



The Future of Clean Hydrogen

LAEDC Future Forum Series

October 6, 2022

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California Governor's Office of Business &
Economic Development (GO-Biz)



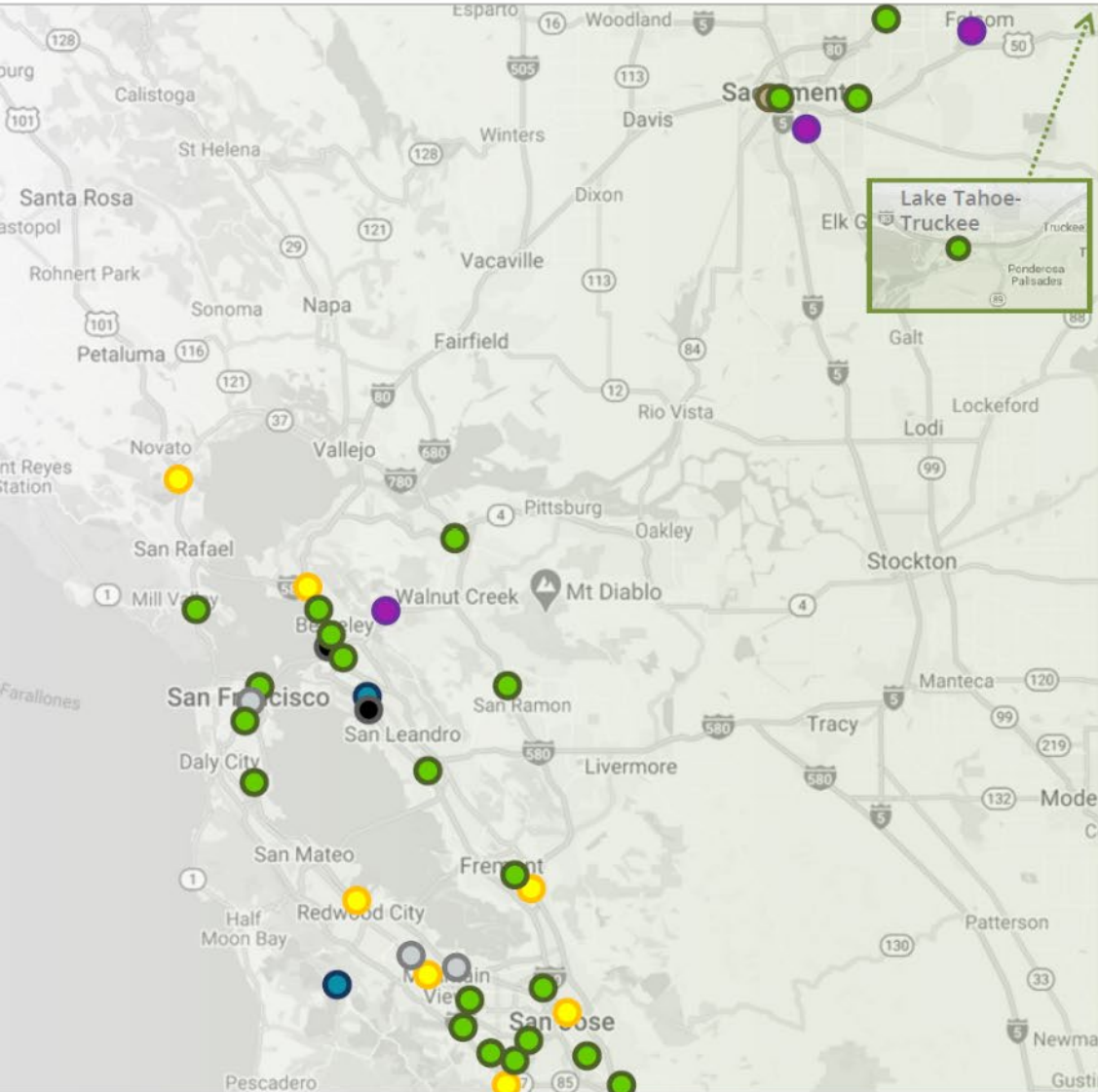


California's Hydrogen Roots

(where we came from)



Northern California Hydrogen Stations



Southern California Hydrogen Stations



- Retail: Open
- Heavy Duty: Bus
- Heavy Duty: Truck
- Retail: In Permitting
- Retail: In Construction
- Retail: Legacy
- Retail: Proposed
- Retail: Currently Unavailable

Recent H2 State Investments

Transportation

Category	Funding Opportunity	Hydrogen-related Awards
Heavy-duty Vehicles	Zero-Emission Transit Fleet Infrastructure Deployment (GFO-20-602)	Two hydrogen bus refueling projects awarded (Aug 2021)
	Zero-Emission Drayage Truck and Infrastructure Pilot Project (GFO-20-606)	30 class 8 drayage trucks and fueling infrastructure at the Port of Oakland (April 2021)
	Hydrogen Fuel Cell Truck and Bus Technology Integration and Demonstration (GFO-21-501)	2 truck projects awarded (Dec 2021)
	EnergIIZE Hydrogen Funding Lane (\$17M)	\$17M - fully subscribed (July 2022) Reopen next year
	Innovative Hydrogen Refueling Solutions for Heavy Transport (GFO-22-502)	NEW Open solicitation (closes 11/18/22)
Maritime and Rail	Hydrogen Fuel Cell Demonstrations in Rail and Marine Applications at Ports (GFO-20-604)	Small fast multi-use hydrogen fuel cell harbor craft (Dec 2020) Hydrogen locomotive project (Dec 2020)



Recent H2 State Investments

Other

Category	Funding Opportunity	Status
Hydrogen Fuel Production	Renewable Hydrogen Transportation Fuel Production (GFO-20-609)	3 applicants awarded (Feb 2022)
	Advancing Cost and Efficiency Improvements for Low Carbon Hydrogen Production (GFO-21-502)	7 applicants awarded (April 2022)
Emergency Response and Resiliency	Mobile Renewable Backup Generation--MORBUGs (GFO-20-310)	Hydrogen fuel cell systems awarded (May 2021)
Buildings and Industry	Examining the Effects of Hydrogen in End-Use Applications for Large Commercial Buildings and Industrial Applications (GFO-21-503)	1 applicant awarded (April 2022)



California's Clean Hydrogen Future

(where we're going)



What is Clean Hydrogen Anyway?

- Multiple (and sometimes conflicting) definitions
- Clean/renewable/green used interchangeably
- The hydrogen rainbow
- Shades of green
 - Electrolytic (Los Angeles definition)
 - Renewable feedstock (SB 100 Joint Agency Report)
- From the hydrogen rainbow to carbon intensity
- DOE's Proposed Standard – 4 kgCO₂e/kgH₂ (lifecycle)
- Common framework would be helpful
 - CA, US, and globally



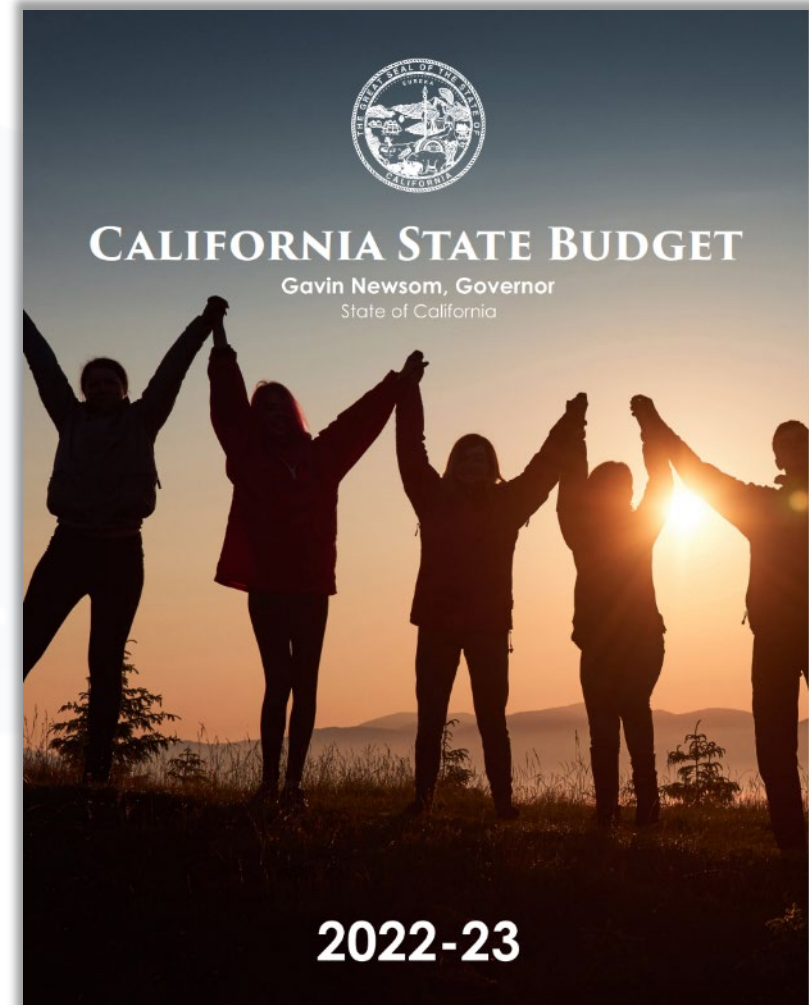
Targeted Sectors, from Draft Scoping Plan

Transportation		H2 as Energy Storage (cross-sector)
<ul style="list-style-type: none"> Light Duty Vehicles = 100% BEV or FCEV sales by 2030 or 2035 Truck ZEVs = 100% ZEV sales by 2030, 2035, 2040, or 2045 	<ul style="list-style-type: none"> Freight and Passenger Rail (50% of line haul sales = ZEV by 2030, 100% by 2035/45) <ul style="list-style-type: none"> Line Haul and Passenger Rail primarily H2, others primarily e- by 2035 	
<ul style="list-style-type: none"> Aviation (10-25% met by e- or H2 by 2035/45) 	<ul style="list-style-type: none"> Ocean Going Vessels (10-25% of OGVs use H2 by 2035/45) 	
Electrical Power		
<ul style="list-style-type: none"> Electricity Generation: H2 fuel cells provide firm capacity 		
Industrial		
<ul style="list-style-type: none"> Chemicals and Allied Products, Pulp and Paper <ul style="list-style-type: none"> H2 for 25-50% of process heat by 2035, 100% by 2045 (or 0 and 10%) 	<ul style="list-style-type: none"> Low Carbon Fuels for Buildings and Industry <ul style="list-style-type: none"> H2 blended in NG Pipeline at 7% energy (30% by volume), ramping up from 2030 to 2040 Dedicated H2 pipelines to serve certain industry clusters in 2030s or 2040s 	

2022-23 Budget Highlights

\$54 billion climate package

- Clean Energy: \$2.1 billion
 - \$100 million for Green Hydrogen
 - \$5 million for CA H2Hub
- Goods Movement and Ports: \$1.2 billion
- Zero-Emission Vehicles: \$10 billion
- Clean Energy Workforce: \$315 million
- Climate Education: \$723 million



But we're not the only ones...
(accelerating our pace)



Bipartisan Infrastructure Law – H2 Highlights

- **Includes \$9.5B for clean hydrogen:**
 - \$1B for electrolysis research, development, and demonstration
 - \$500M for clean hydrogen technology manufacturing and recycling R&D
 - \$8B for at least four regional clean hydrogen hubs
- **Aligns with Hydrogen Shot** priorities by directing work to reduce the cost of clean hydrogen to **\$2 per kg by 2026**
- **Requires developing a National Hydrogen Strategy and Roadmap**



President Biden Signs the Bipartisan Infrastructure Law into law on Nov. 15, 2021.

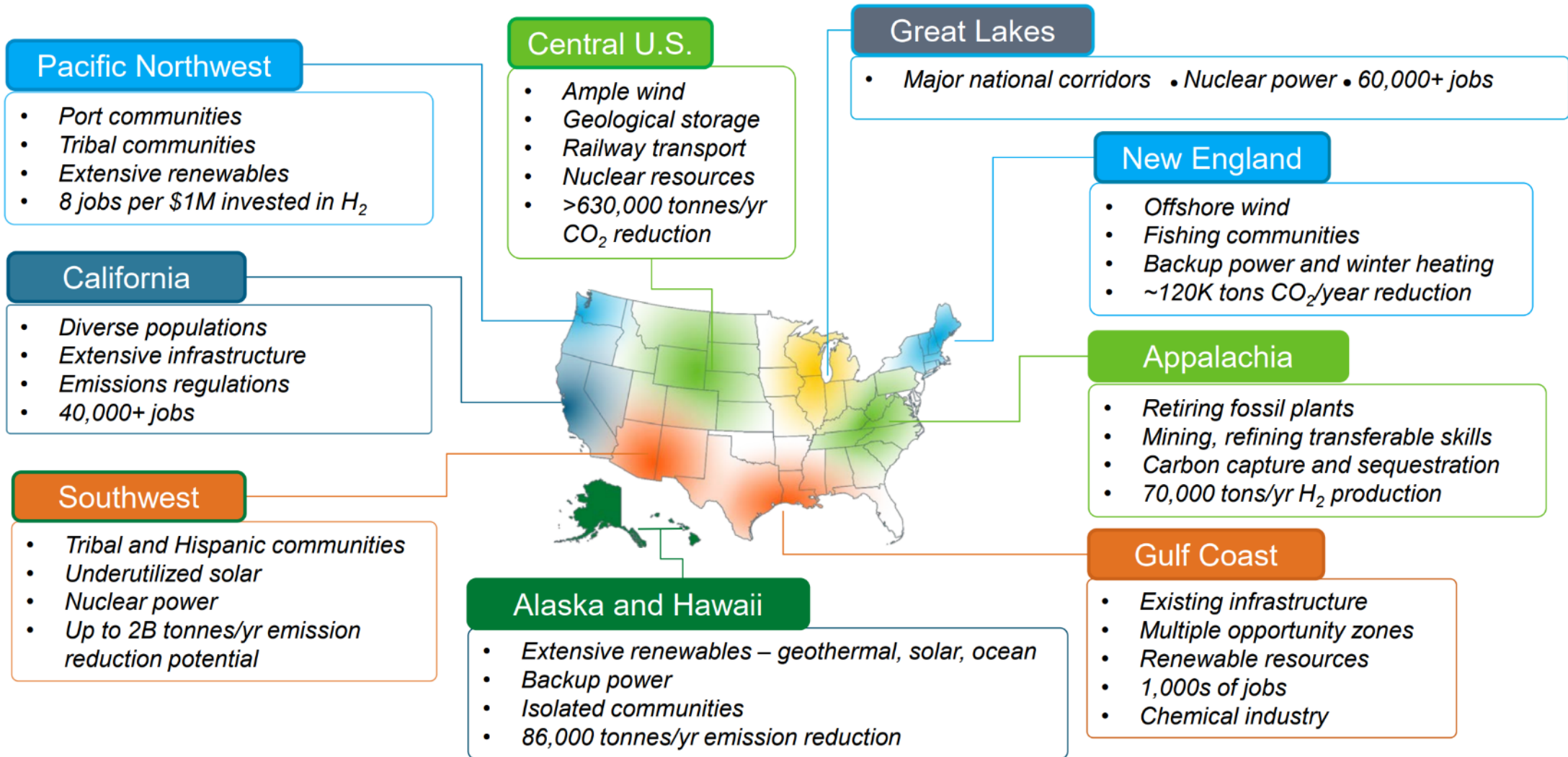
Photo Credit: Kenny Holston/Getty Images

Bipartisan Infrastructure Law – Regional Clean Hydrogen Hubs

- \$8 billion/five years
- *At least* 4 regional clean hydrogen hubs
 - **Definition**: a network of clean hydrogen producers, potential clean hydrogen consumers, and connective infrastructure in close proximity
- Hubs must reflect to the maximum extent practical:
 - **Feedstock Diversity**: at least 1 hub with hydrogen production from **renewables**, nuclear, and fossil fuels with CCS
 - **End-Use Diversity**: at least 1 hub with hydrogen end-use in the **electric power**, **industrial**, residential and commercial heating, and **transportation** sectors
 - **Geographic Diversity**: Each clean hydrogen hub must be located in a different region of the United States and use energy resources that are abundant in that region
 - **Natural Gas-Producing Regions**: At least 2 hubs located in regions with the greatest natural gas resources



California is Well Positioned



California Formally Announces Intention to Create a Renewable Hydrogen Hub

May 18, 2022 | Press Release

Sacramento, CA – Building from a foundation of nation-leading policies and new hydrogen system market development, Governor Newsom's administration is announcing California's intention to leverage federal investment from the Infrastructure Investment and Jobs Act (IIJA) to establish an environmentally and economically sustainable and expanding renewable hydrogen hub. Administration officials, led by the Governor's Office of Business and Economic Development (GO-Biz), will continue working with public and private stakeholders, including California's legislature and leading municipalities such as Los Angeles, to submit one state co-funded application.

In the May Revisé budget, Governor Newsom proposed direct investment in green hydrogen production, in addition to numerous pots of funding that can be leveraged to accelerate hydrogen market development, including zero-emission vehicle market acceleration, industrial decarbonization, and long duration energy storage. Additionally, the administration is committed to collaborating with neighboring states and initiatives to create a resilient supply and delivery chain, helping to facilitate success and learnings across multiple markets.

"California has the market experience, workforce talent, public and private investment base, and renewable resources to partner with the federal government to create an economically resilient, expanding hydrogen hub that helps accelerate national success," said Dee Dee Myers, Director of GO-Biz and Senior Economic Advisor to Governor Newsom. "GO-Biz is leaning in on our deep experience with the hydrogen industry and working with multiple stakeholders to organize a statewide application aimed at one fundamental concept: getting to scale in California and beyond."

"Our recently published draft [Scoping Plan Update](#) makes it clear that renewable hydrogen has an important role to play in reaching our economy wide climate and air quality targets," said California Air Resources Board Chair Liane Randolph. "We are committed to collaborating with all stakeholders to continually improve our robust policy framework to enable rapid renewable hydrogen market development."

"The need for renewable hydrogen is clear, especially as we develop systems to store and use renewable electricity," California Energy Commission Chair David Hochschild stated. "We need federal, state, and private investment to accelerate market development to ensure we meet our carbon neutrality goals—and we are excited to work with stakeholders to build a world class hydrogen hub and believe that federal investments in green hydrogen in California will benefit the state and the nation."

"The California Public Utilities Commission is committed to working with stakeholders to help define the role of investor-owned utilities in the hydrogen market ecosystem," said Commissioner Clifford Rechtschaffen. "Renewable hydrogen can play a variety of important roles in a decarbonized economy."

"From public transit to long-haul trucking, low-cost, renewable hydrogen is one of the key components in our efforts to rapidly reduce pollution from the transportation sector," said California State Transportation Agency Secretary Toks Omishakin. "Hydrogen fuel cell vehicles of all types – including cars, heavy-duty trucks, buses, rail and watercraft – are an ideal complement to battery-powered vehicles as part of a diversified and sustainable transportation system. The hydrogen hub will help lower costs and accelerate California's transition to a zero-emission future."

A federally co-funded hydrogen hub in California would accelerate our collective transition to a carbon-neutral economy, creating the scale needed to drive down cost for businesses and consumers alike, all while creating high paying jobs. Near term hub activities will center on deep investments in electrifying port operations, goods movement, transportation, and energy system resilience. Parties interested in submitting project ideas for consideration can add their information in this [form](#).



Stakeholder/Project Snapshot (as of 10/3)

<https://business.ca.gov/h2hubs-form/>

H2 Leads this Month

228

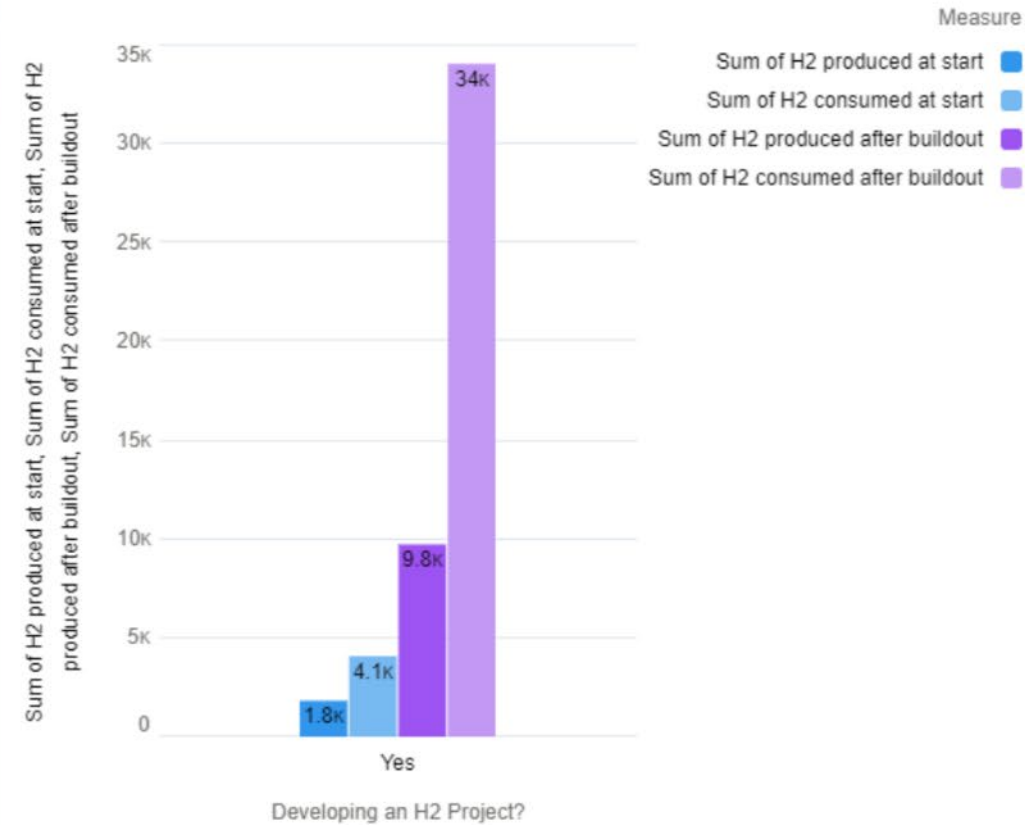
[View Report \(DASHBOARD_H2 Leads by Month\)](#)

Tonnes H2 Produced per Day, Project Start



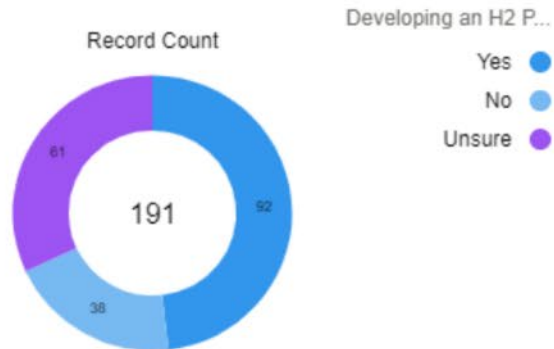
[View Report \(DASHBOARD_H2 Opportunities with Output\)](#)

H2 Opportunities Output



[View Report \(DASHBOARD_H2 Opportunities Output\)](#)

H2 Stakeholders by Project Status



[View Report \(DASHBOARD_H2 Opportunities with Output\)](#)

Tonnes H2 Produced per Day, Full Buildout

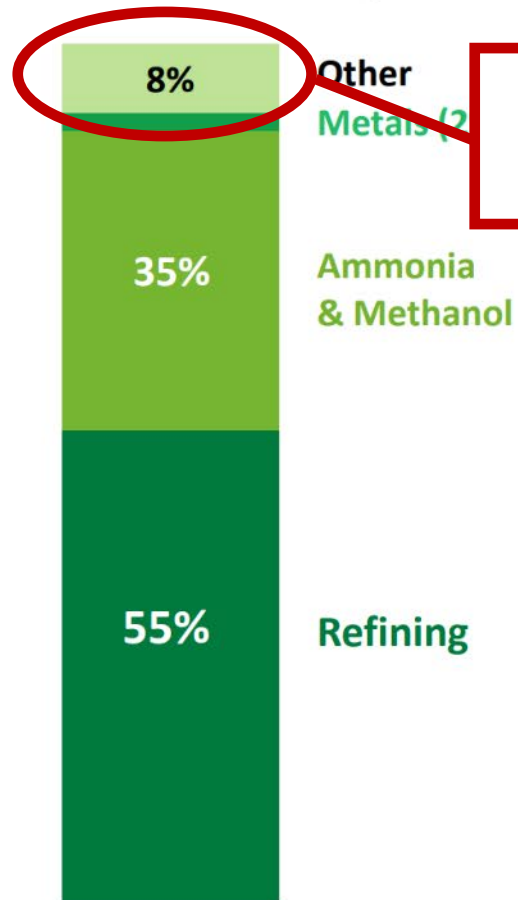


[View Report \(DASHBOARD_H2 Opportunities with Output\)](#)

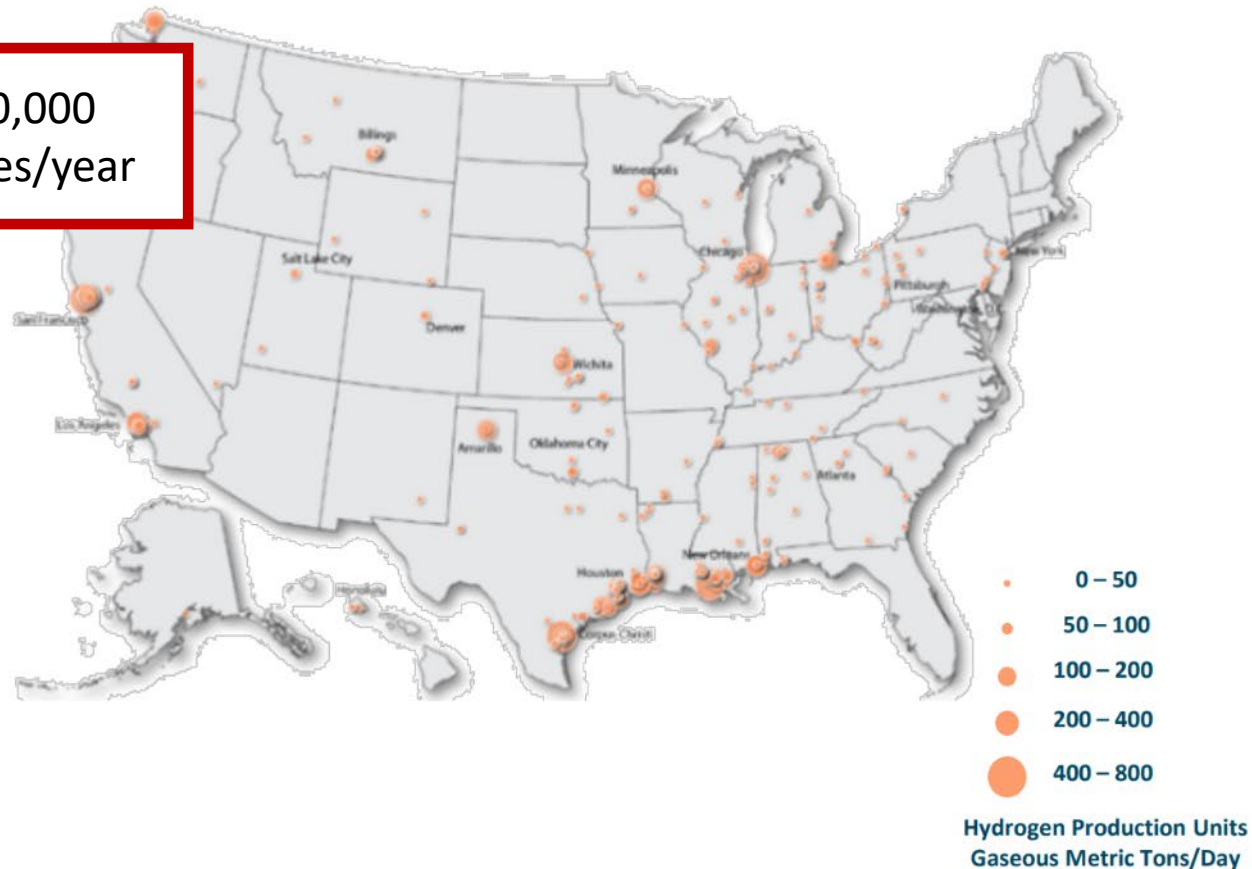
Hydrogen and Fuel Cells in the US

- 10 million metric tons produced annually
- More than 1,600 miles of H₂ pipeline
- World's largest H₂ storage cavern

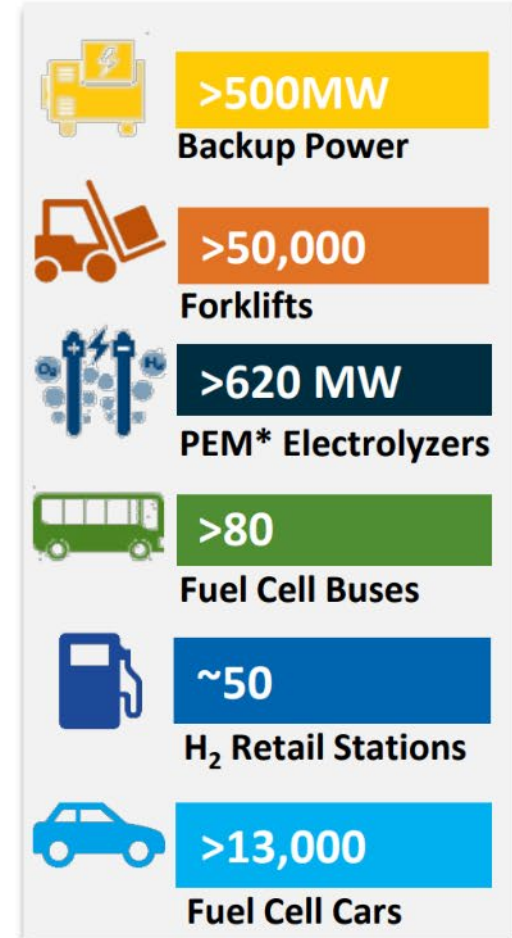
Use of Hydrogen in the U.S. Today



Examples of Hydrogen Production Locations



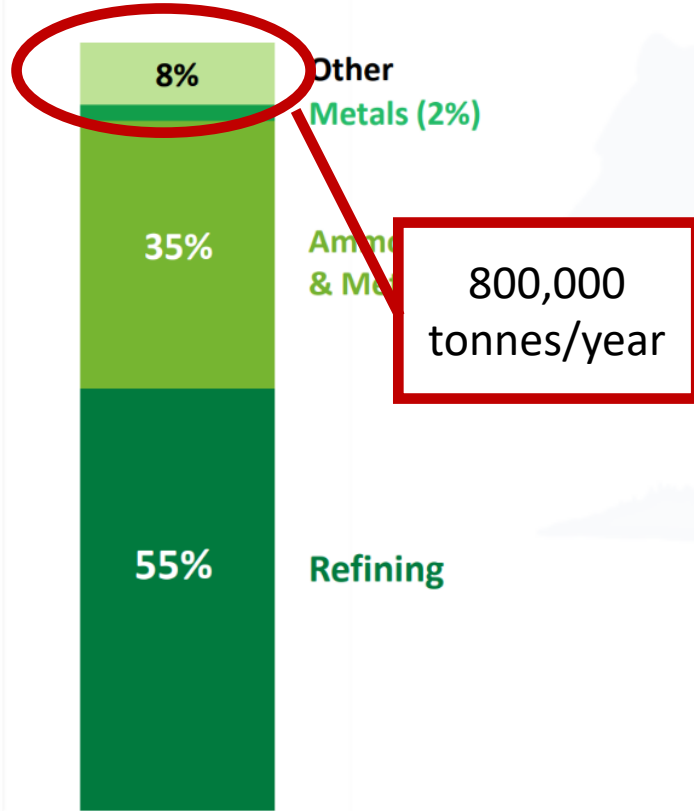
Examples of Deployments



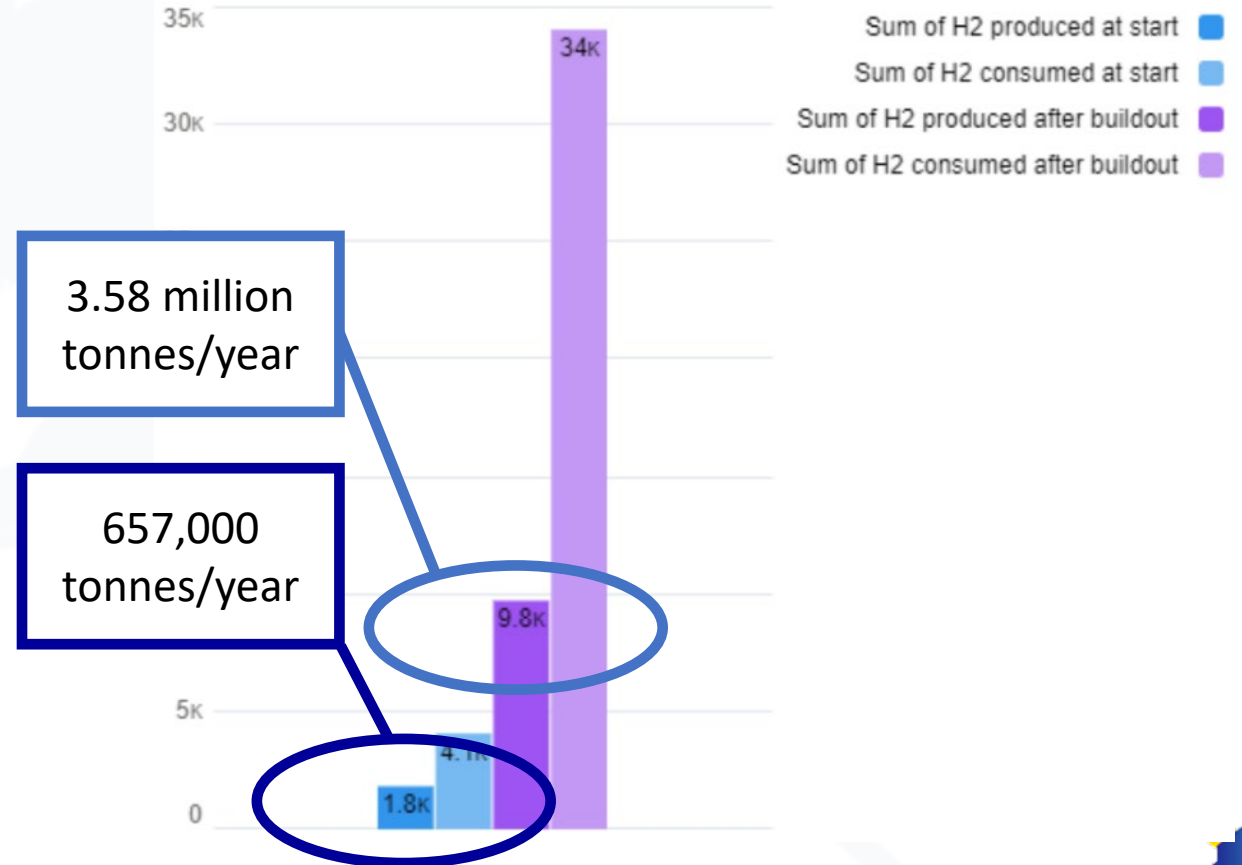
*Proton exchange membrane

The Opportunity: A Monumental Shift

Use of Hydrogen in the U.S. Today



CA H2Hub Collaborator Projects



How do we organize and structure this interest?





The Three Cs

(Collaboration, Connection, Coordination)





Alliance for Renewable Clean Hydrogen Energy Systems

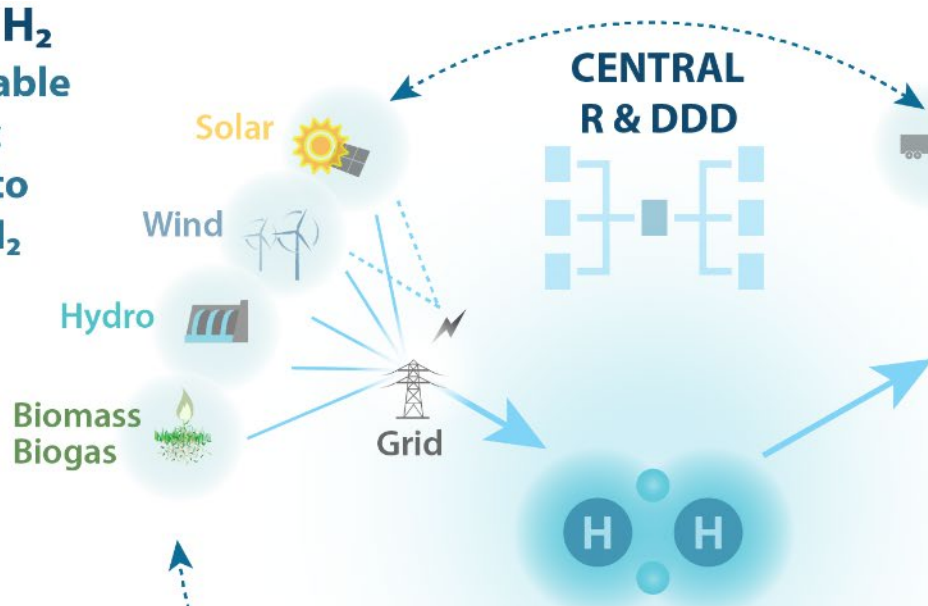
Statewide Public/Private Partnership for a Clean California H₂ Ecosystem

MAKE H₂
Renewable
Electric
Power to
Clean H₂

Central R&DDD
Research & Development
Demonstration & Deployment

People-centered
Energy equity, Environmental Justice
Environmental and Community Impact
Training, Education, Workforce development

Analysis and Guidance
Technoeconomic analysis, modeling, financing
Tech-to-Market, feasibility studies, innovation

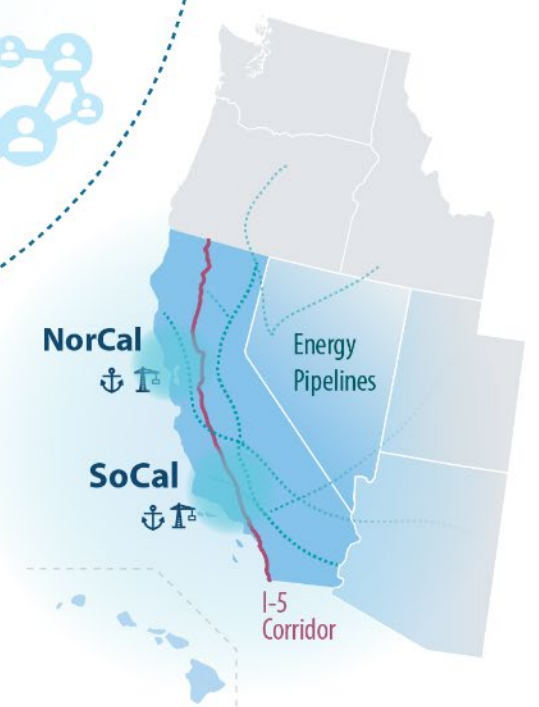


**CENTRAL
R & DDD**

USE H₂
Transportation
Freight / I-5 corridor
Ports and Marine
Rail & Aviation
↓
Industry
Cement
Steel
Ammonia
↓
Agriculture

STORE/MOVE H₂

- Store
- Transport
- Pipelines



Founding Members (for incorporation)



ARCHES



IBEW & NECA
LOCAL 11 LOS ANGELES



Renewables 100
Policy Institute



Governance Principles

1. Representative.
2. Transparent.
3. Responsive / Nimble.
4. Creates Market Opportunities.
5. Fair.

North Star: \$1 per kilogram renewable hydrogen by 2031, and \$2 per kilogram by 2026 (production cost)



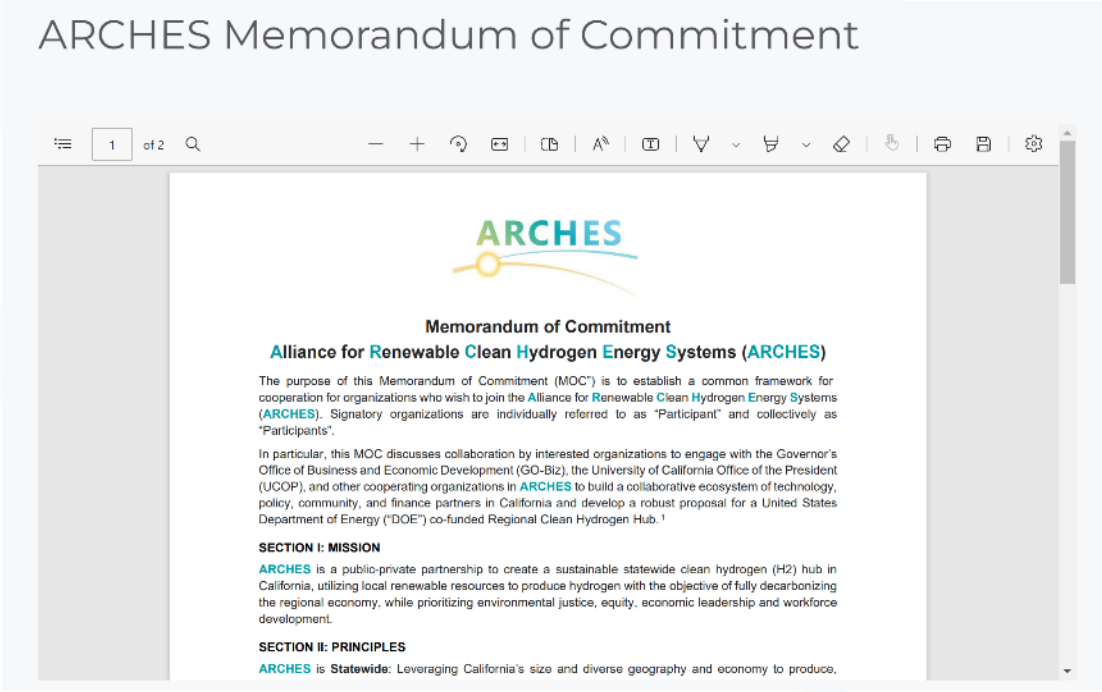


A Growing Network

website being built out

<https://archesh2.org/network/>

Any group can join. Membership is free.



<https://archesh2.org/memorandum-of-commitment/>



Join In

→ ↻ 🔒 https://archesh2.org/contact/ 🔍 ⚙️ ⌵ ⌵ ⌵

ARCHES HOME ABOUT ENVIRONMENTAL JUSTICE WORKFORCE DEVELOPMENT NETWORK NEWS CONTACT 🔍

Alliance for Renewable Clean Hydrogen Energy Systems

Join the ARCHES Network!

Please fill out the contact form below and we'll get back to you.

If your organization is interested in joining the ARCHES network, please have an authorized agent fill out this [Memorandum of Commitment](#) and send it to the email address provided when you submit the contact form.

Full name	Work email	Employer or Organization
<input type="text"/>	<input type="text"/>	<input type="text"/>



Thank You!

Gia Vacin

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Sign Up for GO-Biz's H2 on the Move email list:

<https://business.ca.gov/h2-on-the-move-sign-up/>

H2 Hubs Collaborator Intake form:

<https://business.ca.gov/h2hubs-form/>