Attachment #5.3
Return to Agenda

Plug Power: Hydrogen Technology, Production and Scalability

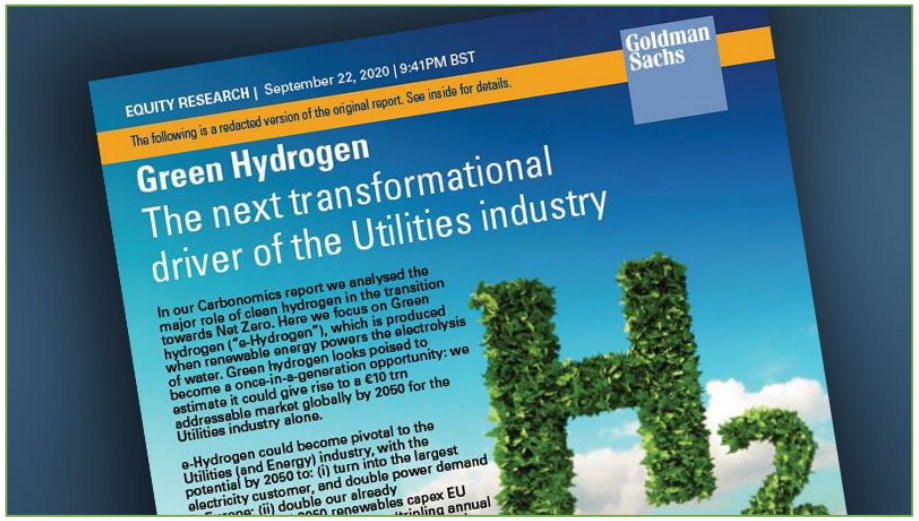
Tim Cortes, Chief Technology Officer

May 13th, 2022

Agenda

1. Plug Overview
2. Plug H2 Technology
3. H2 Market
4. Plug Vertical Integration
5. H2 Production
6. Hydrogen Policy

THE HYDROGEN ECONOMY



"We estimate it could give rise to a €10T addressable market globally by 2050 for the Utilities industry alone."

Source: Goldman Sachs Equity Research

BANK OF AMERICA

Game changer: How green hydrogen could fuel our future

A number of converging factors are shining a light on hydrogen's potential to revolutionize the global energy industry and help solve the climate crisis

"Green hydrogen could provide up to 24% of our energy needs by 2050, helping to cut emissions by around a third. In doing so, the transition to green hydrogen could provide $11 trillion of infrastructure investment opportunities over the next 30 years

Source: Bank of America Global Research

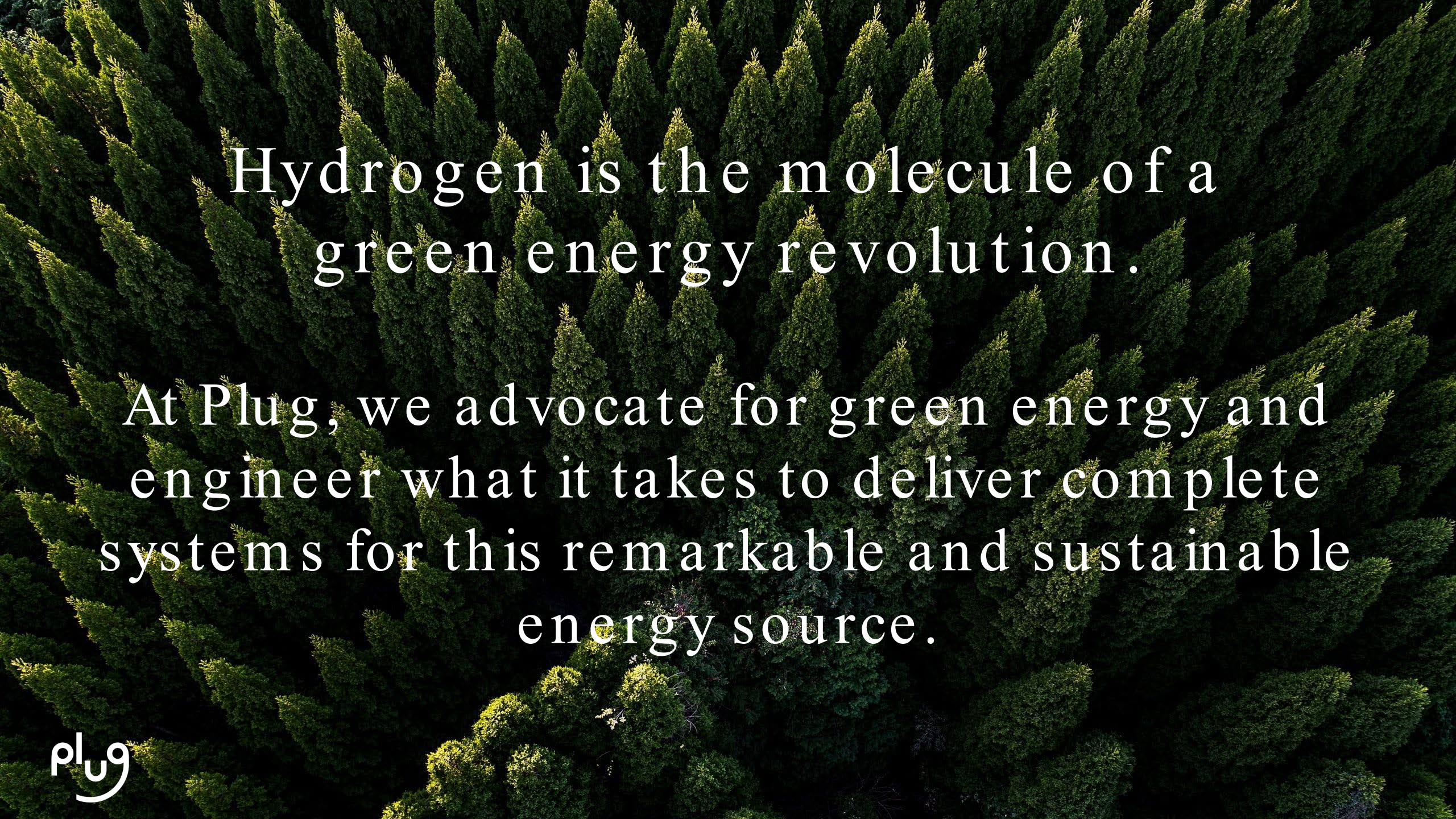
Bloomberg Green

Finance

Green Hydrogen Could Price Gas Out of Power Markets by 2050

"Clean hydrogen could be deployed in the decades to come to cut up to 34% of global greenhouse gas emissions from fossil fuels and industry – at a manageable cost."

Source: Bloomberg New Energy Finance


Hydrogen is the molecule of a green energy revolution.
At Plug, we advocate for green energy and engineer what it takes to deliver complete systems for this remarkable and sustainable energy source.
plug

Plug's New Brand

Purpose

- Plug is here to change the world by weaning the planet from fossil fuels.
- We bring the advantages of the total Green H_2 value chain to customers and people everywhere.

Commitments

- Think, talk, act customer
- Make Hydrogen easy
- Deliver success

Design Principles

- On a mission—to fulfill the promise of the Green Hydrogen revolution
- Accomplished—the first to believe in and make Green Hydrogen a reality
- Humble and Gutsy—we are listeners and learners who put ourselves on the line

The Global Leader in Green Hydrogen

24 years
of H_2 Innovation

38% CAGR
(2013-2020)

2,500+
Global employees

857 million+
Hours of operation

50,000+
Fuel cell systems deployed

Largest user
of liquid hydrogen

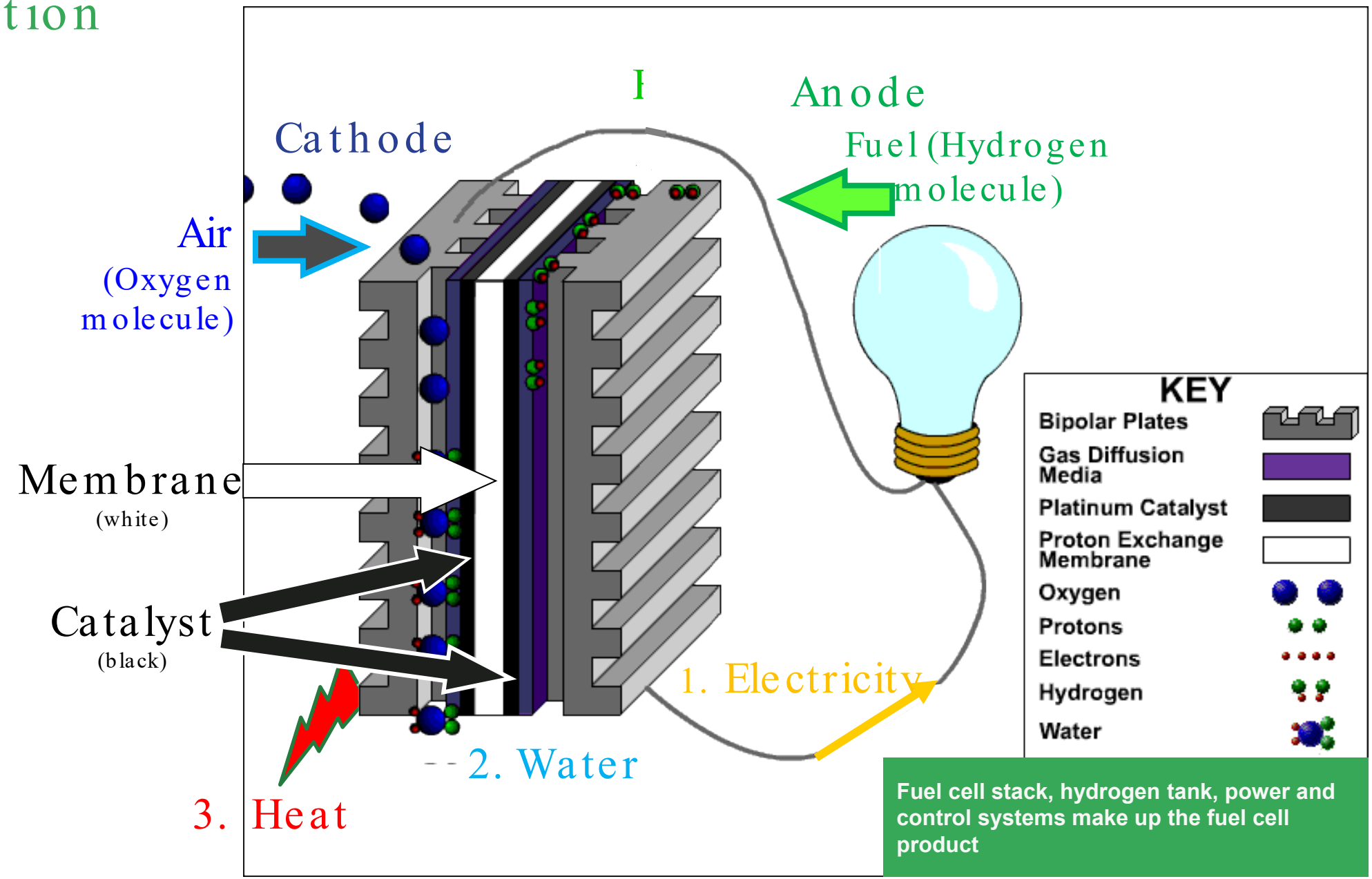
40 tons
of hydrogen used daily

49 million+
Hydrogen fuelings

Headquarters
New York, USA

plug™

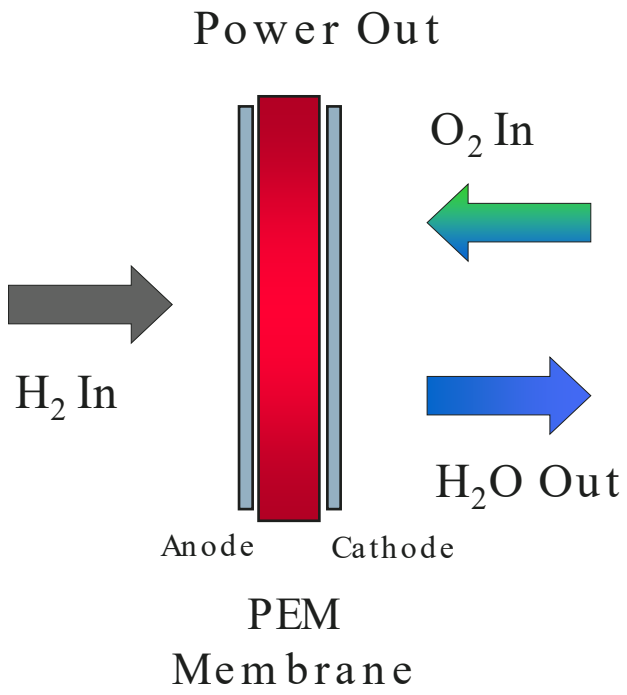
Proton Exchange Membrane (PEM) Fuel Cell Operation



Fuel cell stack, hydrogen tank, power and control systems make up the fuel cell product

ZERO EMISSIONS POWER:FUEL CELLS

Power is generated via an electrochemical process using hydrogen and oxygen with water as the byproduct.



ZERO-EMISSION POWER

Hydrogen fuel cells (HFCs) produce no harmful emissions, the only by-products are heat and water, making our products a zero-emission, sustainable power source.

ROBUST RELIABILITY

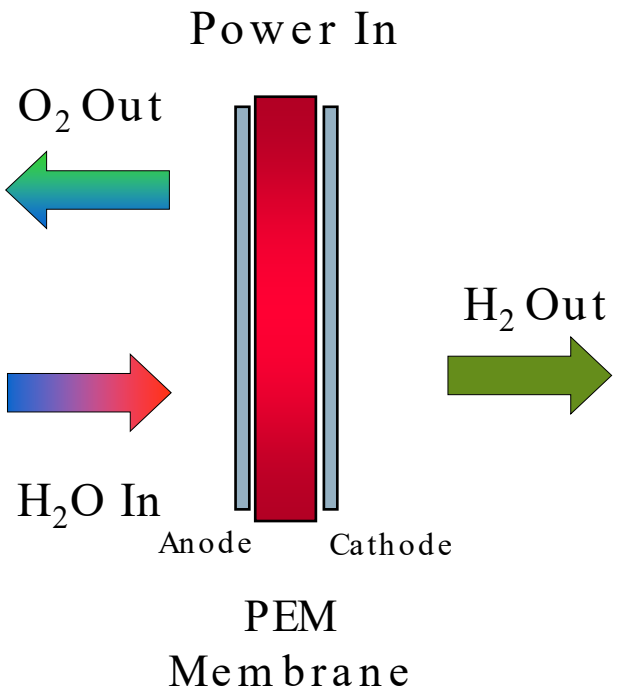
Proven technology in tough conditions, including cold environments as low as -40 degrees F/C, weather environments like hurricanes, deserts, and winter storms, and even the hard-working business environments of material handling warehouses

IMPROVED EFFICIENCY

Hydrogen fuel cells are generally between 40-60% energy efficient. This range compares to the typical internal combustion engine of a car which is about 25% energy efficient

ZERO EMISSIONS POWER: ELECTROLYZERS

Hydrogen is generated via an electrochemical process using electricity to capture hydrogen from water.



ROBUST & DEPENDABLE

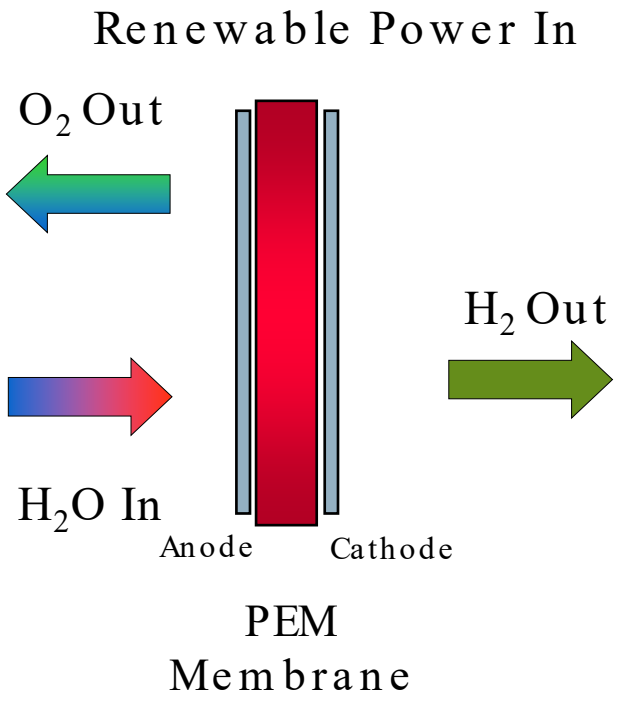
Based on more than 47 years of experience in design, production and sales of electrolyzer stacks and integrated products. Providing industry-leading performance for a variety of diverse applications including heavy industry, e-mobility, renewable energy and energy storage needs.

ADAPTABLE & MODULAR

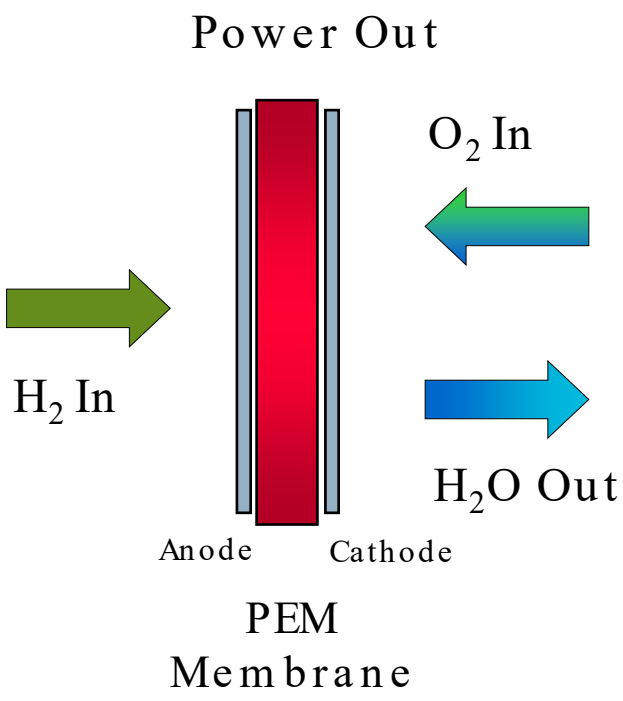
GenFuel electrolyzer solutions support industry expansion – flexible and scalable to meet a wide array of performance requirements. Simplified BOP and reduced stack and system cost make these products cutting edge. PEM technology allows us to have immediate response time the moment that renewable electricity is available to turn it into hydrogen.

ZERO EMISSIONS POWER

Electrolyzers: Green Hydrogen



Fuel Cells: Zero Emission Power



MARKET OPPORTUNITY

MATERIAL HANDLING

$30Bn

- Target addressable market

ELECTRIC VEHICLES

$300Bn

Target addressable market

STATIONARY POWER

$30Bn

Target addressable market

HYDROGEN ECONOMY

$10Tn

Target addressable market

Plug Power Today

Long-Term Growth Trajectory

Forklifts

- More than 6MM forklifts deployed
- 1.5MM forklifts sold annually

On-Road Electric Vehicles

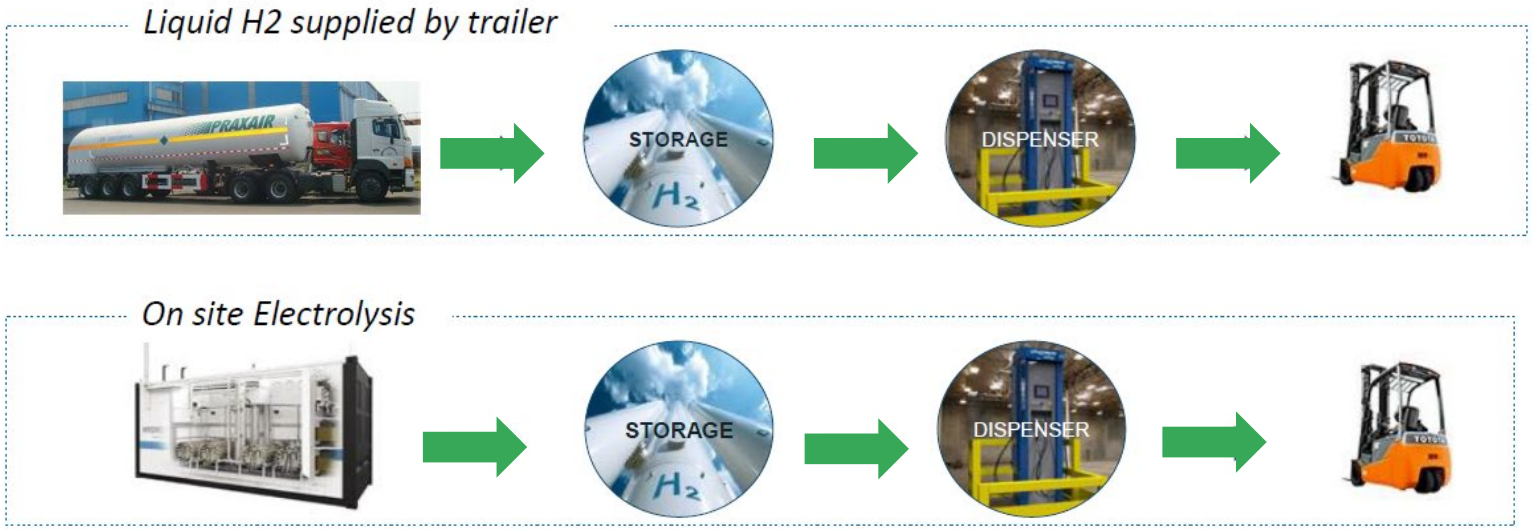
- Energy density is ~10x BEVs
- High asset utilization
- Enables sharing economy
- Faster fueling
- Longer range
- Infrastructure expertise
- Less challenging operating conditions than material handling applications
- Constant power

Data Centers & Wireless Infrastructure

- Small footprint, high power density
- Lower TCO vs. diesel generators

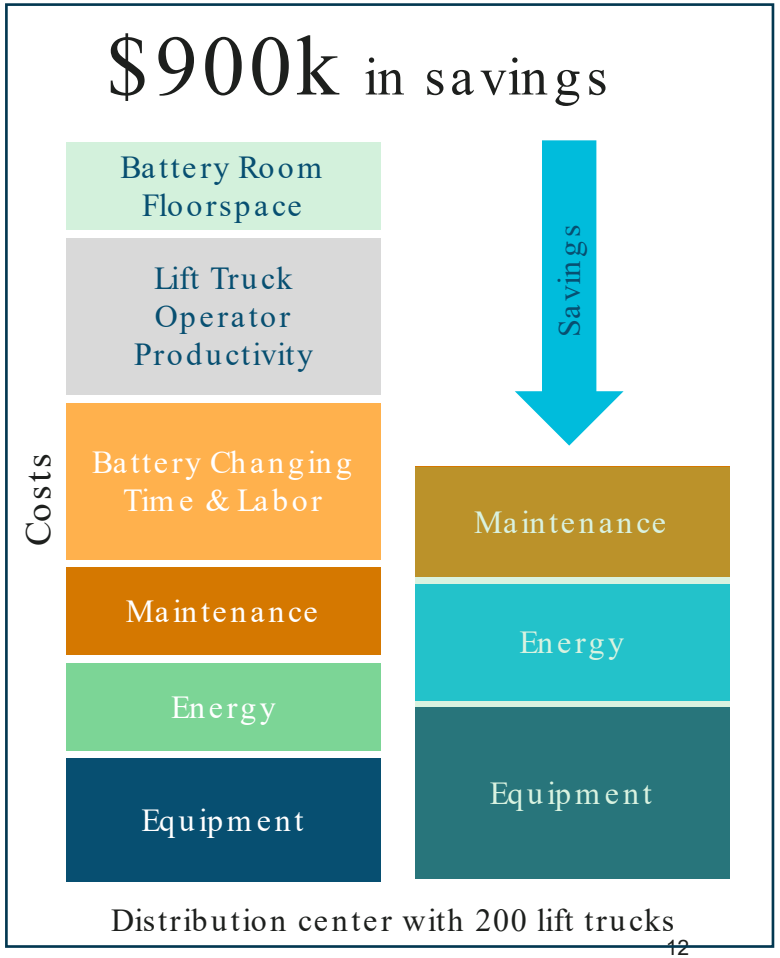
Hydrogen & Equipment

MATERIAL HANDLING: MINI HYDROGEN ECOSYSTEM



30%

of all food and groceries shipped in 2020 moved by Plug fuel cells during pandemic



Industry Leaders Rely on Plug

Zero Emission Transportation and Stationary Power Solutions

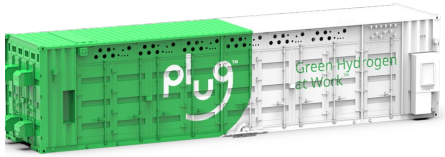
Modular Design Enables Tailored Power Density
Pre-engineered OEM Platform
Easy to Integrate
Enable Multiple Applications

15kW

30kW

85kW

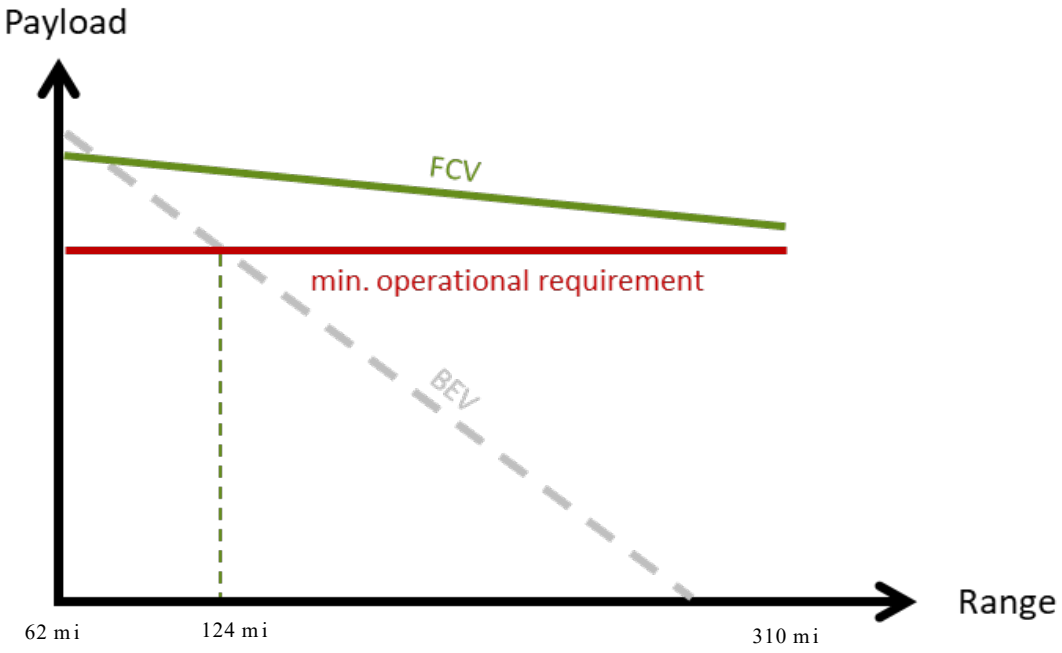
125kW



>1mW

plug

Fuel Cell Trucks Increase Range and Payload



Operational Perspective

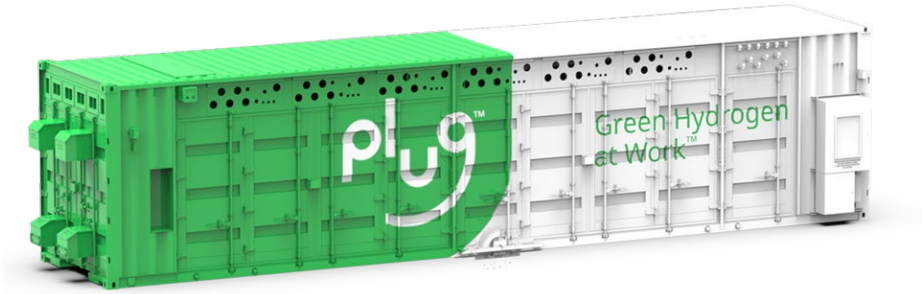
Vehicle Type	Distance	Weight	Charge/Refuel Time
Diesel	500 mile	45,000lb Payload 35,000lb Unloaded	5 Minutes
Battery	125 mile	44,000lb Payload 36,000lb Unloaded	3 Hours
	500 mile	34,600lb Payload 45,400lb Unloaded	11 Hours
Fuel Cell	150 mile	45,000lb Payload 35,000lb Unloaded	5 Minutes
	500 mile	42,600lb Payload 37,400lb Unloaded	15 Minutes

Source: Corporate Incubations, Deutsche Post DHL Group

Hydrogen: The New Diesel

"We're announcing that we're aiming to eliminate diesel fuel by 2030. While diesel fuel accounts for less than 1% of our emissions, we believe it's important to help accelerate the global transition away from fossil fuels and we are charting a new course using low-carbon fuel sources including hydrogen."

Lucas Joppa | Microsoft
Chief Environmental Officer



2019 Generator Usage

CARB studied and quantified customer generator usage during PSPS events

- CARB estimated that customers used ~125,000 backup generators during October alone.
- CARB estimates each generator ran an average of 50 hours.
- They produced PM emissions roughly equivalent to 29,000 heavy duty diesel trucks running for one month.

→ Every solution that can be deployed will decrease the need for customers to run these backup generators, preventing criteria pollutants that have no safe threshold.
→ Incentivizing BTM preferred resources would further decrease the need for gas or diesel generators.

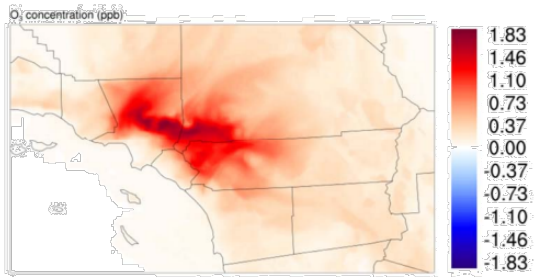
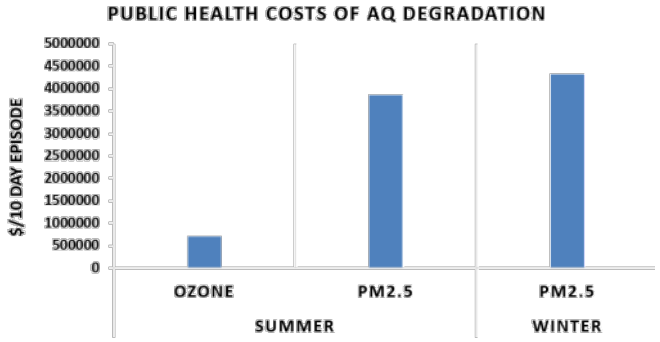


Figure 3. Increases in ground level MD8H summer ozone from the widespread use of fossil backup generators during a grid disruption



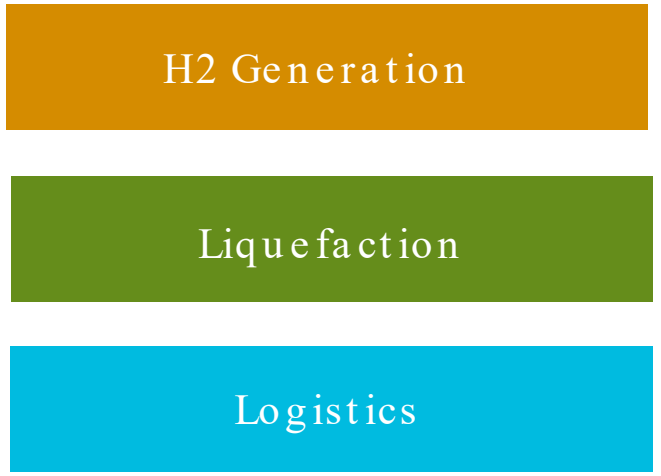
Fuel Cells for large-scale backup power – Deploying pilots in 2021.
Unlocks +$37B TAM (2027)

Vertical Integration - Accelerate Green Hydrogen Strategy

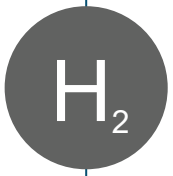
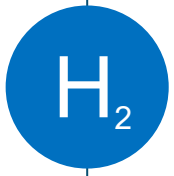
Our comprehensive solutions enables us to successfully serve multiple industries with low-cost Green Hydrogen

- Our capabilities will generate long-term growth
- 40+ years of electrolyzer experience
- Only non-industrial gas company to bring a liquefier online
- Internal demand representing ~15% of liquid hydrogen market

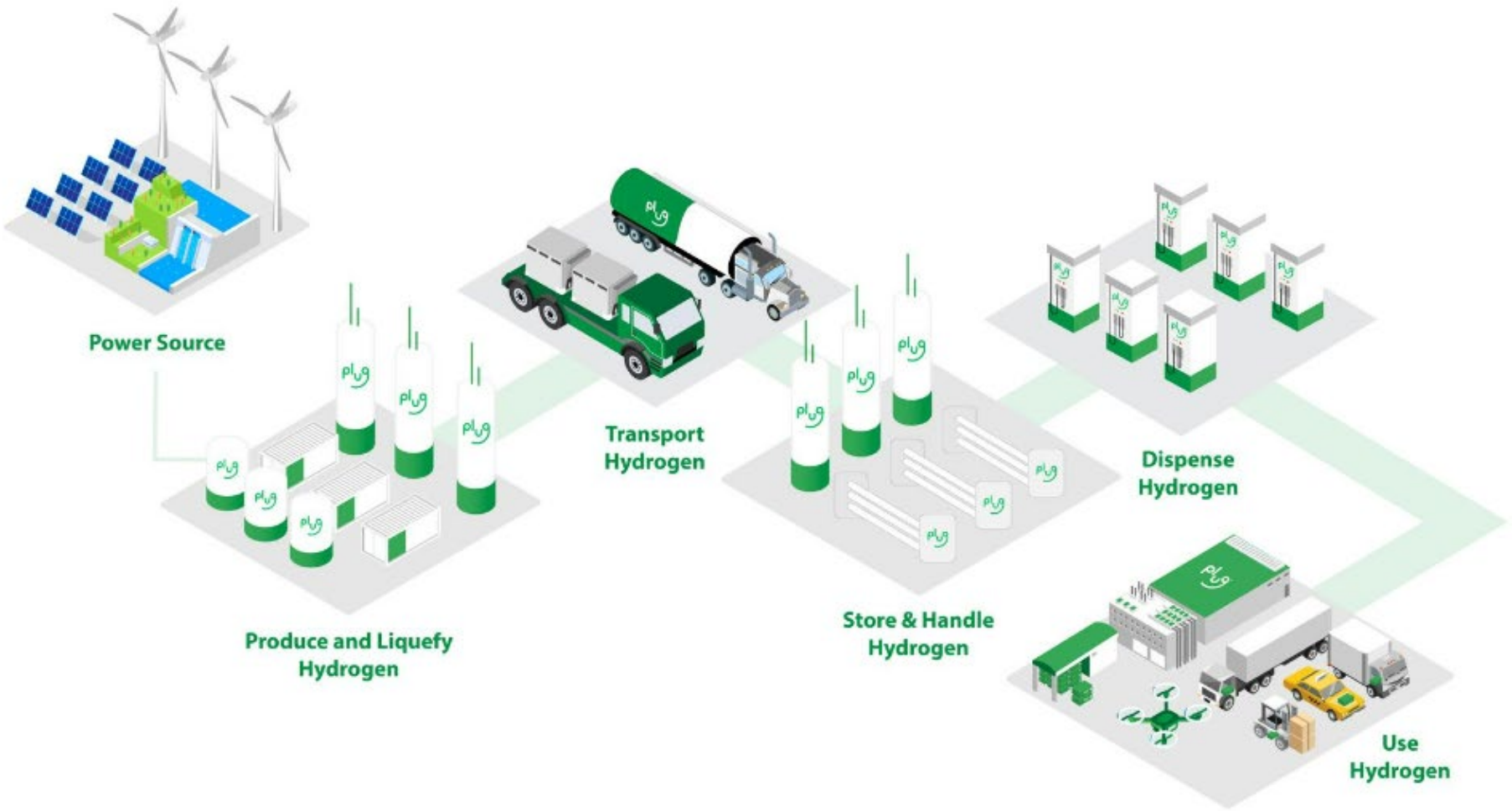
Building Blocks to Plug Power's Green H2 Vertical Integration



What Makes Hydrogen Green?

	Transformed Molecule	Process	Emissions
	Coal	Gasification	NOx, SOx, Black Carbon or Particulate Matter
	Natural Gas (CH4)	Steam-Methane-Reforming	NOx, SOx, Black Carbon or Particulate Matter
	Natural Gas (CH4)	Steam-Methane-Reforming	CO2 that is captured
	Green H2O	Electrolysis through Renewables	Oxygen

Plug's End-to-End Green Hydrogen Ecosystem



DRIVING SCALE: FIRST PEM GIGA FACTORY

Rochester, NY

375
Jobs Created

7M+
MEAs

1 GW
Of Electrolyzers

Green H2
Onsite generation

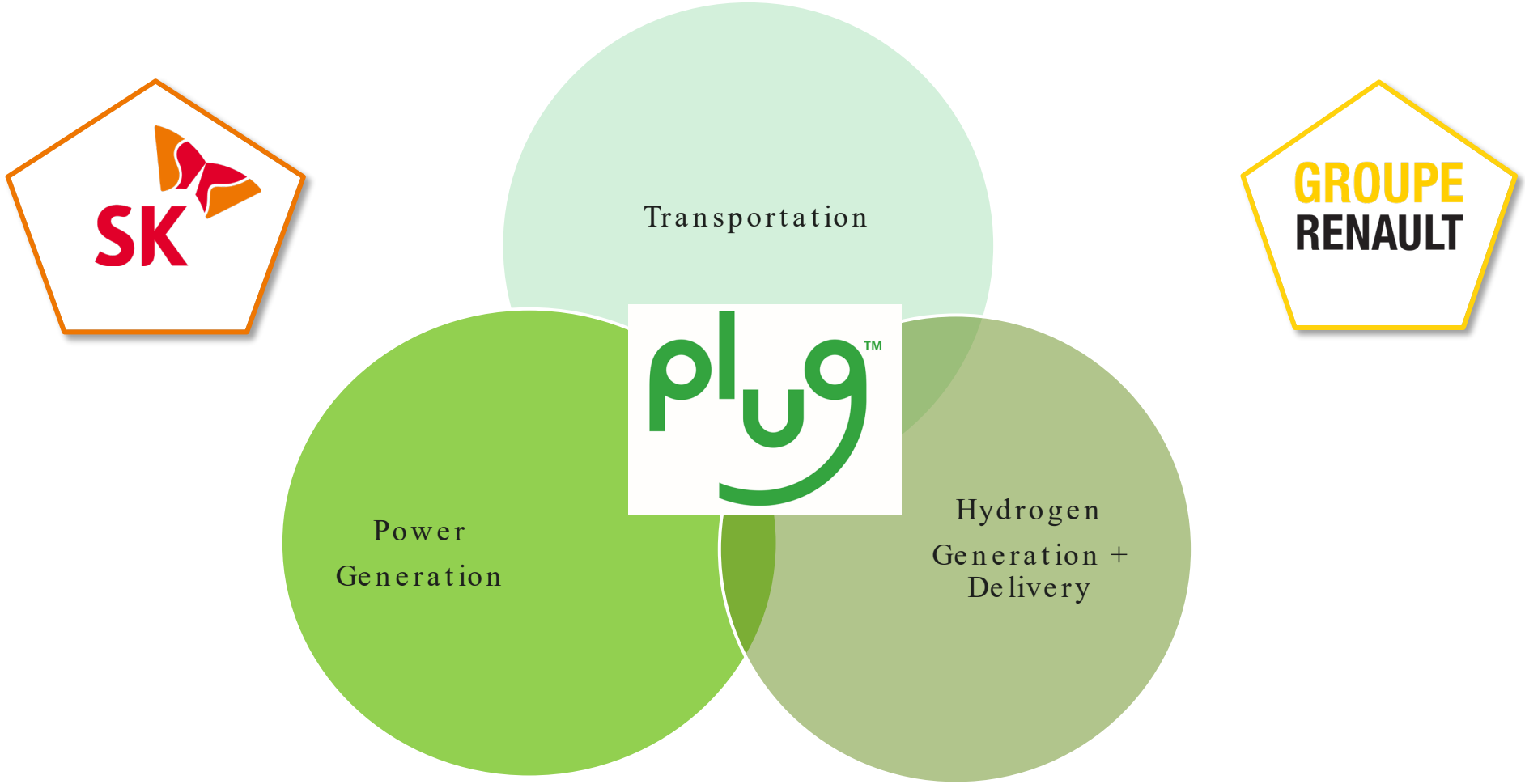
2.5+
Gigawatts output

7M+
Bi-Polar Plates

60,000+
Fuel Cell Stacks

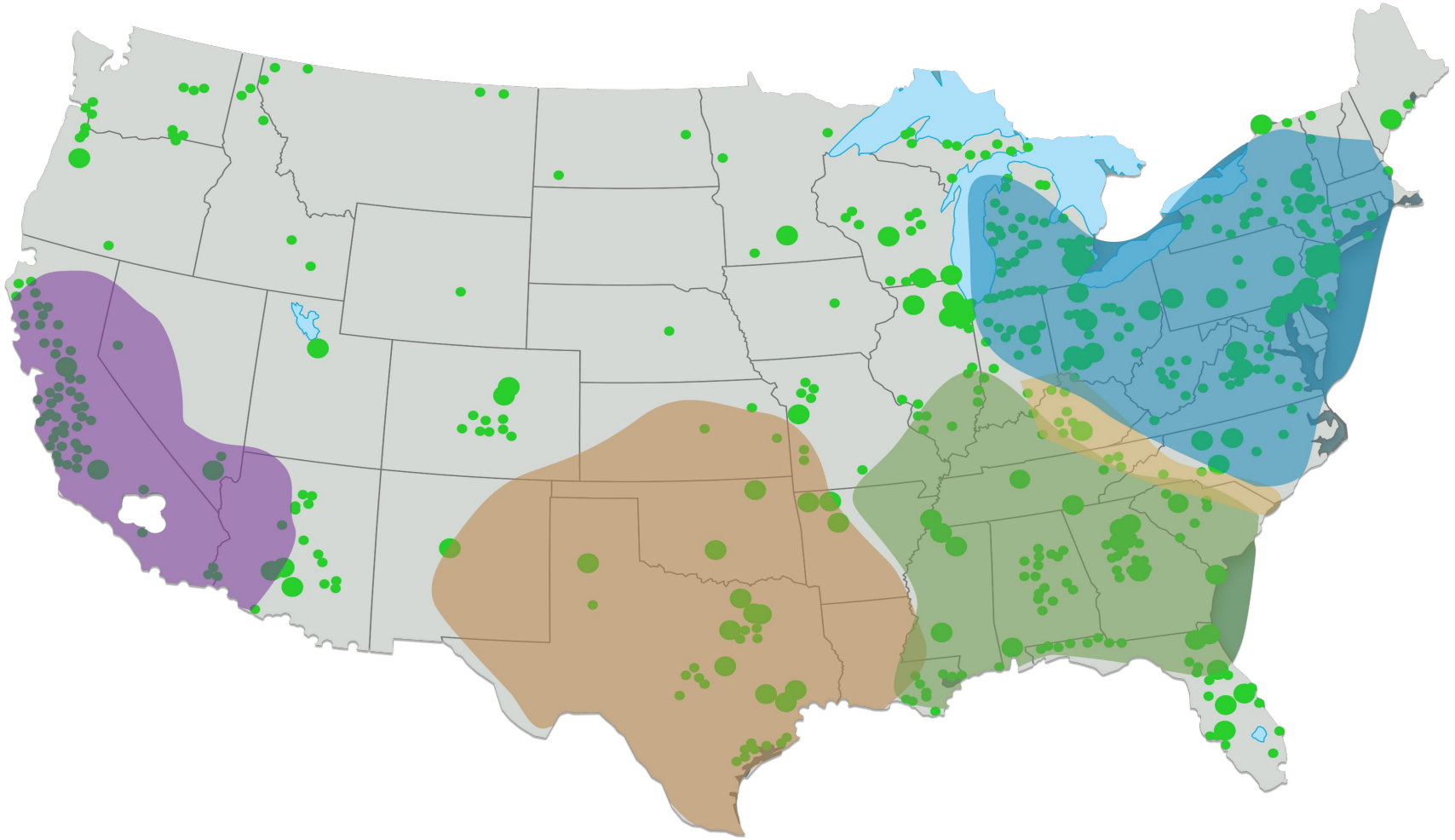
Planned Capacity 2024

PLUG: 1st TO LEAD ENERGY TRANSITION TO HYDROGEN



Only end-to-end Hydrogen Company

Plug: 1st to bring green hydrogen to the market



GenFuel Hydrogen Customer Locations

Stationary Power Customer Locations

We're building the Hydrogen Highway, 500 TPD in 2025, 1000 TPD by 2028

North America Green Hydrogen Plant Timeline

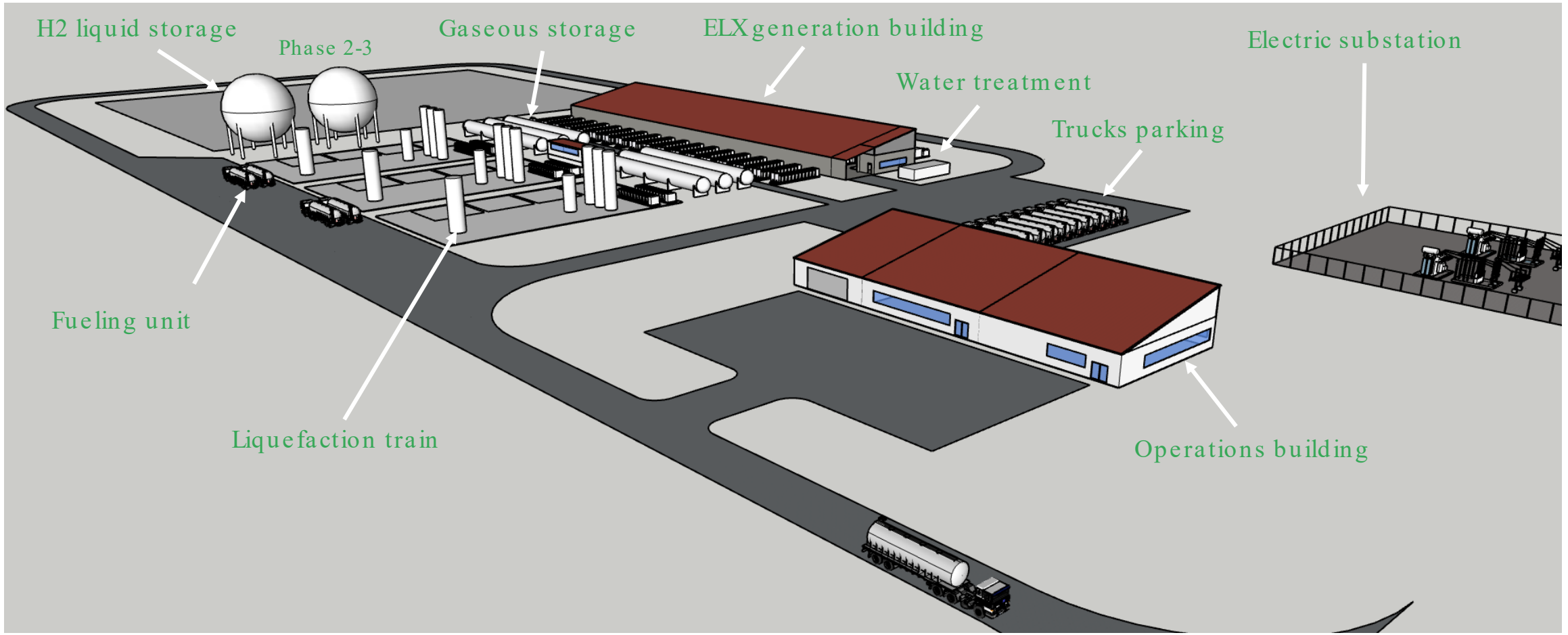
Breaking Ground on 3 Plants in 2021

More than 6 Plants by year-end 2023

10+ Plants by year-end 2025

Standard Plug site for generation of liquid green hydrogen

120MW – In construction



Plug liquid green H2 production site

120MW – In construction

US Hydrogen Policy Opportunities

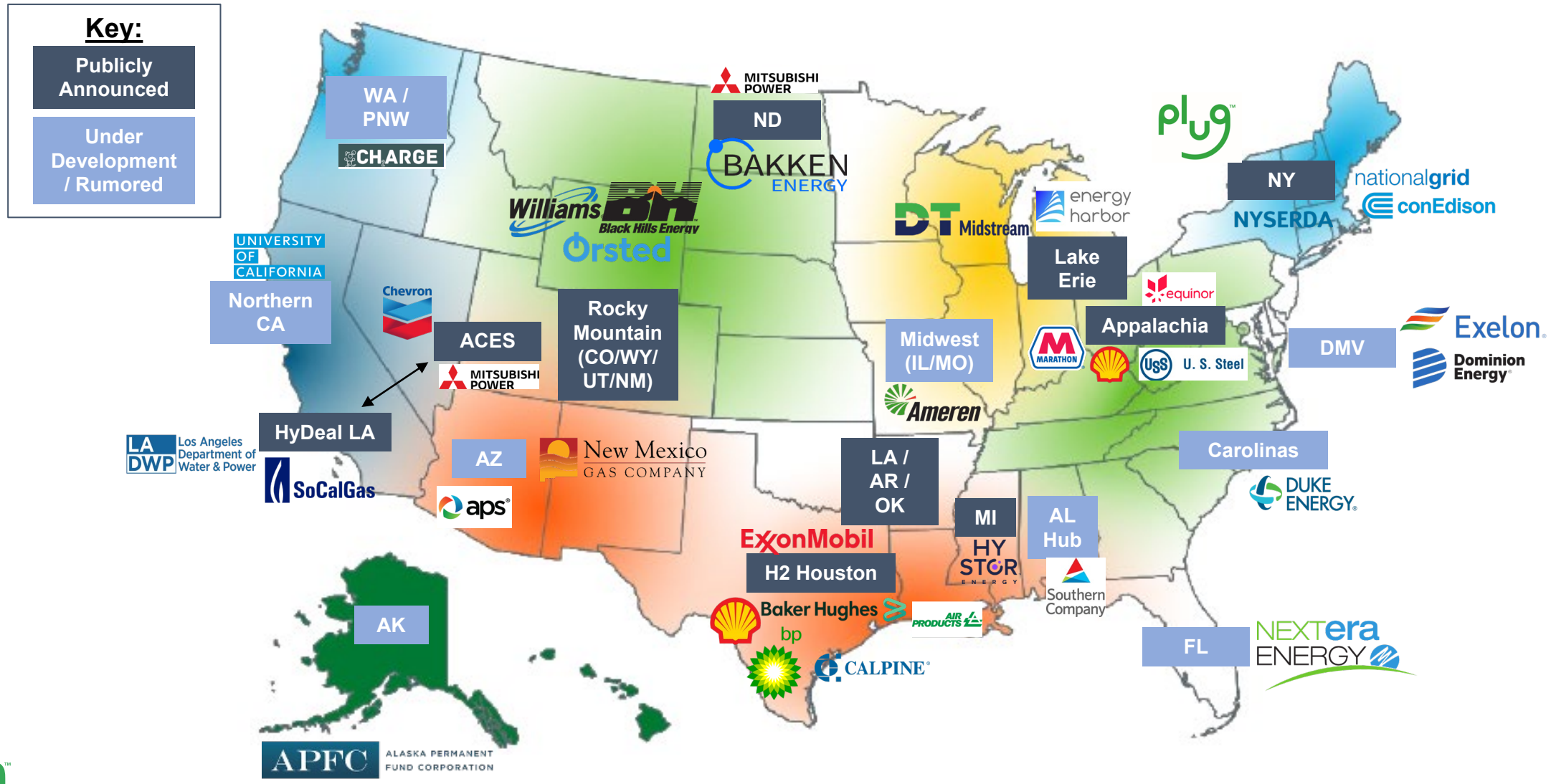
Regional Clean Hydrogen Hubs: $8 billion for *at least* four regional clean hydrogen hubs to demonstrate the production, processing, delivery, storage, and end-use of clean hydrogen.

Clean Hydrogen Electrolysis: IIJA appropriates $1 billion for DOE research, development, demonstration, commercialization, and deployment program for clean hydrogen production with electrolyzers.

Clean Hydrogen Manufacturing and Recycling: IUA appropriates $500 million for clean hydrogen manufacturing, recycling, and R&D to strengthen the domestic supply chain.

NY signed a multi-state agreement, with an initial group of 40 hydrogen ecosystem partners, to develop a proposal to become one of the largest 4 regional clean energy hydrogen hubs.

US Hydrogen Hub Landscape



Climate Leadership and Community Protection Act ("CLCPA")

- Goals:
  - 100% clean electricity by 2040
  - 85% reduction in greenhouse gases by 2050
  - net zero emissions by 2050

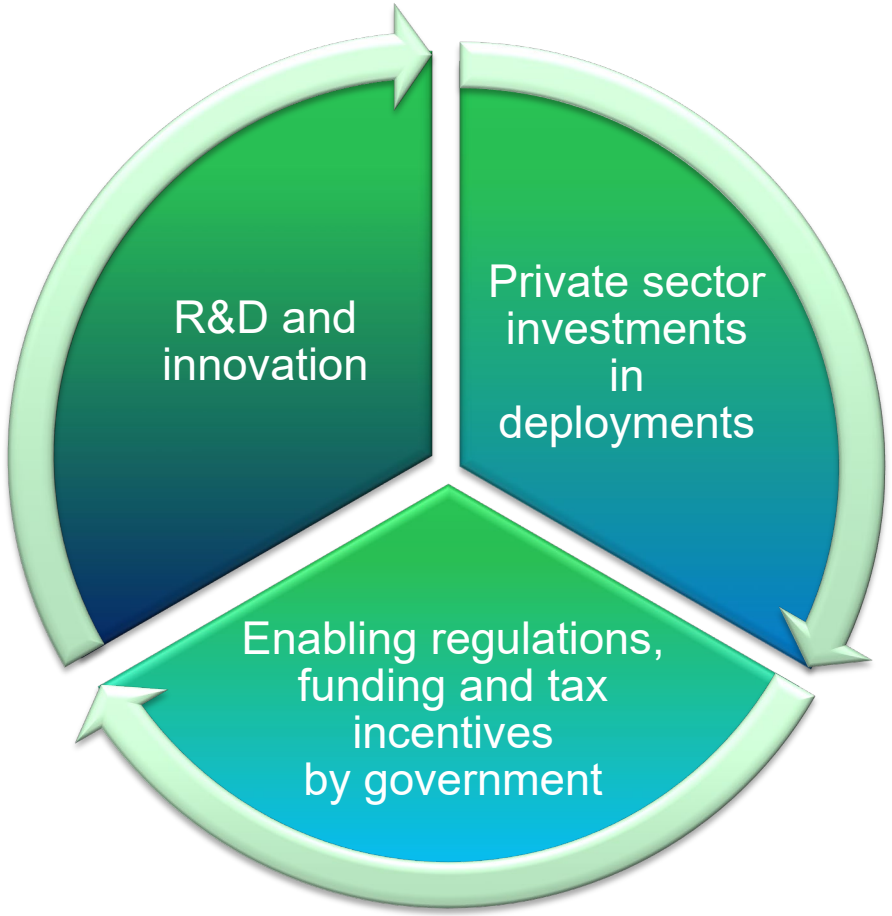
- Timeline:
  - Council released its draft scoping plan at the end of 2021. Currently undergoing robust public review. Final scoping by will be adopted later this year
  - State is tasked with adopting specific legislative, regulatory, or program initiatives to effectuate the scoping plan's recommendations

Climate Leadership and Community Protection Act ("CLCPA")

- The plan is supportive of hydrogen fuel cells – particularly regarding hard-to-decarbonize industrial and mobility sectors
- Making the state a Green Hydrogen Hub bolsters the h2 provisions of the scoping plan
- NYSERDA-led hub application will establish a green hydrogen microgrids program, hydrogen regulatory framework, and funding opportunities to advance clean h2 goals

Concerted effort required to build on momentum and scale up

Scaling up of deployment



Green Hydrogen at Work™