HYDROGEN COMMERCIALIZATION, DEPLOYMENT AND SCALABILITY

New England Energy
Conference & Exposition

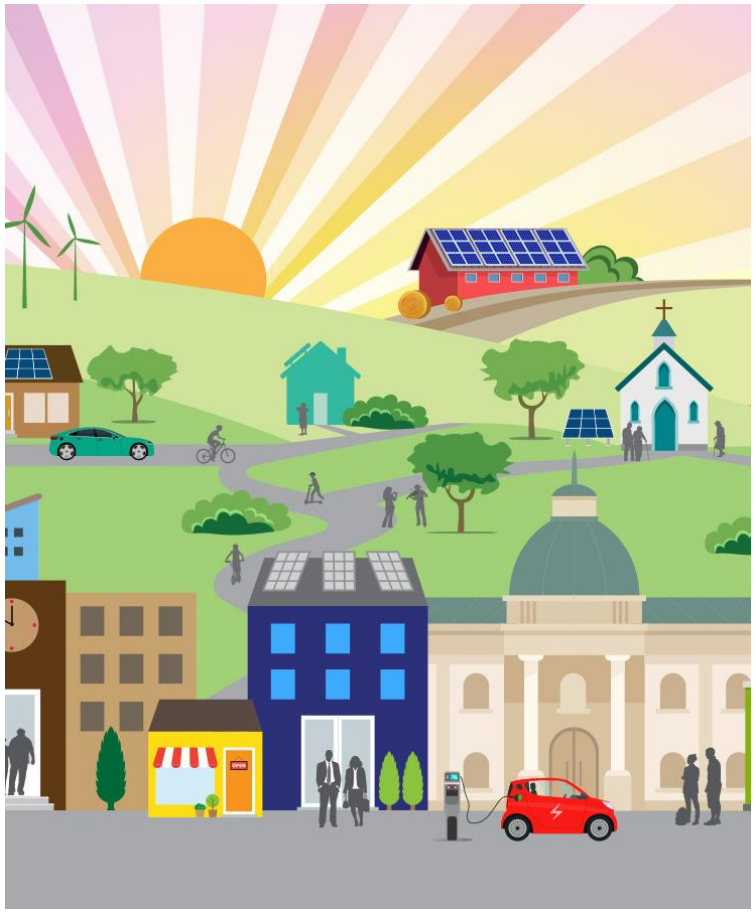
AGENDA

Clean Hydrogen 101

Panelist Presentations

Q&A

CONNECTICUT GREEN BANK



Connecticut Green Bank is the nation's first green bank. Established in 2011 as a quasi-public agency, the Green Bank uses limited public dollars to attract private capital investment and offers green solutions that help people, businesses and all of Connecticut thrive.

Our **mission** is to confront climate change by increasing and accelerating investment into Connecticut's green economy to create more resilient, healthier, and equitable communities

Guiding this mission is our **vision** for "…a planet protected by the love of humanity."

HYDROGEN IS A MATURE TECHNOLOGY

Global Hydrogen Value Chains

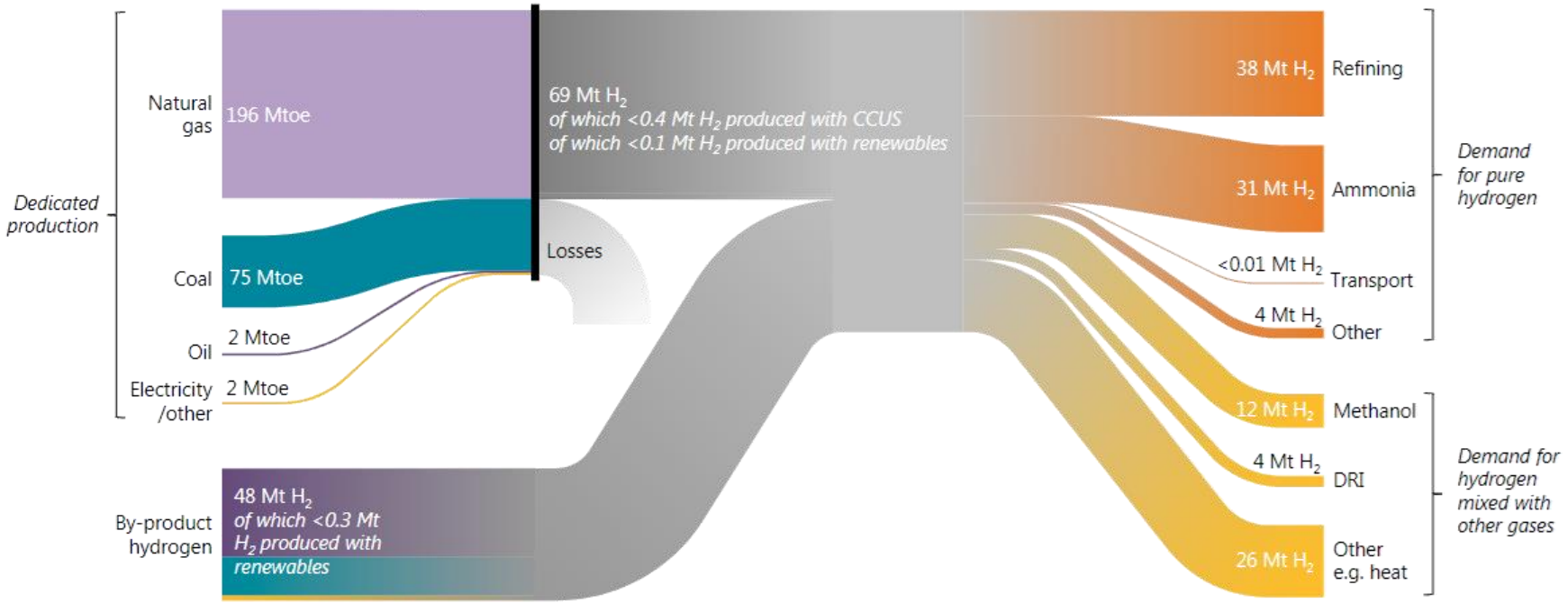


Image from "The Future of Hydrogen: Seizing today's opportunities" report prepared by IEA for the G20, Japan. Mtoe=million tons of oil equivalent. Mt=million tons

Today >99% of hydrogen is made from fossil fuels

WHY HYDROGEN?

Hydrogen offers a solution to **eliminate fossil fuels** for end uses where there are no alternate solutions

High-Heat Industrial Processes

Critical Facilities

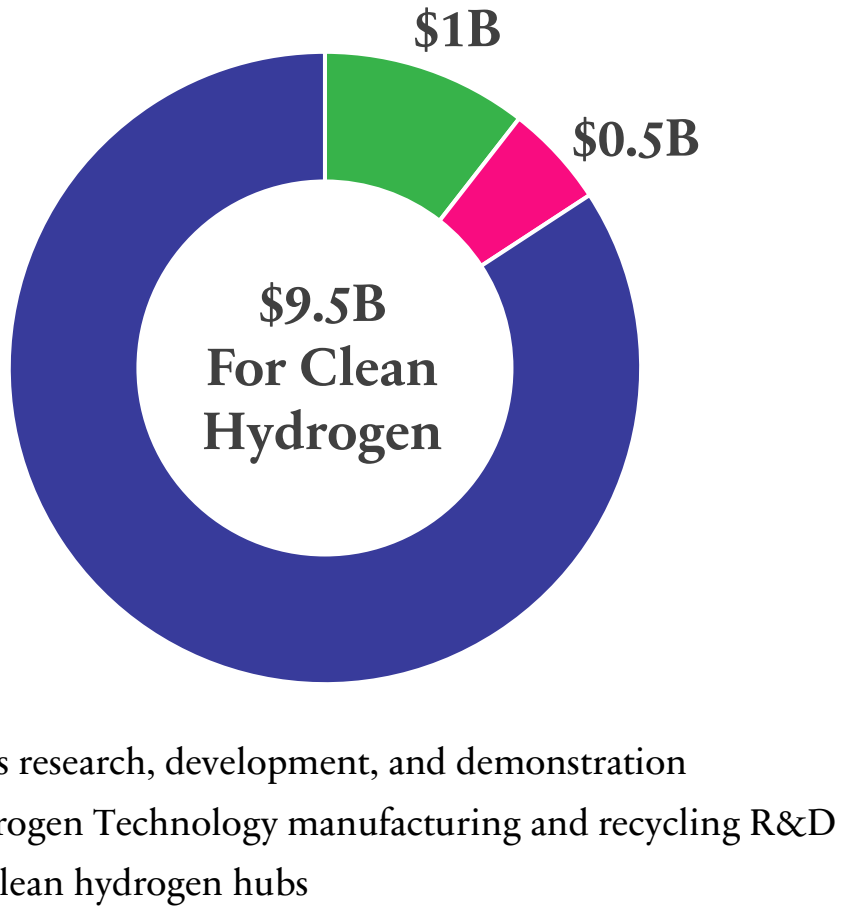
Cargo Ships

Aviation

Long-Haul, Heavy-Duty Trucking

WHY NOW?

The US Government has created **an unprecedented incentive** to construct hydrogen facilities through the Bipartisan Infrastructure Law (BIL) and the Inflation Reduction Act (IRA)



Source: White House (2022), Building a Better America.

DIVERGENT DEFINITIONS

	Hydrogen Type (e.g. clean, renewable, green)	Based on a carbon intensity calculation	Technology agnostic (e.g. includes biomass, biogas, electrolysis, nuclear)	Electrolysis with renewables only	Excludes use of fossil fuels
US DOE	Clean	X	X		
Montana	Green		X		X
Washington State	Renewable		X		
Oregon	Renewable		X		X
Australia	Clean		X		
Canada	Green			X	X
Canada	Low Carbon Intensity	X	X		
Chile	Green			X	X
France	Renewable	X		X	X
France	Low Carbon	X	X		
Germany	Green			X	X
Sweden	Renewable/Clean		X		
CertifHy	Green	X	X		X
CertifHy	Low Carbon	X	X		

SARA HARARI

Associate Director of Innovation
Senior Advisor to the President & CEO
Connecticut Green Bank
Sara.Harari@ctgreenbank.com

FuelCell Energy Platforms for Clean Power and Hydrogen

June 8, 2023

FuelCell Energy snapshot

Our purpose

Enable a world empowered by clean energy

Our technology

Decarbonizes power:

-Produce low- to zero-carbon power from a flexible array of inputs including biogas, natural gas, and hydrogen.

-Capture carbon dioxide (for use or sequestration) while making power.

Produces hydrogen:

-Supply hydrogen from power and water through electrolysis, or co-produce hydrogen, power, and water from fuel.

-Store energy from intermittent renewables by converting excess power to hydrogen – then converting hydrogen back into power when it's needed.

Headquarters

Danbury, CT

- Corporate Headquarters
- Research labs
- Engineering design
- Global Service center

Manufacturing

Torrington, CT

- Module Assembly & Stacking
- 167,000 sq. ft.

Company highlights

HQ	Danbury, Connecticut	>500	Employees	95	Platforms in commercial operation[3]	3	Continents
FCEL	Listing: NASDAQ	>220 MW	Capacity in field	>13	Million MWhs generated with patented technology		

FuelCell Energy

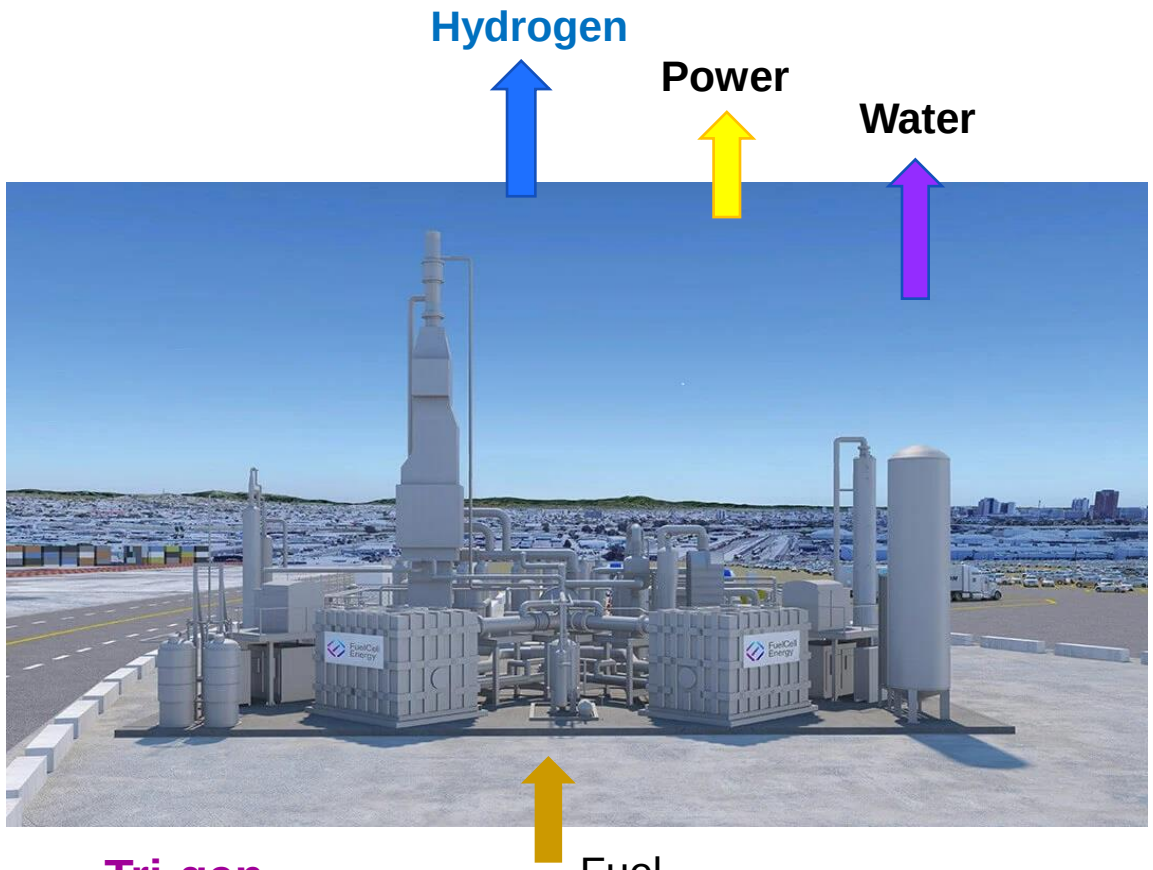
Two leading technologies providing solutions for the energy transition

Application	Carbonate	Solid oxide
Power generation/CHP w natural gas, biogas, or H_2 blends	✓	✓
Power generation/CHP from hydrogen fuel		✓
CO_2 capture from platform	✓	✓
CO_2 capture from external source while making power	✓	
H_2/Power/Water production from natural gas or biogas	✓	✓
High efficiency electrolysis H_2 production		✓
Long duration hydrogen based energy storage		✓

TWO ADVANCED HIGH TEMPERATURE ELECTROCHEMICAL PLATFORMS ADDRESSING MULTIPLE APPLICATIONS

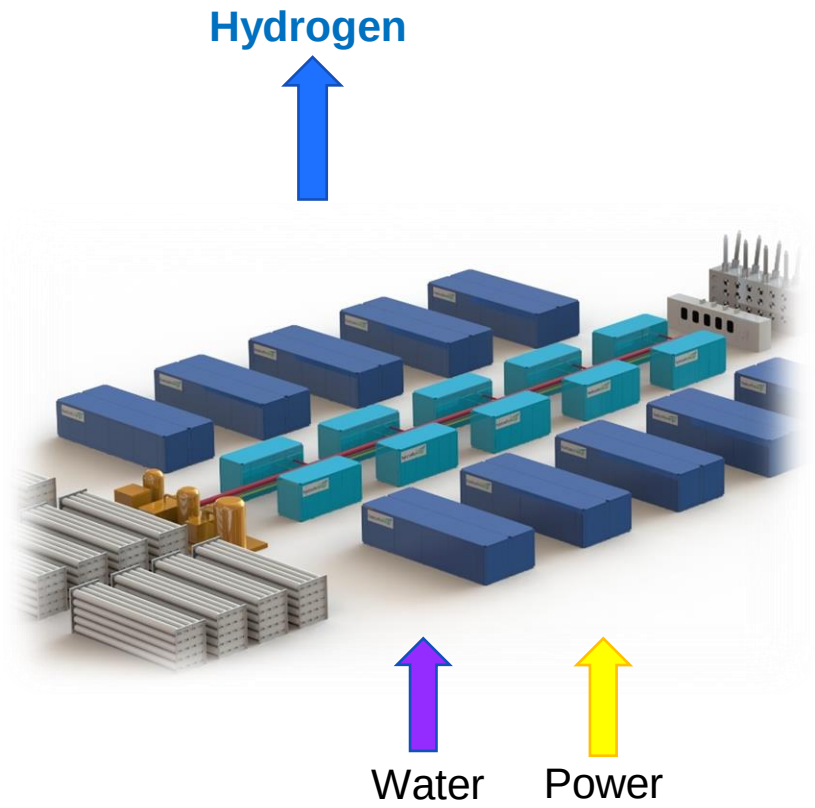
FuelCell Energy

FCE hydrogen producing solutions



Tri-gen

- Clean reforming driven by heat and water from fuel cell power generation process
- Power and Hydrogen revenue streams
- Net water producer



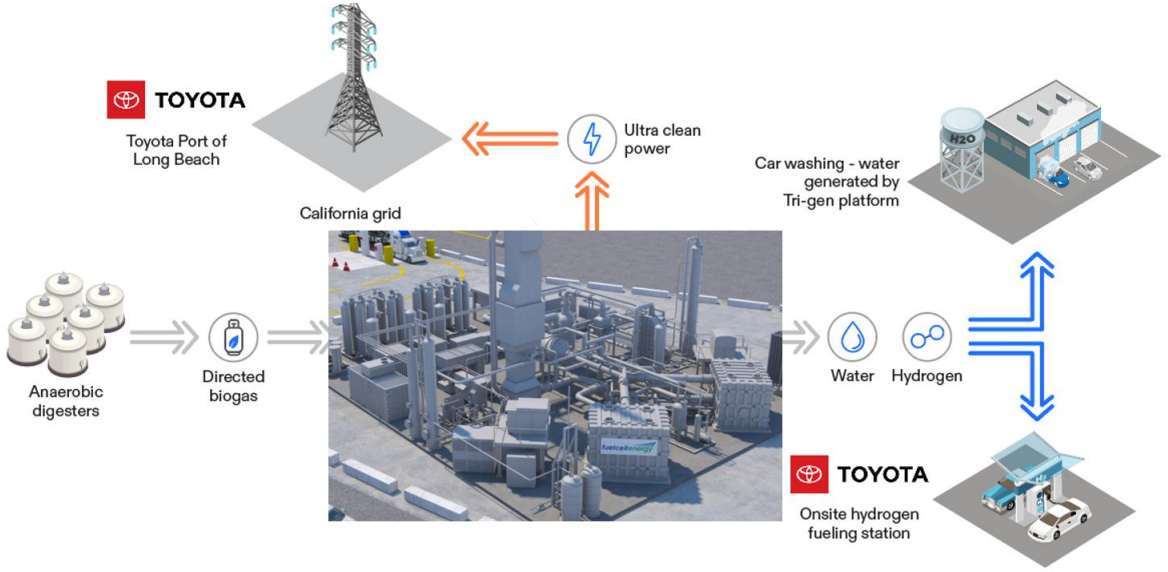
Solid Oxide Electrolysis

- High electrical efficiency
- Ability to increase efficiency with available waste heat

FuelCell Energy

Toyota Long Beach Tri-gen project

- The system will generate:
  - **2.3MW electricity** – powering Toyota facility and supplying to grid
  - **1200kg/day hydrogen** – for fueling Toyota light and heavy-duty hydrogen fuel cell vehicles
  - **1400 gallons/day water** – to support Toyota car washing operations



FuelCell Energy

Solid Oxide platforms

Solid Oxide Fuel Cell Power Generation Platform

- 250kW Rated Output
- Natural Gas, Biogas, or Hydrogen Fuel
- High electrical efficiency
- Higher total efficiency in combined heat and power applications

Solid Oxide Electrolysis Platform

- 1.1MW Rated Input
- 600 kg/day hydrogen production
- Power input reduced to 1.0 MW with supplied waste heat

FuelCell Energy

Thank You

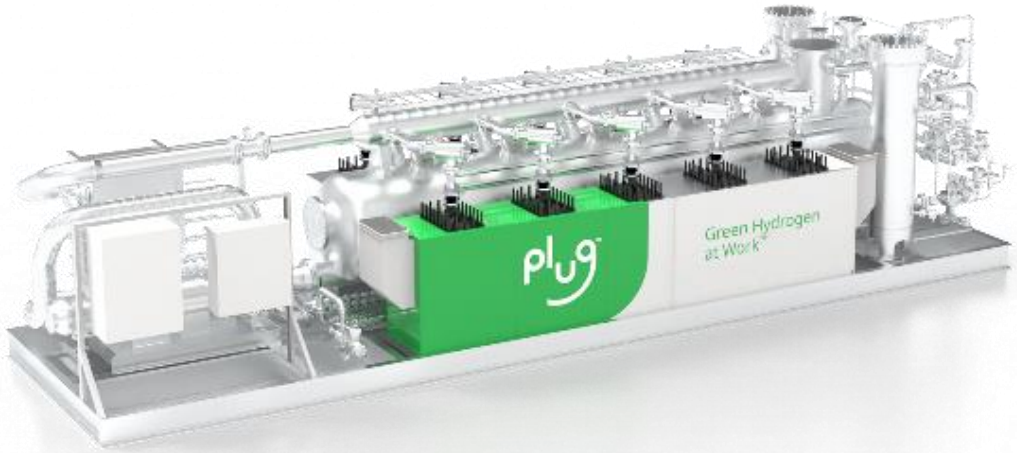
FuelCell Energy

NEECE – Panel IV

Hydrogen: Commercialization, Deployment and Scalability

June 8, 2023
Providence, Rhode Island

Cyrus Tingley
Director, Electrolyzer Sales



Green H2 Economy: Commercialization & Outlook

Hydrogen Market Opportunity

Material Handling	Fuel Cell EVs	Stationary Power	Hydrogen Economy
$30Bn	**$300Bn+**	**$350Bn**	**$10Tn**
Target addressable market	*Target addressable market*	*Target addressable market* (US)	*Target addressable market*

Plug Today

Long-term Growth Trajectory

Forklifts

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

Stationary Power & Data Centers

- Small footprint, high power density
- Lower TCO vs. diesel generators
- Plug & Play design mirroring operational flexibility of diesel generators

Fuel Cell EVs (Light Commercial & Heavy-Duty 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

Hydrogen & Equipment

- The Hydrogen Council projects that by 2050, hydrogen could provide up to [(1)] :
  - 18% of final energy demand
  - 6Gt annual CO2 abatement
  - 30MM jobs created

Hydrogen Demand

New Apps Create Multiplier Effect for Hydrogen Demand

1kg/day
Forklifts

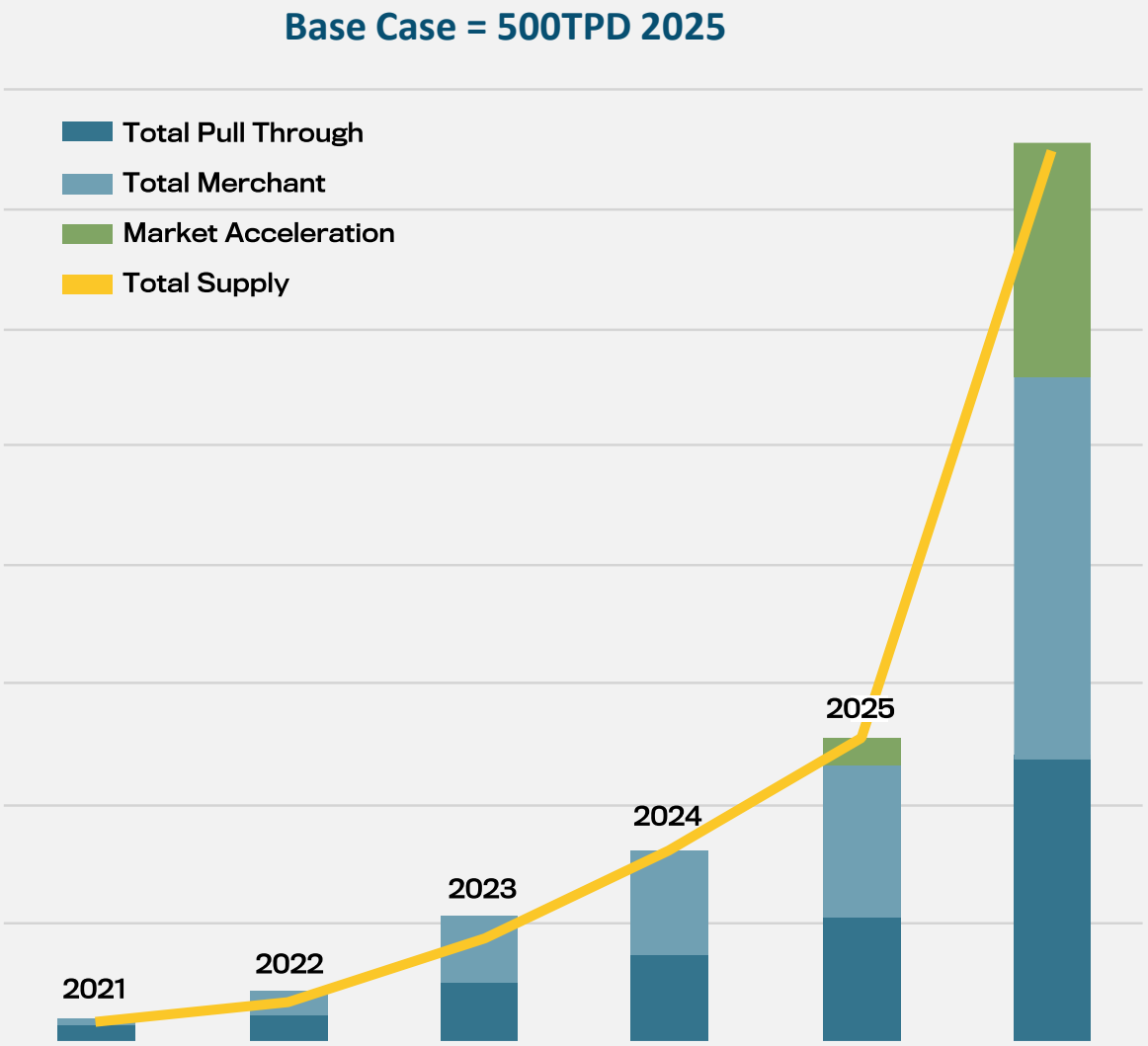
6kg/day
LCV

40-50kg/day
HDV

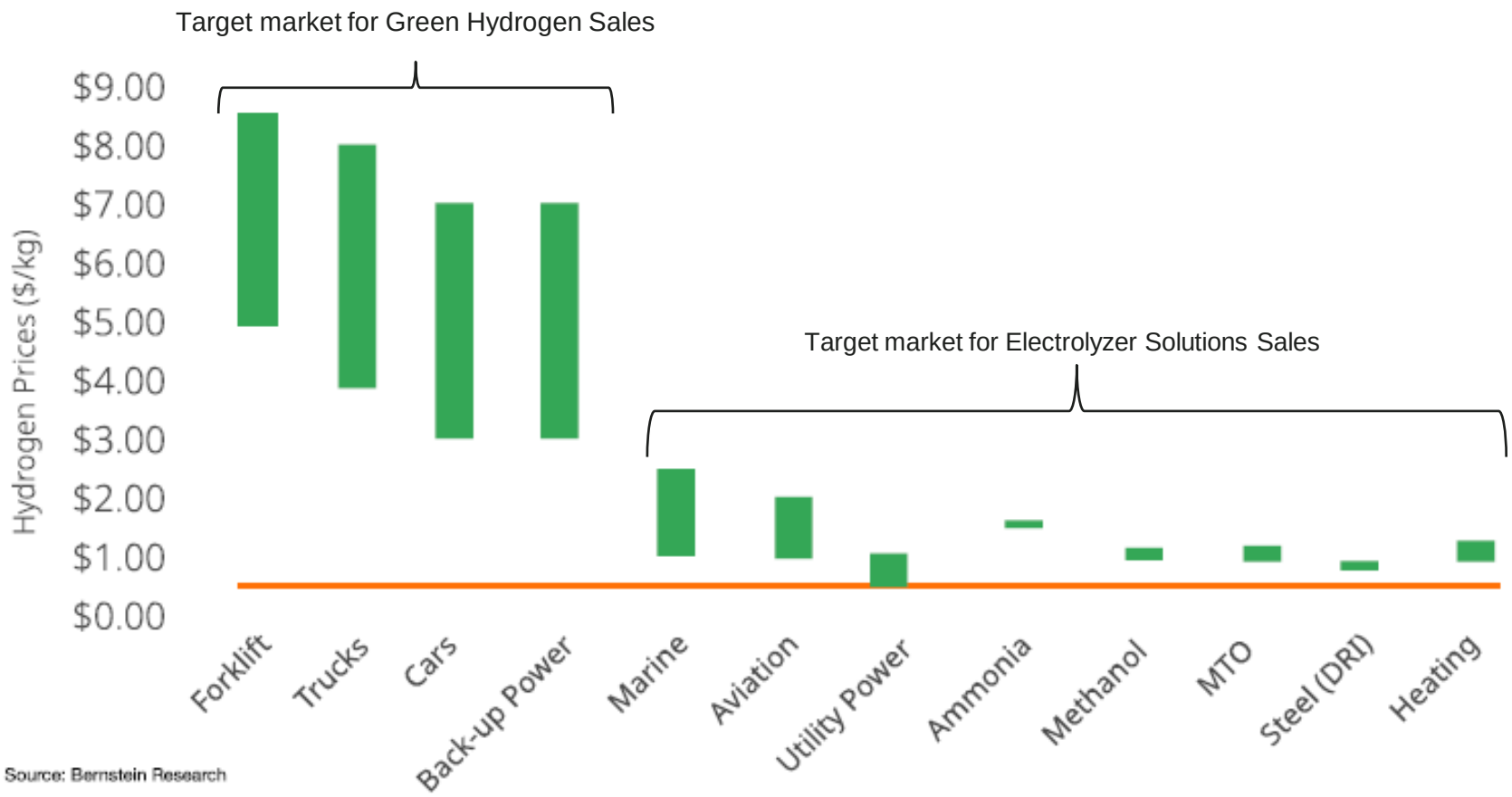
1MW 24/7: >1TPD
Stationary Power

500TPD of demand represents 5,000 class 7-8 trucks and less than 300MW of stationary power

Long haul trucking in NA alone requires 200,000TPD of green hydrogen to displace diesel



Inflation Reduction Act Implications



Source: Bernstein Research

Green Hydrogen Price with PTC (Orange Line) vs. cost of alternative in each market

- $3/kg PTC makes Green Hydrogen competitive in all hydrogen applications and processes immediately
  - All new plants before 2032 will receive 10 years of PTC. 5 years direct pay, then 5 years tax credit
  - Improves original GH plant paybacks by ~4-5 years
- Lowers the total cost of ownership for hydrogen fuel cell productions, accelerating adaption
- Makes the United States the lowest cost producer of Green Hydrogen in the world

The Global Leader
in hydrogen solutions

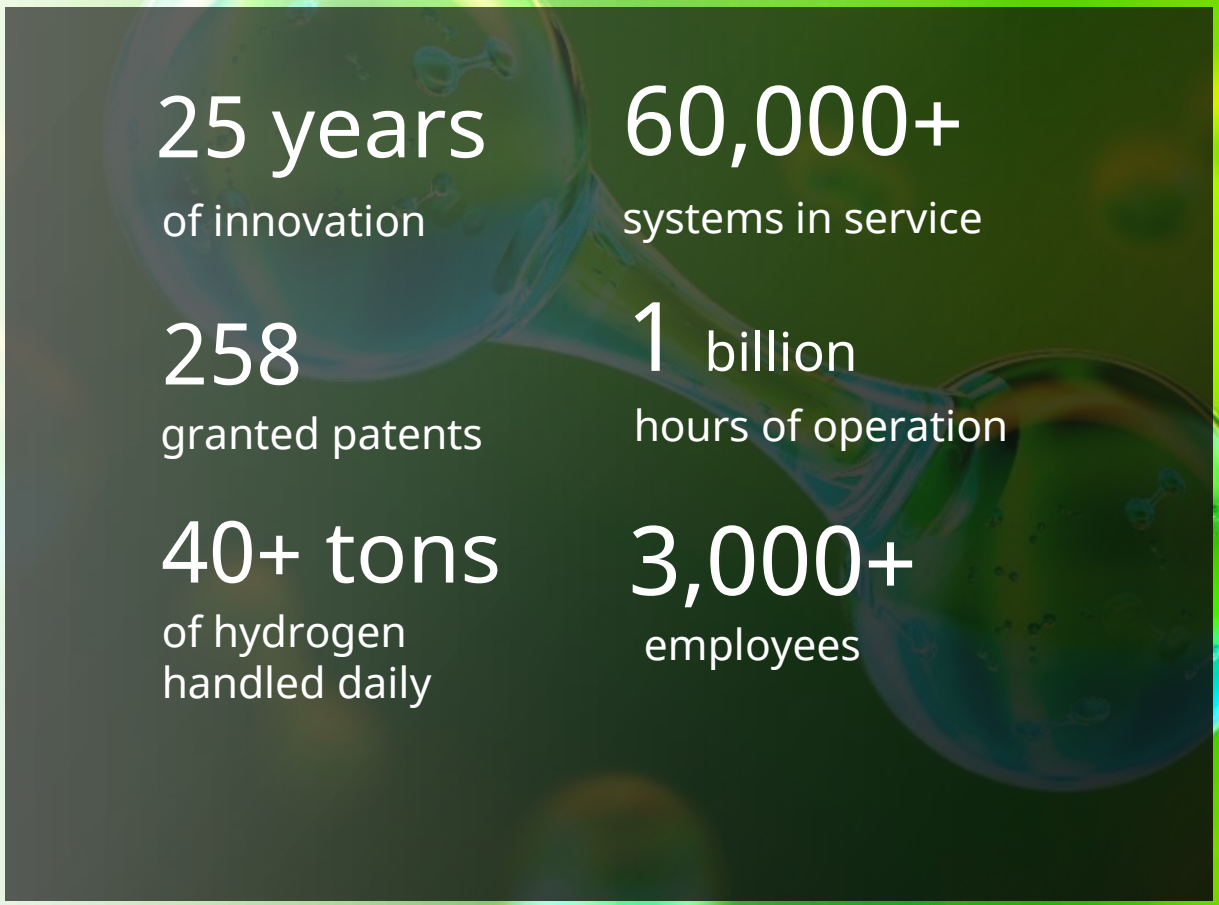
Focus on hydrogen solutions for 25 years

Offerings across entire hydrogen ecosystem

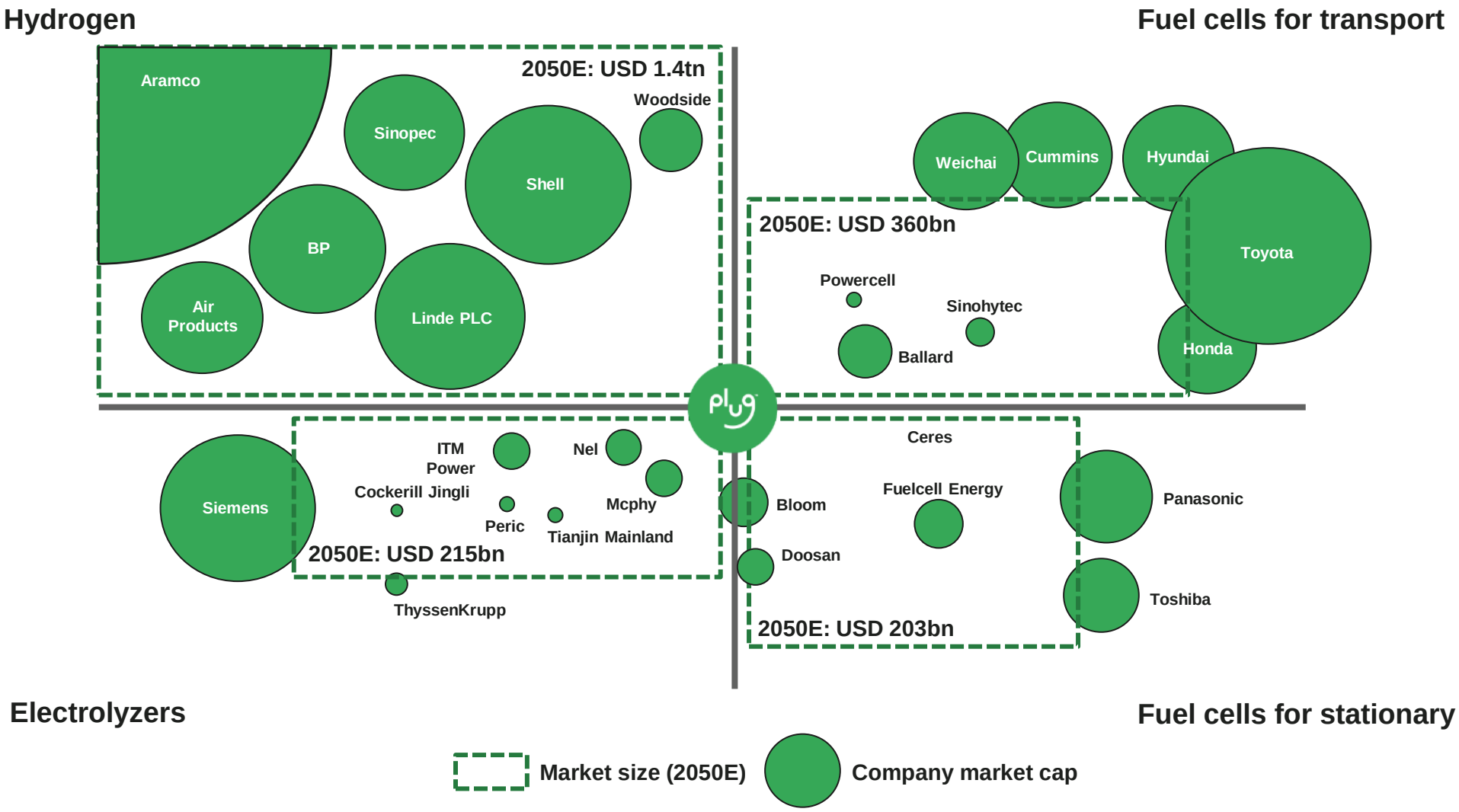
World's largest user of liquid hydrogen

Has built more hydrogen refueling stations than anyone in the world

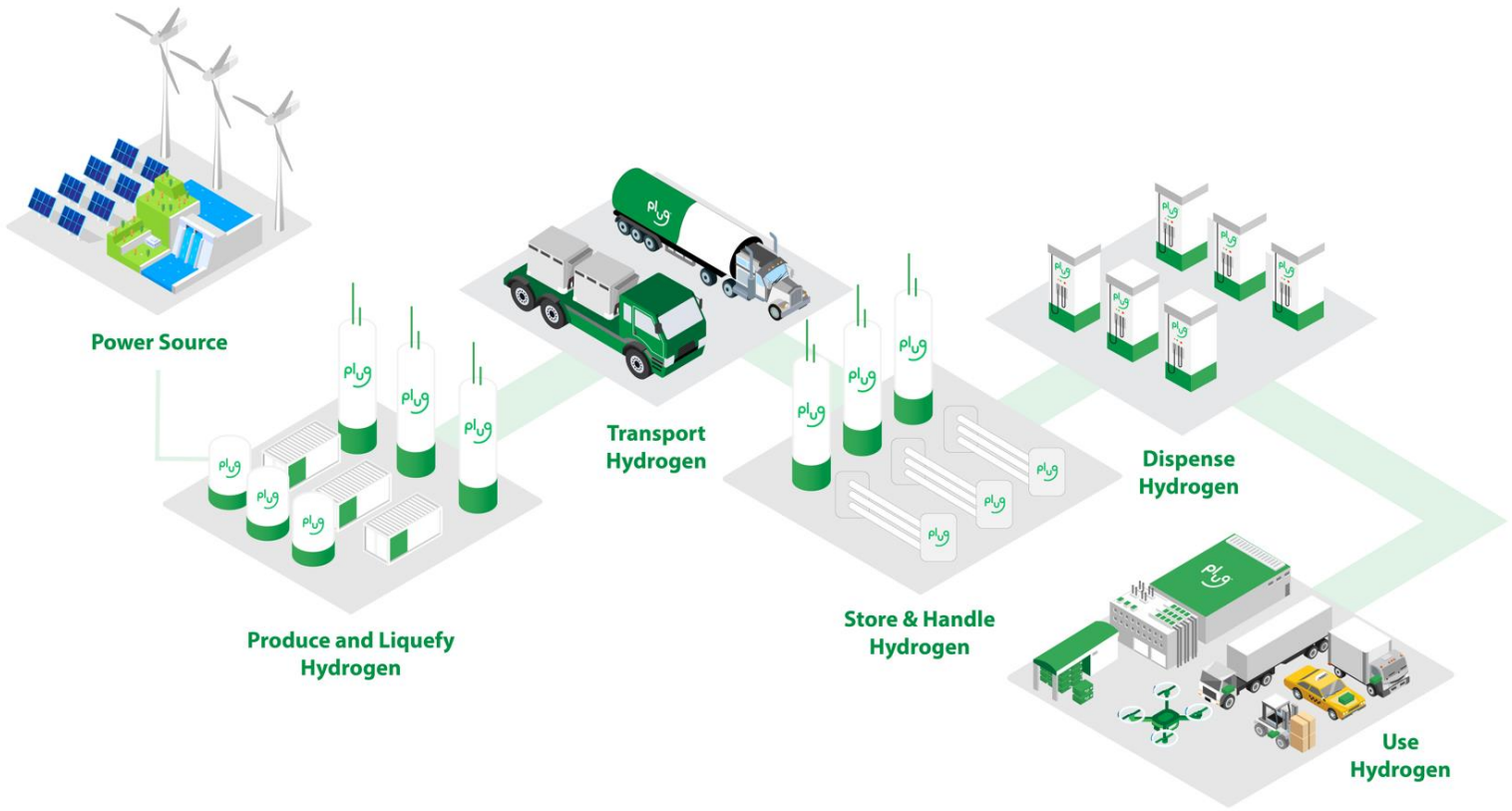
Unmatched footprint of experience with H_2



Plug Power is uniquely positioned at the center of the hydrogen economy



Source: Bloomberg and Bernstein analysis and estimates



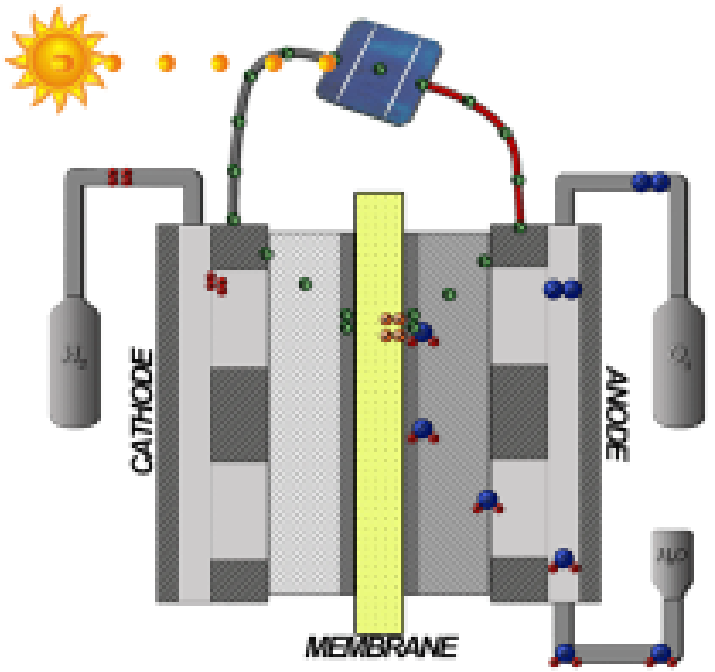
Plug is building an end-to-end green hydrogen ecosystem, from production, storage and delivery to energy generation, to help its customers meet their business goals and decarbonize the economy.

Electrolyzer Solutions

ELX Process Overview

Electrolyzers split water into H_2 and O_2

1. Electricity applied to water (from a renewable source for the H_2 to be "green")
2. Hydrogen (H_2) is split from the Oxygen (O), converting electrical energy to chemical energy
3. The chemical energy (H_2) can then be stored and/or transported in gaseous or liquid form



Plug Brings

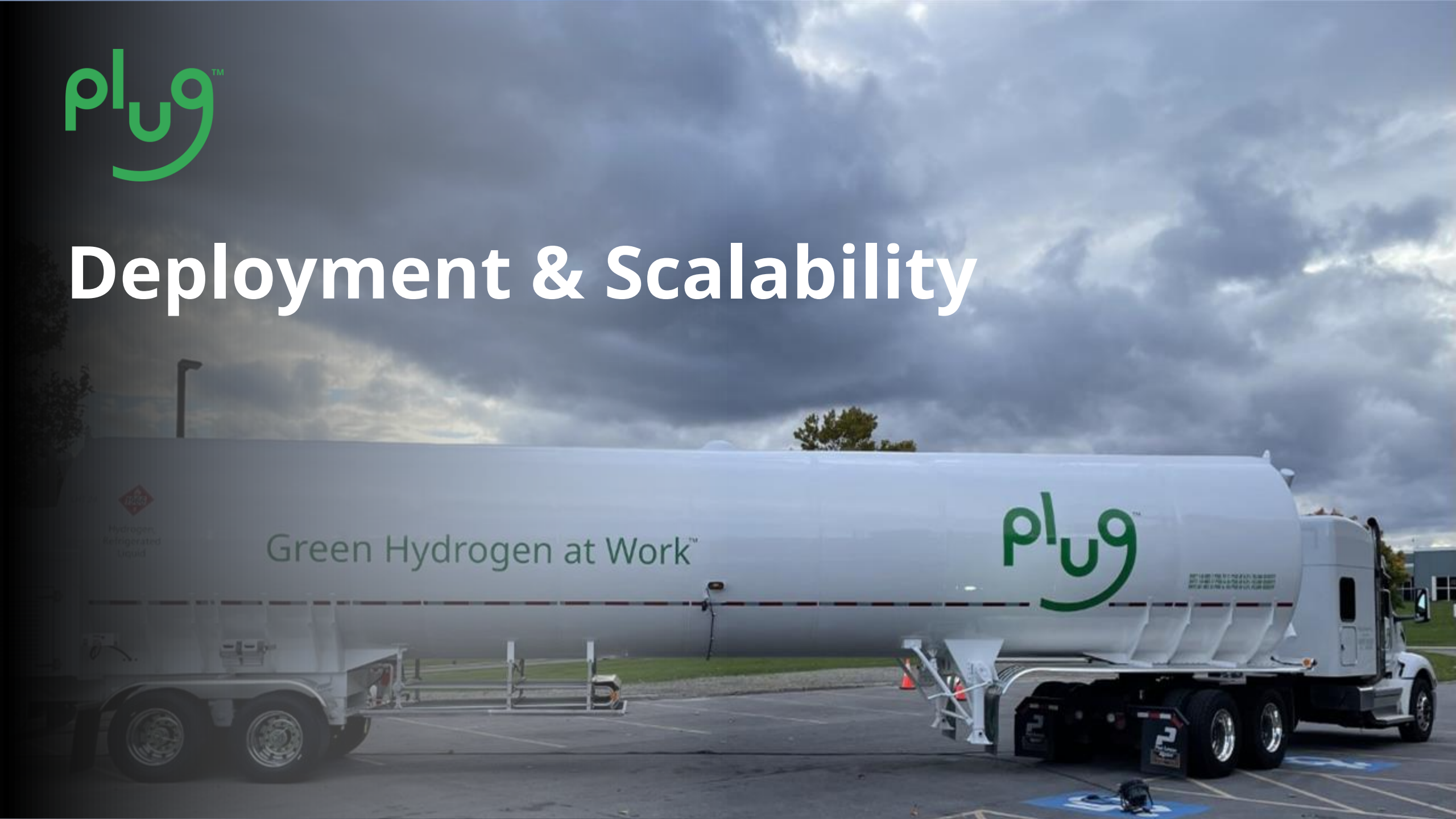
Reliable Performance

- ✓ **PEM Technology** delivers H_2 at 40barg and 99.999% purity
- ✓ **Highest Performance** at 75-85% efficiency and >99% availability
- ✓ **Operational Range** from 1 - 100% rated output
- ✓ **80,000 Hour** Stack life expectancy
- ✓ **Fast start** in under 5 minutes
- ✓ **Instant load following** capability

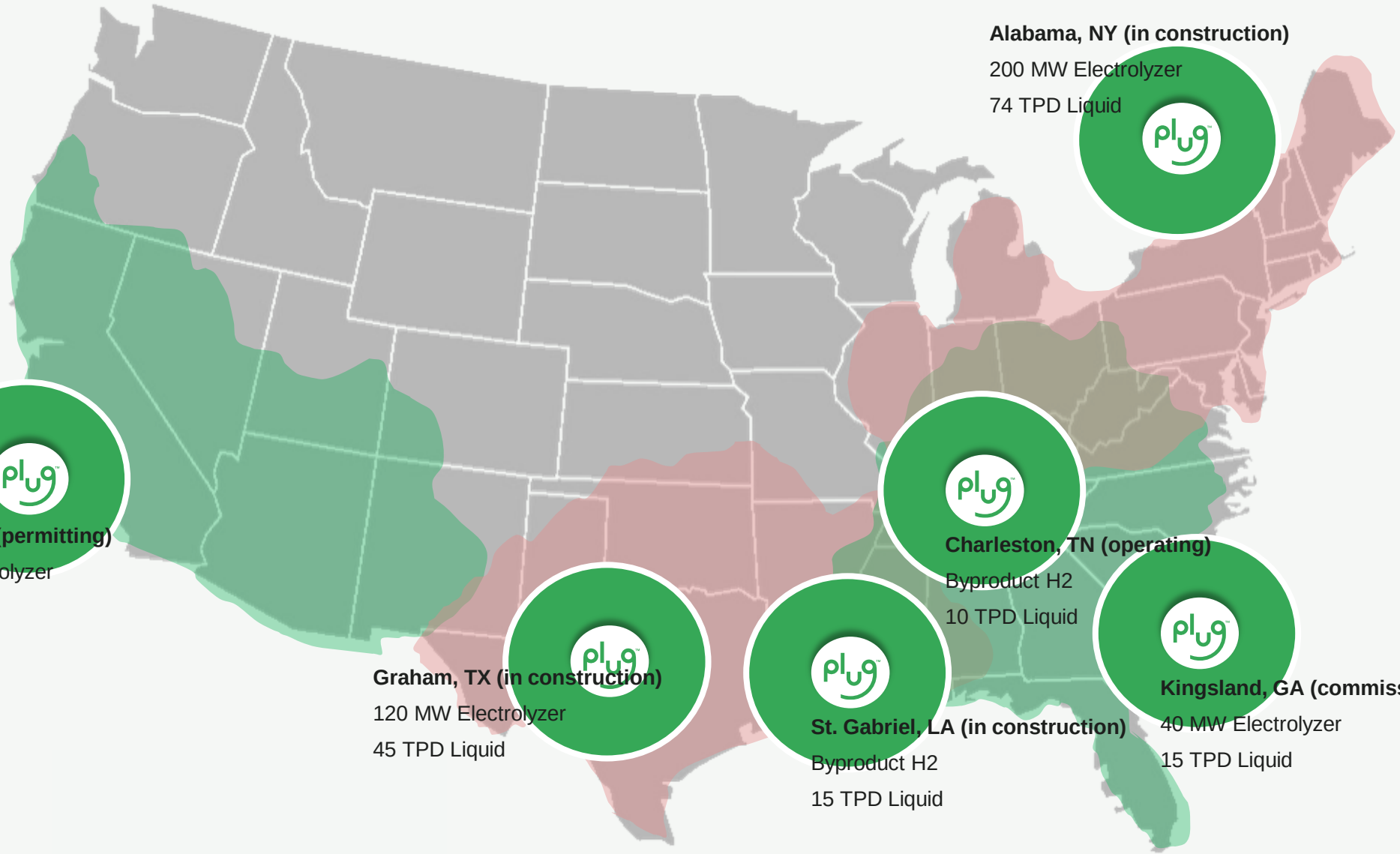
Plug PEM Electrolyzer Products:

Containerized Systems		Large Plant Solution
		
EX-425D	**EX-2125D**	**EX-4250D**
1 MW PEM stack	**5 x 1 MW** PEM Stacks	**10 x 1 MW** PEM Stacks
Fully integrated BoP for plug-and-play deployment from simple municipal water and AC power inputs		Efficient, modular building block for industrial-scale H_2 plants
480V feed to 40’ ISO footprint	Included MV transformer customized to on-site voltage	Shared BoP optimized around process skids in building
Up to 432 kg H_2 /day	Up to 2,160 kg H_2/day	Up to 4,320 kg H_2/day

Deployment & Scalability



Plug's Current Hydrogen Generation Status:



Alabama, NY (in construction)
200 MW Electrolyzer
74 TPD Liquid

Mendota, CA (permitting)
120 MW Electrolyzer
30 TPD Liquid

Charleston, TN (operating)
Byproduct H2
10 TPD Liquid

Graham, TX (in construction)
120 MW Electrolyzer
45 TPD Liquid

St. Gabriel, LA (in construction)
Byproduct H2
15 TPD Liquid

Kingsland, GA (commissioning)
40 MW Electrolyzer
15 TPD Liquid

Global Green Hydrogen Network

Plug to Build Large-Scale Green Hydrogen Generation Plant in Europe at Port of Antwerp-Bruges

Plug's 100 MW Electrolyzers Will Produce 35 Tons Per Day of Green Hydrogen for European Market

June 08, 2022 04:00 ET| Source: Plug Power, Inc. Follow

30-year concession signed

2nd largest port in Europe

Permitting underway, H2 in 2024

Conceptual 1 GW Green Hydrogen Plant Design – collaboration with Tier 1 EPC McDermott Inc.

Plug Power plans $6 billion hydrogen projects in Finland

Reuters

May 30, 2023 9:36 AM EDT · Updated 2 days ago

Finnish grid: 87% renewable power

H2 Applications: ammonia, green steel, transportation

Plug – Peachtree Project: 40 + 5 MW

Kingsland, Camden County, GA

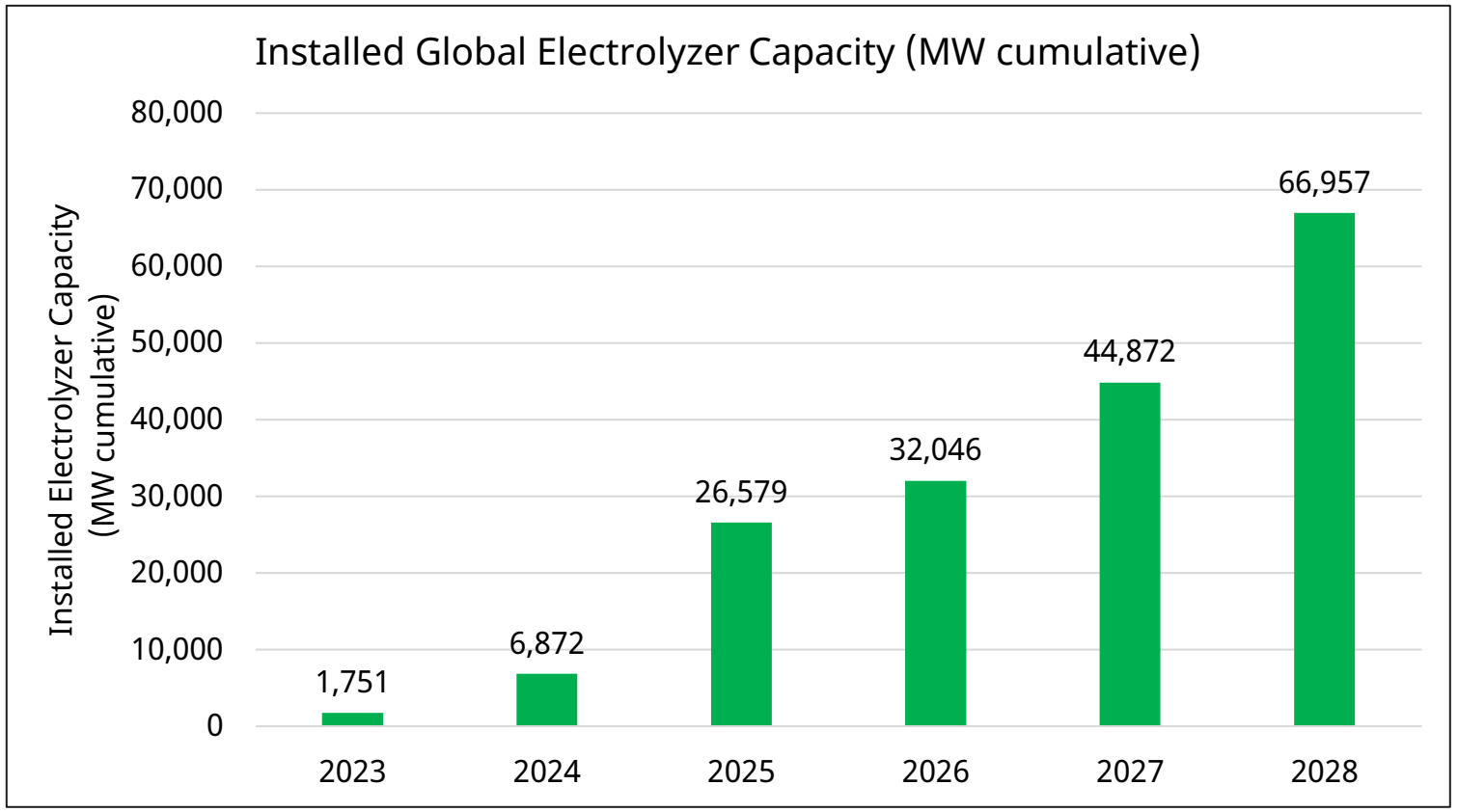
April 2023 drone footage still

- “Pathfinder” 5 MW PEM operational since Fall 2022, nearly 1000 operational hours, exporting high-pressure H2 gas in trailers to customers
- “Peachtree Phase 1” 40 MW PEM + 15 TPD liquefaction construction completed in 11 months; commissioning Q223
- Plug uniquely OEM + owner/operator gaining valuable experience deploying and operating which will grow along with our on-balance sheet portfolio, with high value to 3rd party equipment customers
- “Peachtree Phase 2” 80 MW PEM (8x10 MW EX-4250D) + 30 TPD liquefaction immediately underway adjacent

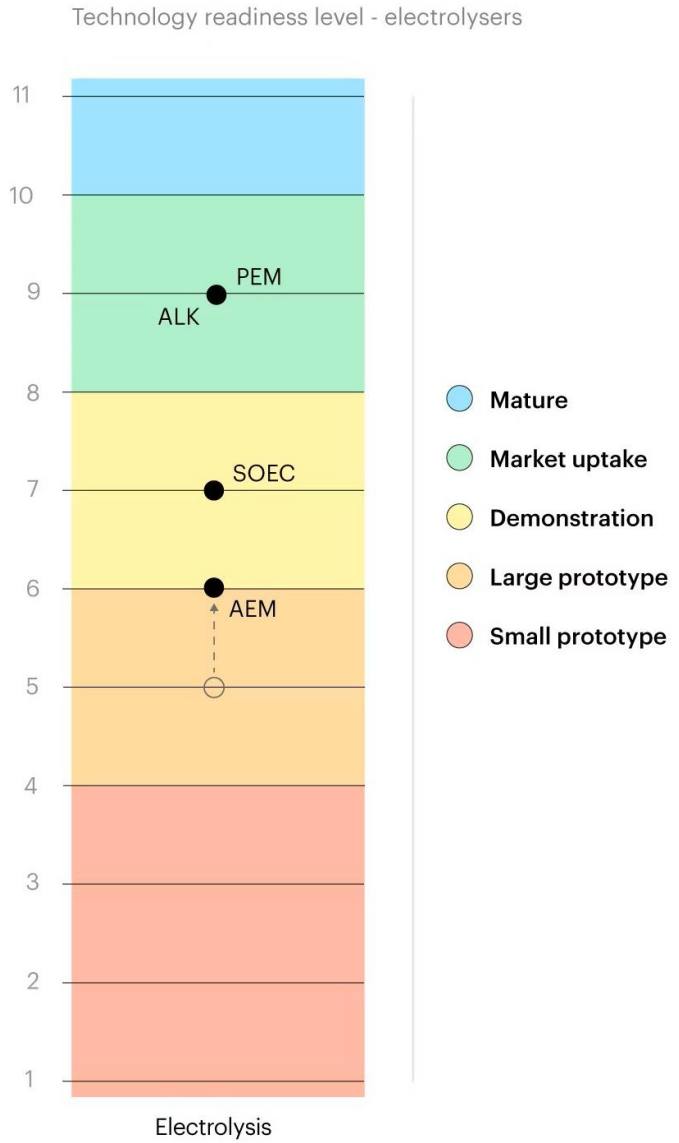
May 2023 Video Tour Update: CLICK HERE

Installed Global Electrolyzer Capacity (MW cumulative)

projection based on projects currently in planning or in construction (not just announced)



Data source: IHS Markit (May 2023)
Projected installed electrolyzer Capacity in MW (cumulative)
Based on project level data, for projects that are either in planning or construction stages



Top “big name” players by planned installation of electrolyzers

projection based on projects currently in planning or in construction (not just announced)

		Electrolyzer (MW)
1	Fortsecue Future Industries	4250
2	Woodside	3542
3	Cepsa	1802
4	Lotte Chemical Corporation	1374
5	Sinopec	1144
6	Yara	567
7	Air Liquide SA	420
8	RWE AG	378
9	ACME Group	300
10	Uniper AG	230
11	EDP BV	203
12	Vattenfall AB	200
13	ENGIE SA	193
14	Orsted A/S	175
15	ABB	154

		PEM (MW)
1	Air Liquide SA	220
2	Orsted A/S	165
3	ABB	154
4	Scatec	95
5	Shell	90
6	Suncor Inc	90
7	Linde PLC	50
8	Florida Power & Light Co	25
9	Wacker Chemie AG	20

Data source: IHS Markit (May 2023)
Projected installed Capacity in MW (total) from 2023 to 2028
Based on project level data, for projects that are either in planning or construction stages

- If we include announced projects, RWE (309 MW) and Iberdola (200 MW) will also show up as “big name” players who plan to do PEM

TAM estimates up to $23.6B by 2028
CAGR estimates 24-37%
Goldman Sachs: Hydrogen Generation Could Become $1 Trillion/Year

Plug Innovation Center and Gigafactory
Rochester, NY

Plug Innovation Center & Factory

Industry-First proudly sited in USA

GlobeNewswire

Plug Announces Record Production of PEM Electrolyzer Stacks in Q1 2023; On Track to Meet 100MW per Month Target in Q2

$150M+ investment / 400+ new jobs / 155K ft² / Rochester, NY, USA

Unlocking Credible Green Hydrogen (GH_2) Deployment: An Effective & Compatible H_2 Tracking & Attribution Framework

Bob Grace, President & Managing Director, Sustainable Energy Advantage

29TH ANNUAL NEW ENGLAND ENERGY CONFERENCE AND EXPOSITION (NEECE23): POWERING THE FUTURE THROUGH INNOVATION 06.08.23

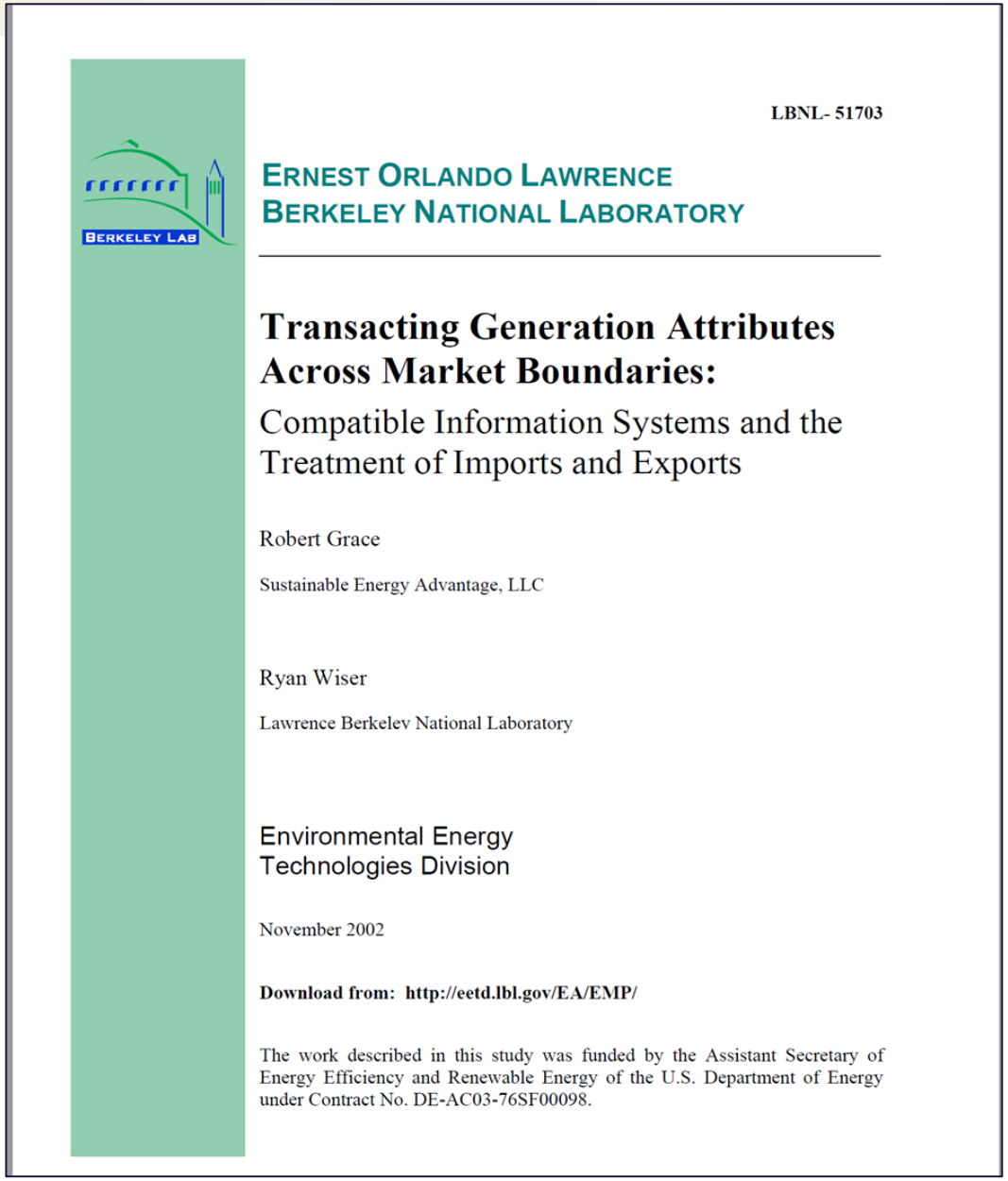
Genesis of this work

- Self-initiated by Sustainable Energy Advantage (SEA) in 2021 to address a perceived gap
- Advanced in 2022/23 in examination of *Green Hydrogen & Tracking Systems: Implications for the New York Generation Attribute Tracking System (NYGATS),* funded by New York State Energy Research & Development Authority (NYSERDA), unpublished/internal, May 2023

Disclaimer

- Any opinions expressed are solely those of the author and do not represent those of NYSERDA or any SEA clients

déjà vu.. We've been here before



LBNL- 51703

ERNEST ORLANDO LAWRENCE
BERKELEY NATIONAL LABORATORY

Transacting Generation Attributes Across Market Boundaries:

Compatible Information Systems and the Treatment of Imports and Exports

Robert Grace

Sustainable Energy Advantage, LLC

Ryan Wiser

Lawrence Berkelev National Laboratory

Environmental Energy
Technologies Division

November 2002

Download from: http://eetd.lbl.gov/EA/EMP/

The work described in this study was funded by the Assistant Secretary of Energy Efficiency and Renewable Energy of the U.S. Department of Energy under Contract No. DE-AC03-76SF00098.

What is Green Hydrogen? (GH_2)

- Hydrogen (H_2) created by electrolysis (electrolytic hydrogen) is used for
  - ✓ Electricity production
  - ✓ Directly in hard-to-electrify transportation, heating, and industrial process uses
- **Green Hydrogen (GH_2)** is produced from **renewable energy** sources
- Other hydrogen 'colors' are also of interest for policy & market purposes
- Deployment of GH_2 is central to GHG reduction plans
  - Federal production incentives
  - State GH_2 policy initiatives
  - GH_2 production & use applications are progressing rapidly

The hydrogen 'rainbow'

Brown/Black - Produced from Coal
- GHG emissions: High

Grey - Steam methane reformation using Natural Gas
- GHG Emissions: Medium

Turquoise - Pyrolysis of Natural Gas
- GHG Emissions: solid carbon

Blue - Steam methane reformation using Nat. Gas + CCS
- GHG Emissions: Low

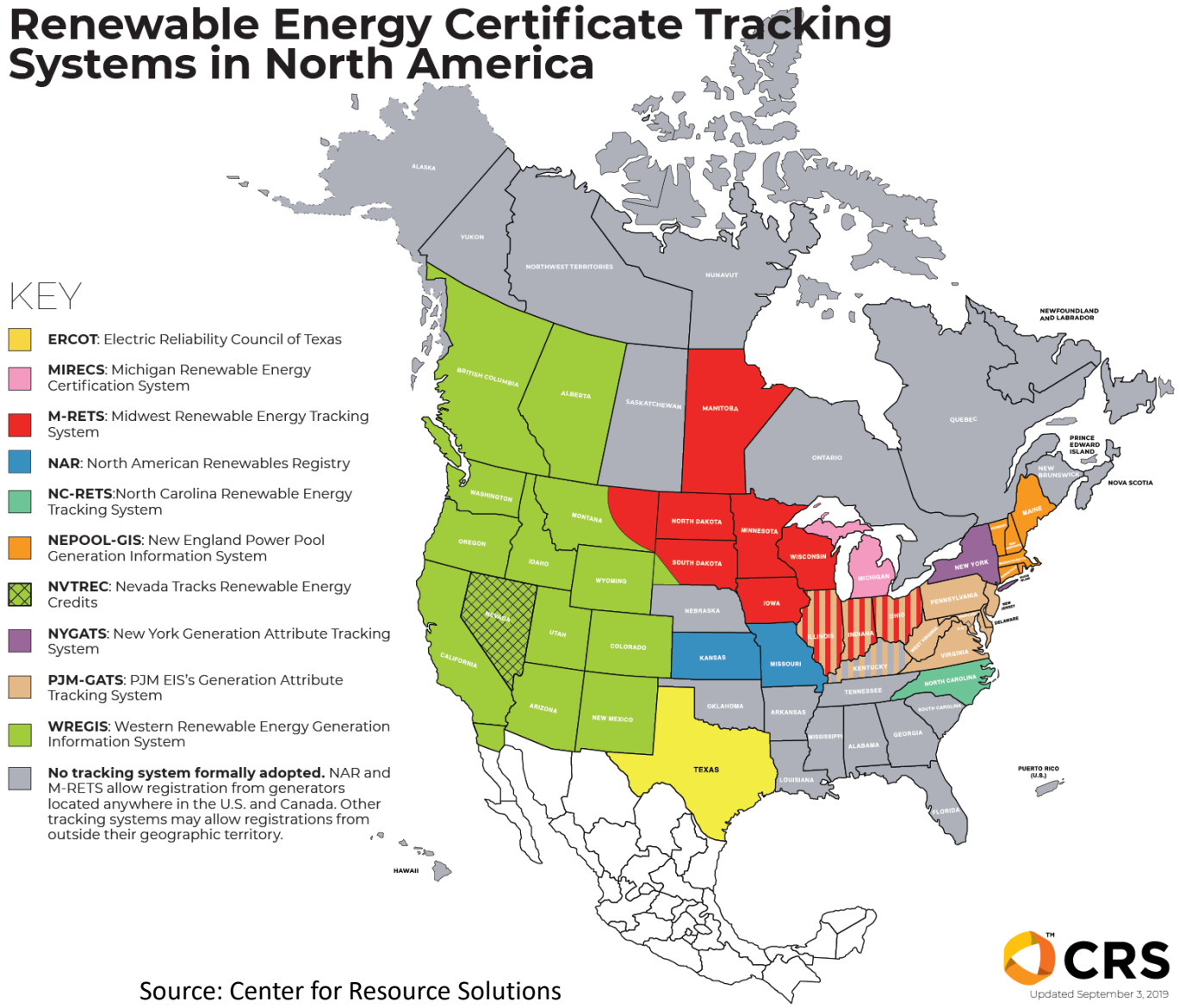
Pink - Electrolysis using nuclear
- GHG Emissions: Minimal

Green - Electrolysis using renewable energy
- GHG Emissions: Minimal

Source: Sustainable Energy Advantage, LLC, amalgamated from sources so numerous one can't tell where they started

The GH_2 Tracking & Attribution Challenge: Context

- Unique attribution of **renewable energy** via established generation attribute certificate, or **renewable energy certificate (REC) tracking systems**
- GH_2 is stored & transported ➔ GH_2 ecosystem inherently complex ➔ introducing need to track it:
  - ***Between*** production, transportation, storage & use
  - ***Back & forth*** between media (electricity & chemical)
  - ***Across*** geographic boundaries, when transported
  - ***Over periods of time***, when stored
- Federal incentives for '**Clean H_2**' production & use…
  - associate lifecycle per-kg emissions with H_2
  - will also need to associate H_2 with its source
  - Ongoing debate over details rooted in additionality
- **At present, there is no established system for GH_2 tracking and attribution from source, through transportation and/or storage, to usage**



Source: Center for Resource Solutions

CRS Updated September 3, 2019

The GH_2 Tracking & Attribution Challenge: Implications

Developers, investors, buyers, etc. **lack a framework to document/ verify unique GH_2 use and claims**… How can you contract, invest?

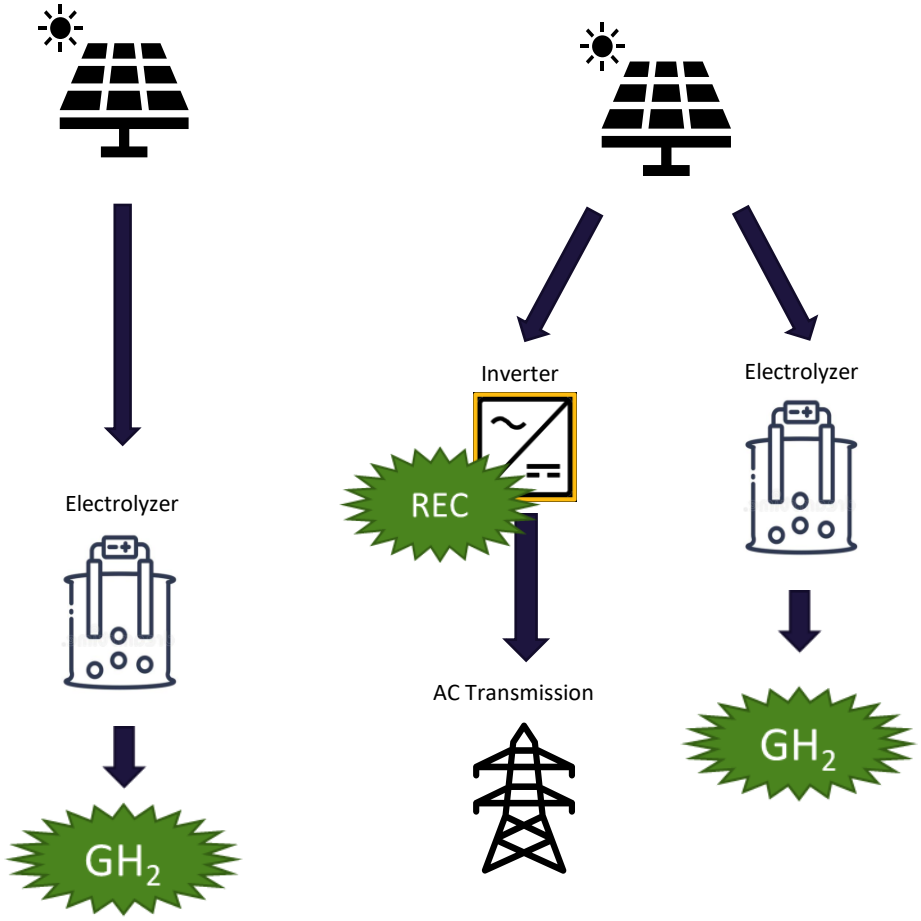
Federal efforts re: attribution for Clean H_2 *production* incentives proceed **without considering existing REC attribution,** state clean energy or GHG policy needs that focus on *usage*

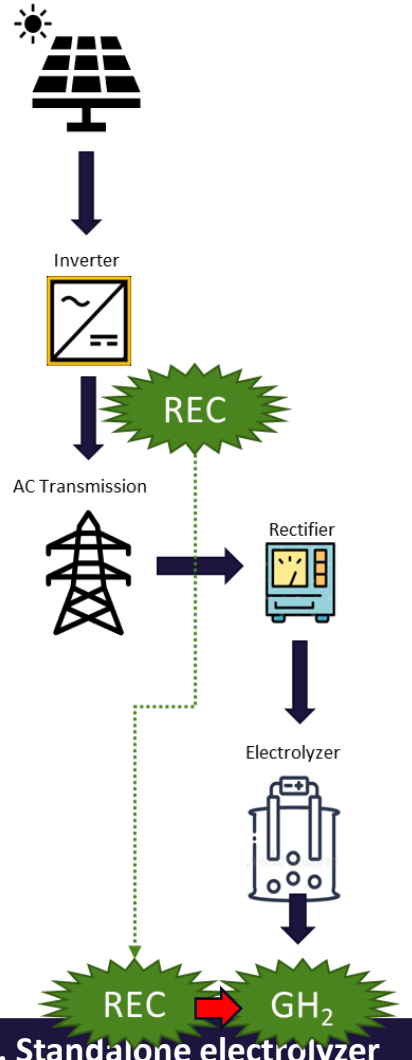
Without a synchronized framework supporting state, federal and private needs, **expect conflict with established REC & GHG tracking, inadvertent double counting or intentional malfeasance**

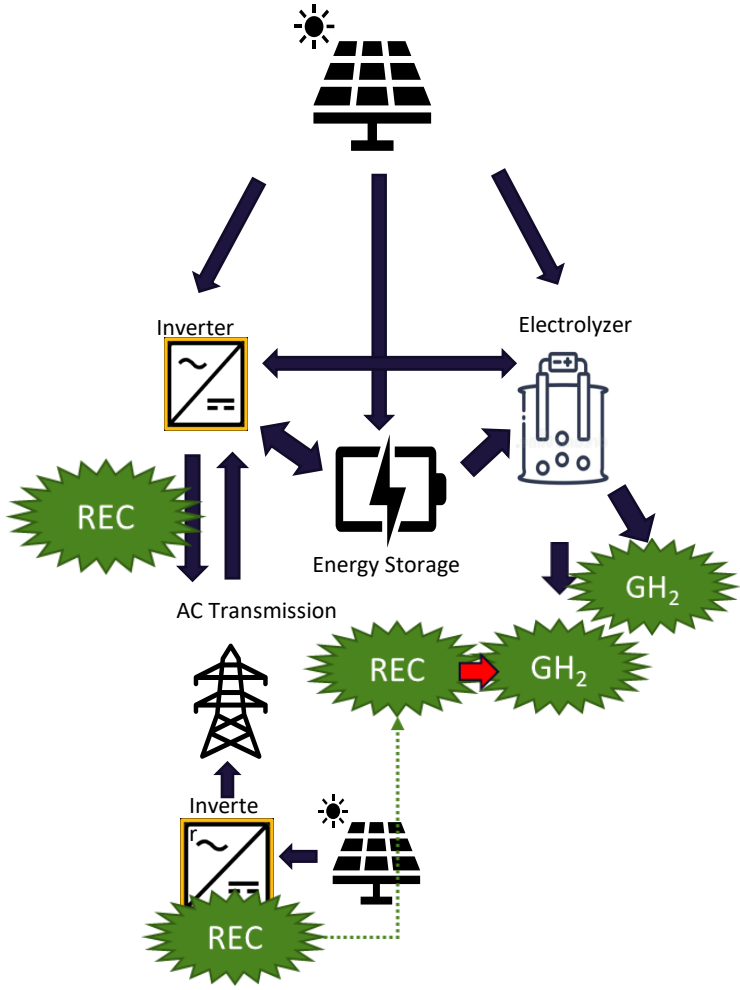
GH_2 initiatives & investments in applications are moving quickly ➔ deployment of a framework is needed now

GH_2 Production Scenarios Likely to be Deployed Near-Term

Depicted here for solar, but work the same for wind, hydro, other RE



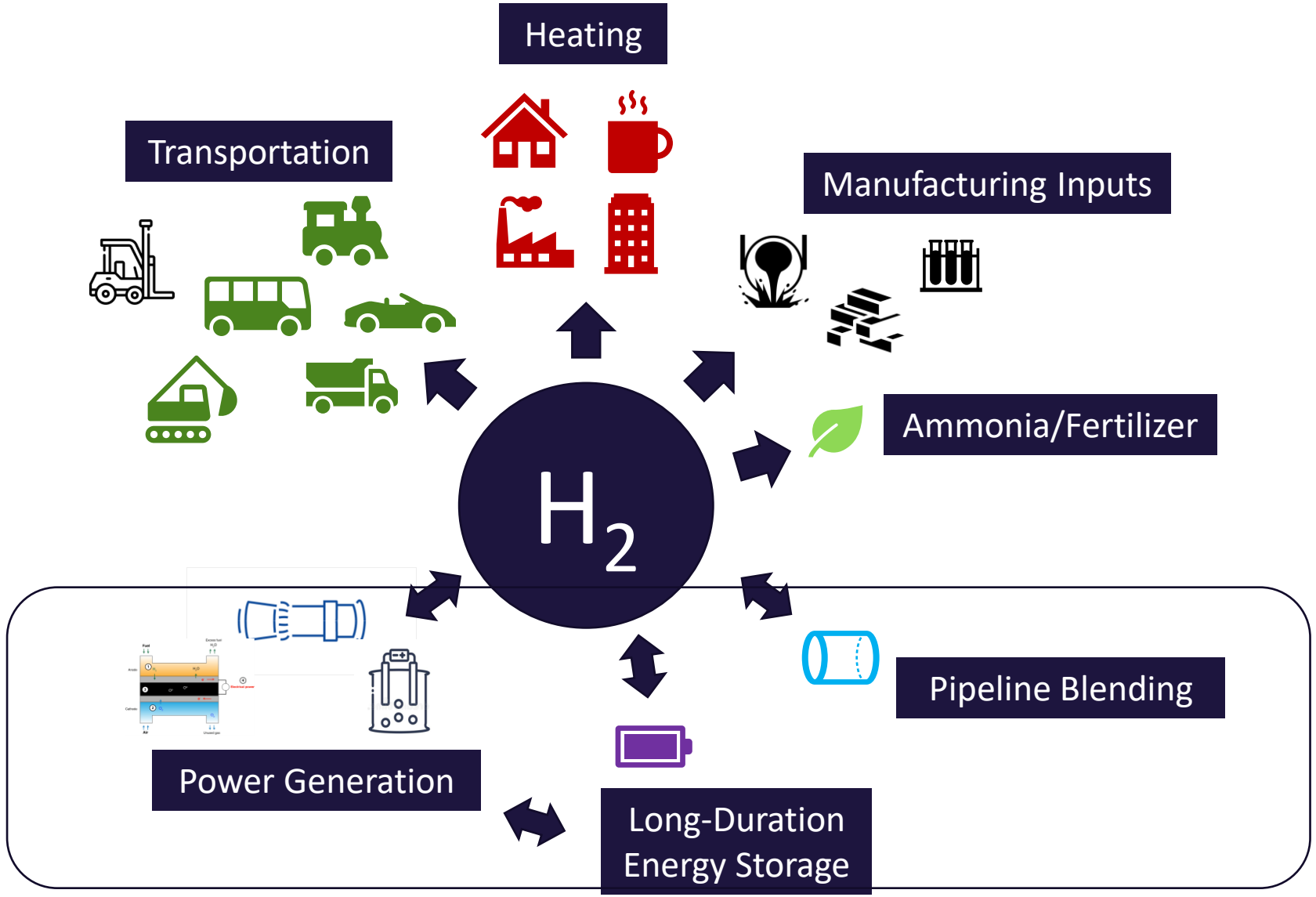




Production Configuration	1. Renewable to GH_2, all 'on-site'	2. Renewable to Grid or GH_2	3. Standalone electrolyzer producing GH_2 using grid power claimed as renewables	4. Hybrid Renewable to Grid, BESS, or GH_2 and Grid Renewable[1] to GH_2

Footnote: 1: RECs must be associated with the energy for it to be "green" hydrogen

Hydrogen End Uses

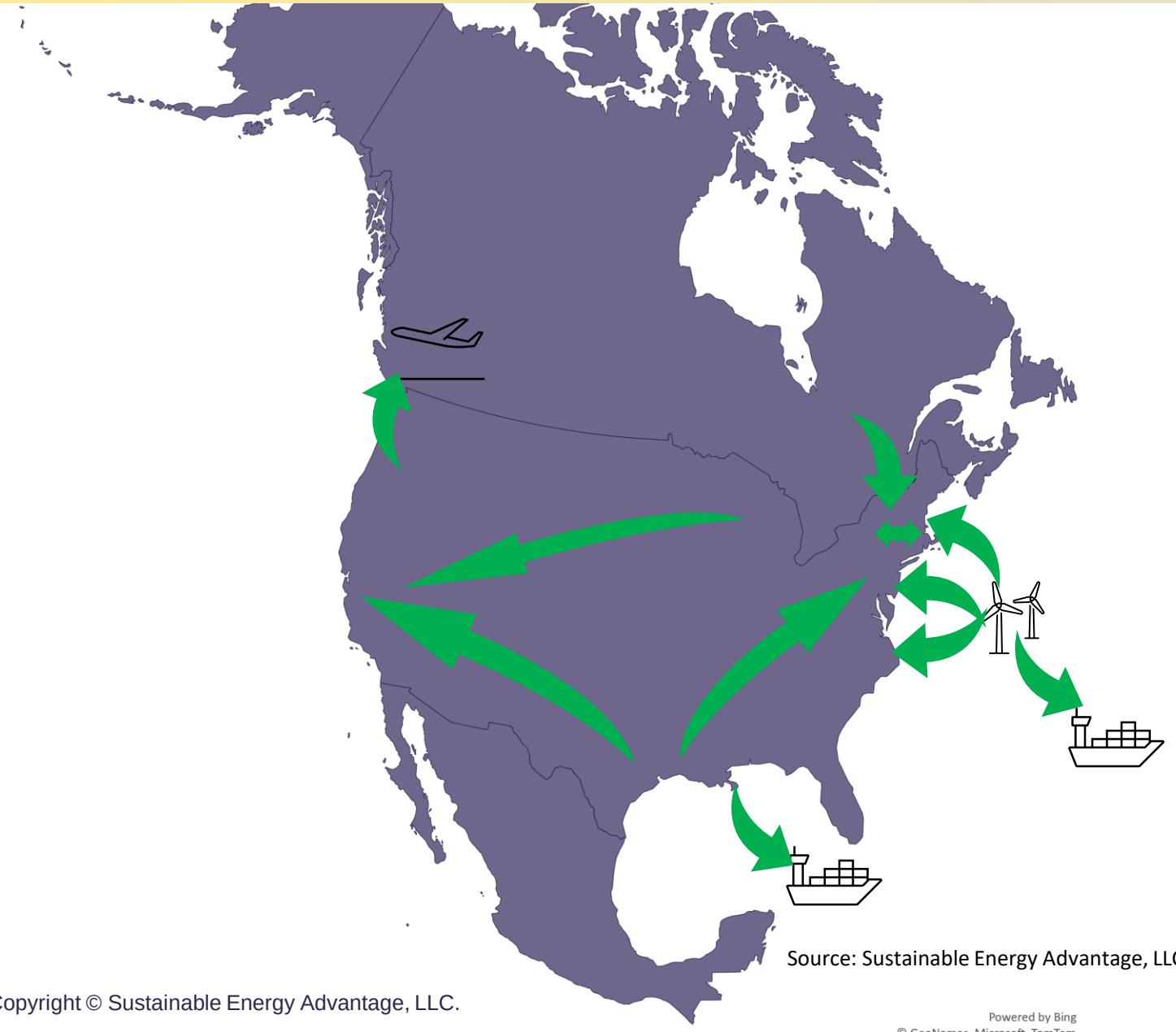


Converted 2X

Source: Sustainable Energy Advantage, LLC

Illustrative Geographic Considerations (GH_2 moves)

Consider all the types of transactions, for example…



Source: Sustainable Energy Advantage, LLC

- GH_2 made in Quebec fueling forklifts in Buffalo or heavy-duty trucks in border states
- GH_2 produced in Lancaster County, PA → converted to electricity in a NY fuel cell
- OSW hydrogen island in Federal waters delivering electricity over an offshore network to NY, MA and NJ, while creating GH_2 for use in international maritime mobility applications, electricity generation and heavy industry
- GH_2 made from bottled-in wind production in the wind belt, shipped to users far and wide
- Interstate pipeline blending
- Aviation fuel for international flight

With GH_2 electricity production, REC systems & states will have choices to make, and to accommodate… and may not make the same decisions

Examples of Choices

- H_2 Blending
- RPS Eligibility rules
- Distant RECs?
- Credible treatment of conversion losses

- *Further discussion in appendix*

Updates to REC Tracking System Rules

- Guidance to verify GH_2 provenance
- REC Retirement (metered MWh➔ GH_2)
- BTM electricity to electrolyzer: Metering/REC minting (or not)
- Combining RECs + grid power = GH_2?
- Metering
- Hybrid configurations
- Accounting for losses
- Multi-fuel blending conversion to RECs, treatment of losses, disaggregation

Universal Design Requirements for GH_2 tracking & attribution

Same principles applicable to H_2 generally and other renewable fuels

A credible, accurate and effective *framework* must…

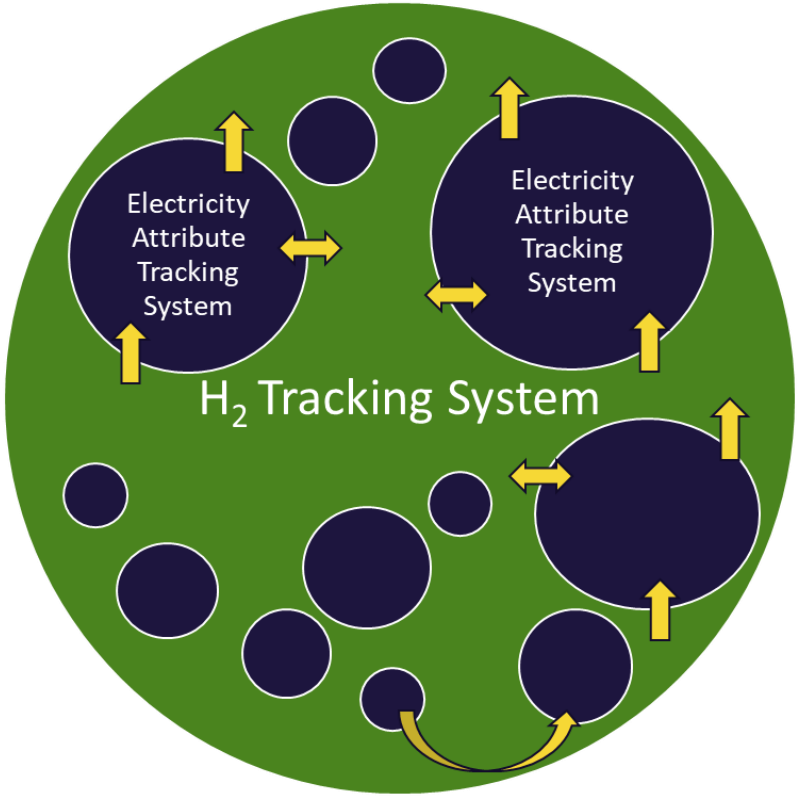
1. **Assure unique attribution** & no double counting/claim of electricity sources creating GH_2
2. **Assure the ultimate *user* can claim & verify** their resource is GH_2 or generated from GH_2
3. **Dovetail** with state GHG tracking & Federal production credit lifetime emissions calculations, attribution & verification
4. **Track transportation** of GH_2 across geographic boundaries
5. **Track H_2 through storage over time** periods different from timing of production
6. **Accurately account for losses** through each conversion
7. **Accommodate H_2 fuel blending** with non-renewable fuels
8. **Recognize & support state/regional/voluntary eligibility & data requirement differences** to support provenance verification

When? To survive investment due diligence, in time to accommodate all realistic or likely use cases **prior to reaching financial investment decision**

What does a system capable of tracking and attributing GH_2 (and other colors of the H_2 rainbow) look like?

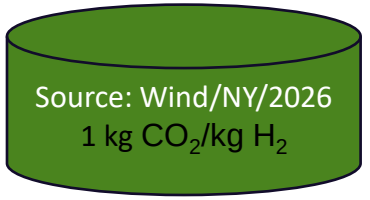
… and how does it interact with existing REC tracking?

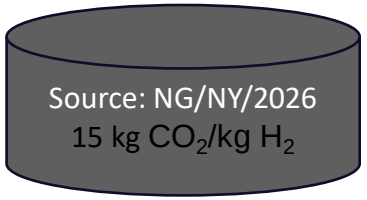
A Single Hydrogen Registry, Untethered from Geography!



How would H_2 be 'labeled'?

a) Generation source (or blend)
b) Provenance info (production location, vintage, etc.) required to assess RPS or other eligibility, additionality, etc.
c) Lifecycle GHG emissions





Wrap Up

- Key points:
  - A clean/green H_2 tracking system is needed (and soon) to enable credible GH_2 implementation
  - Because of the geography of the H_2 ecosystem, individual electric generation attributed/REC tracking systems can't do it alone… a system of broad scope (national, international, untethered from geography?) is required
  - No such system is under development… it's time to get to work

- Where to go from here?
  - Identify sponsor(s)/funder(s)
  - Engage stakeholders/reach consensus on approach/details for framework
  - Develop functional specifications for tracking/attribution system
  - Identify & fund an institutional home
  - Develop detailed operating rules
  - Build the system
  - Press 

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Interested?

Join us in moving this forward ➔

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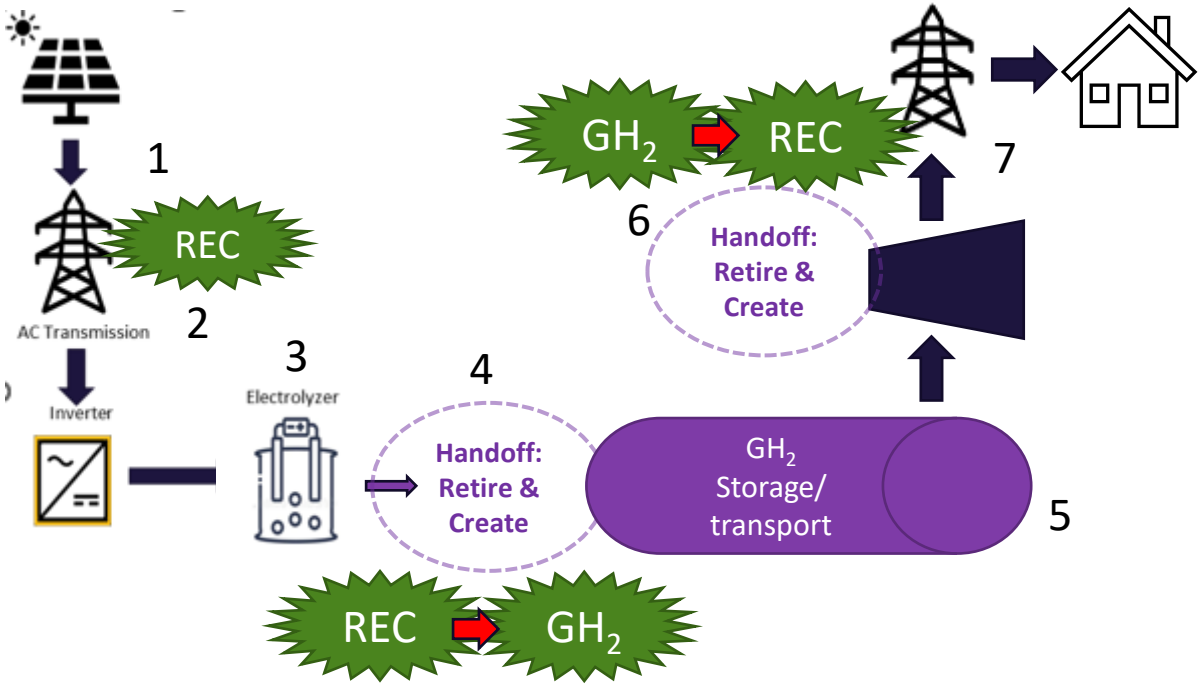
Appendix

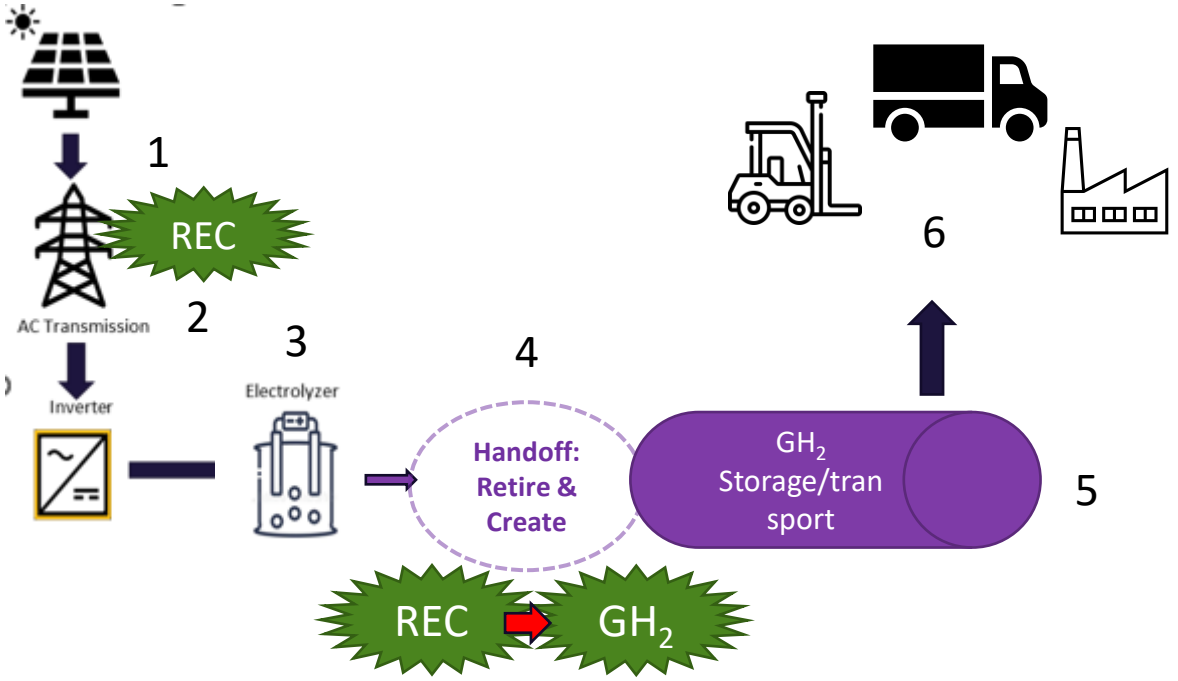
Use Case: Electricity to Hydrogen to Electricity



1. Renewable Energy put onto the grid in source market
2. RECs are created
3. Hydrogen is created using grid power
4. RECs are retired in source tracking system & H_2 production is registered in H_2 Tracking System
5. H_2 is sold/transported to sink market
   a) H_2 certificate follows hydrogen
6. H_2 is used to create electricity
   a) Hydrogen certificate is retired in H_2 tracking system
   b) Native RECs are created in sink tracking system, *which may be same or different than source*
7. Electricity settled to load, native RECS can be retired/used for compliance purposes in sink tracking system

Source = location of renewable energy generation
Sink = location of ultimate usage of GH_2
Native = location of electricity production from GH_2

Use Case: Electricity to Hydrogen to end use



1. Renewable Energy put onto the grid in source market
2. RECs are created
3. Hydrogen is created using grid power
4. RECs are retired in source tracking system & H_2 production is registered in H_2 Tracking System
5. H_2 is sold/transported to sink market
   a) H_2 certificate follows hydrogen
6. H_2 is used in end use, e.g., forklift, heavy-duty vehicle, steel manufacturing, etc.
   a) Hydrogen certificate is settled in H_2 tracking system

Source = location of renewable energy generation
Sink = location of ultimate usage of GH_2
Native = location of electricity production from GH_2

With GH_2 electricity production, REC systems & states will have choices to make, and to accommodate… and may not make the same decisions

Examples of Choices

- **H_2 Blending**:
  - Electricity RPS eligibility, disclosure, and/or tracking system rules already have approaches for blended biofuels that can be mirrored for H_2
  - Different REC tracking systems & states policies treat blended fuels differently for eligibility purposes, including whether disaggregation is allowed ➔ a framework capable of handling different rules required
- **RPS Eligibility rules:**
  - Will certificate adopt characteristics (type, vintage) of the electricity source, *regardless of when the original GH_2 was produced*, if provenance and retirement of generation attribute certificates in source system is verifiable?
  - Can Tier 1-eligible certificates be generated from electricity produced using GH_2 created from non-Tier 1 renewable resources (type, vintage, location)?
- **Distant RECs?**
  - Will allowing RECs from a distant generation attribute registry, without electricity delivery, to be bundled with local 'brown power' to make GH_2 locally used to make RPS-eligible green electricity be incompatible with state policies to fully decarbonize? (e.g., Texas wind RECs + system power produced largely from northeast natural gas)
- **Credible treatment of conversion losses**
  - How are losses accounted for? Can losses in a fuel blend be disaggregated? (e.g., all losses associated with natural gas, preserving all renewable attributes through production or consumption conversion?

Updates to REC Tracking System Rules

- Create guidance necessary to verify the provenance of GH_2 used to produce electricity in market sufficient to mint clean energy certificates?
- If MWh production metered, then converted to GH_2, retire associated RECs so they can't be settled to load
- Clarify whether or not MWh to electrolyzer are metered and corresponding RECs minted?
- Rules dictating combining RECs with grid power to make GH_2, and retiring RECs so they can't be settled to load
- In hybrid configurations (see production #4) rules governing the parsing/tracking of electricity and RECs between grid and onsite electricity (potentially cycled through battery) that is settled to load (for elec. consumption) vs. RECs retired or never minted because converted to GH_2
- Rules accounting for battery round-trip storage losses and attributing to associated source
- Rules for multi-fuel blending conversion to RECs, treatment of losses, and addressing disaggregation

Coordination Issues between the existing REC tracking ecosystem and new Federal H_2 incentives rules (1)

- **DOE, U.S. Treasury/IRS establishing rules to support Federal 'Clean H_2' Tax Incentive Eligibility**
  - Extensive comments received; rulemaking efforts ongoing
- **EPA Proposed 111(d) Power Plant Emissions Limits, if adopted**:
  - Set new & existing power plant Emission Guidelines, requiring states to develop plans for new/existing coal & gas plants to meet limits
  - Onsite mitigation/compliance possible via by co-firing with Clean H_2
- **Stakeholder interests differ**:
  - **Federal production incentives**: agencies interested in electricity tracking system identifying the *production source* of Clean H_2 and associated *embedded emissions*, but the interest stops before considering the *use* of Clean H_2
  - **EPA/state air agency purposes**: compliance tracking for states and obligated entities requires a mechanism to track/verify that a subject generator has *used* hydrogen from production sources with specific characteristics, through storage and transport to usage
  - **State clean energy policies, greenhouse gas policies** require data to support emission inventories (*production*) & compliance verification (*use*, e.g., for RPS) aligning with policy objectives and eligibility
  - **Consumers** of clean hydrogen, whether for end uses or for electricity production, require data that can verify provenance and eligibility consistent with applicable *usage* eligibility requirements or claims.

Coordination Issues between the existing REC tracking ecosystem and new Federal H_2 incentives rules (2)

- Nationally >25% of electricity supply from existing nuclear & hydropower, much lacking markets for their ZECs and RECs ➔ could (in theory) divert existing clean generation being used to serve existing loads to serve H_2 demand ➔ allowing national RECs to back Clean H_2 production claims risks deploying Federal Clean H_2 incentives without increasing clean energy ➔ Stakeholders conveyed to DOE/Treasury several related implementation issues requiring resolution, including:
  1. Geographic proximity/deliverability
  2. Temporal matching (annual settlement versus hourly matching of clean energy resources to H_2 production)
  3. Additionality/vintage of electrolysis energy source
  4. Distinguishing between behind-the-meter and grid-connected electrolyzer supply
  5. Defining the accounting period over which to look at emissions associated with H_2 production

Rules development and consideration of these factors is ongoing.

- **The Risk of lack of coordination:** Federal production incentive rules and supporting tracking infrastructure could conflict with existing REC tracking systems throughout North America, resulting in competing claims, double counting, or activities that are compliant but not advancing the underlying policy objectives.

Q&A