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U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

DOE Hydrogen and Fuel Cell Remarks

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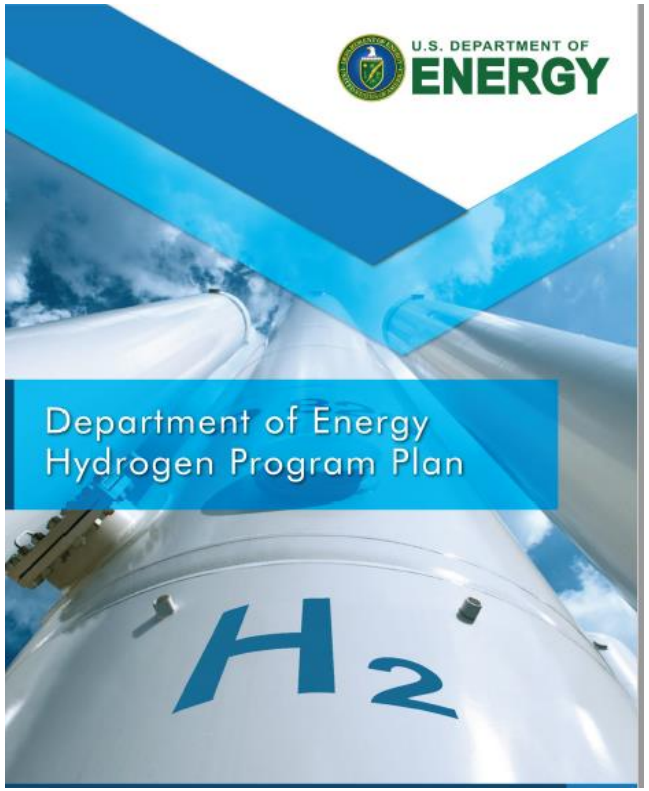
Director, U.S. Department of Energy Hydrogen and Fuel Cell Technologies Office

July 28, 2021

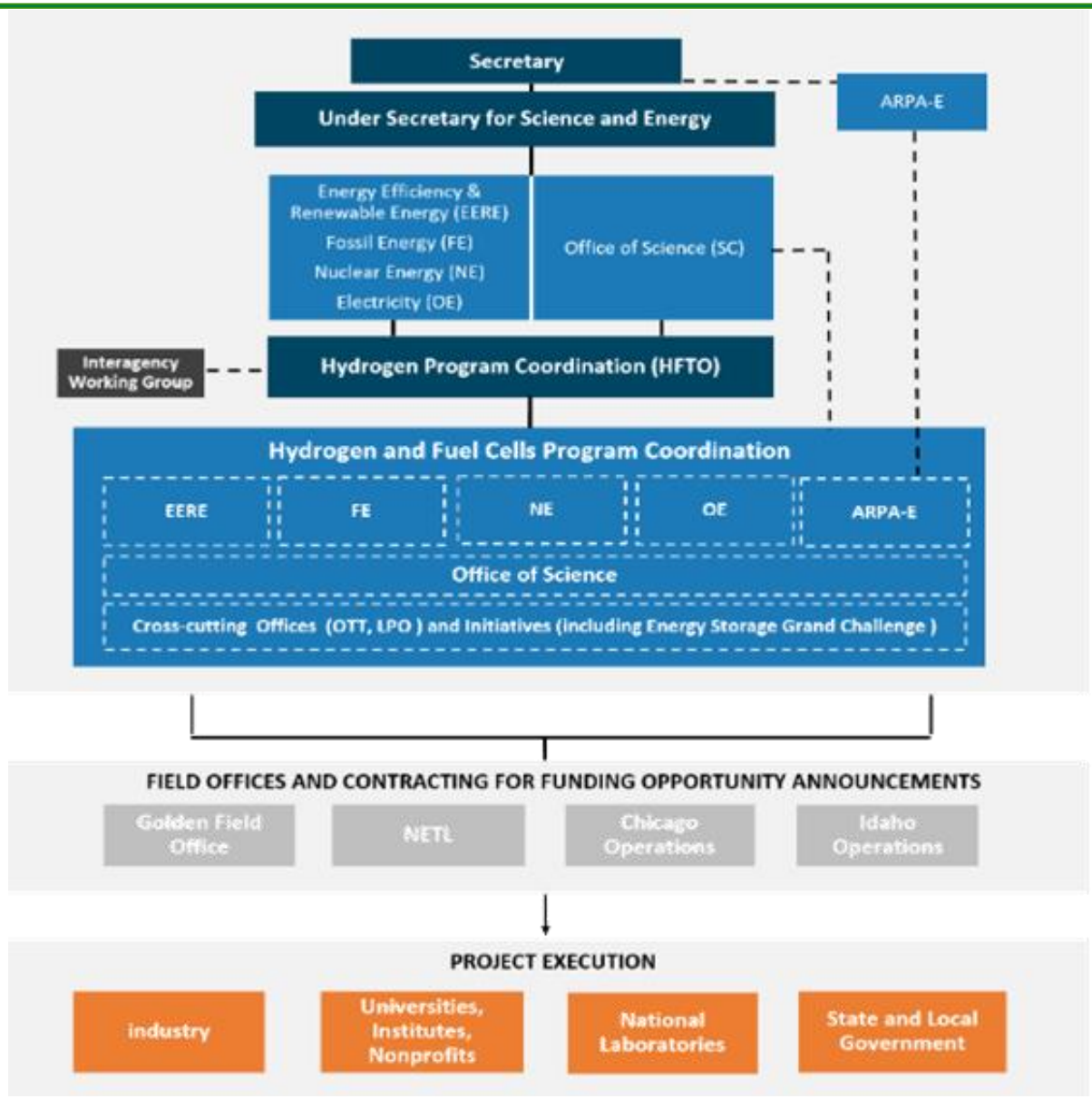
The U.S. DOE Hydrogen Program

The Energy Policy Act (2005) Title VIII and Energy Policy Act of 2020 provide key authorization

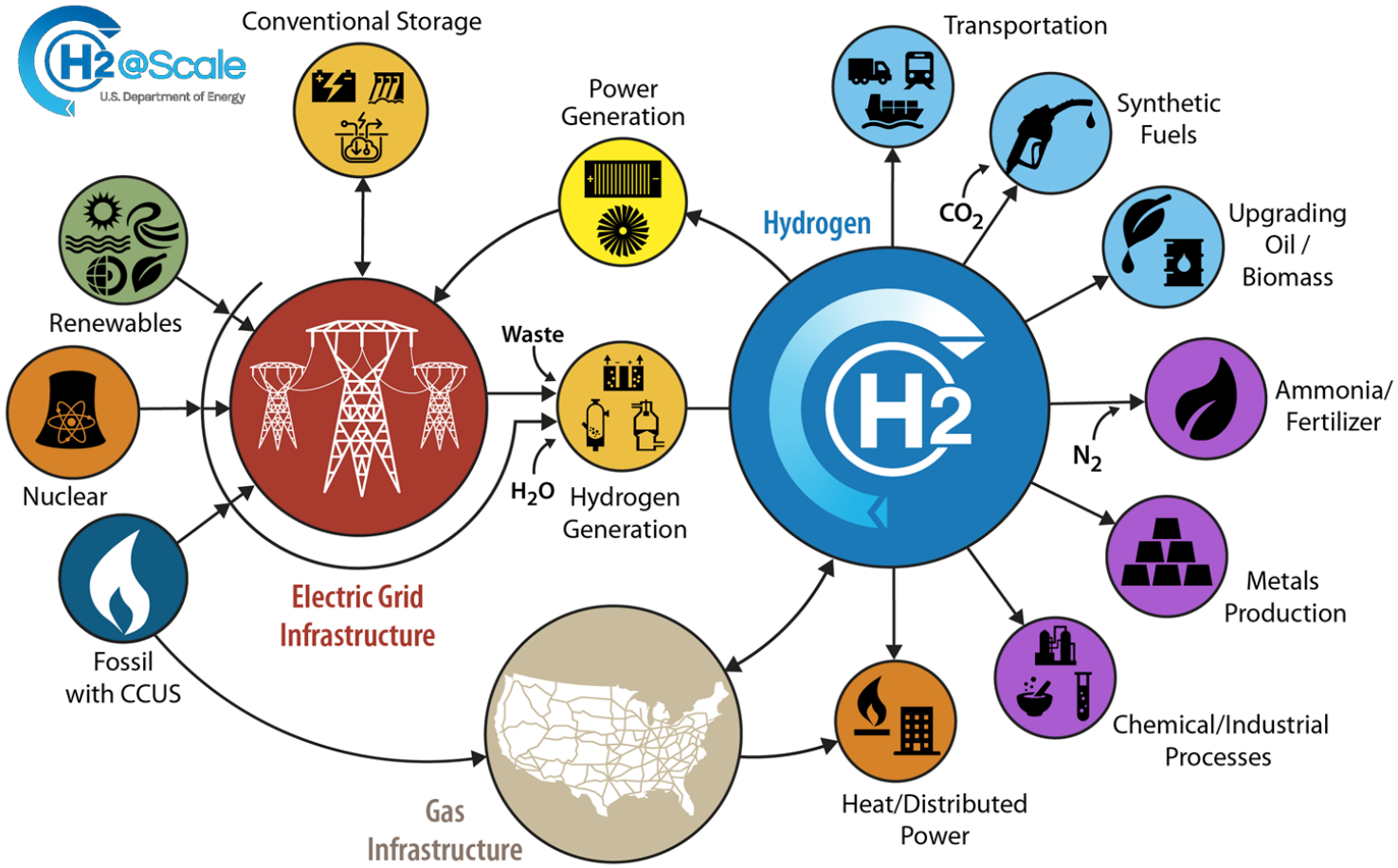
Hydrogen is one part of a broad portfolio of activities



www.hydrogen.energy.gov



H2@Scale: Deep Decarbonization, Economic Growth, Jobs



H_2 is part of a broad portfolio that contributes to Administration goals including:

- **100% carbon-pollution-free electric sector by 2035**
- **Net zero emissions economy by 2050**

Environmental Justice (EJ) 40 Initiative: 40% of benefits in disadvantaged communities

10 MMT of H_2/yr produced today with scenarios for 2-5X growth. +10 MMT H_2 would ~ double today's solar or wind deployment

Industry study shows potential for $140B in revenue, 700K jobs by 2030. 16% GHG reduction. Analysis underway (export, etc.)

Snapshot of Hydrogen and Fuel Cell Applications in the U.S.

Examples of Applications Deployed

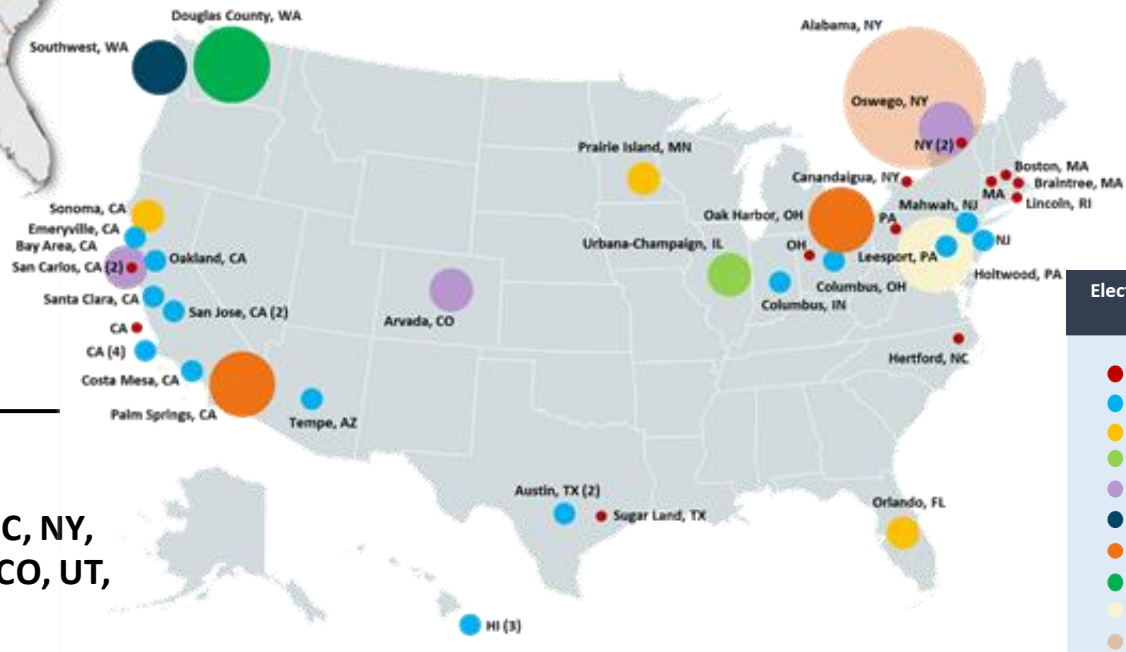
- **>500MW** Backup Power
- **>40,000** Forklifts
- **>172 MW** PEM* Electrolyzers
- **>60** Fuel Cell Buses
- **>45** H_2 Retail Stations
- **~10,000** Fuel Cell Cars

* Polymer electrolyte membrane

Hydrogen Produced

- 10 million metric tons produced annually
- More than 1,600 miles of H_2 pipeline
- World's largest H_2 storage cavern

PEM Electrolyzer Installations



Current and under construction installations over 120 kW as of Jun. 2021

** Source: Arjona, et al, DOE HFTO Program Record, June 2021*

Hydrogen Stations Plans Across States

California
200 Stations Planned California Fuel Cell Partnership Goal

Northeast
12 – 20 Stations Planned

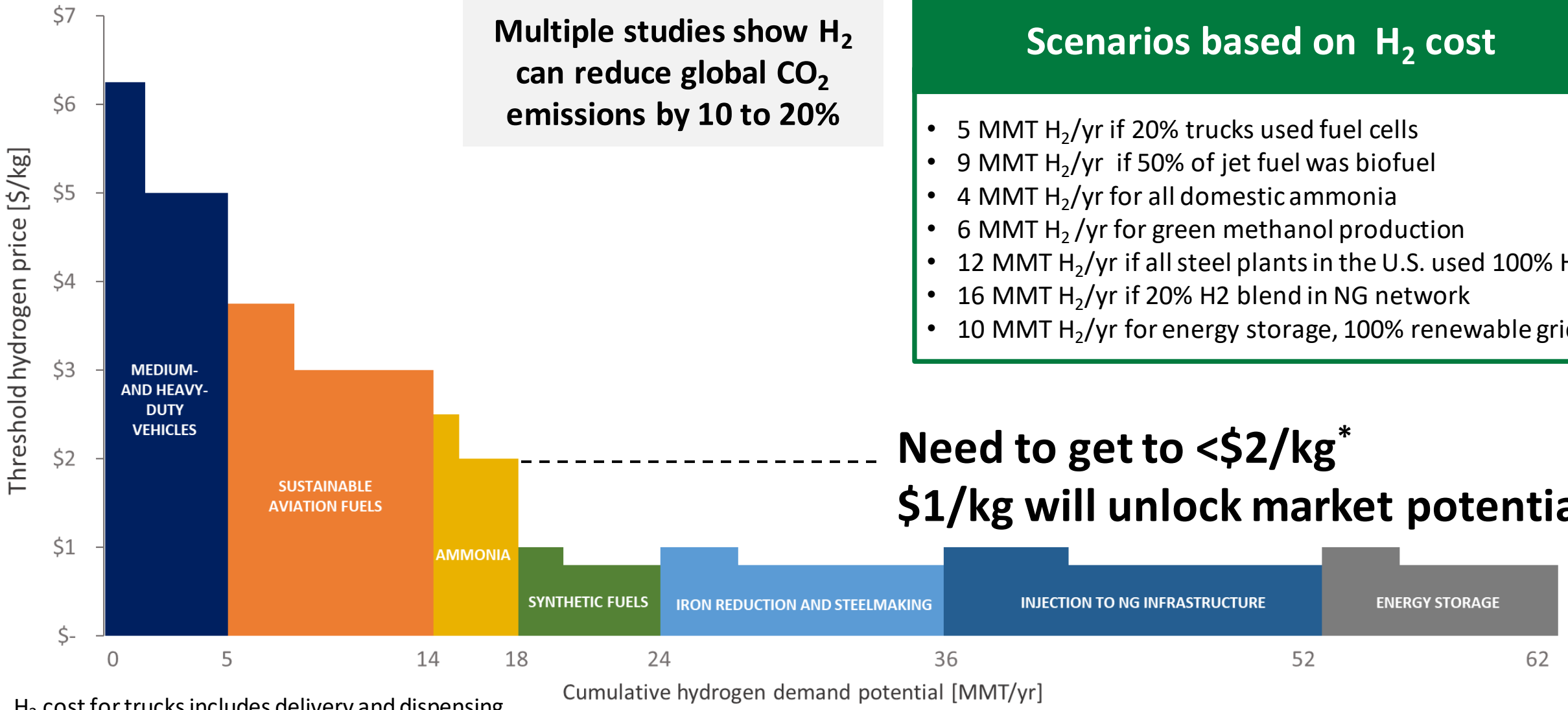
HI, OH, SC, NY, CT, MA, CO, UT, TX, MI
And Others

Analysis Determines Market Potential Scenarios

Multiple studies show H_2 can reduce global CO_2 emissions by 10 to 20%

Scenarios based on H_2 cost

- 5 MMT H_2/yr if 20% trucks used fuel cells
- 9 MMT H_2/yr if 50% of jet fuel was biofuel
- 4 MMT H_2/yr for all domestic ammonia
- 6 MMT H_2 /yr for green methanol production
- 12 MMT H_2/yr if all steel plants in the U.S. used 100% H_2
- 16 MMT H_2/yr if 20% H2 blend in NG network
- 10 MMT H_2/yr for energy storage, 100% renewable grid



**Need to get to <$2/kg*
$1/kg will unlock market potential**

H_2 cost for trucks includes delivery and dispensing

* H_2 could compete at $1 to $2/kg higher cost with a carbon price

Results based on preliminary analysis

President Biden and Energy Secretary Granholm at Climate Summit

"…I've asked the Secretary of Energy to speed the development of critical technologies to tackle the climate crisis. No single technology is the answer on its own because every sector requires innovation to meet this moment."

President Joseph R. Biden
April 23, 2021

Launch of Hydrogen Energy Earthshot
First of the Energy Earthshots
June 7, 2021
at DOE Hydrogen Program Annual Merit Review

Secretary Jennifer Granholm
June 7, 2021

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Hydrogen Energy Earthshot

“Hydrogen Shot”

“1 1 1”
$1 for 1 kg clean hydrogen in 1 decade

Launched June 7, 2021

Hydrogen Shot: “1 1 1”
$1 for 1 kg in 1 decade for clean hydrogen

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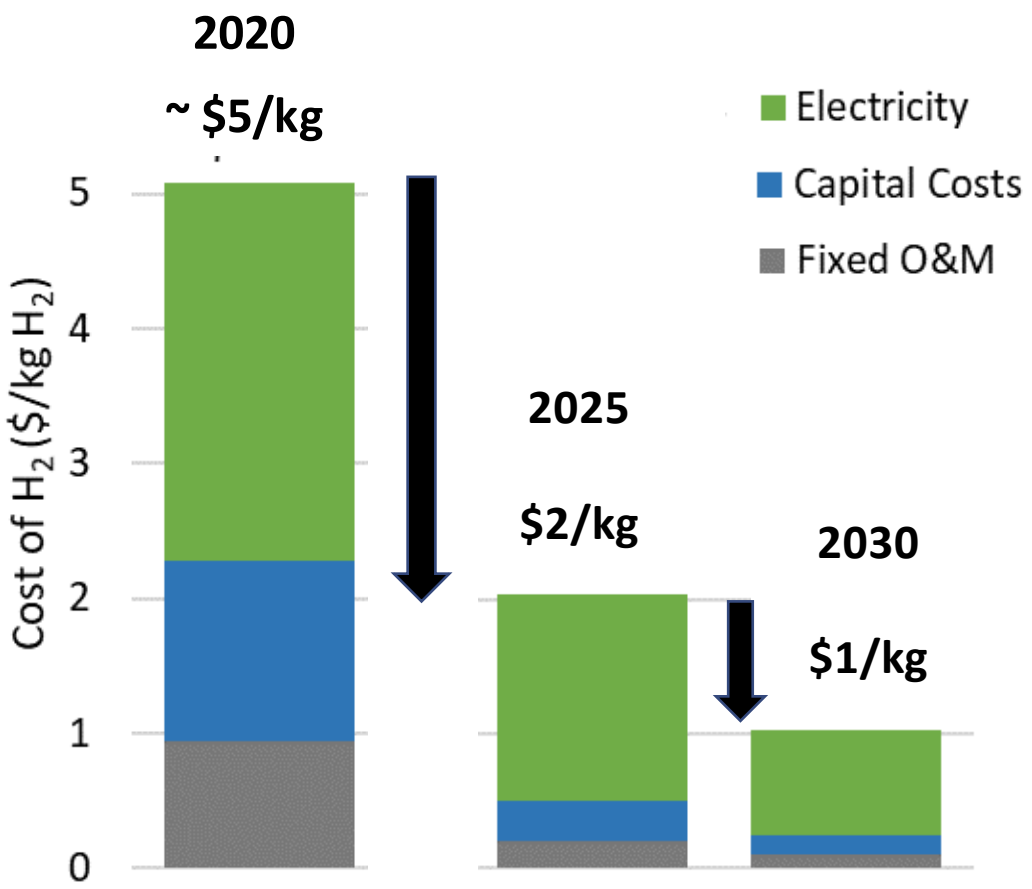
Example: Cost of Clean H_2 from Electrolysis



One of several pathways

- Reduce electricity cost from >$50/MWh to
  - $30/MWh (2025)
  - $20/MWh (2030)
- Reduce capital cost >80%
- Reduce operating & maintenance cost >90%

All pathways for clean hydrogen included: Thermal conversion with CCS, advanced water splitting, biological approaches, etc.

2020 Baseline: PEM low volume capital cost ~$1,500/kW, electricity at $50/MWh. Need less than $300/kW by 2025, less than $150/kW by 2030 (at scale)

Request for Information (RFI) solicited feedback from stakeholders (closed July 2021)

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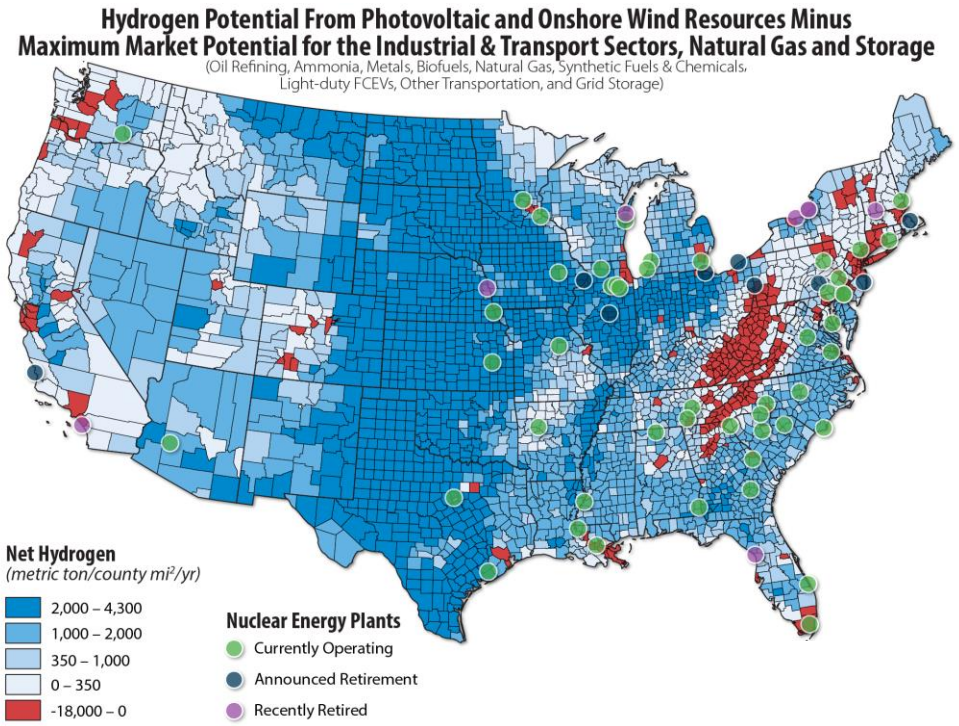
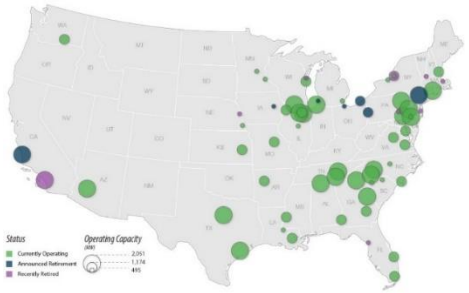
Renewables



Red: Regions where projected industrial & transportation demand exceeds local supply.

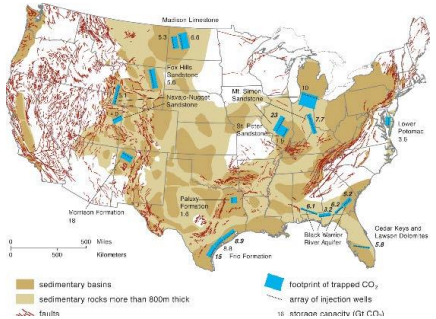
Hydrogen Shot Summit and Stakeholder Engagement Planned Aug 31-Sept 1

Nuclear



Natural Gas (SMR)

CCS



- Production, Resources, Infrastructure
- End Users, Cost, Value Proposition
- Co-location potential
- Emissions Reduction Potential
- DEI, Jobs, EJ
- Science & Innovation Needs and Challenges

DEI: Diversity, Equity and Inclusion
EJ: Environmental Justice

H2@Scale Projects to Demonstrate Technology and Train Future Workforce

Different regions, hydrogen sources, end uses & educational opportunities

H_2 for Marine Application

California

1st-of-its-kind maritime H_2 refueling on floating barge - up to ½ ton H_2 /day

H_2 from Renewables

Texas

Integrates wind, solar, RNG from waste with onsite electrolysis and multiple end-uses

H_2 for Data Center

Washington

Integrates a 1.5MW fuel cell with a data center to provide reliable and resilient power

H_2 for Steel Production

Missouri

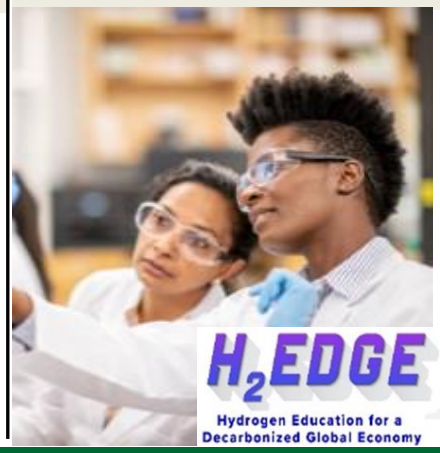
Reduction of 30% in energy and 40% emissions vs. conventional processes

H_2 from Nuclear Energy

New York

Demonstrates a MW electrolyzer with a nuclear plant (collaboration with Nuclear Energy Office)

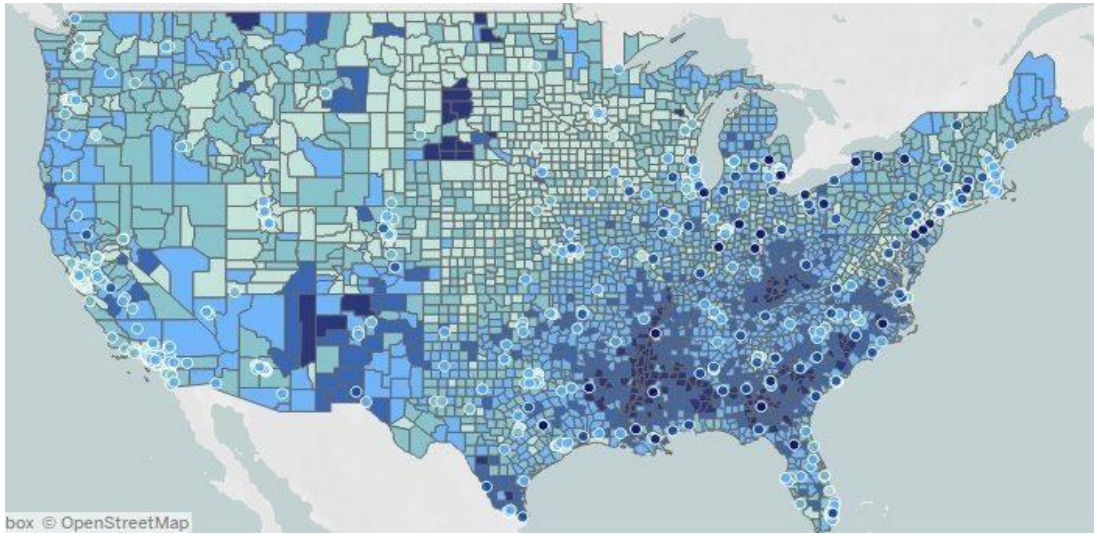
Workforce Development



Multi-state

A Training, education and recruiting program to build skills needed in the H_2 industry

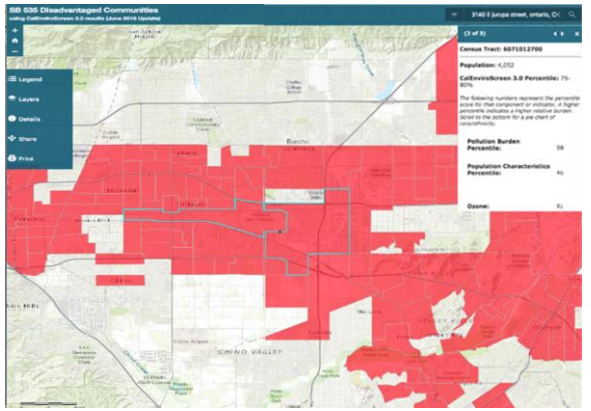
Focus on Benefits in Underserved & Disadvantaged Communities



[New index ranks America's 100 most disadvantaged communities | University of Michigan News (umich.edu)]

Funding Opportunities will encourage broader engagement, demonstrating benefits, including DEI (minorities, gender equity, etc.)

Example: DOE project with CTE for UPS Fuel Cell Delivery Vans



Trucks will be demonstrated in Ontario, CA- disadvantaged community

Goal: Demonstrate 15 fuel cell trucks (up to 125-mile range)

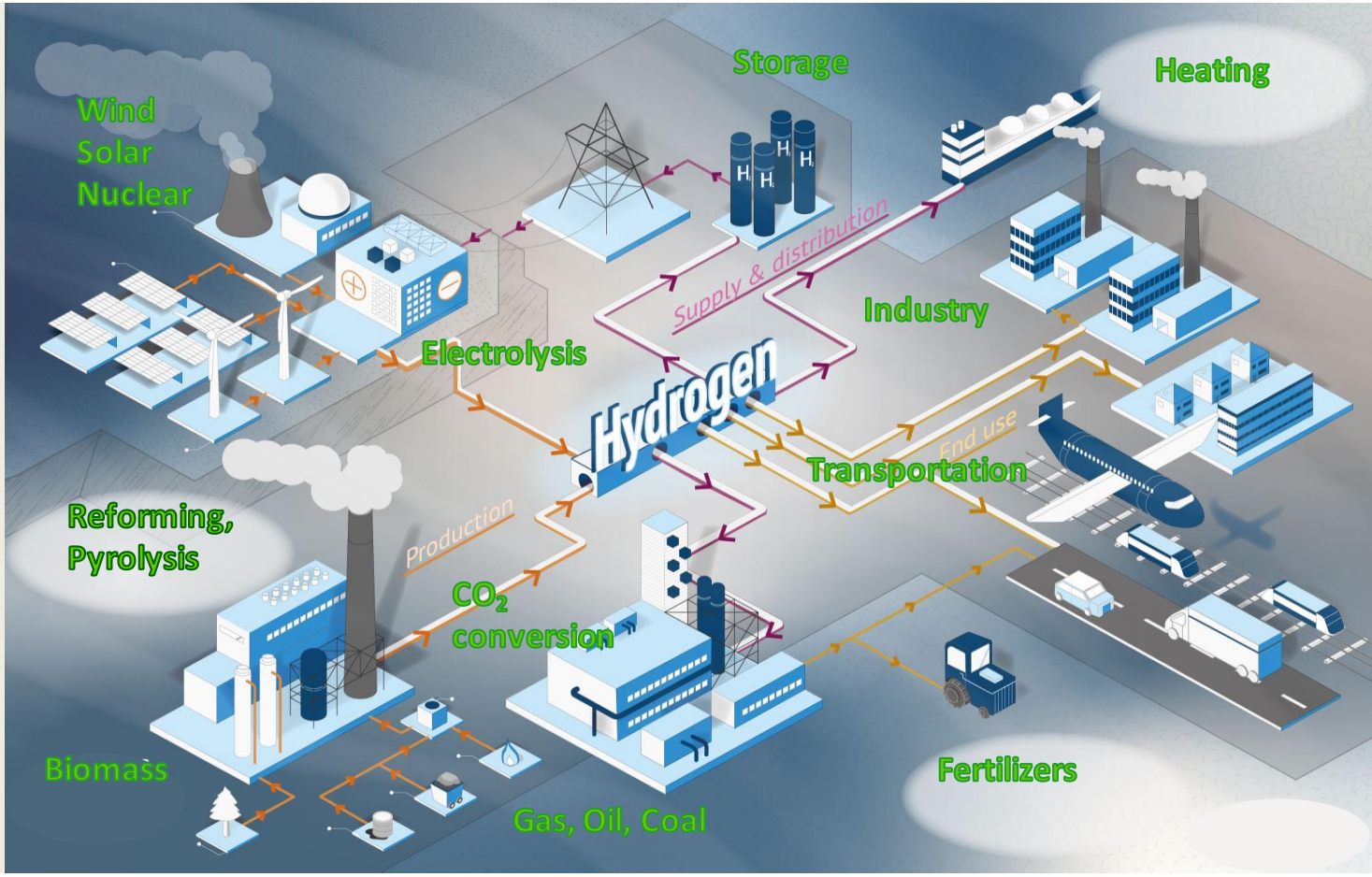
Project impact per year: Savings of

- **285 metric tons of CO_{2e}**
- **280,000 grams of criteria pollutants**
- **56,000 gallons of diesel**

**in honor of Bob Rose, founder of US Fuel Cell Council*

Summary: Strategy and Next Steps

1) **Accelerate R&D to reduce cost**
2) **De-risk demonstration and enable deployments**
3) **Strategic scale up**
   - **Clusters**: co-locate supply and demand (e.g., at ports) and enable infrastructure
   - **RFI feedback** and regional analysis will guide activities



Identify jobs, EJ, and workforce development opportunities (e.g., transition from fossil fuel to H_2, ports, etc.)

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Save the Date

The Hydrogen Shot Summit – Aug. 31 to Sept. 1

- Two-day summit **bringing together stakeholders from industry, research, academia and government to identify pathways to meet the Hydrogen Shot** in the next decade
- **Technical breakout sessions to cover multiple hydrogen production pathways** and other topics including:
  - Electrolysis
  - Thermal conversion with CCS
  - Advanced pathways
  - Deployment and financing
- More info available coming soon at **www.energy.gov/eere/fuelcells/hydrogen-shot**

Other Ways to Connect – Events, Resources and Career Opportunities

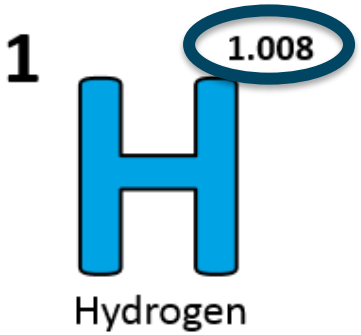
Save the Date

June 6 to 9, 2022:

DOE Hydrogen Program Annual Merit Review and Peer Evaluation Meeting (AMR)

Oct 8 - Hydrogen and Fuel Cells Day

- Held on hydrogen's very own atomic weight-day
- DOE EERE comms campaign all week



Open ORISE Fellowships

- Fuel Cells (2 positions):
  - DOE-EERE-STP-HFTO-2021-1800
- Hydrogen Production:
  - DOE-EERE-STP-HFTO-2020-1804
- Hydrogen Infrastructure:
  - DOE-EERE-STP-HFTO-2020-1804

Apply at zintellect.com

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Visit H2tools.Org For Hydrogen Safety And Lessons Learned

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CENTER FOR Hydrogen SAFETY
Connecting a Global Community

www.aiche.org/CHS

Sign up to receive hydrogen and fuel cell updates

www.energy.gov/eere/fuelcells/fuel-cell-technologies-office-newsletter

Learn more at: energy.gov/eere/fuelcells AND www.hydrogen.energy.gov

CENTER FOR Hydrogen SAFETY
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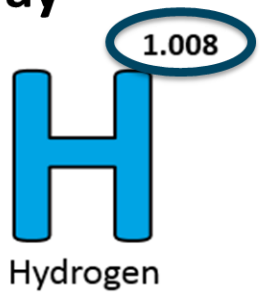
Thank You

Oct 8 - **Hydrogen and Fuel Cells Day**

(Held on its very own atomic weight-day)



INCREASE YOUR H_2IQ
www.hydrogen.energy.gov

Looking for more info?

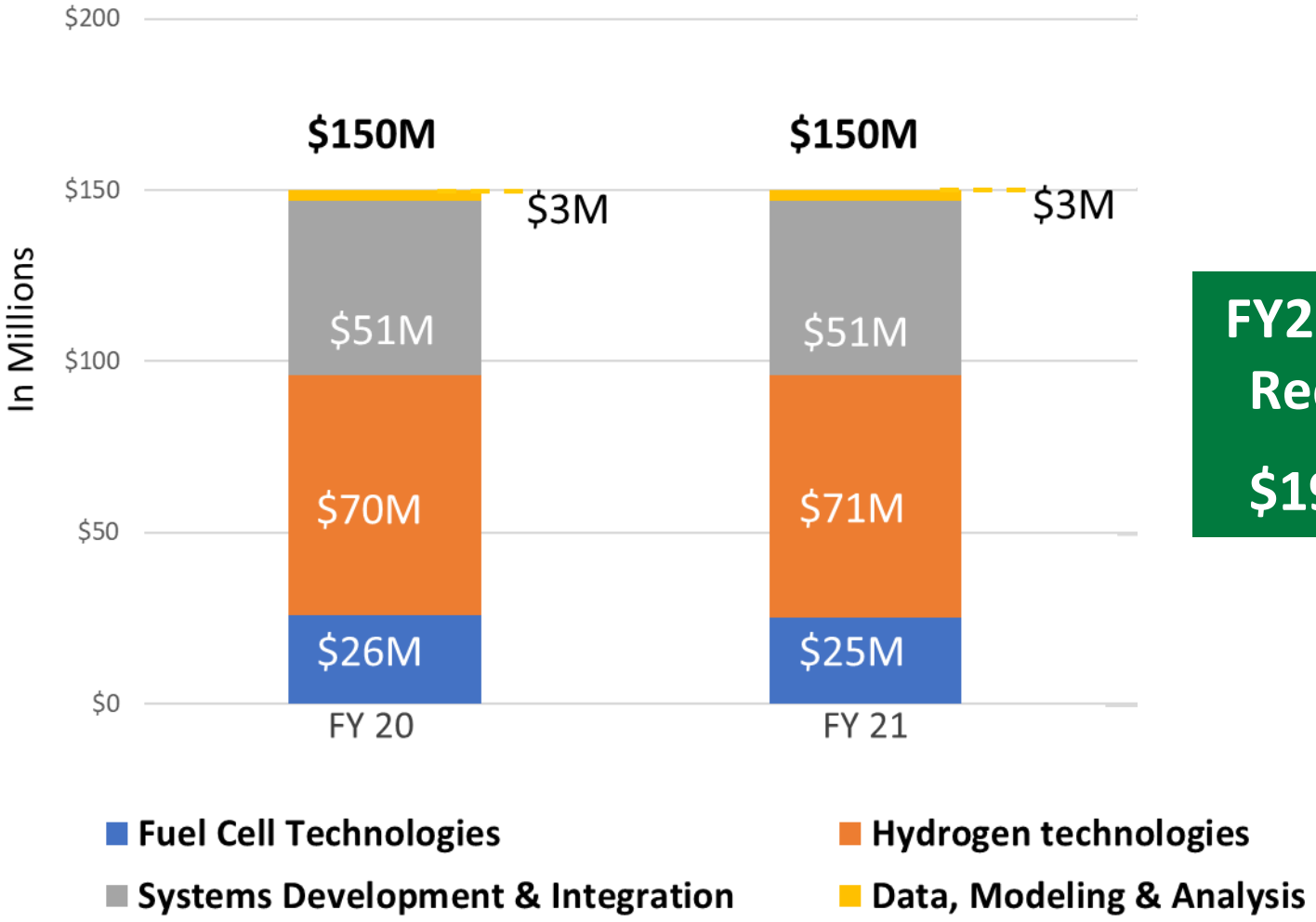
#H2IQ

IPHE

www.iphe.net

hydrogen.energy.gov

Funding for Hydrogen and Fuel Cell Technologies Office (HFTO)



FY22 HFTO Request:

$197.5M

HFTO has funded over 190 companies, 109 universities, and 16 National Labs across 40 States over the last decade