Hydrogen Powered xMUs

North American Challenges

October 2023

ALSTOM
• mobility by nature •

Agenda

1. About Alstom
2. Alstom’s North American Roadmap to Green
3. xMU of the future
4. Infrastructure challenges
5. Conclusion

01

About Alstom

We are where mobility is needed

Over
80,000
employees

Over
22,000
engineers

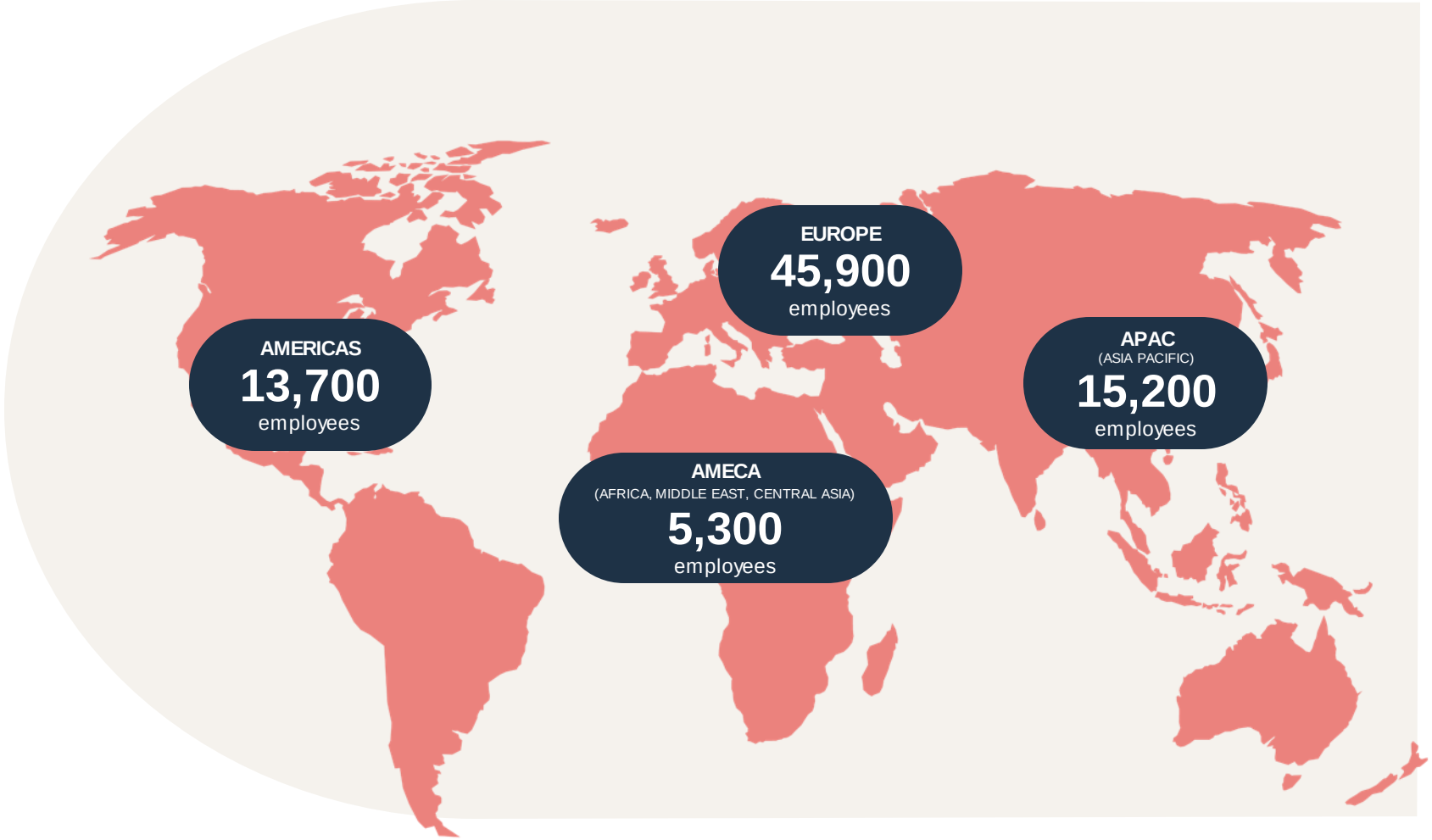
from
175
nationalities

Over
10,000
patents

Over
250
sites

Partner to over
300
cities

63
countries

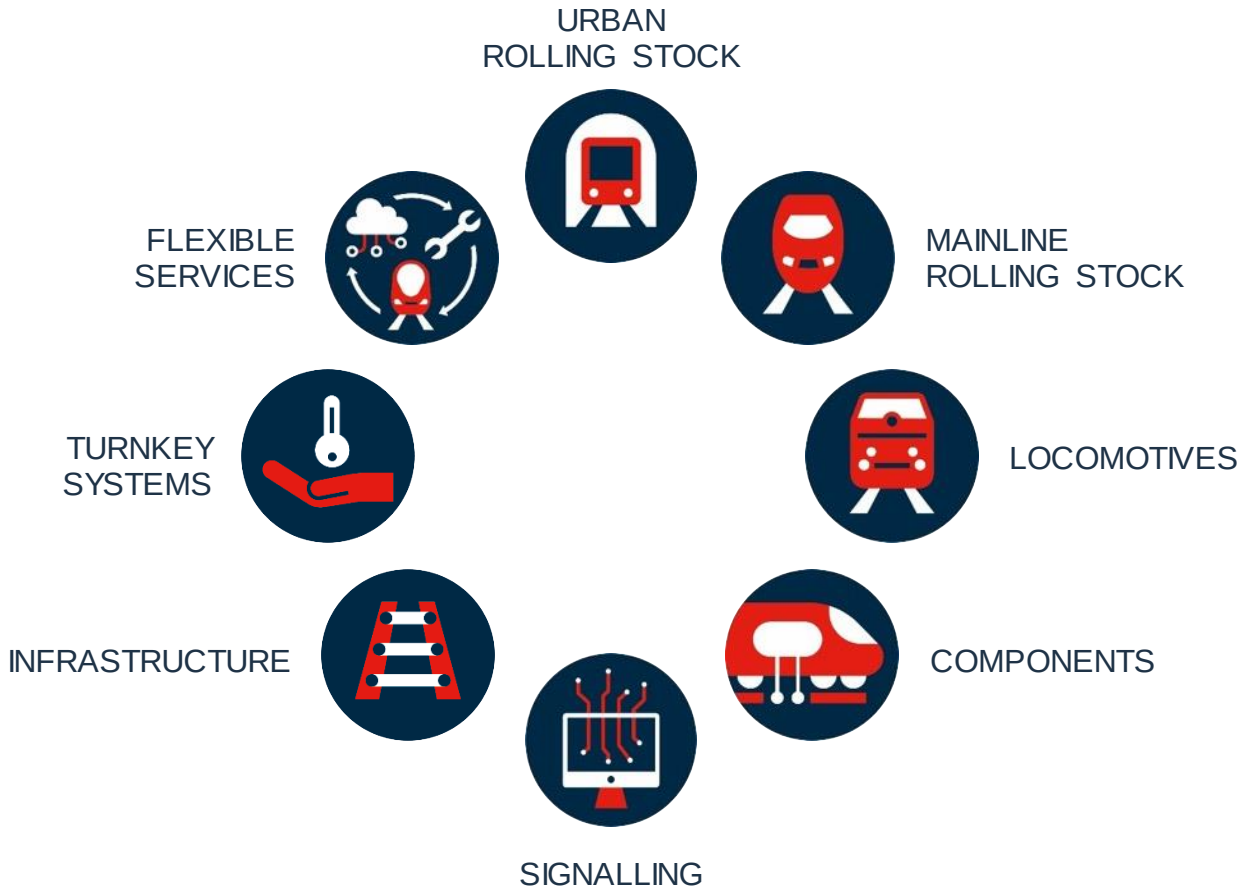


As of 31 March 2023

A dedicated player and global leader in rail mobility

Alstom develops and markets mobility solutions that provide sustainable foundations for the future of transportation.

Our comprehensive product portfolio ranges from high-speed trains, metros, monorail and trams, to turnkey systems, services, infrastructure, signalling and digital mobility solutions.



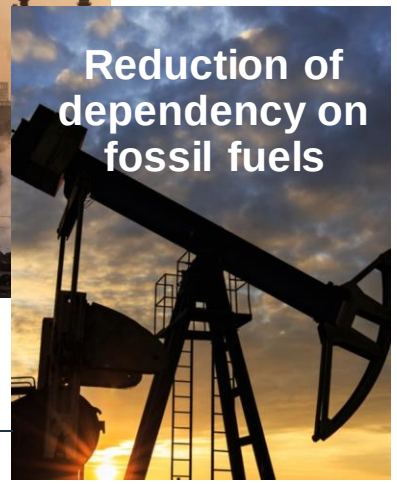
02

Alstom’s North American Roadmap to Green

2018 – iLint – First **100% H_2** train in commercial service

Paris Agreement:
Net Zero by 2050

Multiple "diesel bans" by 2040



Clean energies required

https://www.youtube.com/watch?v=JmmlHZ_yWt0 (1 min 37sec)

Rail network in North America: the least electrified network in the world

Freight + Commuter + Intercity excluding urban networks

North America	Europe	China	India
< 1% electrified	~50% + electrified	66% electrified	~40% electrified

A great opportunity: GHG reduction + diesel phasing out

Alstom North American journey to green transition | Zero-Emission by 2050

2022 ▶ **2023** ▶ **2022-2030** ▶ **2030-2035** ▶ **2030-2050**

Americas Green Innovation Center

Hydrogen demonstrator in Charlevoix Québec

Development of components & green solutions

Product Maturity

Serial Production

Net-zero ambition

Alstom is ready to commit towards a net-zero scenario that will drive the corporate climate action for the coming years. The net-zero ambition means that climate targets will be gradually expanded to cover the whole value chain, by setting the right measure efforts and establishing the milestones towards complete CO2 elimination solutions by 2050.

03

xMU of the future

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

- Based on successful Coradia Lint 54 DMU
- Designed for Central Europe application
- No technical components in the passenger area
- Zero local emissions and reduced noise level
- TSI compliant, easy access for PRM

Length / Axle load	54 m / 18 t (class B1)
Multiple unit operation	up to 4 vehicles
Capacity	150 seats / 1 toilet / Flex Area
Low floor entrance	620 or 810 mm
Vmax	**140 km/h**
Range	1000 km

xMU of the future: Commuter/Intercity single-deck solution

Single-deck xMU and coach addressing American and Canadian markets

Coach

- High- and low-level boarding (8” to 51”) with vestibule
- Single-car
- Max speed 125 mph

EMU

- High- and low-level boarding (8” to 51”) with vestibule
- 2-car married pair
- Catenary 25 kV AC or third rail 750 V DC
- Max speed 125 mph

BEMU

- High- and low-level boarding (8” to 51”) with vestibule
- 4-car (2-car married pairs)
- Catenary 25 kV AC / battery
- Range up to 60 miles*
- Max speed 100 mph

HMU / HEMU

- High- and low-level boarding (8” to 51”) with vestibule
- 4-car (2-car married pairs)
- Fuel cell propulsion
- Range up to 600 miles*
- Max speed 100 mph

* Depending on operational conditions

04

Infrastructure challenges

Coradia iLint in Quebec, North America

What is it?

A 4-month demonstration of our hydrogen train

When is it planned?

Mid-June to September 2023

Where it take place?

Next to Quebec city, in the Charlevoix region

Why we did it?

UNESCO Biosphere reserve, G7, accessibility to private line, regulation

Energy supplier including hydrogen part of Energy Transition

Energy supplier

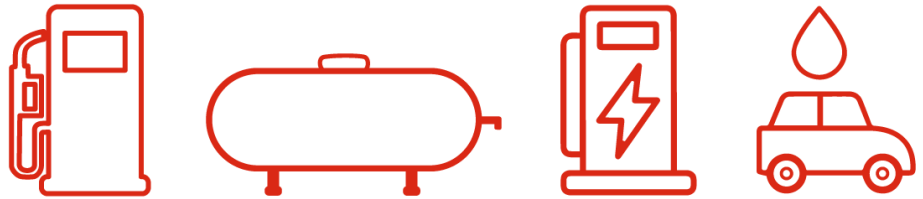
- Fuels
- Services

Pioneer of hydrogen in Quebec

- First hydrogen distribution station in Quebec
- Open since 2019

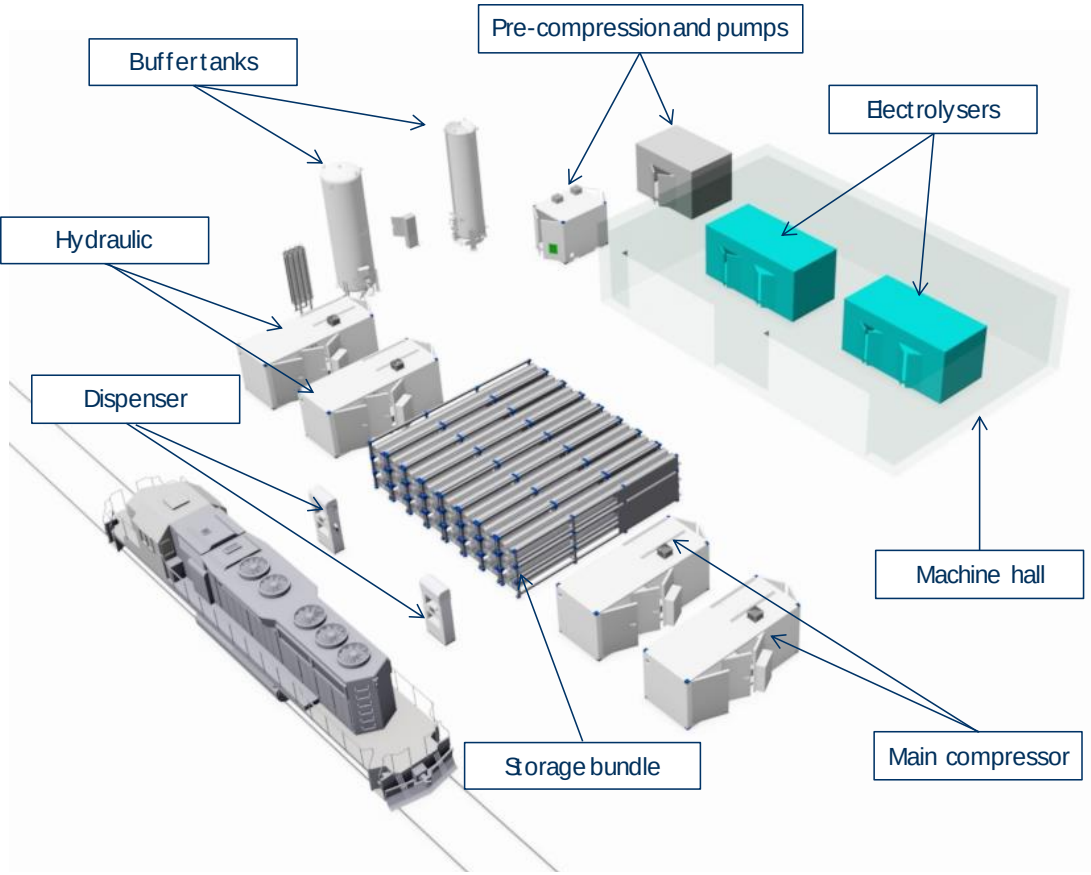
Several solutions and offers

- Electrolyser and compressors
- Gasoline, diesel and hydrogen pumps
- Electric charging station



Hydrogen production & supply (example)

From Theory



To reality

Production
Electrolysis/Byproduct/Steam reforming

Purification / Measurement / Transportation

Compression (HP: High Pressure)

Storage (HP)

Hydrogen refilling station / Dispenser

Harnois Énergies

Électrolyser & compress0r

Convenient store

Gaz station & hydrogen fueling

EV charging

H2 Value Chain Ecosystem with

Hydrogen refueling requires a complete infrastructure

Energy

Electric energy can be obtained from any source (**Hydroelectric power from HydroQuebec**).

Production

H_2 is produced through electrolysis processes (considered as the Greenest process)

Compression

H_2 is compressed to optimize storage space utilization.

Storage

H_2 is stored in tanks at low pressure (500 bar) or high pressure (900 bar).

Transportation and distribution

H_2 is transported by truck which emissions are offset by Carbon Boreal

Refueling

Trains are refilled at hydrogen refueling stations with 350 bar pressure (at 15°C).

Réseau de Charlevoix | H_2 refueling site in Baie-St-Paul, Quebec

H_2 refueling station was set up in 3 months

H_2 produced in Quebec City, transported by road to refueling station (55 miles)

H_2 train refueling in ≈30 minutes

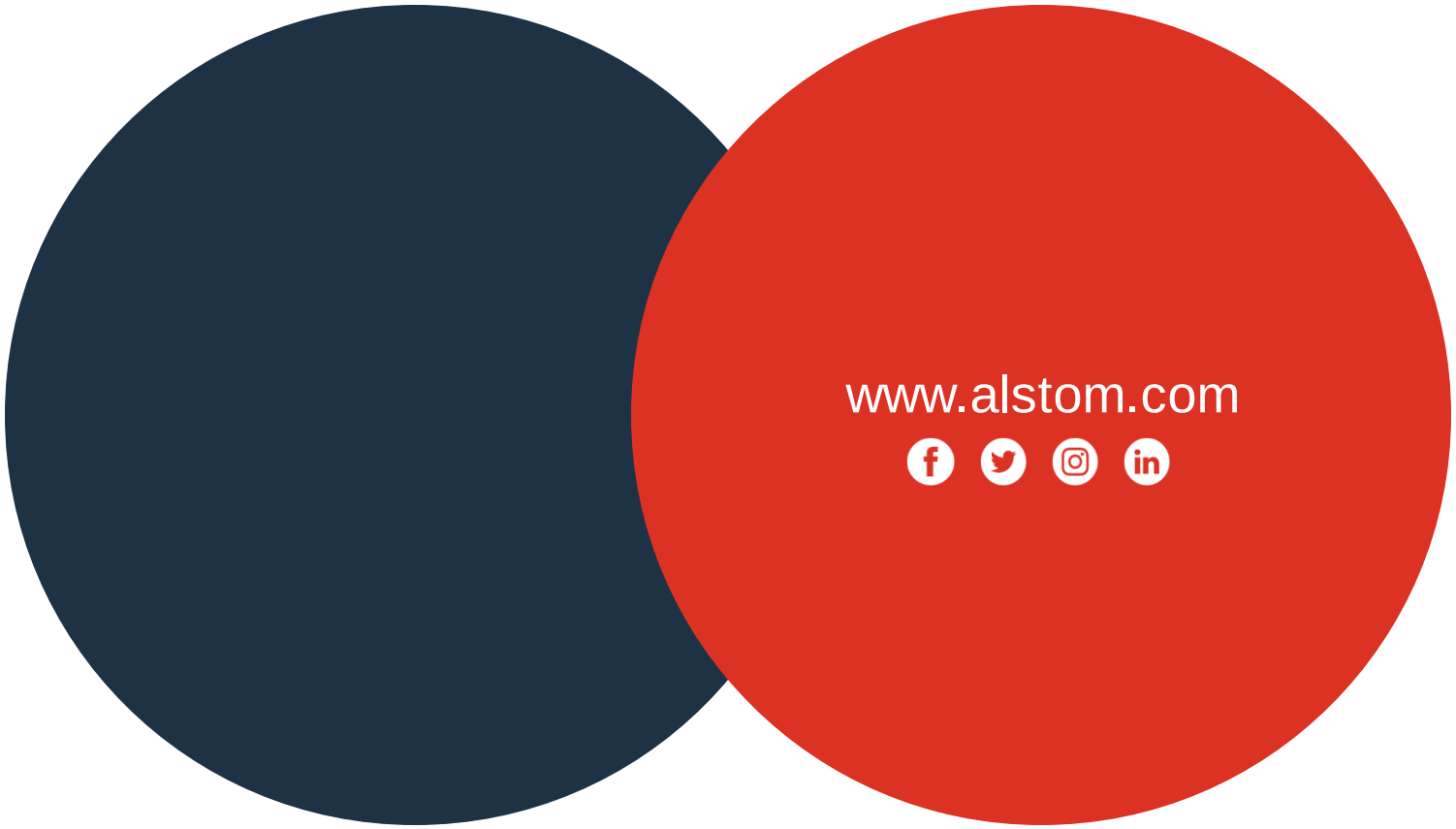
iLint LVNG line dedicated refueling site in Germany for entire fleet

05

Conclusion

Conclusion

- **Alstom is offering a Full Suite of Green Solutions for North America**
- **It is possible to quickly implement a small local infrastructure for H_2 trains operation**
- **Large scale deployment brings many challenges and requires collaboration between the different stakeholders**
  - Hydrogen production and cost
  - Transport & distribution



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