



# HYDROG(E)NICS

SHIFT POWER | ENERGIZE YOUR WORLD

HARNESSING RENEWABLE ENERGY STORAGE  
TO POWER HEAVY MOBILITY FLEETS

Mark Kammerer  
Business Development Manager  
Hydrogenics GmbH

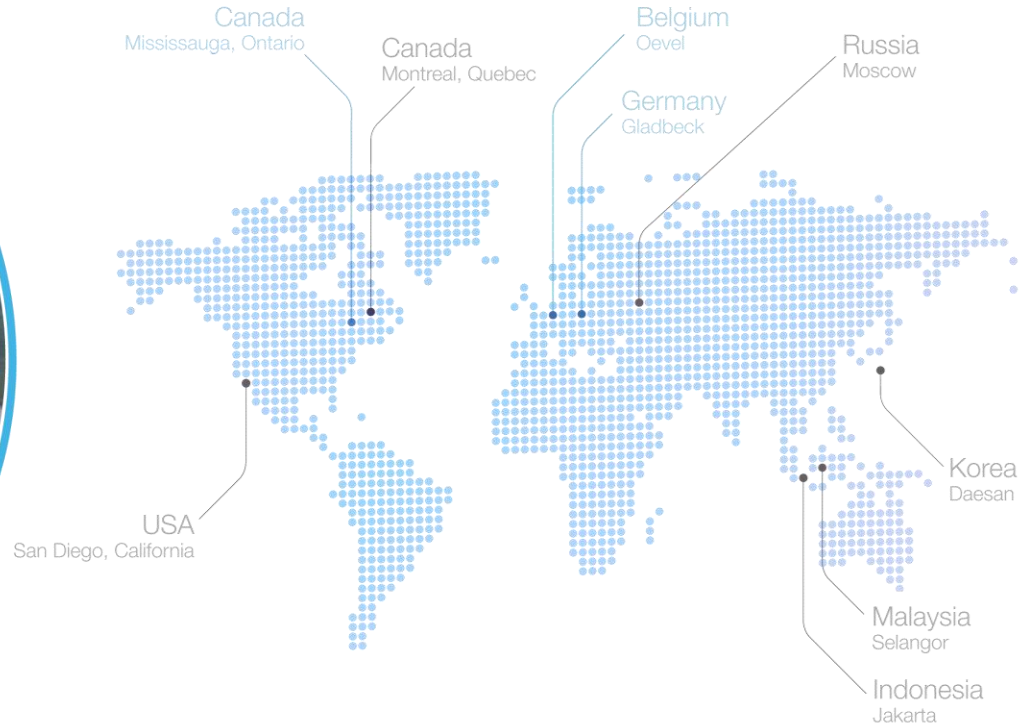
FCH 2 JU & S2R JU  
HYDROGEN TRAIN WORKSHOP  
Brussels, 2017-05-15



FUEL CELLS  
AND HYDROGEN  
JOINT UNDERTAKING



# Shifting Power - Across Industries - Around the World



# Our Principal Product Lines

## HyPM™ and CELERITY™ PEM Fuel Cell Power Modules and Systems for Mobility

- World leading feature list, innovation and product line maturity
- Variants customized to any requirements



## HyPM™ Fuel Cell Power Modules and HyPM™-R FC Racks Systems for Critical Power

- World leading feature list, innovation and product line maturity
- Unlimited scalability



## HySTAT™ Alkaline Electrolyzer Plants for Industrial, Hydrogen, Energy Storage and Fueling

- World leading market share
- The industrial standard



## HyLYZER™ PEM Electrolyzer Plants for Energy Storage and Fueling

- Input power > 1 MW
- World's most power dense electrolyzer stack
- Unlimited scalability



# Global Leader in Hydrogen Technology

Our raw materials,  
water & renewable power are  
**infinite!**

**2,000+**  
fuel cell sites

Leading PEM  
Stack &  
System  
Technology  
Innovator

> \$50 M USD  
multi-year  
fuel cell  
contract with  
leading rail  
OEM

> \$90M USD  
multi-year  
fuel cell  
contract with  
hi-tech  
mobility OEM  
(since 2012)

1 single focus:  
**hydrogen solutions**

Unmatched  
power  
density in a  
single  
electrolysis  
stack (3MW)

# HYDROG(€)NICS

> \$100 M USD  
order  
backlog YE  
2016)

**Publicly  
traded**

NASDAQ (HYGS) and  
TSX (HYG) since 1995

**500+**  
electrolysis plants  
in operation

**Global leader**

in 2 main hydrogen technologies:  
electrolysis and fuel cells

Servicing  
products in >  
100 countries  
worldwide

**65+**  
years  
of experience

> 55 H2  
Fueling  
Stations with  
Hydrogenics  
electrolysers  
worldwide

**1,500+**  
electrolysis plants  
sold since 1948





*Saint Gobain, Colombia*



*Elemash, Russia*



*Bushan, India*

# Onsite Hydrogen Generation - Industrial



*Camao, Brazil*



*Nyagan, Russia*



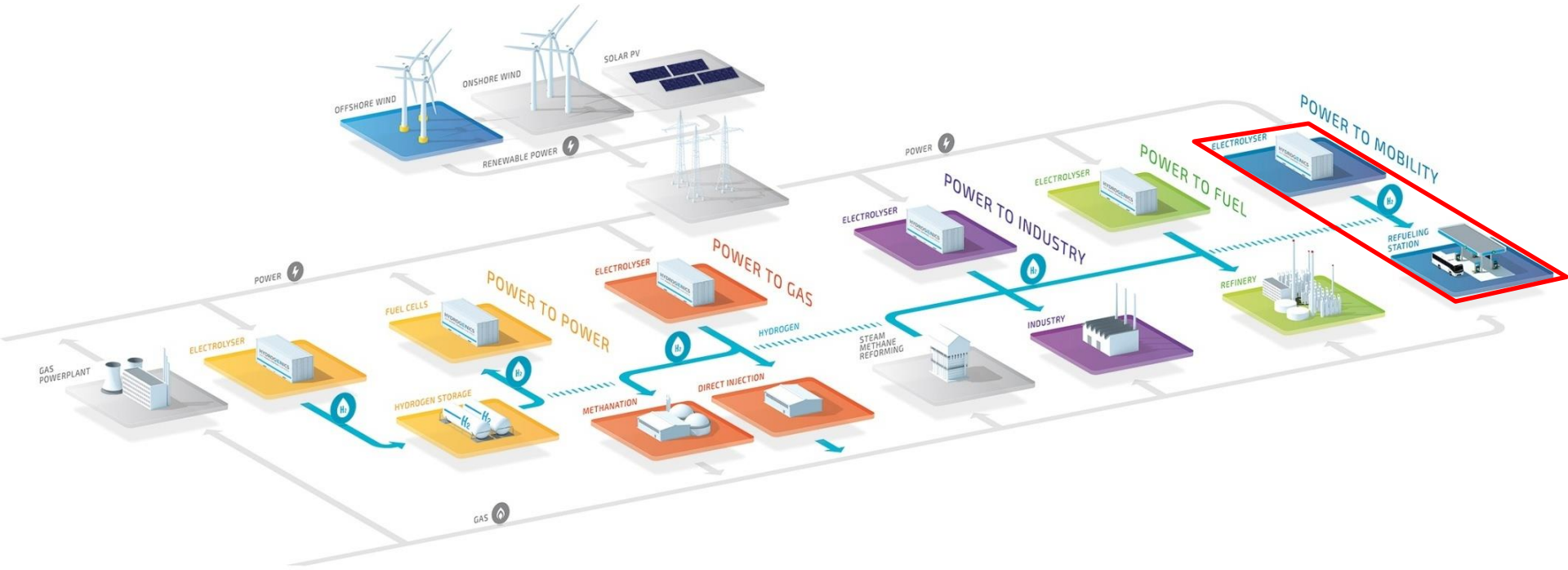
*Kirovgrad, Russia*



# Renewable Hydrogen & Energy Storage



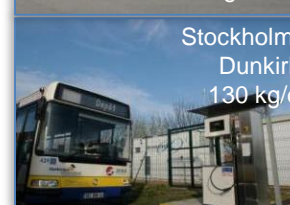
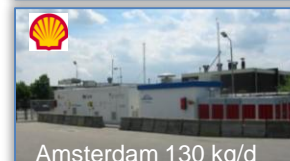
# Renewable Hydrogen Versatility





# Hydrogen Fueling for European FC Bus Fleets

11 of 13 electrolyzer FC Bus fueling stations with HySTAT by Hydrogenics



CUTE	HYFLEET	CHIC	HiVLOCity	HyTransit
Reykjavik	Reykjavik	Bolzano	Aberdeen	Aberdeen 2
Amsterdam	Amsterdam	Aargau	San Remo*	
Porto		Hamburg	* delivered	
Barcelona	Barcelona	Oslo		
Hamburg	Hamburg			
Stockholm				

2001

2017



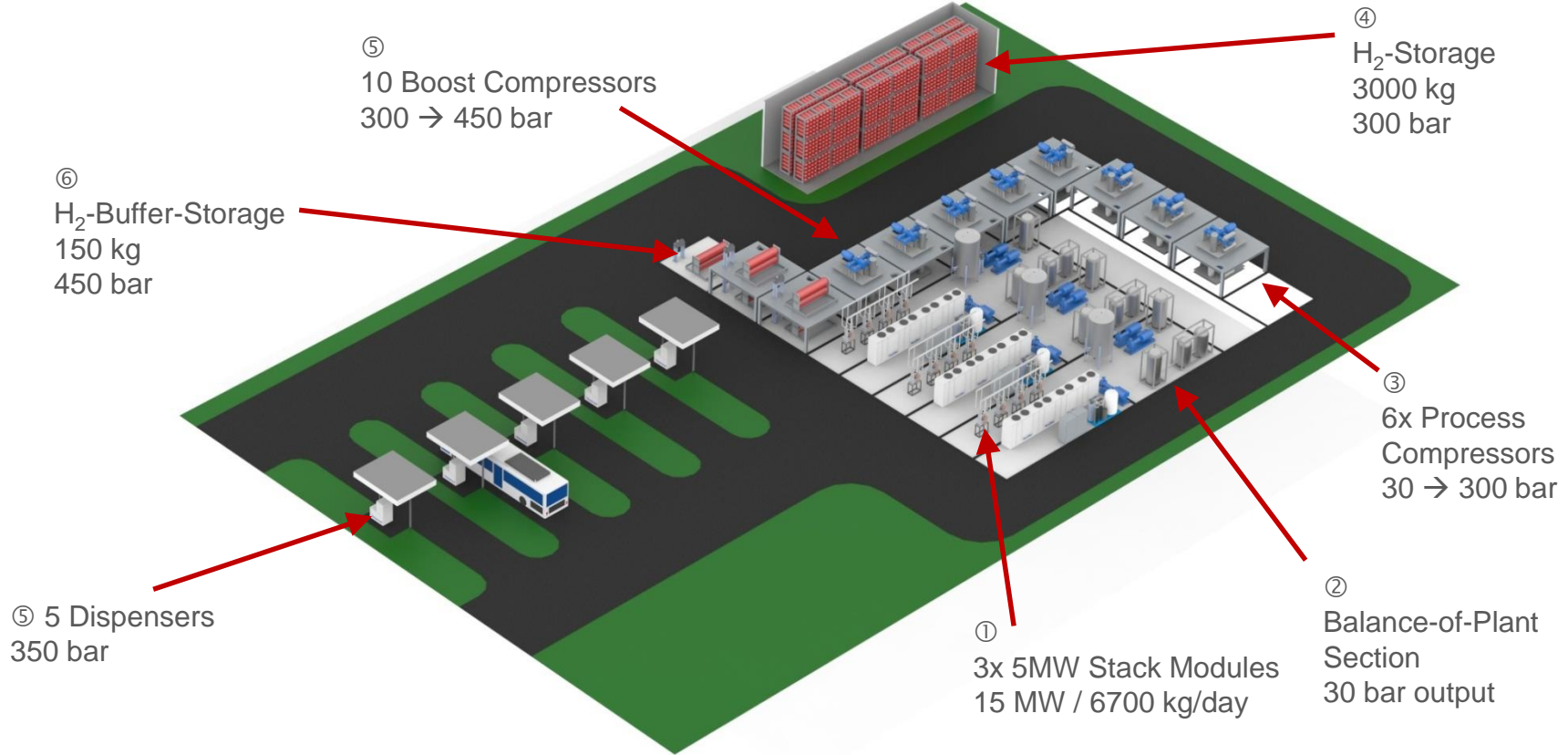
# Electrolyzer Hydrogen Refueling Station



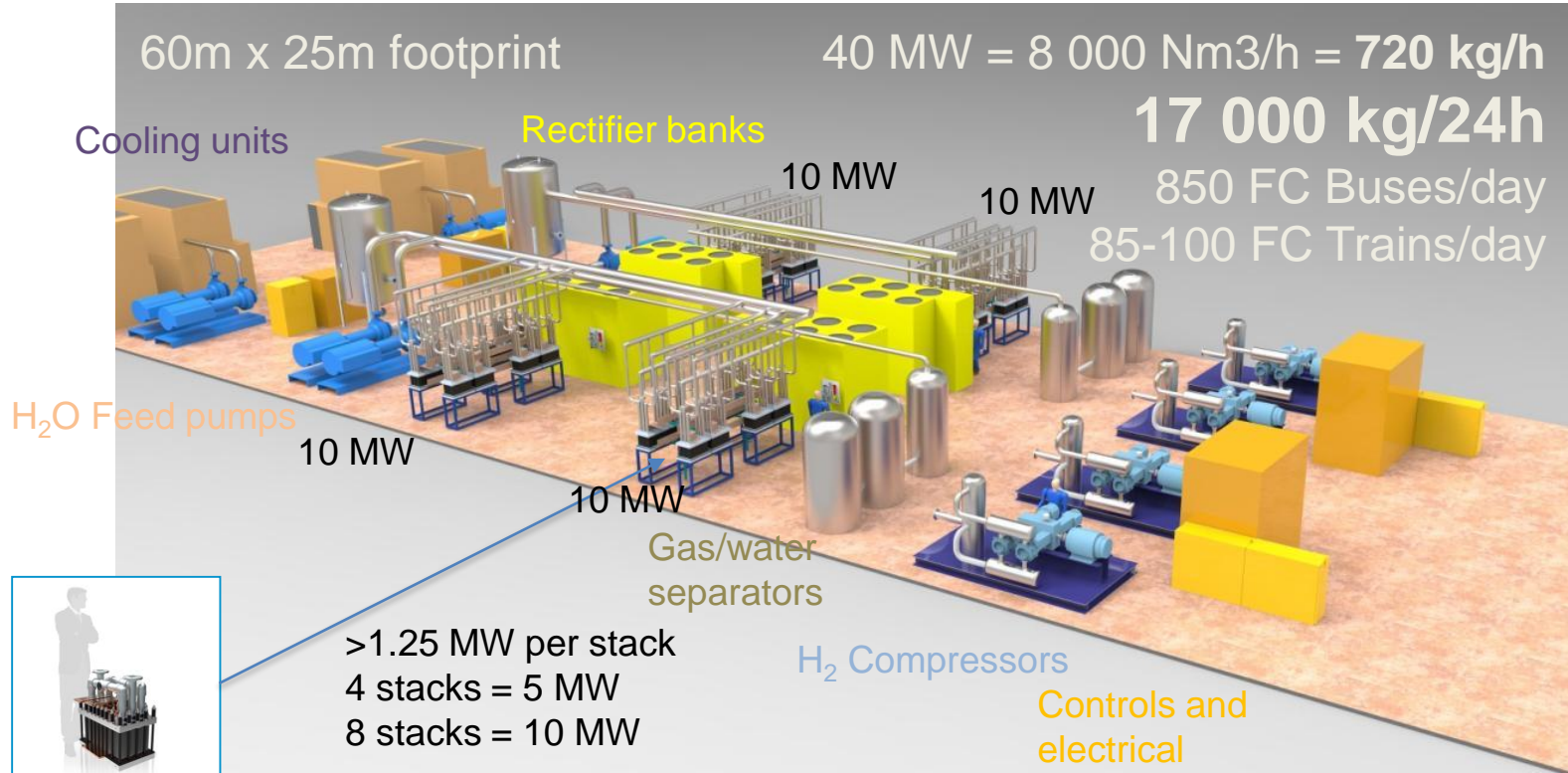
15 MW  $\rightarrow$  3 100 Nm<sup>3</sup>/h  $\rightarrow$  280 kg/h  $\rightarrow$   
**6 700 kg/24h  $\rightarrow$**   
300 FC Buses/day  
30-45 FC Trains/day



# PEM Electrolysis HRS – Capacity for 300 Buses or 30 Trains



# Large Scale Power-to-Fuel



*Concurrently Ancillary services, Demand response, Energy storage...*



# Fuel Cell Product Selection for Heavy Duty Vehicles



10-30 kW

- PEM FC Power Module
- Freeze-protected
- Integral Balance of Plant
- Ease of Integration



60 kW

Designed for direct connection with Siemens Elfa electric drive

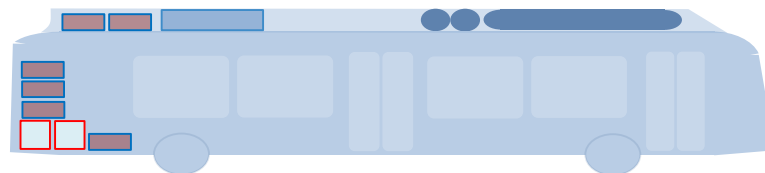
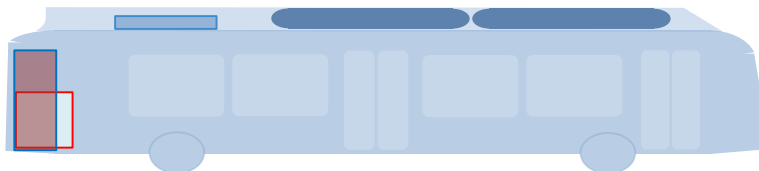
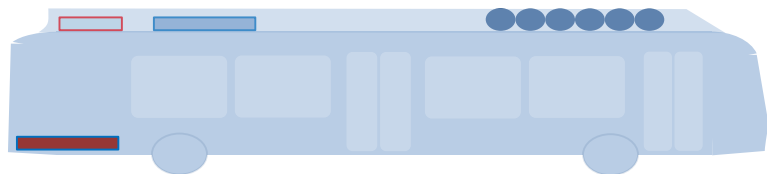
Full feature set, including Pre-charge, Load contactor, Reverse current protection, IP rated enclosure



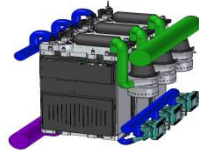
≥ 90 kW

- Fuel cell modules plus:
- Frame and enclosure
- Manifolding
- Single interface set
- 120/150/180/240kW+ variants

# Flexible installation



# Trucks: flexible power as needed, easy Integration,





# HyPM™ in Urban Transit Applications



# Alstom: Zero-emission hydrogen fuel cell regional trains



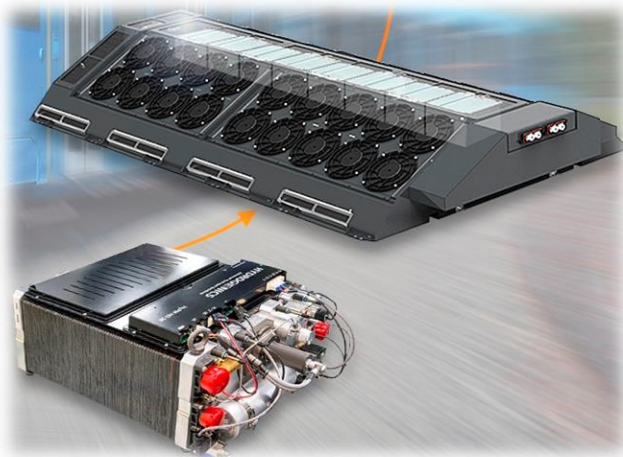
- ~ 40% of rail network in Germany is not electrified (operated with diesel)
- Increasingly stringent regulations (exhaust emission, noise)
- Expected price increase for diesel
- LOI from 4 German States zero emission passenger trains signed in 2014
- First 2 trains integrated and in testing and certification phase 2017
- First operation with passengers expected beginning of 2018





# Design and Testing Schedule

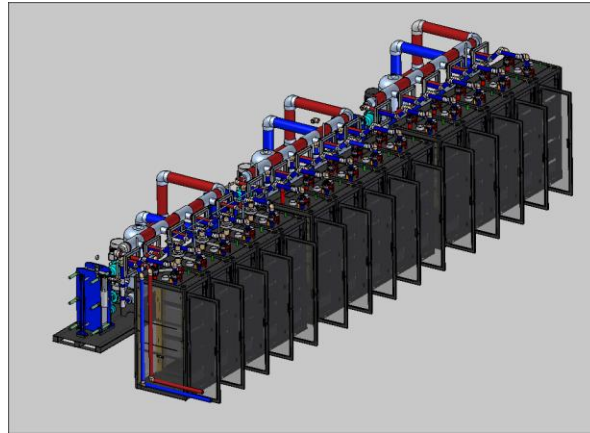
- 2015/2016 Prototype bench testing in France
- 2016 Fuel cells for first 2 trains tested and delivered
- 2017 Integration into the first trains
- 2017 March 14 - First operation on the test track
- 2017 Validation in Germany and the Czech Republic
- 2018 First operation with passengers



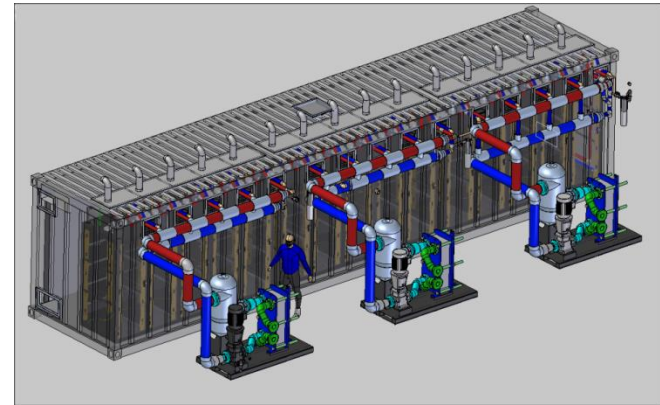
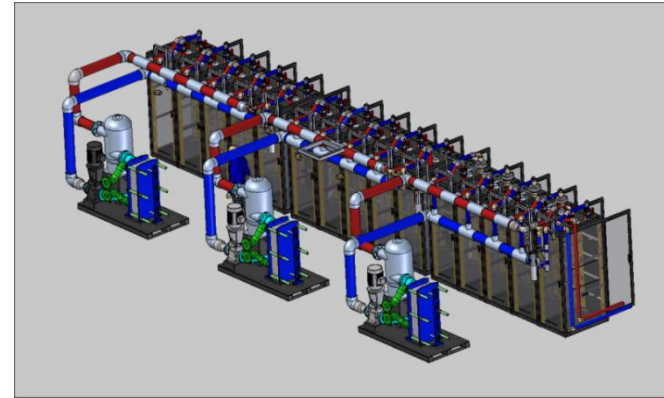
Fuel cell  
production and  
testing for  
Alstom's Coradia  
iLint



# 1.8 MW PEM Fuel Cell Plant - 40 foot ISO container



- 15x 120kW FC Racks
- 1.8 MW gross power\*
- \* before power electronics, ventilation and secondary cooling loop



## Power-to-Fuel Value for Trains



- Distributed and Scalable Solution
  - PEM Electrolyser system scales to meet hydrogen fuelling requirement (5MW → 2 tonnes/day to 100MW → 40 tonnes/day)
- Decarbonizes non-electrified train routes
  - Enables zero emission trains where the cost of catenary lines are not feasible
  - Longer range without catenary than battery-only hybrids
- Capture full capacity of renewable energy generation assets
  - P2F (HRS) plant runs off-peak (16 hours/day) and when renewable energy production exceeds demand
  - Avoids daily peak power demands (evening “rush hour”) or when renewable power production is low
- Grid Services for Grid Operator
  - Regulation Services
  - Flexibility Ramping (down)
  - Spinning Reserve

# Hydrogen is the Renewable Energy Enabler



Offgrid:  
Fixed fuel  
price for the  
operating life  
of the  
equipment!

**100% Fossil Fuel:**  
Imported energy  
Polluting emissions  
Fuel expense dictates cost

**Uncontrollable**

**100% Renewable:**  
Fully self-sufficient  
Zero-emissions  
CapEx defines cost

**Bankable**

