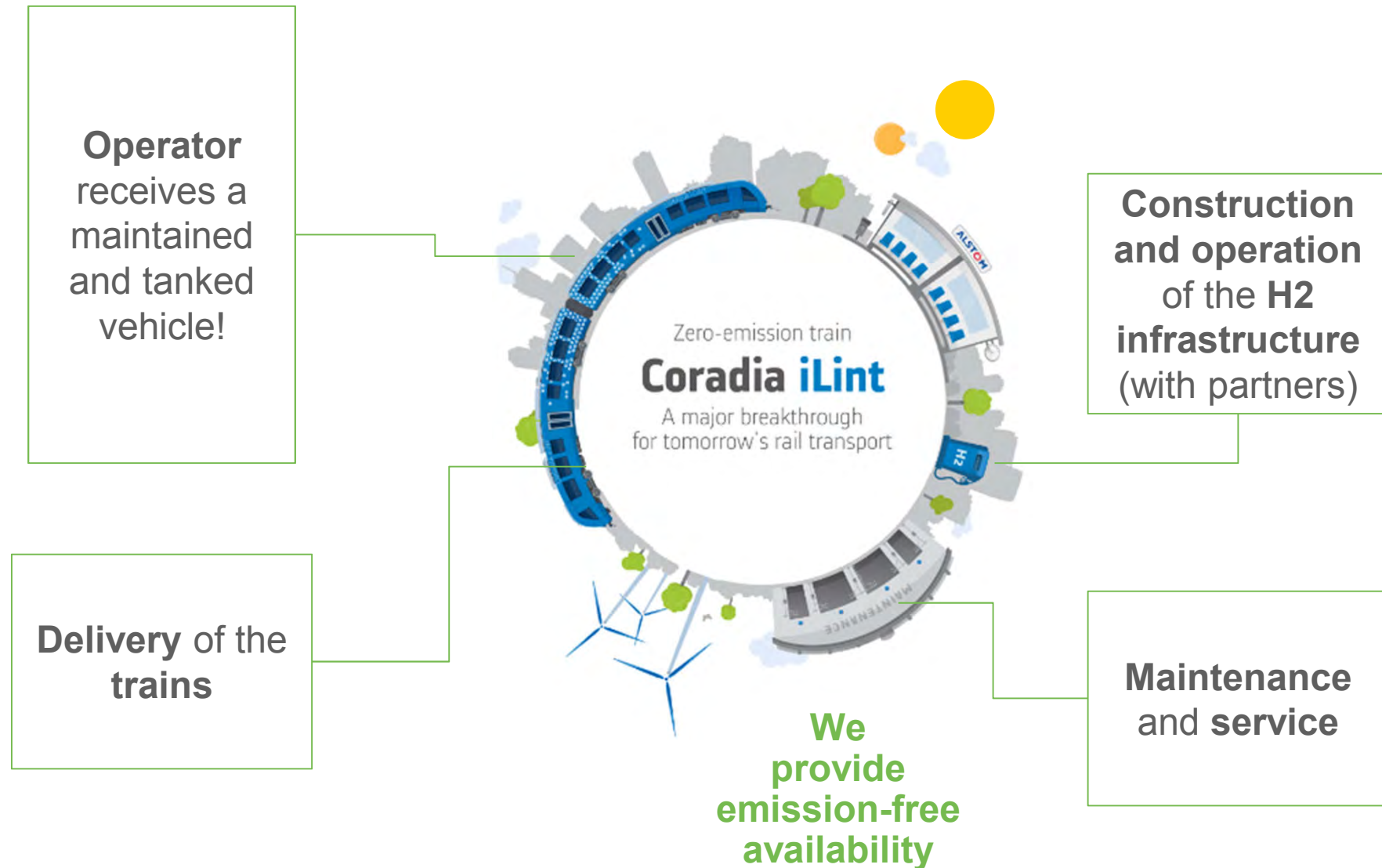
The manufacturing method of the hydrogen is decisive for the savings of CO₂

Major decrease of CO₂ emission



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Our mission: A joint service out of one hand – emission-free availability!



Hydrogen Infrastructure

Hydrogen need per day (example)

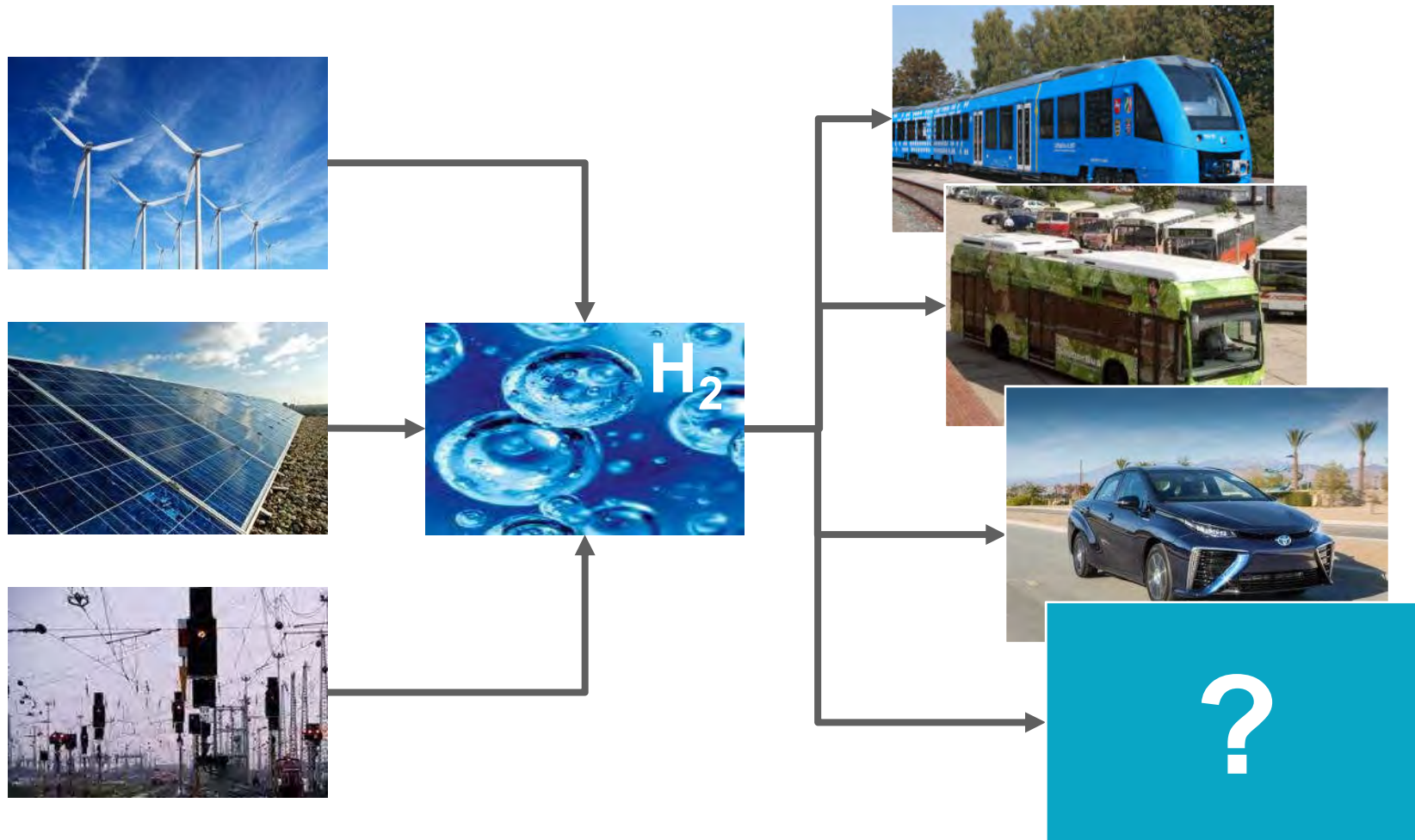
	Network 1	Network 2
Amount of trains	10	20
Km per day	600 km	750 km
H ₂ per km	0.25 kg/km	
Consumption per day	1.500 kg	3.750 kg



Production, Transport and storage of large quantities of hydrogen

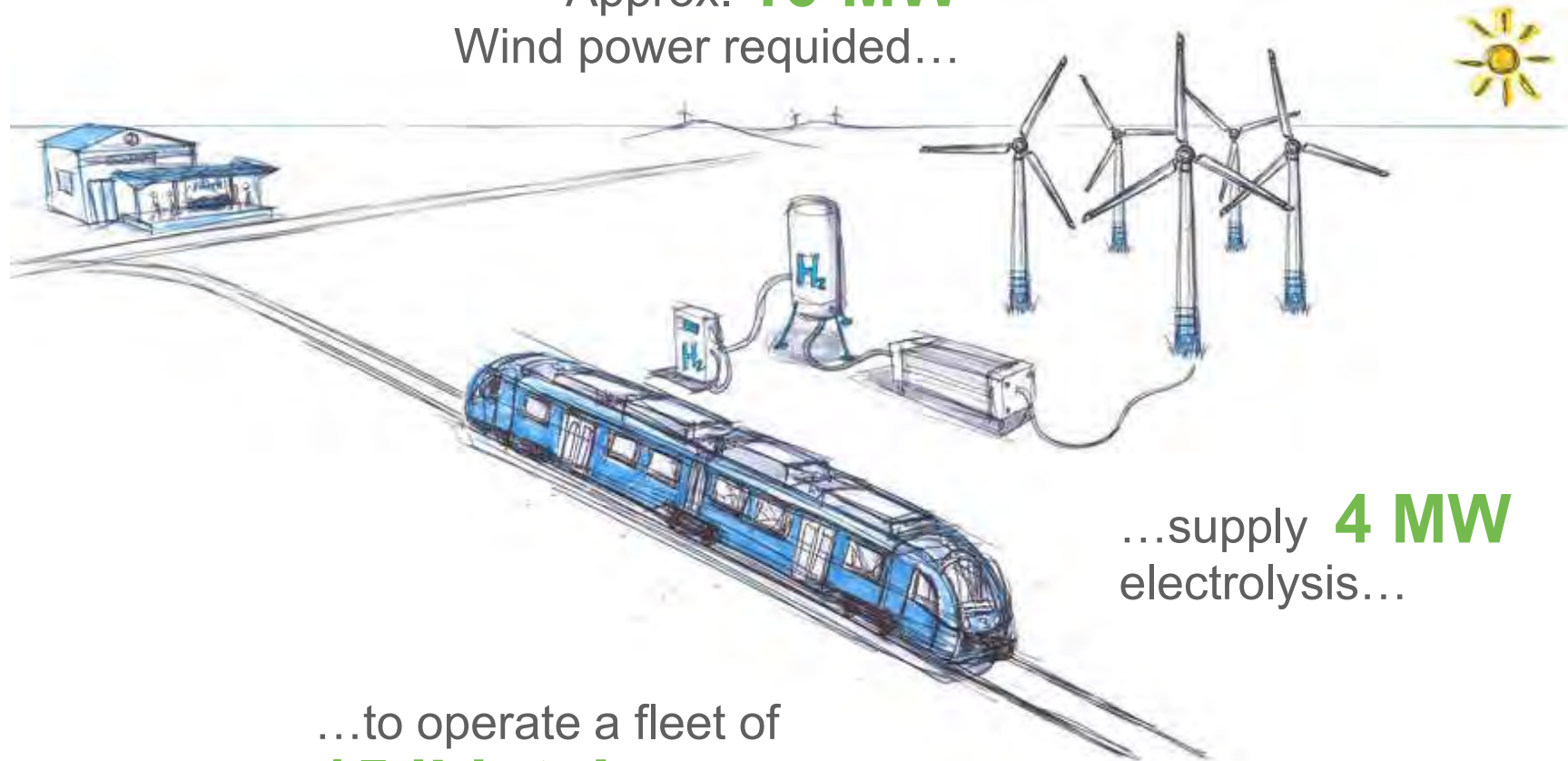
Electrolysis

Basis for environmentally friendly traffic solutions



Production of Hydrogen using regenerative sources

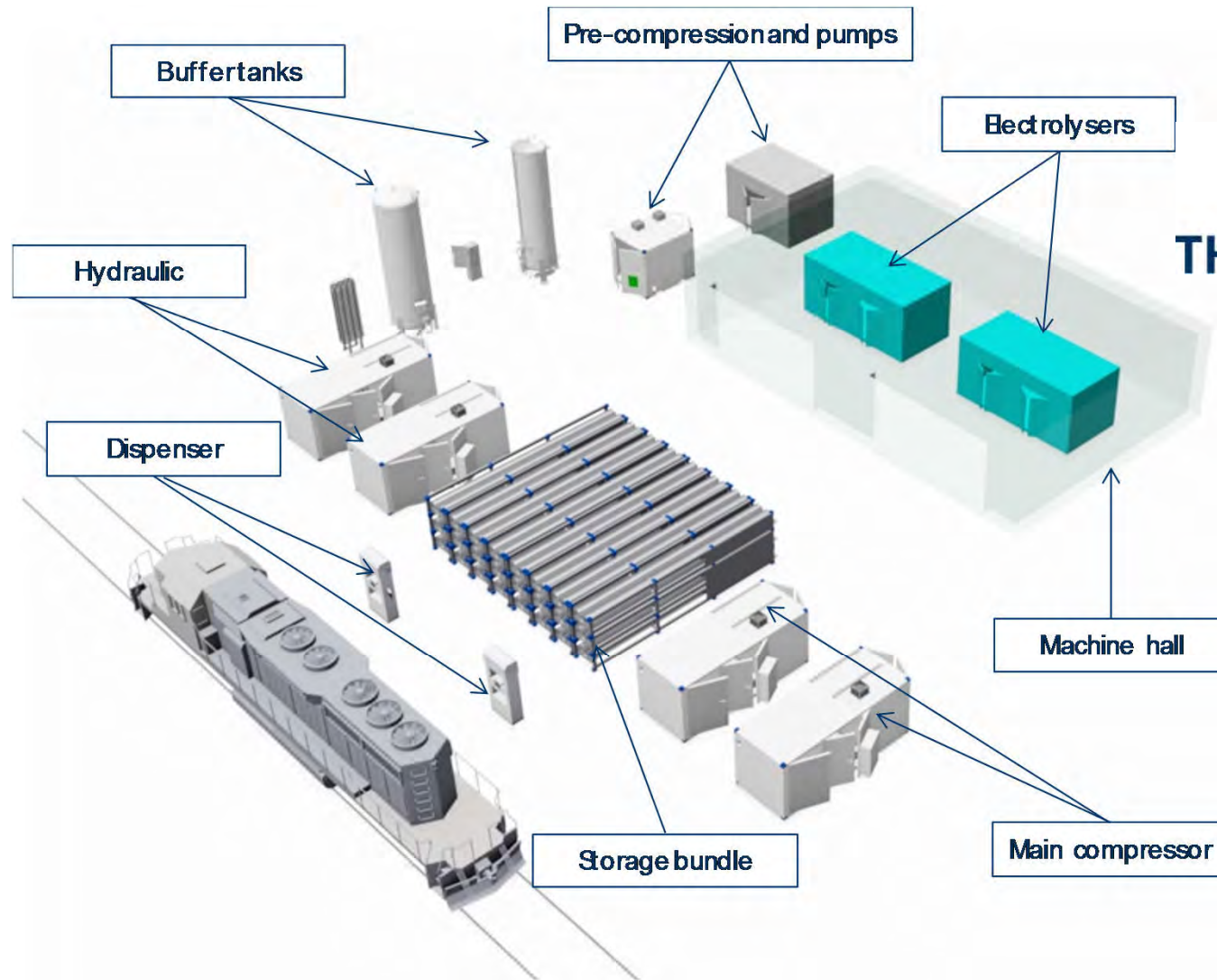
Approx. **10 MW**
Wind power required...



...supply **4 MW**
electrolysis...

...to operate a fleet of
15 iLints!

Hydrogen & Hydrogen Technology from The Linde Group: Hydrogen from electrolysis



Site-Layout – Top-View

Wuppertal, Germany



Source: Hydrogenics

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VATTENFALL 

HYDROGENICS
SHIFT POWER | ENERGIZE YOUR WORLD

Hydrogen Fueling

Onsite hydrogen generation eliminates need for hydrogen tube trailer deliveries in downtown core.



Hamburg, Germany

780kg/day, 350/700 bar dispensing

Located in the center of Hamburg in front of "Der Spiegel" newspaper offices, the station is the biggest worldwide, capable to refill busses and passenger cars. The station has 120Nm³/h electrolysers, 430kg 45bar storage and 250kg 830bar storage and follows the SAE J 2601 refueling protocol.

Coradia iLINT

Key factors of differentiation

Diesel hybrid with batteries



example

Electric train with batteries



example

Hydrogen fuel cell train



Coradia iLINT

Autonomy

- 900-1000 km

- 40-60 km (w/o catenary) *)

- > 800 km

Weight

- High

- High

- Low (< 18 t/axle)

Flexibility in Operation

- High

- Low

- High

Infrastructure

- Diesel re-fueling

- Battery charging

- HRS - Hydrogen Re-fueling Station
- Usable as well for busses

Environment

- Not emission-free

- Emission-free

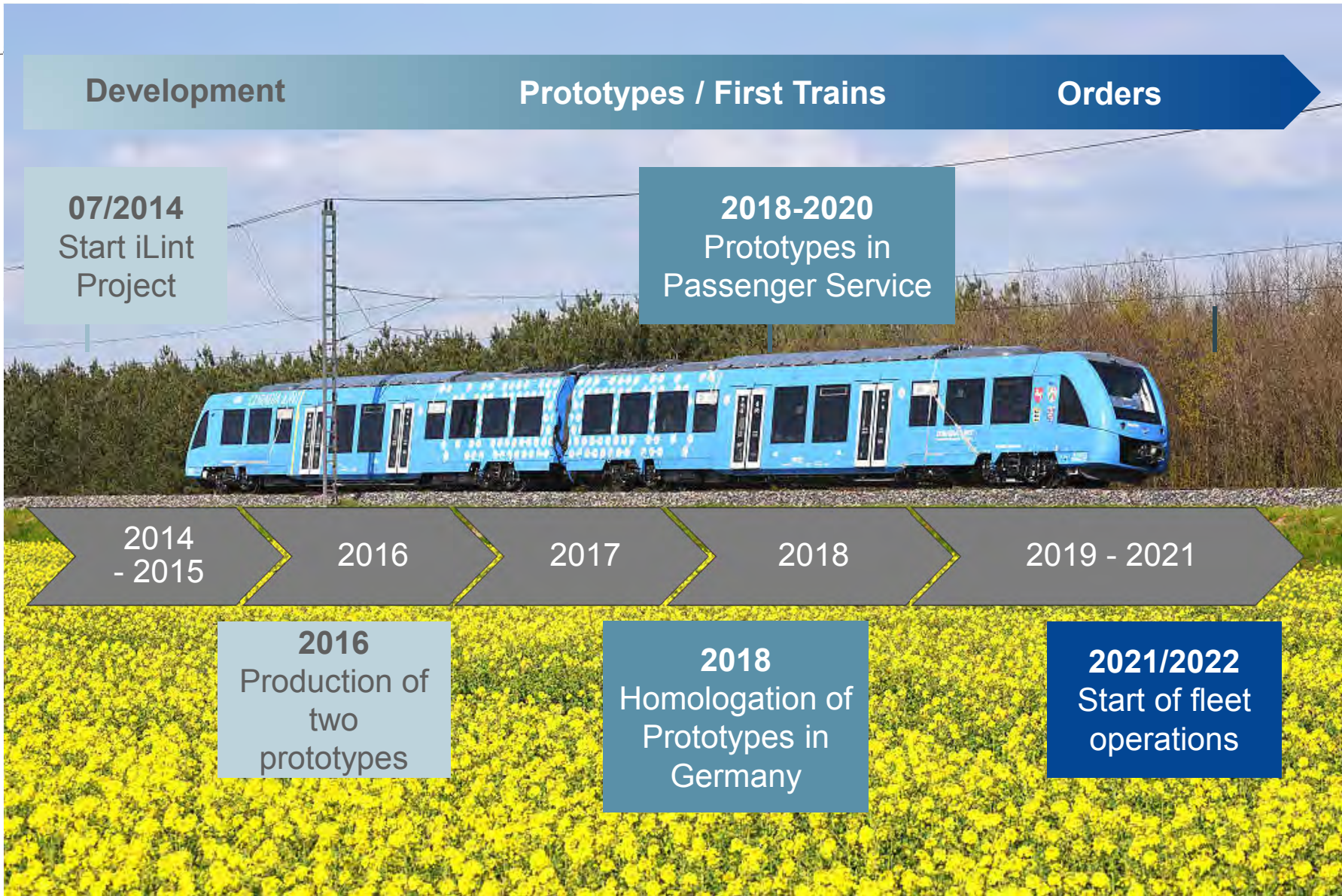
- Emission-free

*) source Bombardier

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Coradia iLINT Program

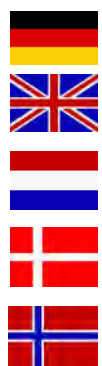


Coradia iLINT

1 Contract + LOIs signed for around 60 trains in Germany



Also ideal prerequisite for emission-free public rail transport in Canada and European countries

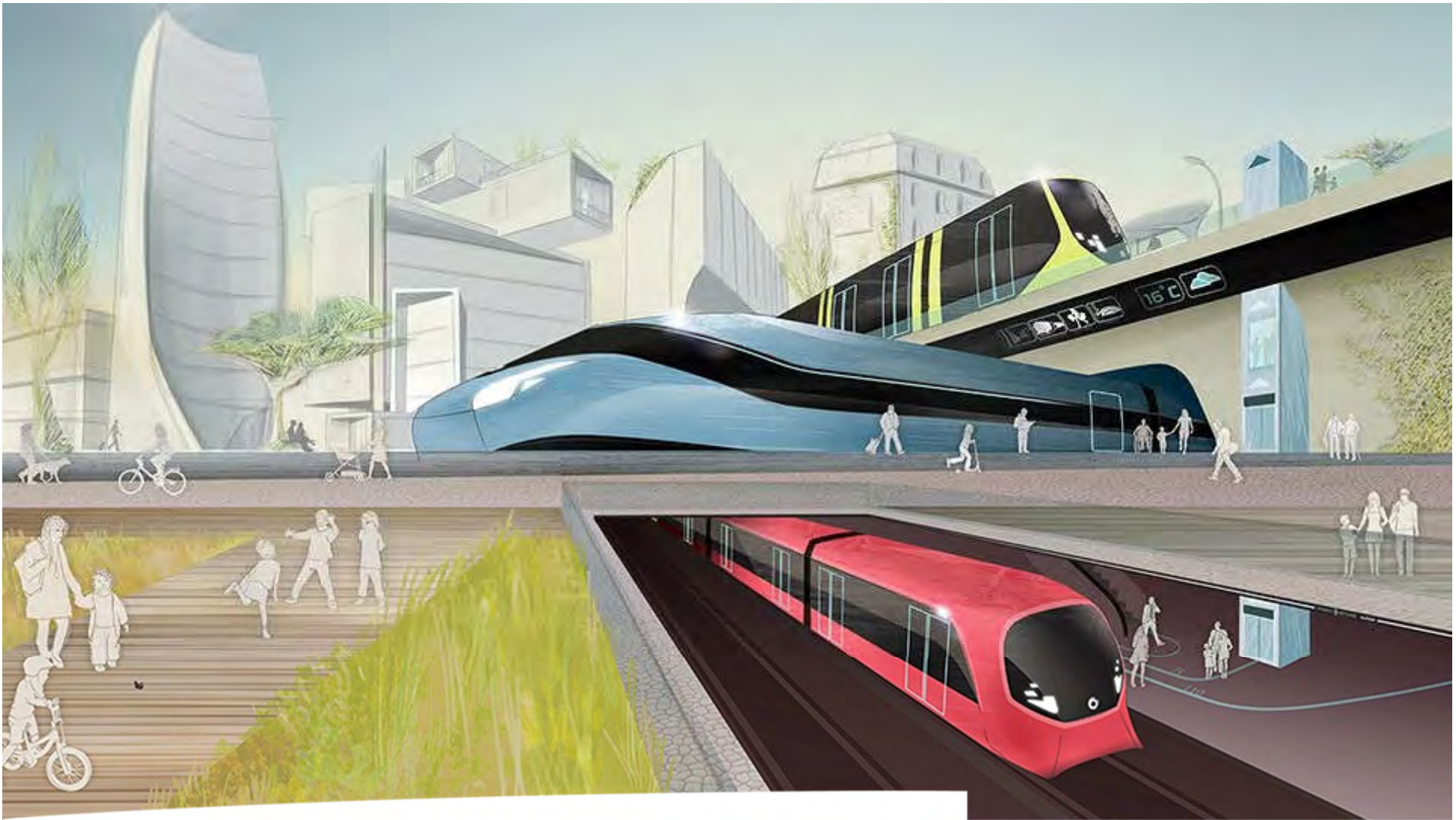


- Ambitious climate protection goals
- Trendsetting traffic management
- Local hydrogen production

We would like to go new ways together with you!



- Passenger service of two vehicles in Germany 2018
- Development of the hydrogen infrastructure
- Start of operation in four federal states using up to 60 vehicles in 2020 / 2021
- Further partners are welcome!



www.alstom.com

ALSTOM
Designing fluidity

Back-up

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