Fuel cells and hydrogen in rail applications:
Current plans and roll-out Strategy

Michael Ritter, April 27th, 2017

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Designing fluidity

Alstom is offering a full range of products and services for the growing rail market

Trains

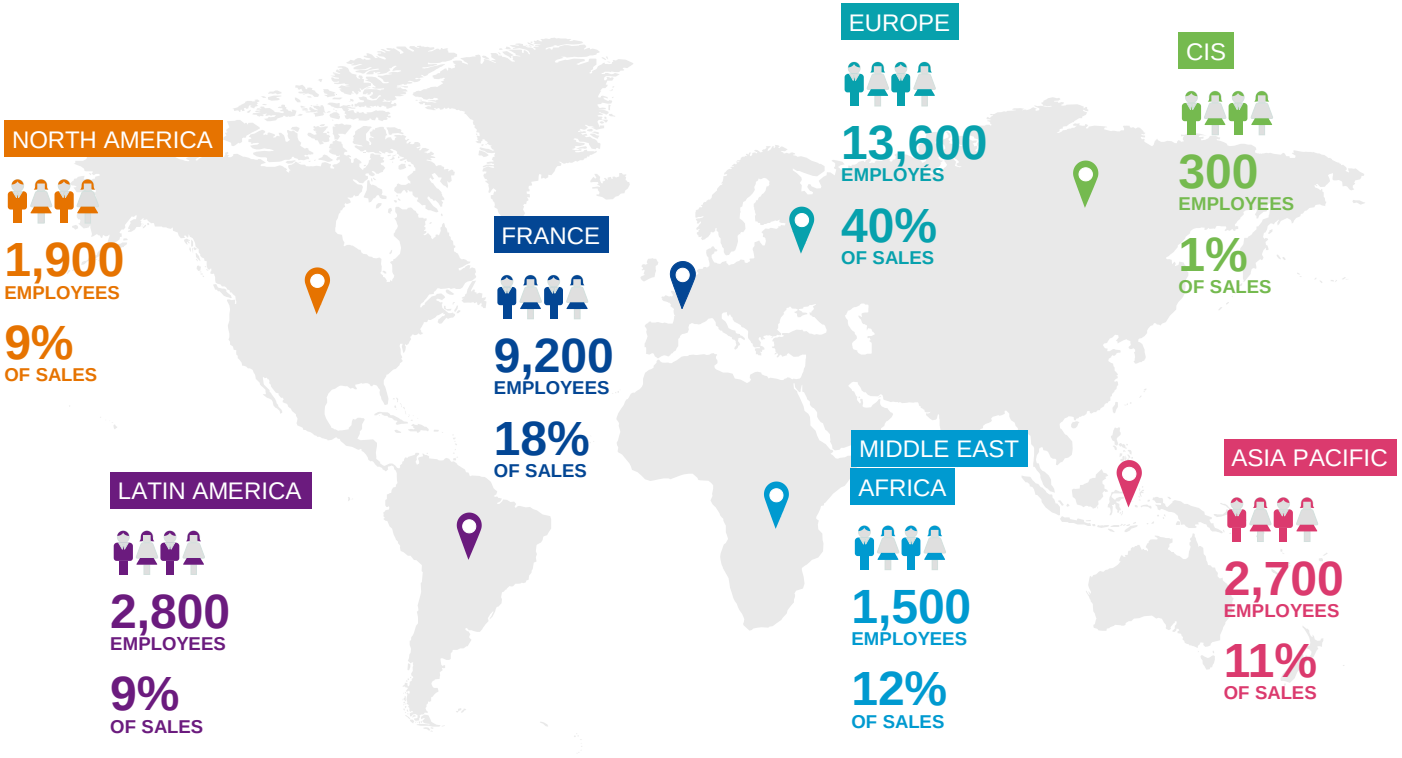
Systems

Services

Signalling

With a worldwide presence, Alstom is able to serve its clients on a global level

32,000 employees working on **105 sites** in **60 countries** serving **200 customers**



The vision: Our customers receive emission-free train availability

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

Maintenance and **service**

Delivery of the **trains**

Operator receives a maintained and tanked vehicle!

Several drivers force the rail sector to seek alternative fuel technologies

Significant part of the **rail network not electrified** (e.g. Germany: 40%)

→ Emission-free trains for lines without catenary

Increasing prices for **diesel and traction current** in the medium and long term

→ Alternative to fossil fuel

Legislation and expectations on **air quality** and **noise reduction**

→ Emission and noise reduction

Less acceptance and political discussion about **ban of diesel** in **urban areas**

→ Compliant technology

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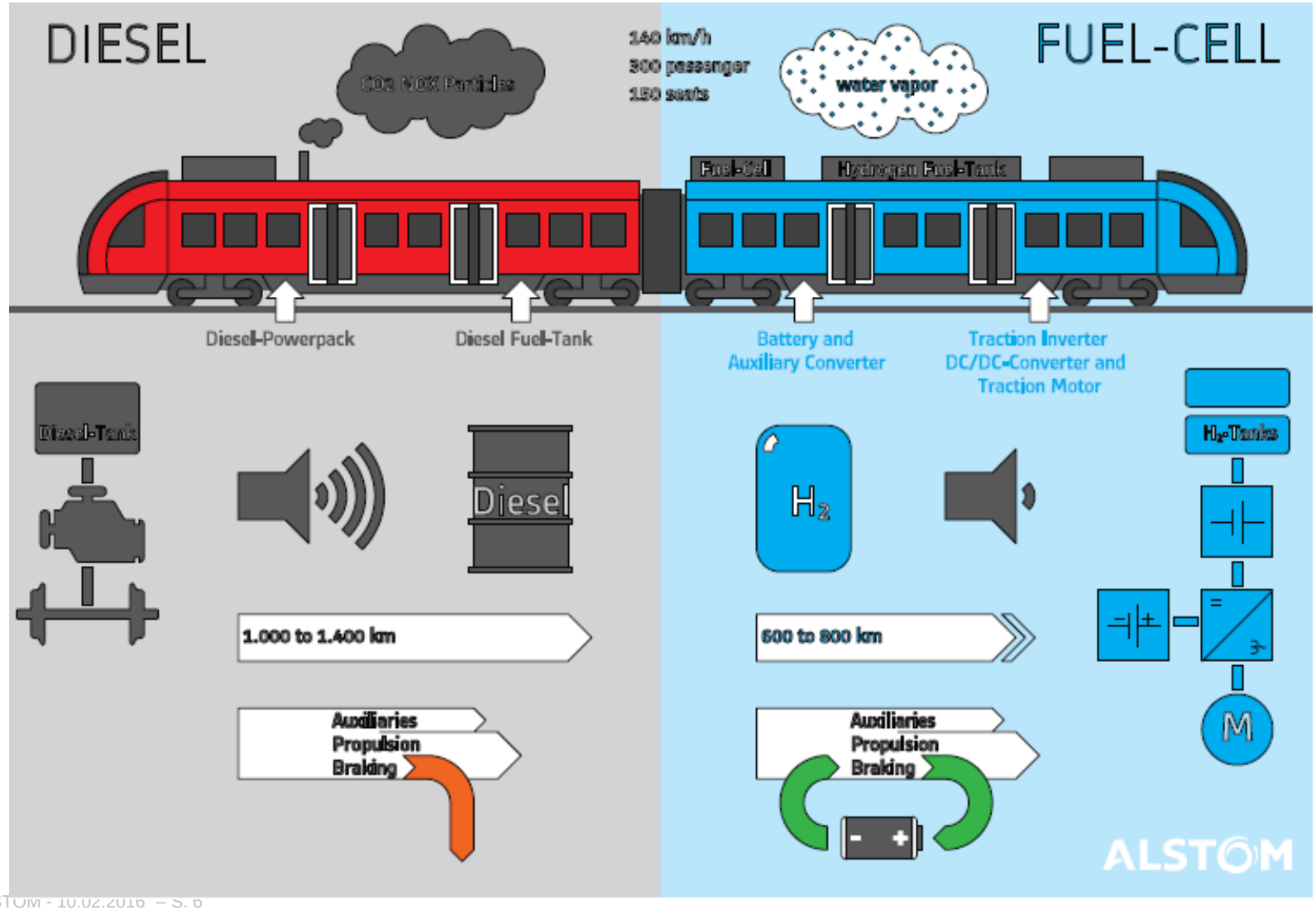
Alstom answers this challenge with the hydrogen powered Coradia iLint



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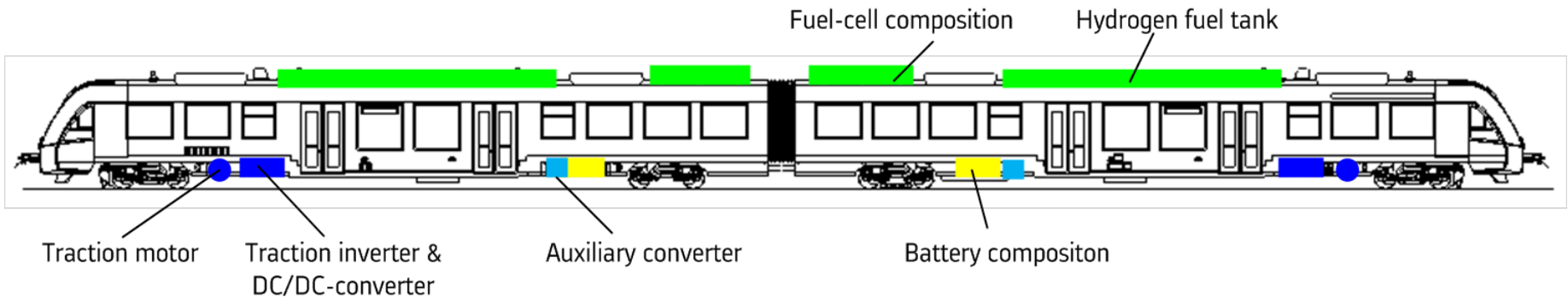
The diesel technology was replaced by hydrogen and fuel cell technology

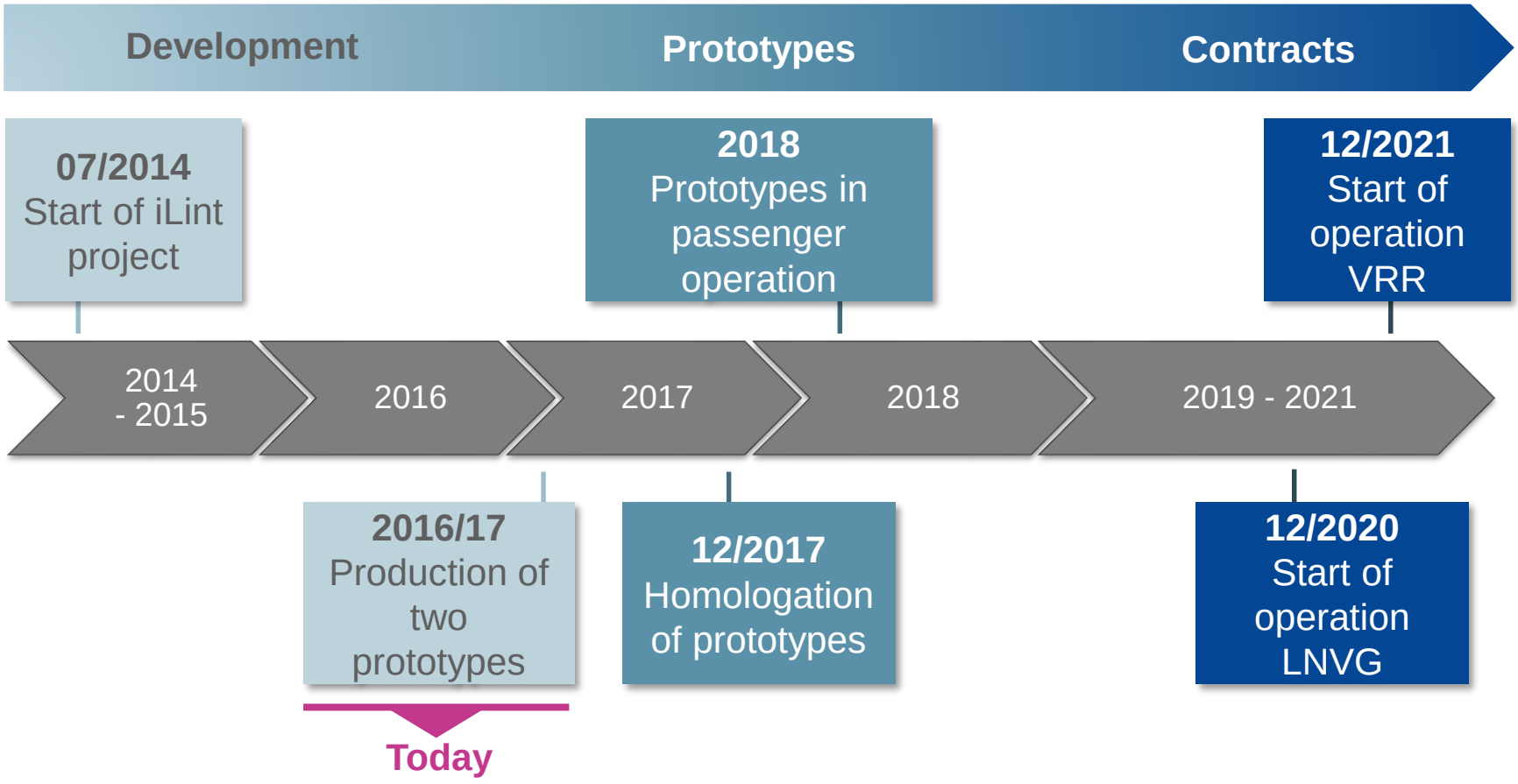


- Electric drive system
- Primary energy by fuel cells
- Intermediate storage by li-ion batteries…
  - …for additional acceleration
  - …for the recovery of braking energy

➢ **Combined propulsion and energy storage system**

Coradia iLint was presented to the public at InnoTrans in Berlin in September 2016

Currently, Alstom produces two prototypes – in operation by end of 2017



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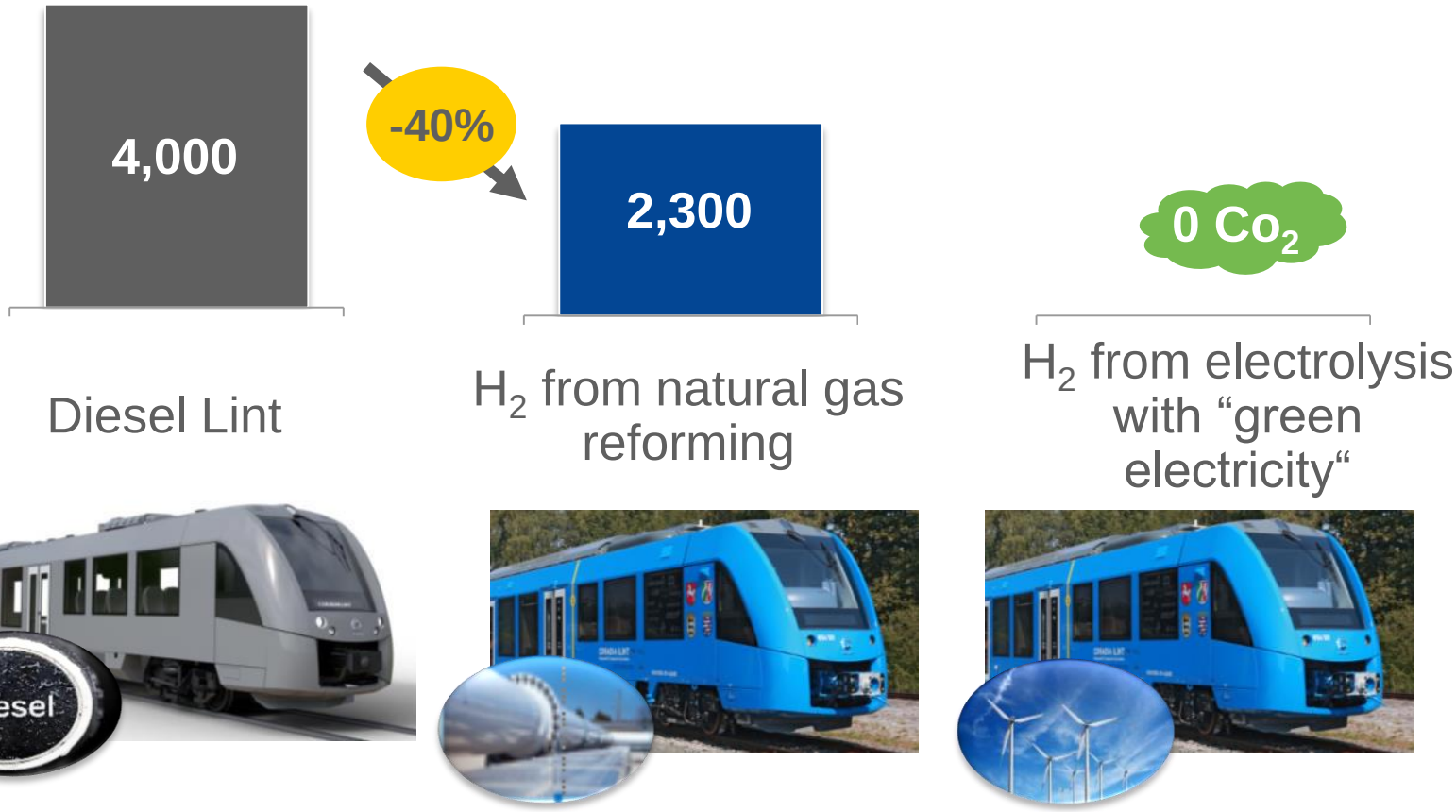
First steps towards zero emission with „grey“ hydrogen – future solutions have to rely in „green“ hydrogen“

CO_2 emission per vehicle km (in gram)



With green hydrogen, one iLint saves about ~700t of CO2 per year, a typical fleet of 15 trains more than 11.000t

minus
700t CO2
per year…

…corresponds to the annual output of
400 cars

Saving per iLint

minus
11,000t CO2
per year…

…corresponds to the annual output of
6,000 cars

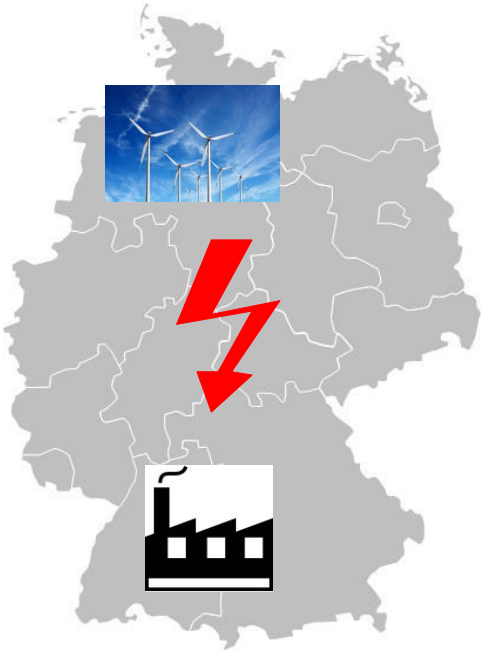
Saving per iLint fleet

Local usage of wind energy provides solution to increasingly overloaded electricity grids

As **capacity** of renewable energy **grows**…

… **electricity grids** are increasingly **under stress**.

Solution: **Local usage** of green electricity for **electrolysis**



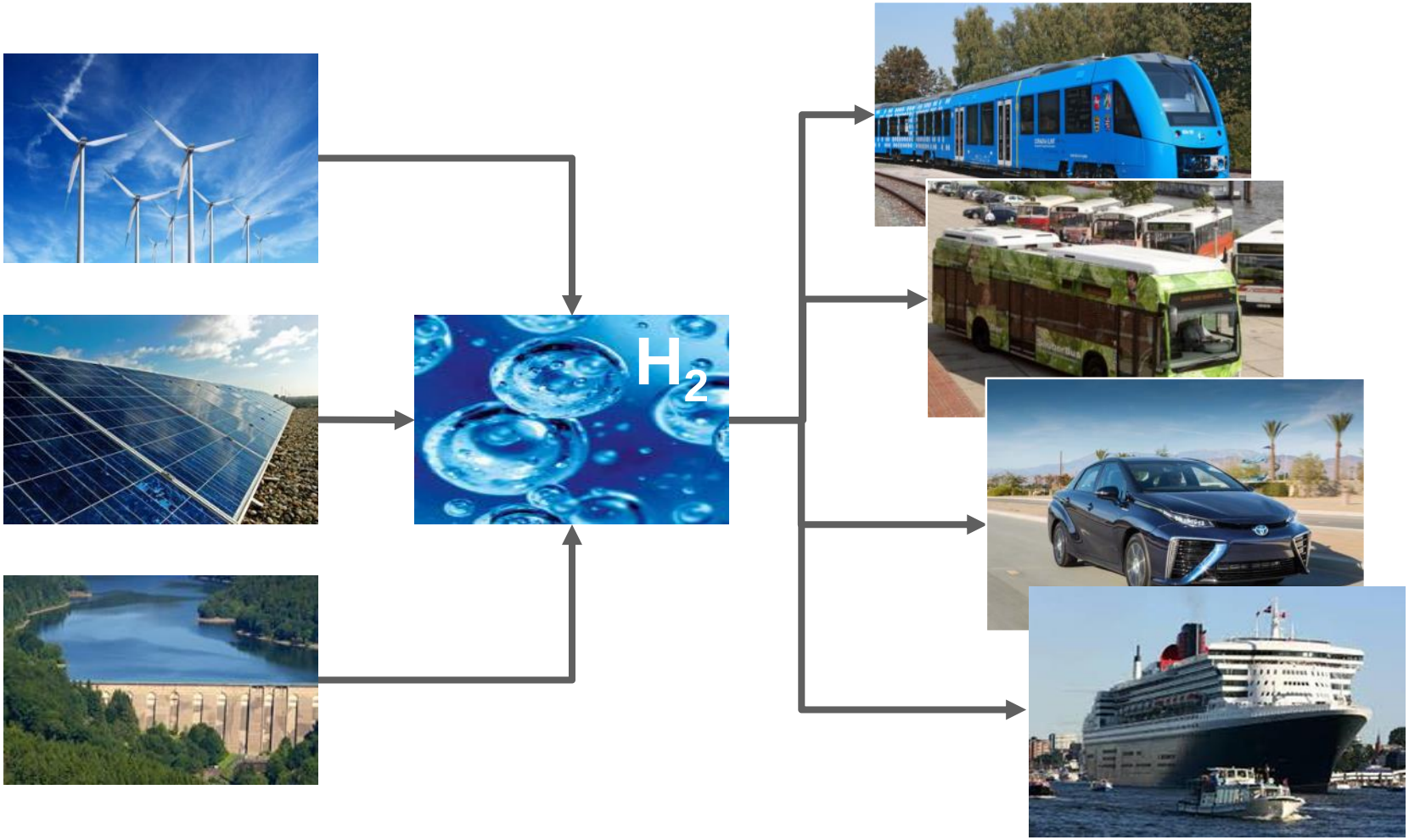
10 MW of wind power are necessary to power a 4MW electrolysis plant for 15 iLints

About **10 MW** of wind power necessary…

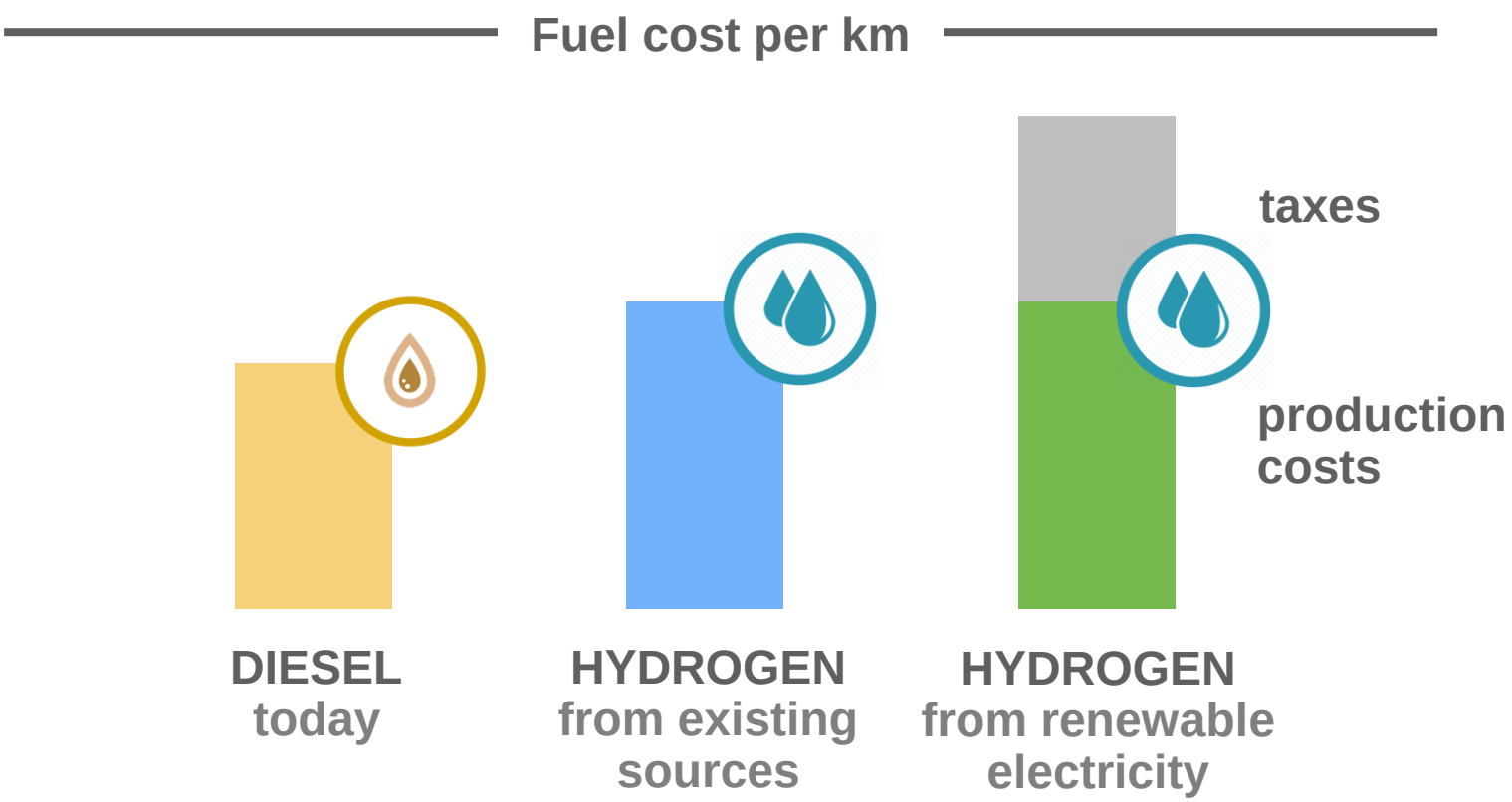
…to power a **4 MW** electrolysis plant…

…to run a fleet of **15 iLints!**

Green hydrogen as a basis for further environmentally friendly transport solutions

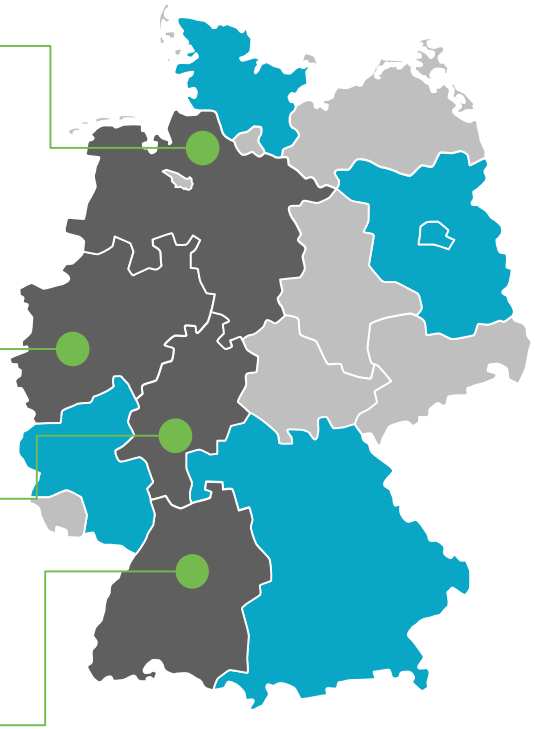


Current taxes and other charges impede the competitiveness of true green hydrogen



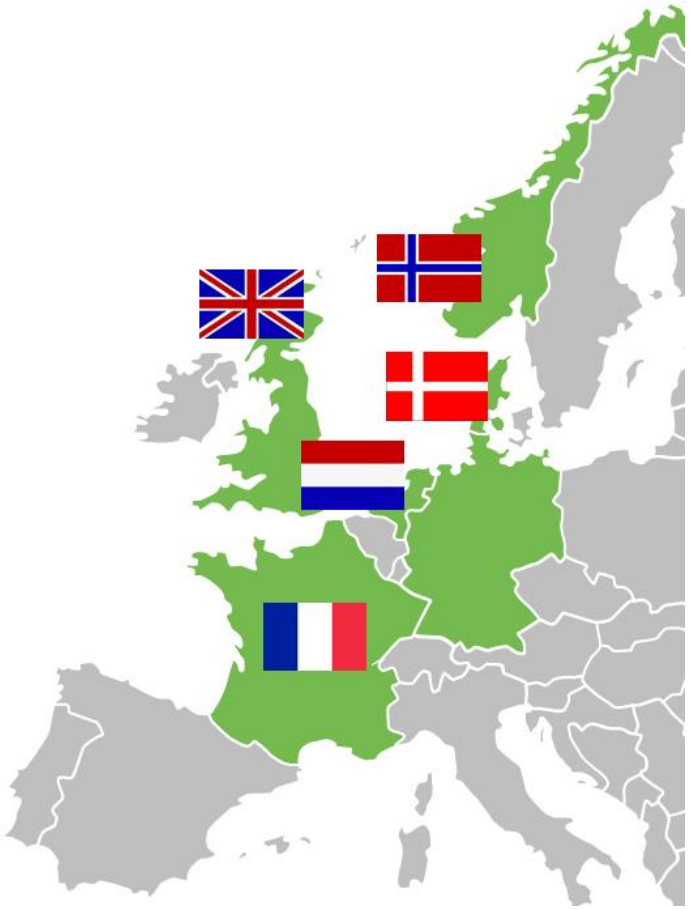
For the projects in the near future, a mix of hydrogen from different sources ensures economic viability

- **Lower Saxony:**
  14 trainsets, prototypes starting 2018, fleet completed mid 2020
- **North Rhine-Westphalia:**
  14 trainsets until end 2021
- **Hesse:**
  20 trainsets until end 2021
- **Baden-Württemberg :**
  15 trainsets until end 2021(plus option for 5 trains)



- Interest from other federal states

Also ideal prerequisites for emission-free public rail transport in other European countries



- Ambitious climate protection goals
- Trendsetting traffic management
- High potential in energy generation
- Local hydrogen production
- Cross-border traffic → European funding

Summary

- Hydrogen and fuel cell technology are ready to be employed for large scale rail application
- First two prototypes in operation in Lower Saxony / Germany starting end of 2017, negotiations for several other projects in progress
- Hydrogen from windparks is an important module to switch to a carbon-neutral economy
- Wind energy only part of the solution – current regulatory framework inflates costs
- More common steps necessary to realize full potential of green hydrogen

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