Alstom Green Solutions

Hydrogen Trains

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CCI France Grèce

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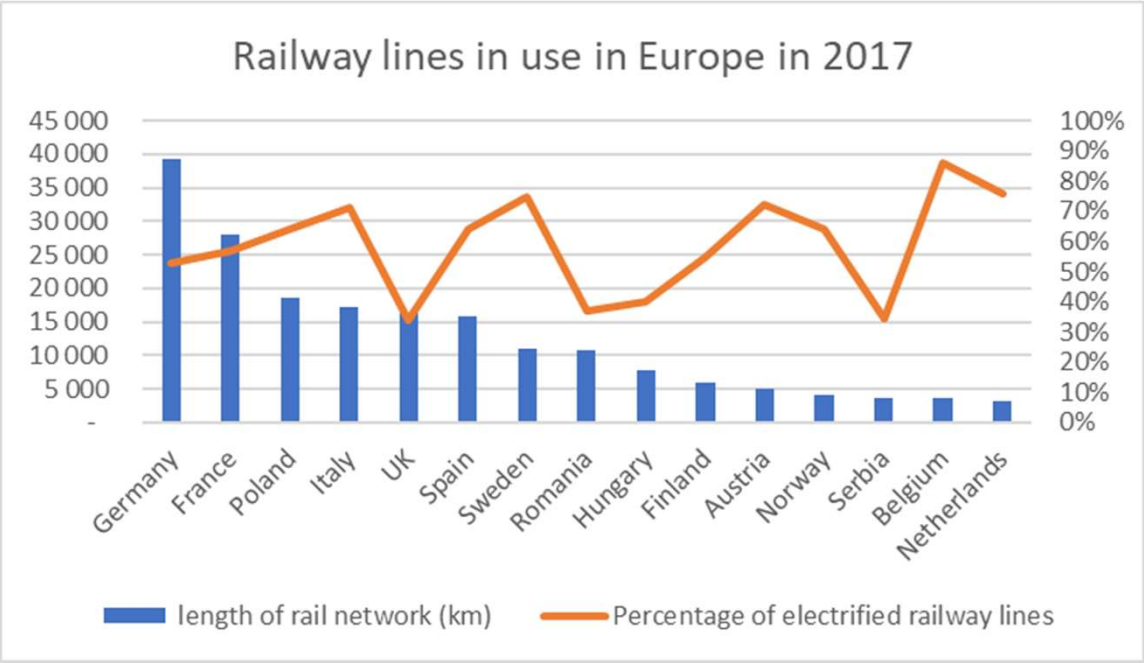
European Railway Network



- Total route length in Europe: 226,000 km
- ~46% not electrified
  => Operated with Diesel as of today
- Even more non-electrified lines in the rest of the world.

Source: https://www.statista.com/statistics/451500/length-of-railway-lines-in-use-in-europe/
https://www.statista.com/statistics/451522/share-of-the-rail-network-which-is-electrified-in-europe/

Alstom green mobility solutions for non-electrified railways

Electrified lines are the most efficient solutions, but how to decarbonize non-electrified lines?

Reduced emission

Bi-mode (Diesel + EMU) / Hybrid (Diesel + energy storage)

- Bi-mode: Make use of catenary when operating on **electrified sections.**
- Hybrid: Energy storage, **reduction of energy consumption**, boost during acceleration. Plug-in option for full electric autonomy.

Prima H3 Hybrid Plug-in

Zero emission

Battery (BEMU / Battery power car)

- Current range of **80-120 km on batteries**
- Suited for **catenary-free operations** with **recharging** in electrified sections and stations
- **Kinetic energy recovery** during braking


Coradia Continental BEMU

Hydrogen (H_2) (FCMU / Hydrogen power car)

- Current range **up to 1000 km**
- **Performance equivalent to diesel trains**
- Suited for **catenary-free operations** with requirement of **hydrogen refueling station**


Coradia iLint

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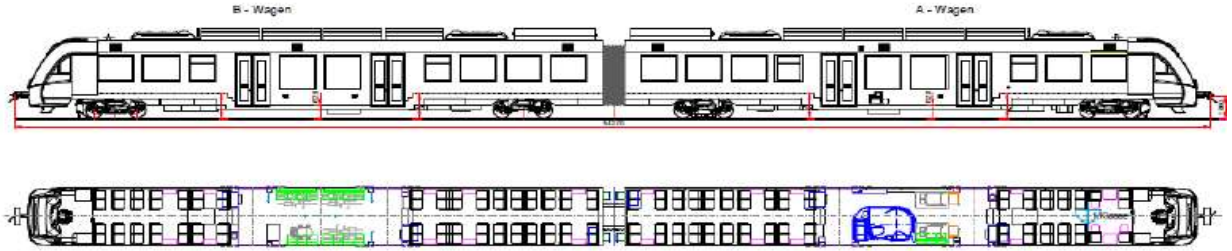
Alstom’s fuel cell trains

Alstom's Coradia iLint – A zero emission solution for tomorrow's challenges

- Based on successful Coradia Lint 54 DMU
- Designed for Central Europe application
- Low floor entrance (620 or 810 mm)
- Max. speed 140 km/h
- 1.000 km range
- No technical components in the passenger area
- 150 seats / 1 toilet / Flex Area
- Zero emissions



Alstom's Coradia iLint – A zero emission solution for tomorrow's challenges

How does it work?

Fuel cell composition

$2\ H_2 + O_2 \Rightarrow 2\ H_2O$

Hydrogen storage

Storage at 350 bar

Lithium-Ion battery composition

The main components:
-> fuel cell composition,
-> hydrogen storage,
-> lithium-Ion battery composition

Alstom's Coradia Stream - The Brescia Iseo Edolo line

Target of the project is to convert the actual line today served by diesel trains in a completely «green line» operated by ALSTOM hydrogen trains

The railway line Brescia Iseo Edolo

Length of the not electrified line

- 103 km

Number of trains

- Today 14 diesel trains
- 51 train services per day
- 90.000 km/year/train

Regione Lombardia

Ca. **-10 000 t./year**
Equal to approx.
6000 cars

The project will be developed in three steps:

- **Phase 1** : 6 HMU trains + refueling station in Iseo
- **Phase 2** : 8 HMU trains + refueling station in Brescia
- **Phase 3** : 40 hydrogen buses

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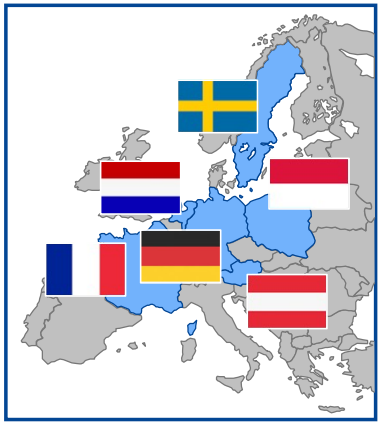
First application: Coradia iLint

Alstom's Coradia iLint - Validation of fuel cell trains (1/2)



Germany

- Sep 2018 – March 2020
- **Commercial operation with passengers**
- Bremervörde – Cuxhaven - Bremerhaven
- Fully homologated by EBA
- 180.000 km of Passenger operation

Netherlands

- Feb 2020 – 2 weeks
- **Test campaign**
- Groningen-Leeuwarden
- First hydrogen train in the Netherlands
- Operational test, infrastructure and timetable compliance

Austria

- Sep 2020 – Dec 2020
- **Commercial operation with passengers**
- Aspangbahn (Vienna), Wiener Neustadt-Puchberg, Gutensteig
- ÖBB as operator of the trains
- Full homologation for Austria

Alstom's Coradia iLint - Validation of fuel cell trains (2/2)

Poland

- Jun 2021
- **Test campaign**
- Railway Research Institute
- First H_2 rail trial in Poland
- Test track in Żmigród

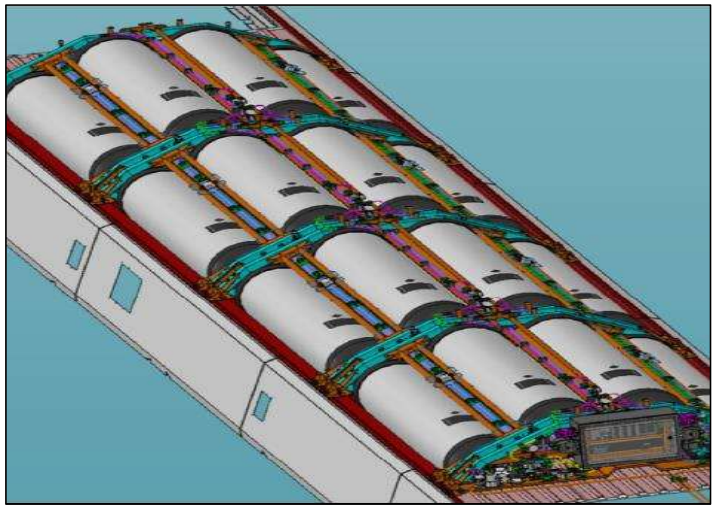
Sweden

- Aug 2021
- **Operation & presentation**
- Operated from Östersund
- First H_2 rail trial in Sweden

France

- Sep 2021
- **Tests in Railway Test Centre**
- First H_2 rail trial in France
- *In 2022: tests in Tours-Loches*

Alstom’s Coradia iLint – Serial production under full steam in Salzgitter



- New tank arrangements increased operational range by 25 %

- Optimal architecture of fuel cell composition led to 30% active components reduction

- Reduced maintenance and cleaning costs

The New Coradia iLint – Making the difference

3 Hydrogen Infrastructure

Hydrogen Infrastructure – Refueling station

- Alstom's transportable Hydrogen Refuelling Station (HRS) in Bremervörde during passenger operation of the Coradia iLint pre-serial trains and final solution for serial trains.

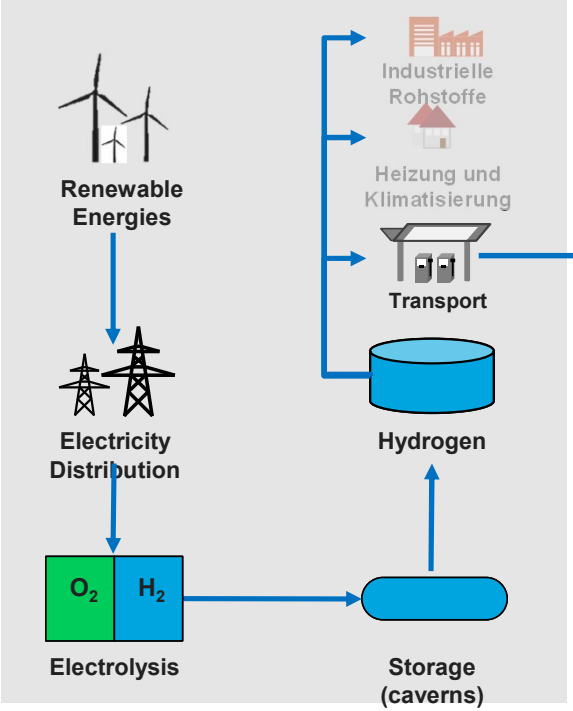
Transportable HRS for train trial operations

Final refueling station for serial trains

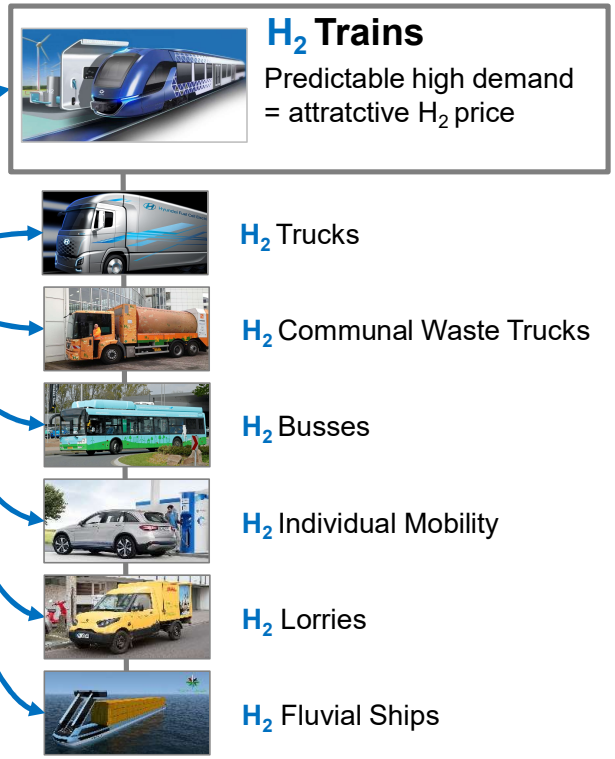
Hydrogen Infrastructure

Focus on infrastructure

- Hydrogen Society

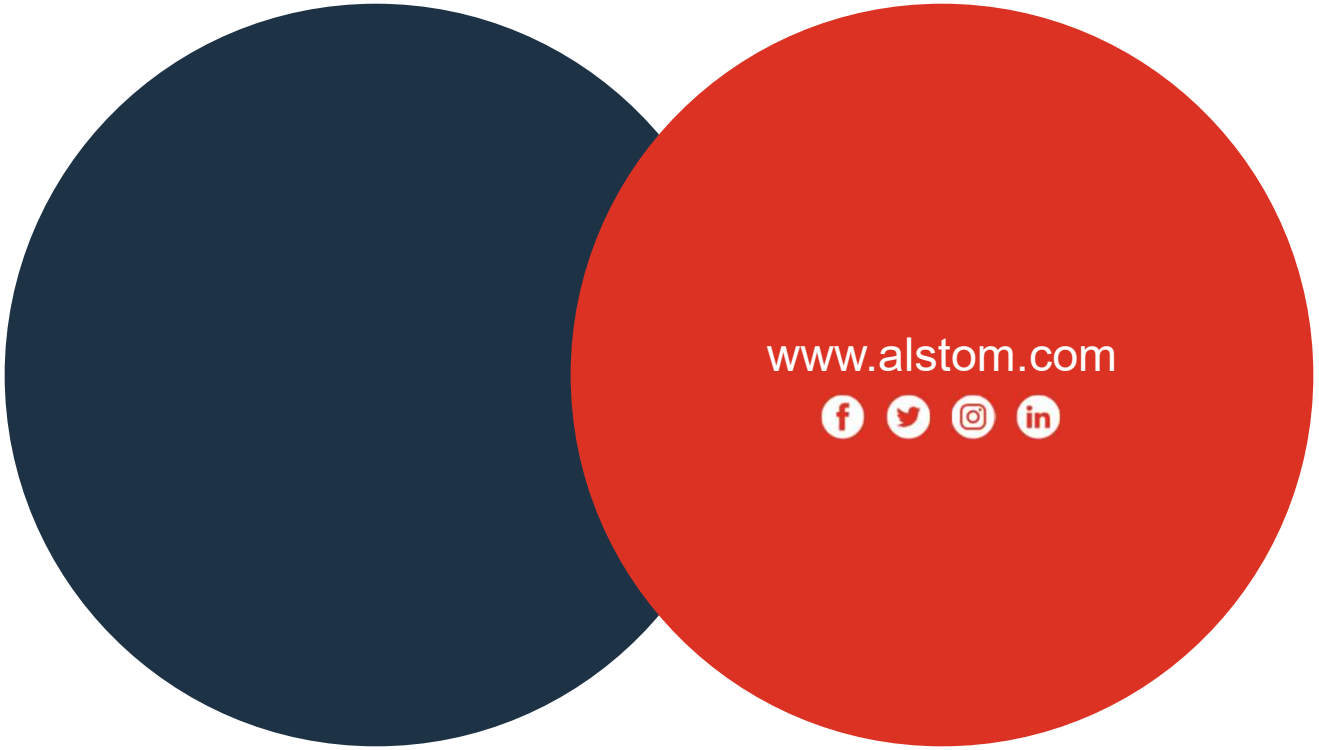


- Zero emission mobility




450
400


Hydrogen
H2
ALSTOM
Powered



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