

Aluminum Gallium Company

Hydrogen-on Tap for Commercial Vehicles



BY AlGalCo

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Energy Security

Emissions



Sustainability

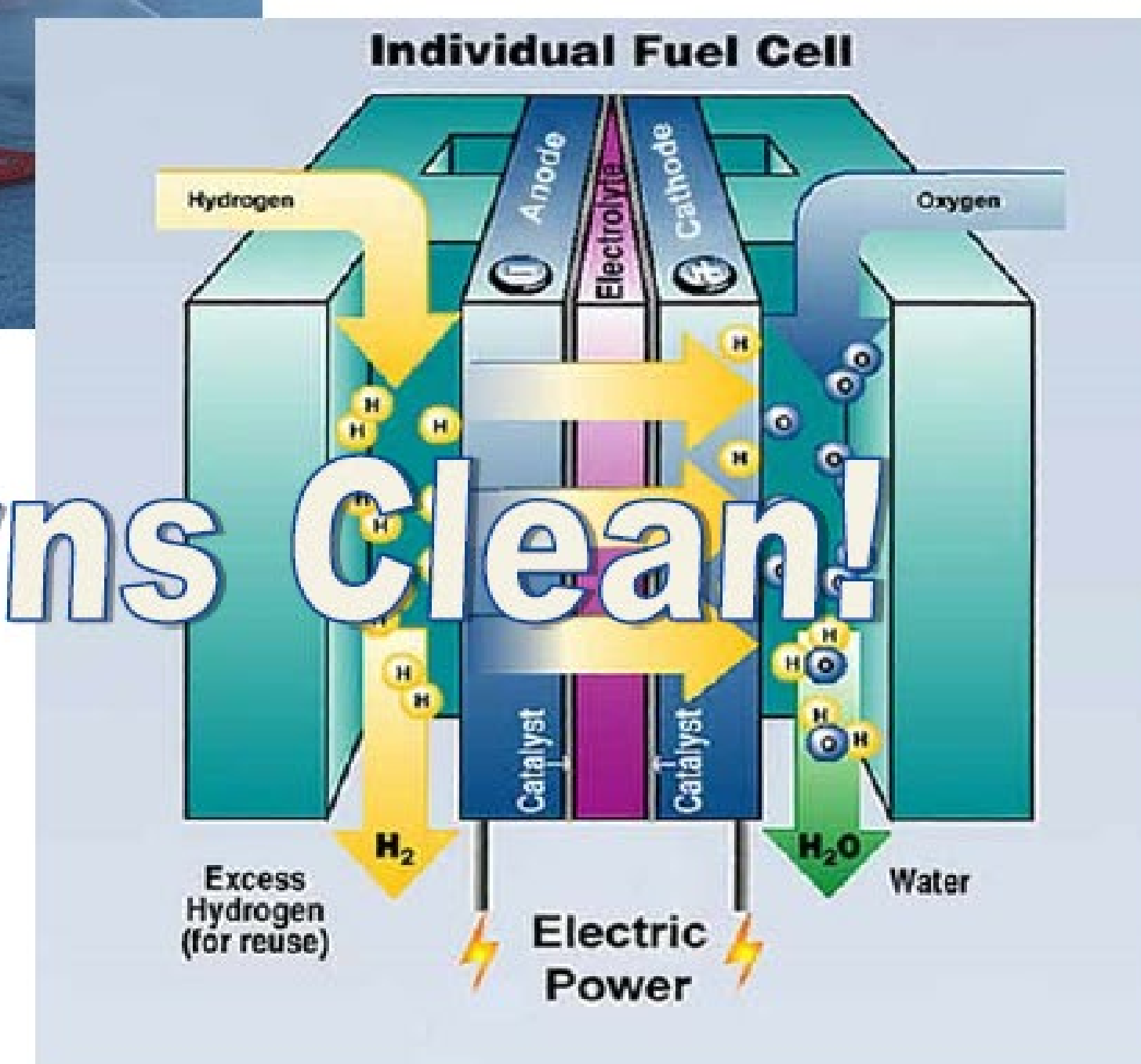


Why **H**ydrogen?

Reduces dependency on oil!

**Most abundant
Element in
the universe!**

Burns Clean!





The Problem – Why Not Hydrogen

- **Expensive to extract**
- **Difficult to Transport**
- **Storage**

Market

- **Transportation — land vehicles including over the road trucks**
- **Ocean going ships**
- **Energy storage — windmill farms**
- **Trillion dollar plus global markets**
- **Dominated by multinational oil and gas companies**





Why AlGalCo?



Abundant

Aluminum-based



Renewable

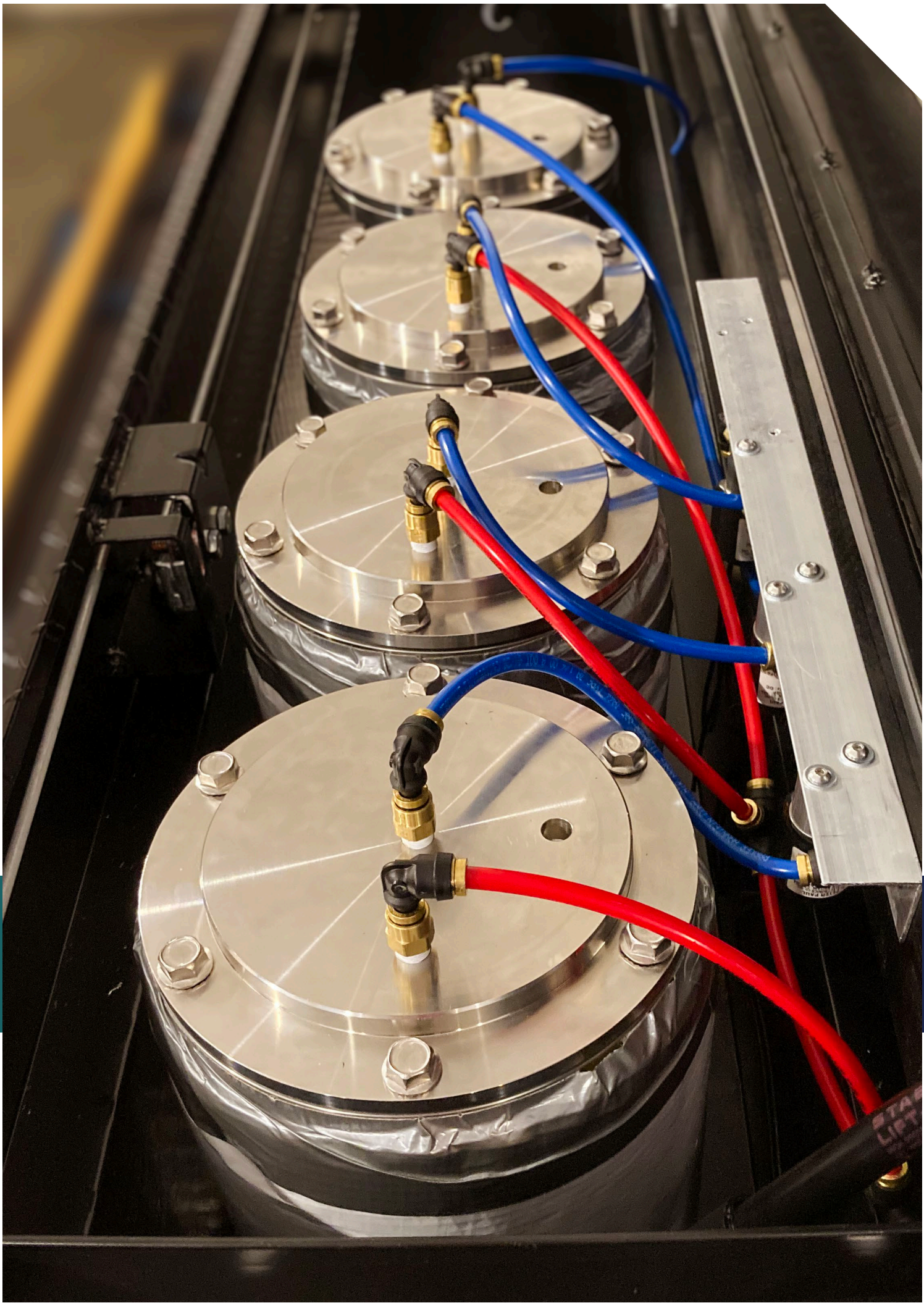
Burns Clean



Introducing Hydrogen on Tap (HOT)



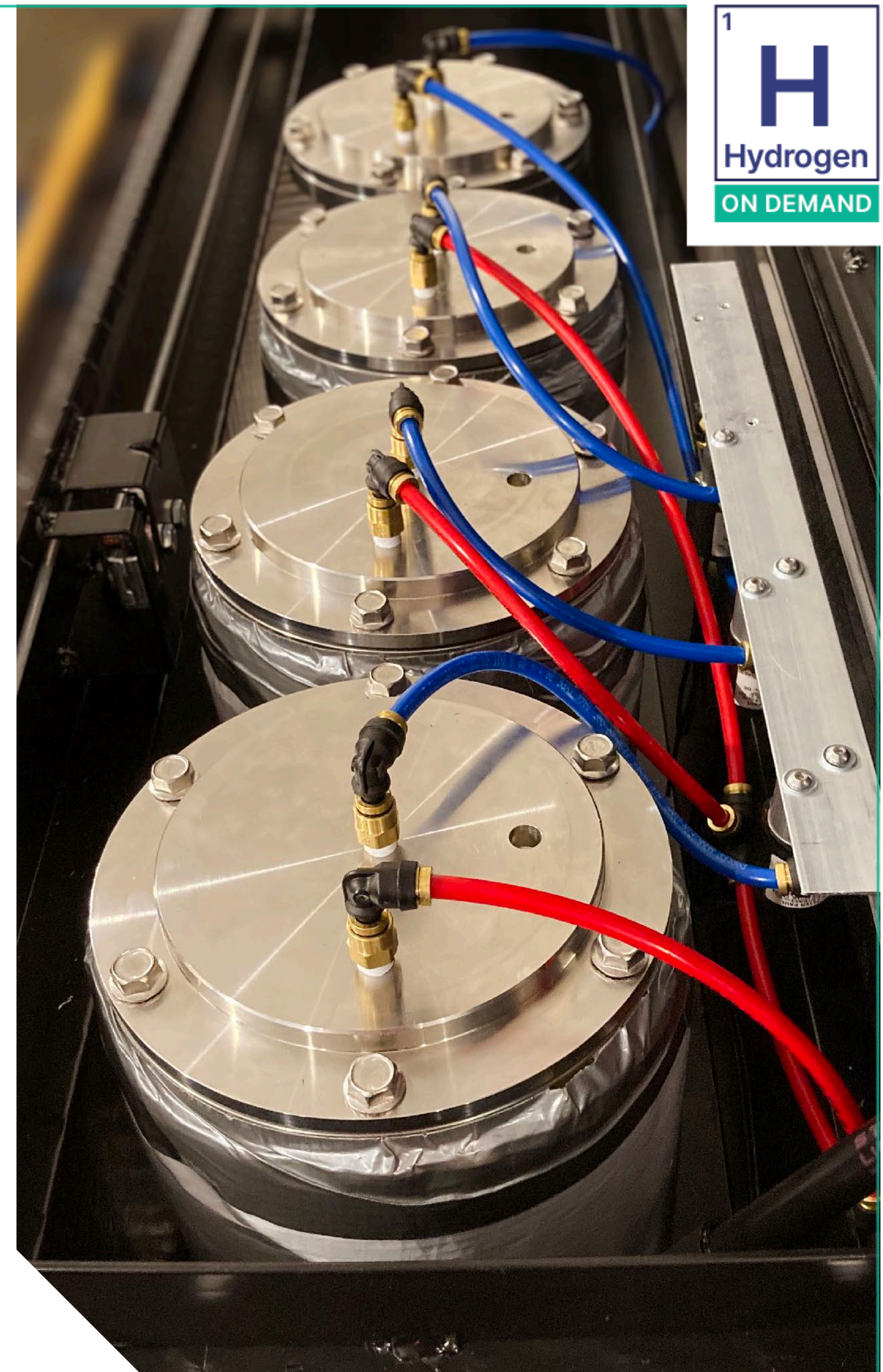
SYSTEM 5.0



Technology

- Issued Patents – Material Science
- Proprietary Technology – Actual Operation

Patented Technology

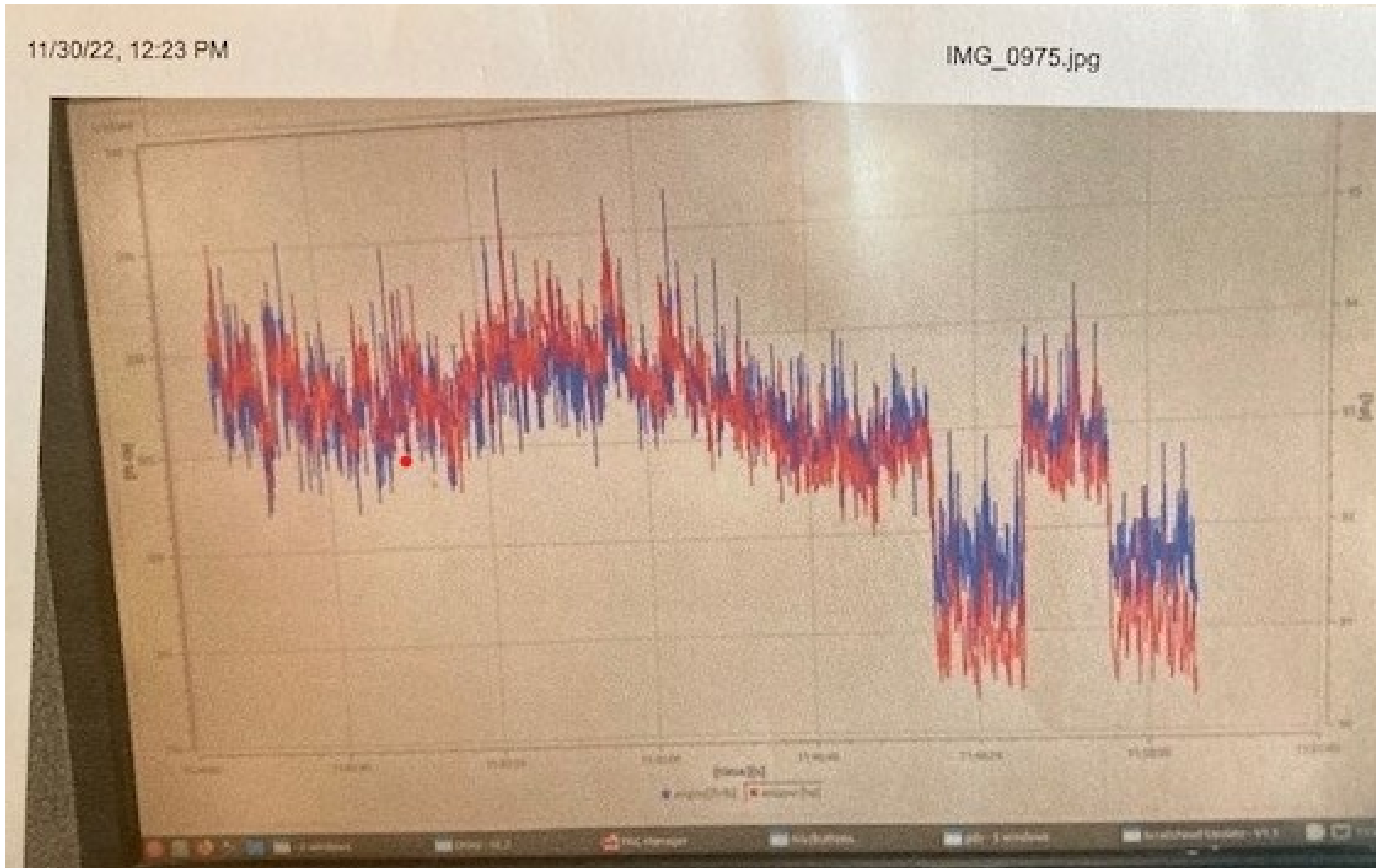


Test Results

				Positive		Negative				No change	
Reference	Test conditions			Performance		Emissions					Comments
	Load	EGR	H2 supply	BTE	BSFC	PM	HC	NOx	CO	CO2	
Varde and Frame (37)	82%, 100%	No	1.4% - 1.7%								1800rpm
Lill et al. (38)	25%, 75%	0 - 13%	2.5% - 15%								1600rpm
	25%, 75%	0 - 13%	2.5% - 15%								
Saranan and Nagarajan (33)	25%, 100%	No	9.4% - 17%								
	50%, 75%	No	9.4% - 17%								
Saranan & Nagarajan (34,35)	25%	No	2 - 9.5lpm								
	50%, 75%	No	2 - 9.5lpm								
	100%	No	2 - 9.5lpm								
Zhou et al. (41)	10%	No	10% - 40%								
	30%	No	10% - 40%								
	50%	No	10% - 40%								
	70%, 90%	No	10% - 40%								
Sandalci and Karagöz (43)	100%	No	0 - 45%								
Masood and Mehdil (47)	20% - 100%	No	10% - 100%								
Saranan et al. (48)	100%	No	0 - 38.5%								Variation of injection timing
Saranan and Nagarajan (49)	0 - 100%	No	0 - 100%								NOx reduced for H2>30%
Tsujimura and Suzuki (50)	3 - 9bar IMEP	No	0 - 90%								NOx increase for high loads
Suzuki and Tsujimura (51)	Partial	0 - 35%	50% - 78%								
Suzuki et al. (52)	4.2 - 10.5bar IMEP	0 - 29%	0 - 83%								

- Supplemental Hydrogen in ICE proven technology
- AlGalCo Hydrogen actual operations results

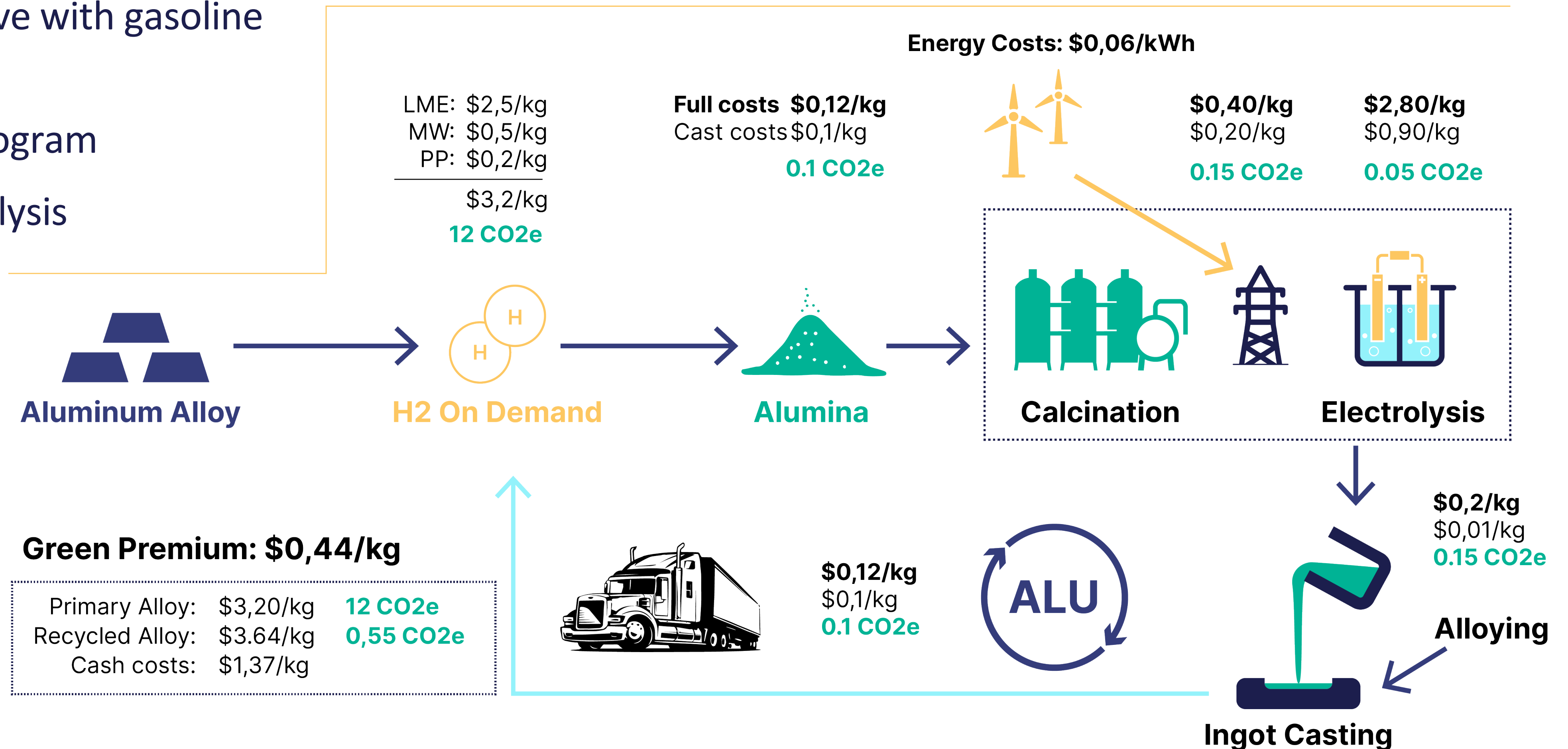
Test on 15L Diesel Engines



- Lower emissions
- Increased fuel efficiency

Closed Loop Recycling Hydrogen On Tap Aluminum Alloy Industrialization

- Cost competitive with gasoline and diesel
- Inert anode program
- Molten electrolysis



For cost reduction of the Hydrogen

Mid-size engines generate 1kg/truck/week
Class 8 diesel engines generate 150kg/truck/week

Class 8 trucks	7,800	Kg/y	
NA market	4,000,000	Trucks	
# of trucks			Market
10	78	MT/y	0.00025%
100	780	MT/y	0.0025%
1,000	7,800	MT/y	0.025%
10,000	78,000	MT/y	0.25%
100,000	780,000	MT/y	2.5%
1,000,000	7,800,000	MT/y	25%

128,205 trucks generate 1,000,000MT of “grey powder” = 3.2% market penetration

Recycling and Expansion

Recycling



Aluminum smelters



Energy storage

Expansion

Transportation applications



Marine diesel engine
emissions reductions

Value Proposition

**Reduces demand for gasoline
and diesel**

**On Demand, so NO high pressure
storage or refueling**

Reduces harmful emissions

**Completely renewable
aluminum-based feedstock**

No new refueling infrastructure

**Cost-competitive with
gasoline and diesel**

**No modifications of vehicle
engine**

EPA compliant

Meets or Exceeds GREEN Fleet Initiative Metrics

Scalable



PORTABLE
GENERATORS



FUEL
CELLS



5.4 LITER V-8
GAS POWERED FLEET
VEHICLES



15 LITER
OVER THE ROAD
DIESEL TRUCKS

Competition

Benefits	AlGalCo	Natural Gas	Water Electrolysis
Recyclable	Yes	No	Yes
Storage	Yes	No	No
Fuel Cells	Yes	Yes	No
Infrastructure	Yes	No	No

Advantages to Energy EcoSystem

- Fleet service providers
- Commercial Fleets
- OEMs
- The aluminum industry
- Windmill Farms
- Utilities

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