



U.S. DEPARTMENT OF
ENERGY

U.S. DOE Hydrogen Program and National Clean Hydrogen Strategy

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U.S. Department of Energy

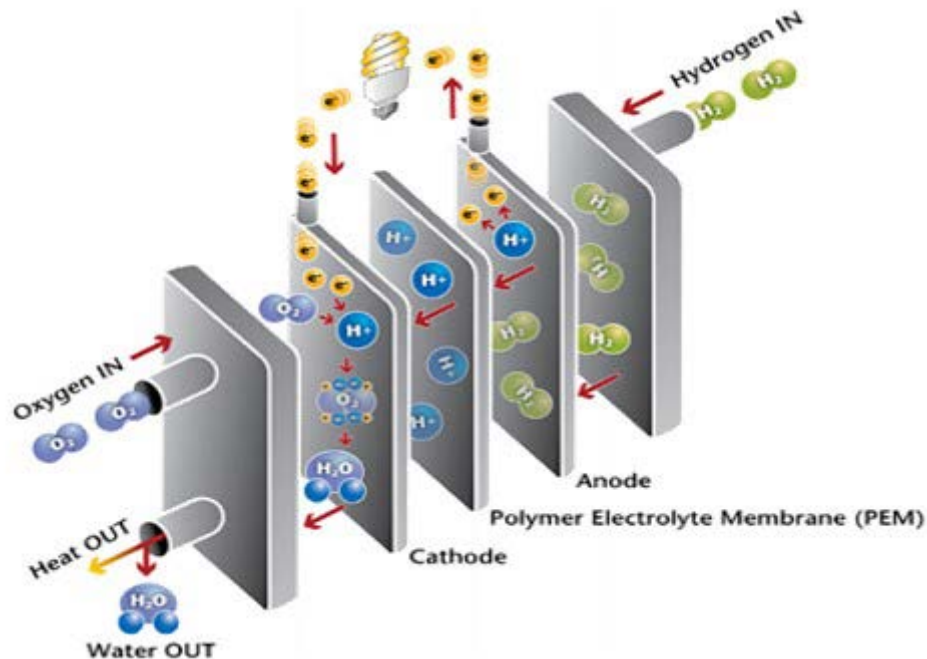
January 2024



Fuel Cells and Electrolyzers 101

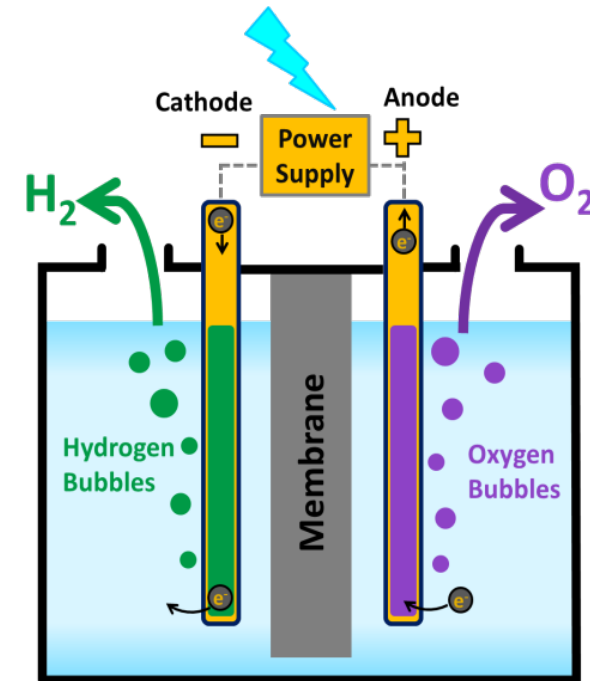
Fuel Cells: Can Use Hydrogen

- Hydrogen and Oxygen IN
- Electricity and Water OUT
- Makes electricity using hydrogen
- No combustion involved



Electrolyzers: Make Hydrogen

- Electricity and Water IN
- Hydrogen and Oxygen OUT
- Makes hydrogen using electricity
- Operates like a fuel cell “in reverse”



U.S. DOE Hydrogen Program

Hydrogen is a key element of a portfolio of solutions to decarbonize the economy.

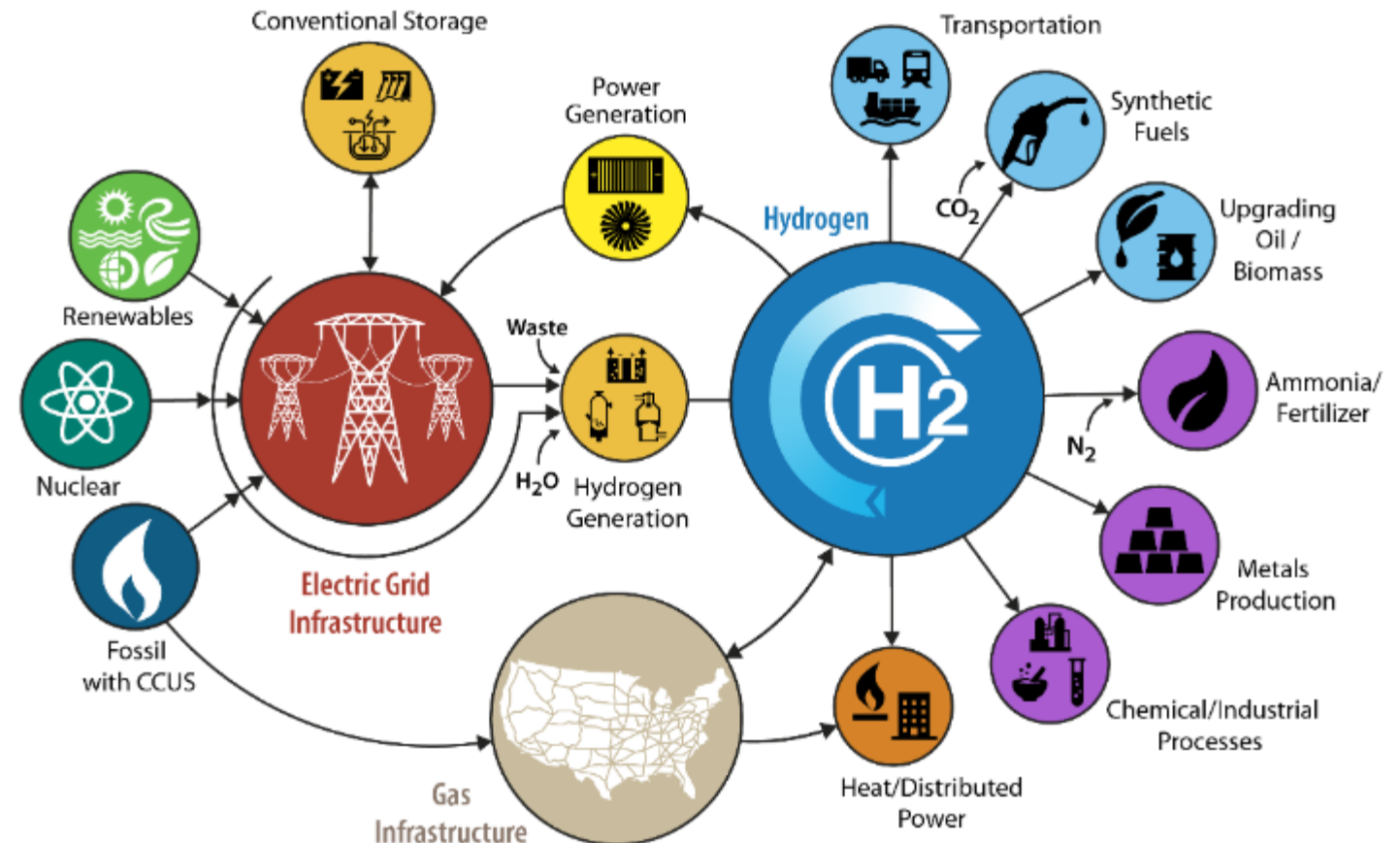
Hydrogen Program

Coordinated across DOE on research, development, demonstration, and deployment (RDD&D) to address:

- The entire H₂ value chain from production through end use
- H₂ production from all resources (renewables, nuclear, and fossil + CCS)

www.hydrogen.energy.gov

H2@Scale vision: Enables clean-energy pathways across sectors



Legislation Highlights: 2021 – 2022

Bipartisan Infrastructure Law

- Includes \$9.5B for clean hydrogen:
 - \$1B for electrolysis
 - \$0.5B for manufacturing and recycling
 - \$8B for at least four regional clean hydrogen hubs
- Requires developing a **National Clean Hydrogen Strategy and Roadmap**



President Biden Signs the Bipartisan Infrastructure Bill into law on November 15, 2021. Photo Credit: Kenny Holston/Getty Images

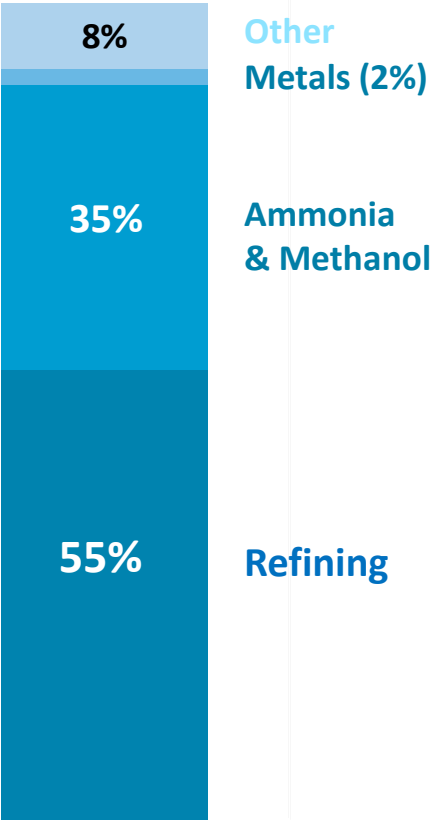
Inflation Reduction Act

- Includes significant tax credits (e.g., up to \$3/kg for production of clean hydrogen)

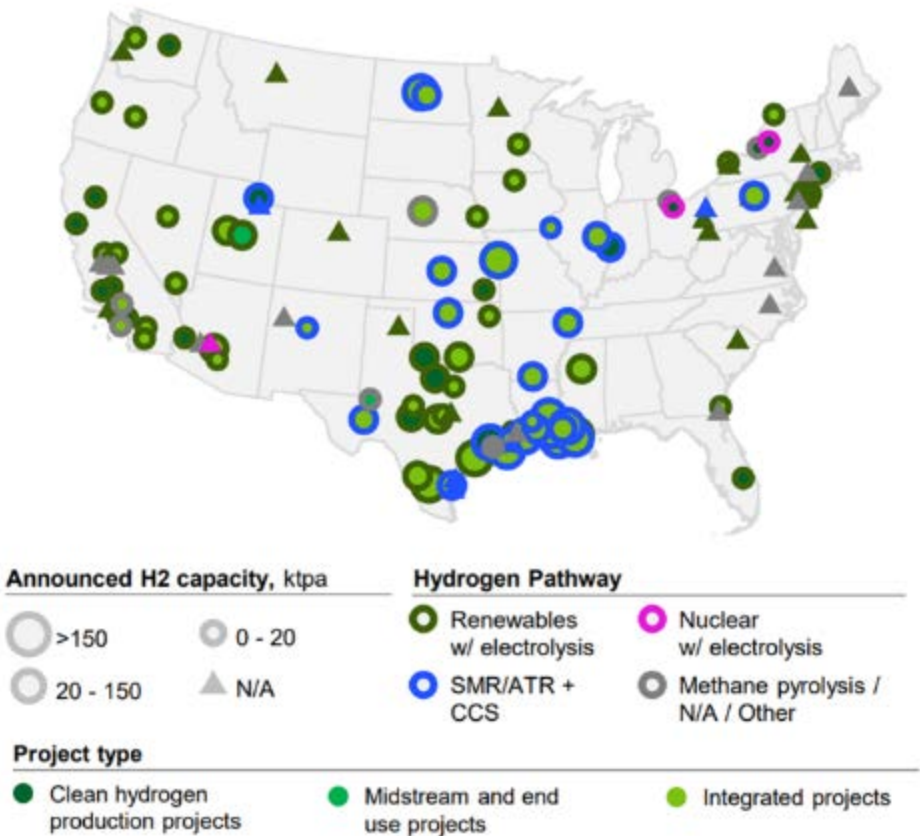
Snapshot of Hydrogen and Fuel Cells in the U.S.

- 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

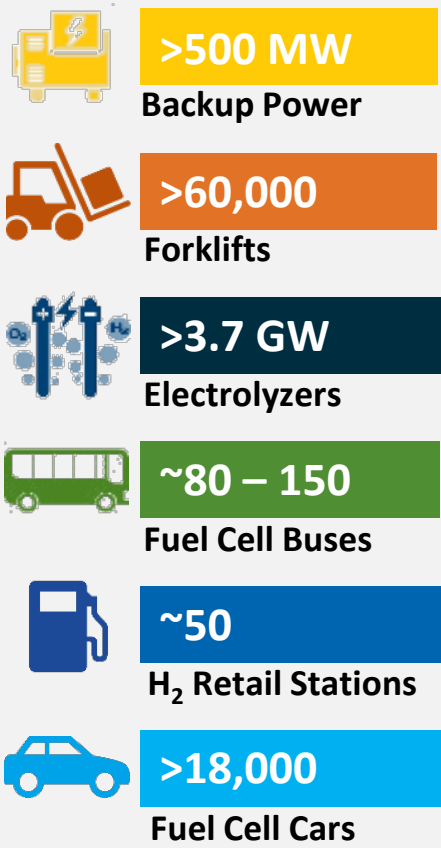


Current publicly announced clean hydrogen production projects*

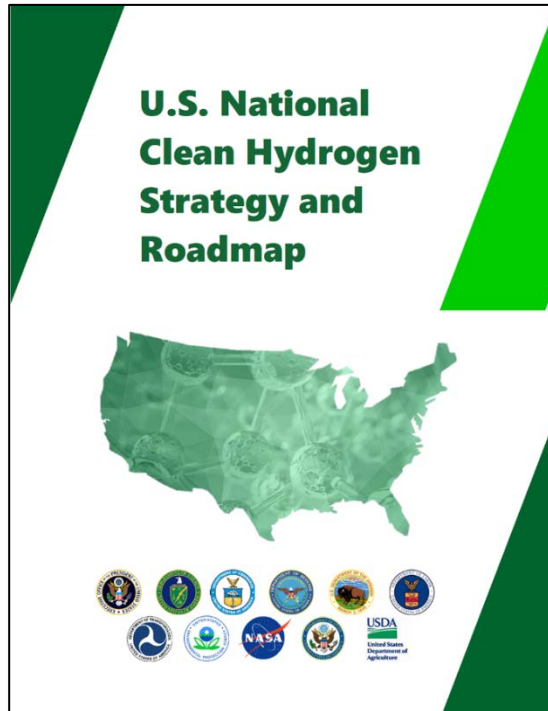


*as of EOY 2022, DOE Commercial Liftoff Report

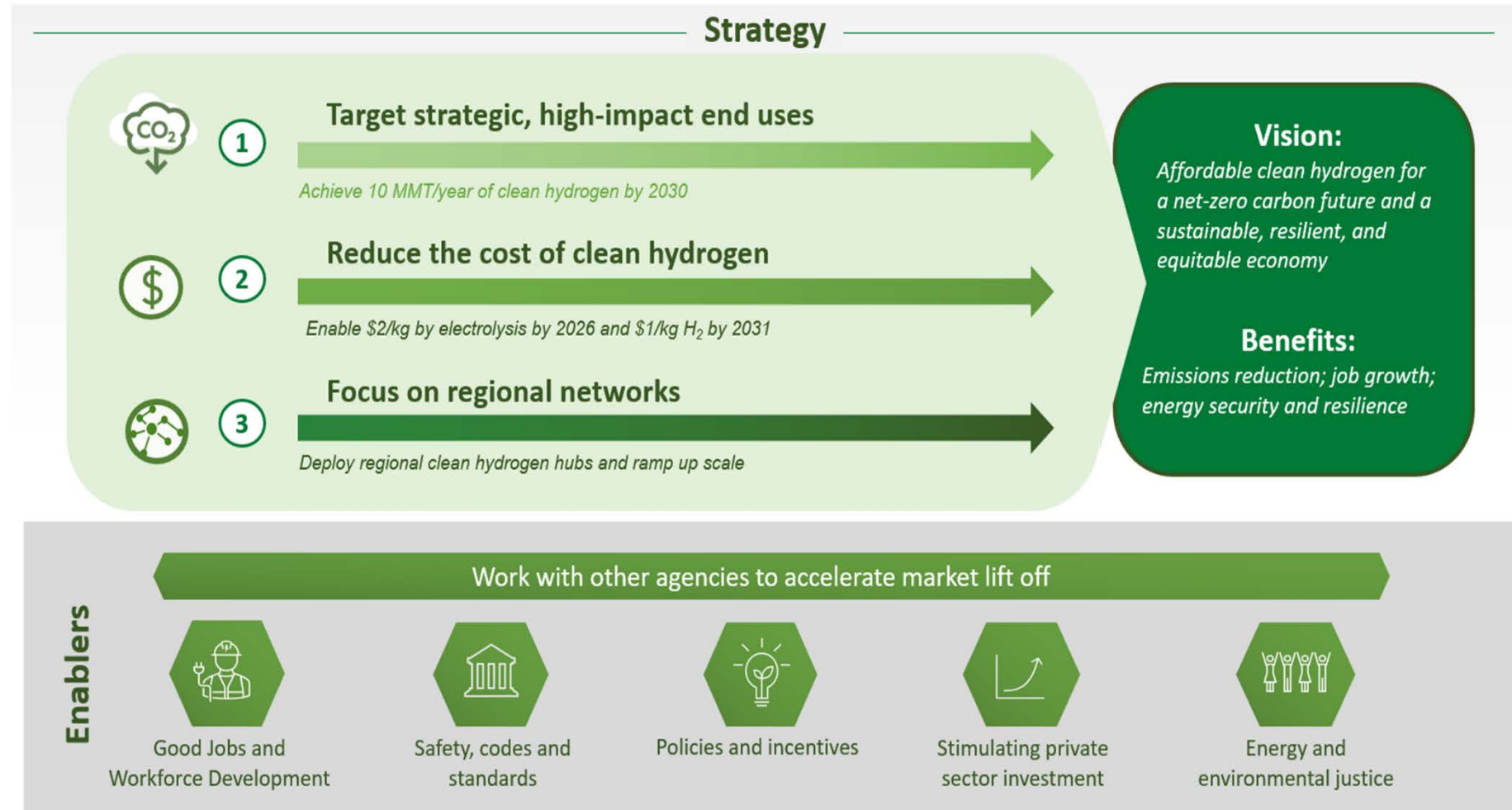
Examples of Deployments



U.S. National Clean Hydrogen Strategy and Roadmap

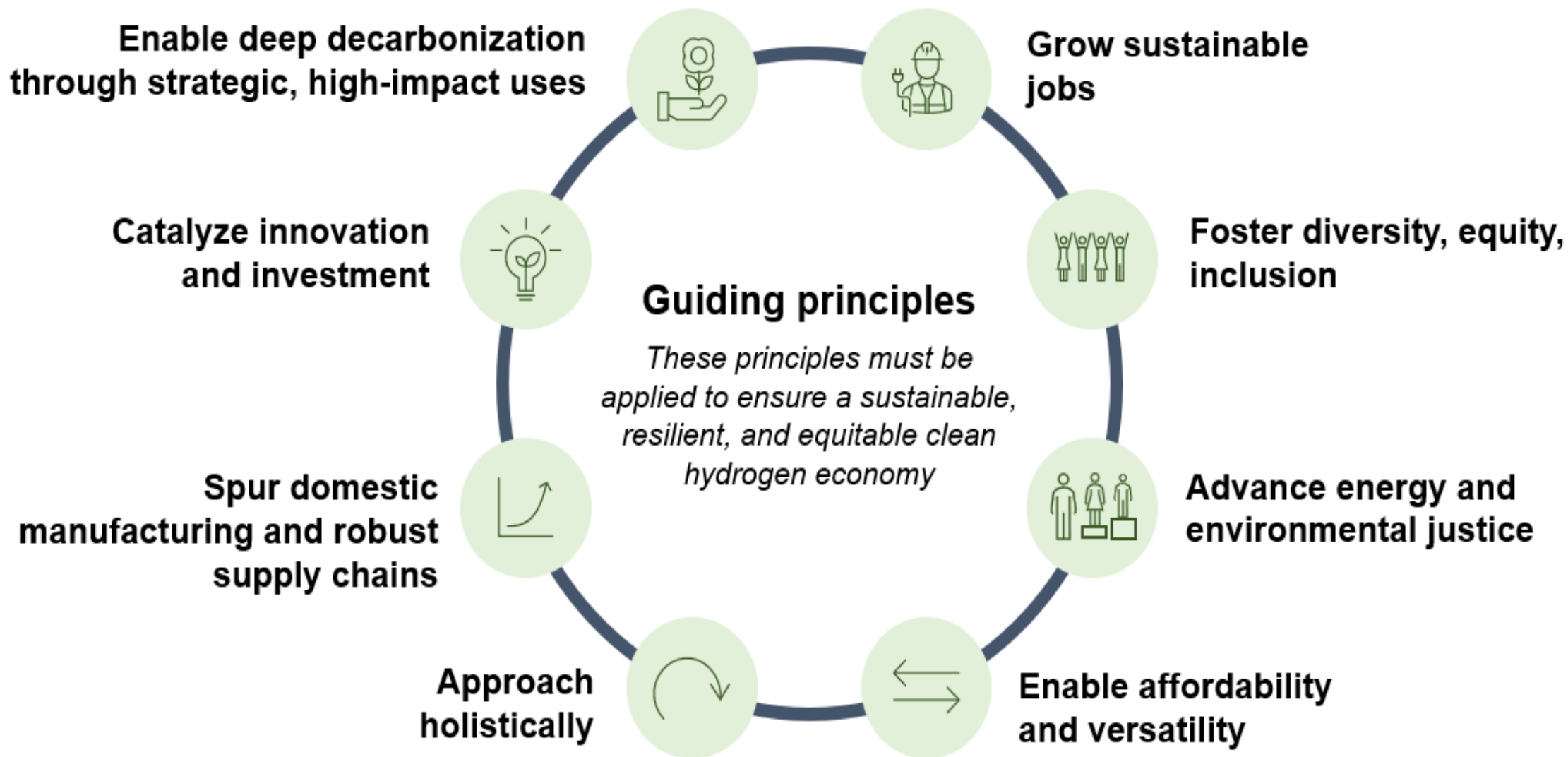


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Released June 5, 2023



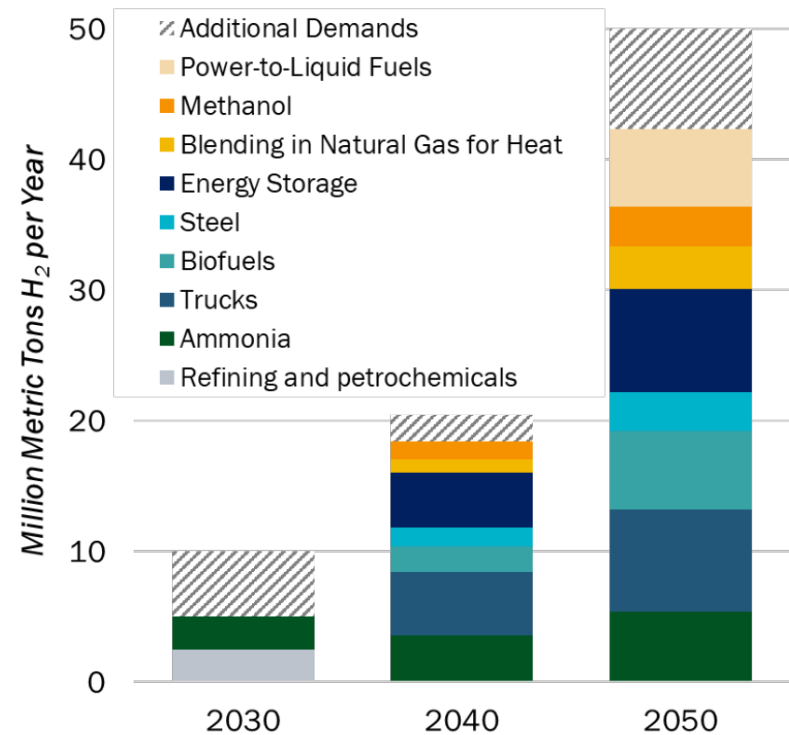
U.S. Opportunity: 10MMT/yr by 2030, 20 MMT/yr by 2040, 50 MMT/yr by 2050. ~10% Emissions Reduction. ~100K Jobs by 2030.

Guiding Principles



Strategy 1: Target Strategic, High-Impact End Uses

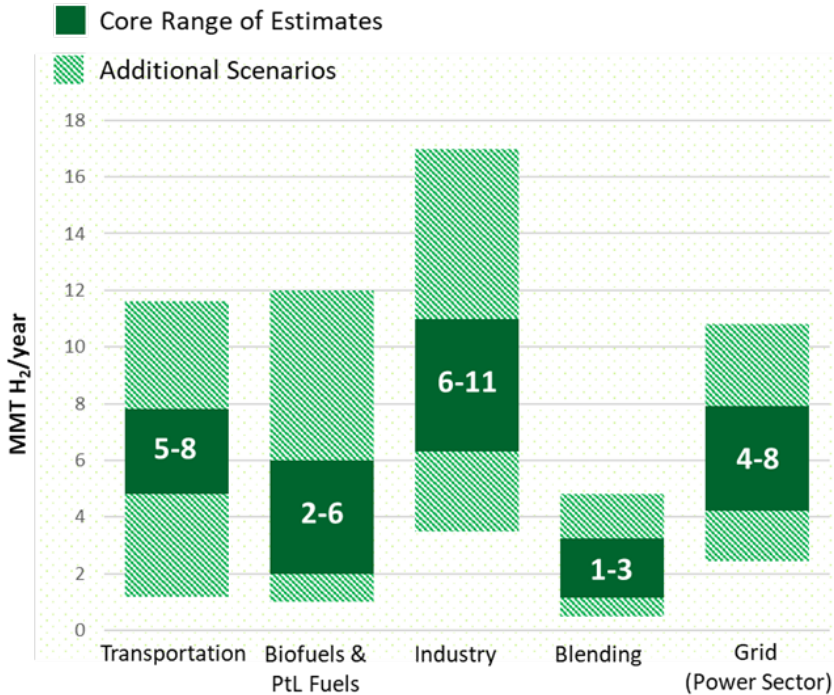
Opportunities for Clean Hydrogen Across Applications



Clean Hydrogen Use Scenarios

- Catalyze clean H₂ use in existing industries (ammonia, refineries), initiate new use (e.g., sustainable aviation fuels (SAFs), steel, potential exports)
- Scale up for heavy-duty transport, industry, and energy storage
- Market expansion across sectors for strategic, high-impact uses

Range of Potential Demand for Clean Hydrogen by 2050



• Core range: ~ 18–36 MMT H₂

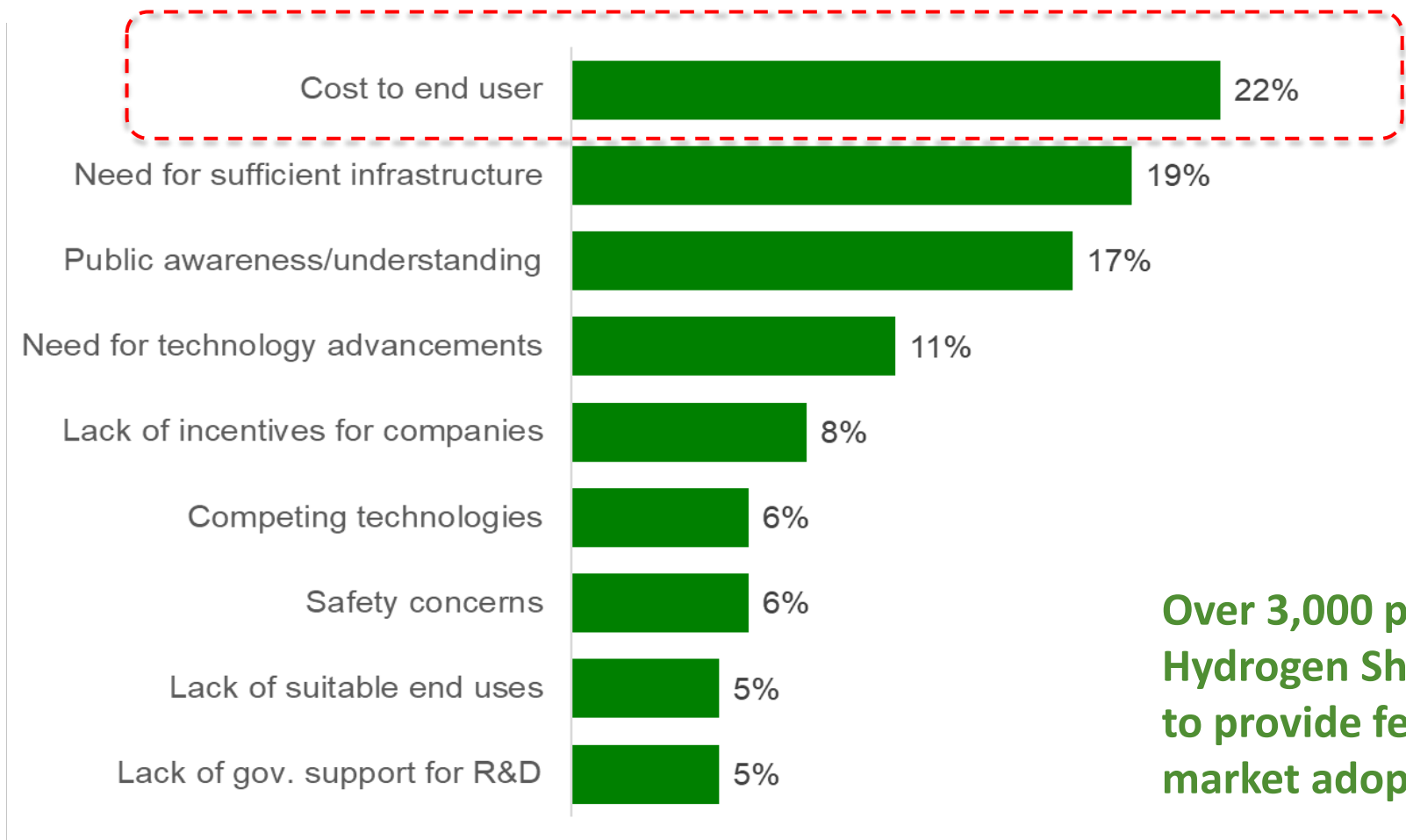
• Higher range: ~ 36–56 MMT H₂

Refs: 1. NREL MDHD analysis using TEMPO model; 2. Analysis of biofuel pathways from NREL; 3. Synfuels analysis based off H2@Scale ; 4. Steel and ammonia demand estimates based off DOE Industrial Decarbonization Roadmap and H2@Scale. Methanol demands based off IRENA and IEA estimates; 5. Preliminary Analysis, NREL 100% Clean Grid Study; 6. DOE Solar Futures Study; 7. Princeton Net Zero America Study

U.S. Opportunity: 10MMT/yr by 2030, 20 MMT/yr by 2040, 50 MMT/yr by 2050. ~10% Emissions Reduction. ~100K Jobs by 2030

Strategy 2: Focus on Cost-Reduction

Stakeholder Reported Barriers to Hydrogen Market Adoption



Over 3,000 participants at DOE Hydrogen Shot Summit were requested to provide feedback on key barriers to market adoption of hydrogen

Source: Hydrogen Shot Summit, Sept 2021

<https://www.energy.gov/eere/fuelcells/hydrogen-shot-summit>

Hydrogen Energy Earthshot

“Hydrogen Shot”

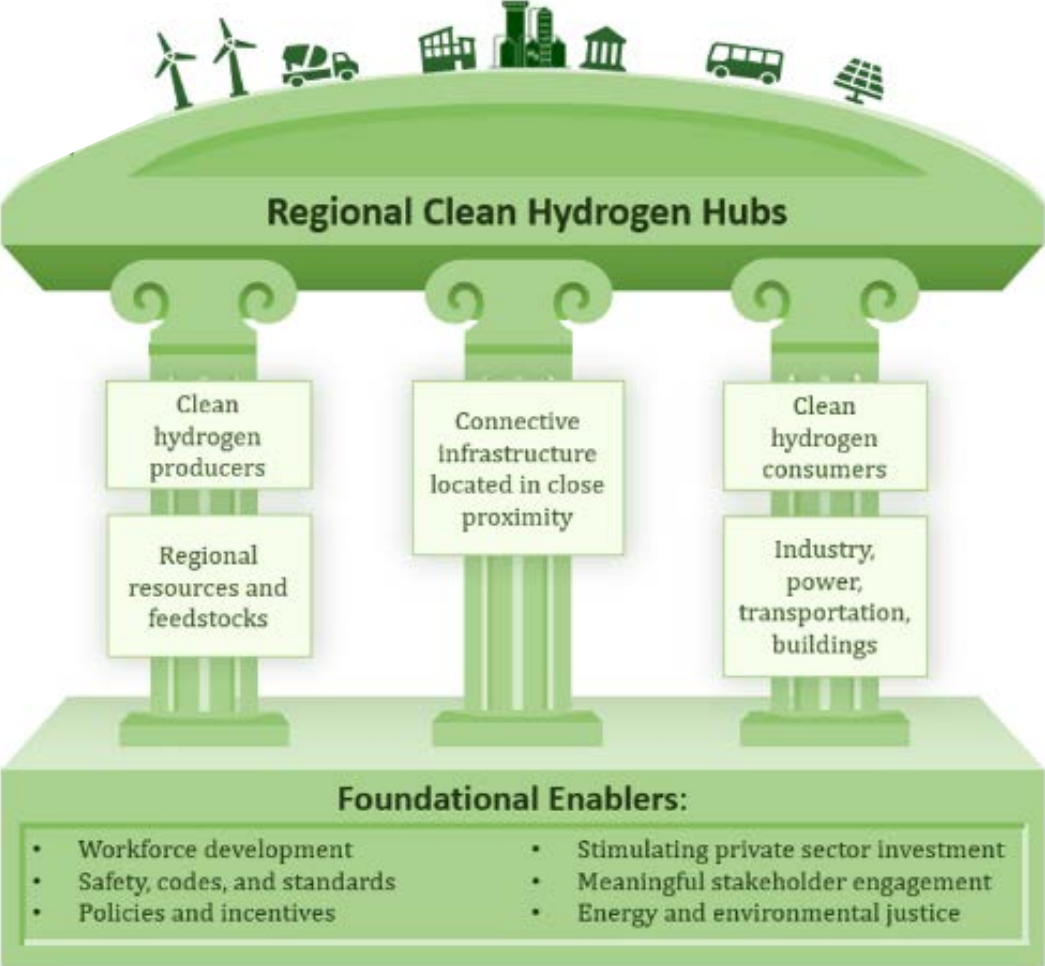
“1 1 1”

\$1 for 1 kg clean hydrogen in 1 decade

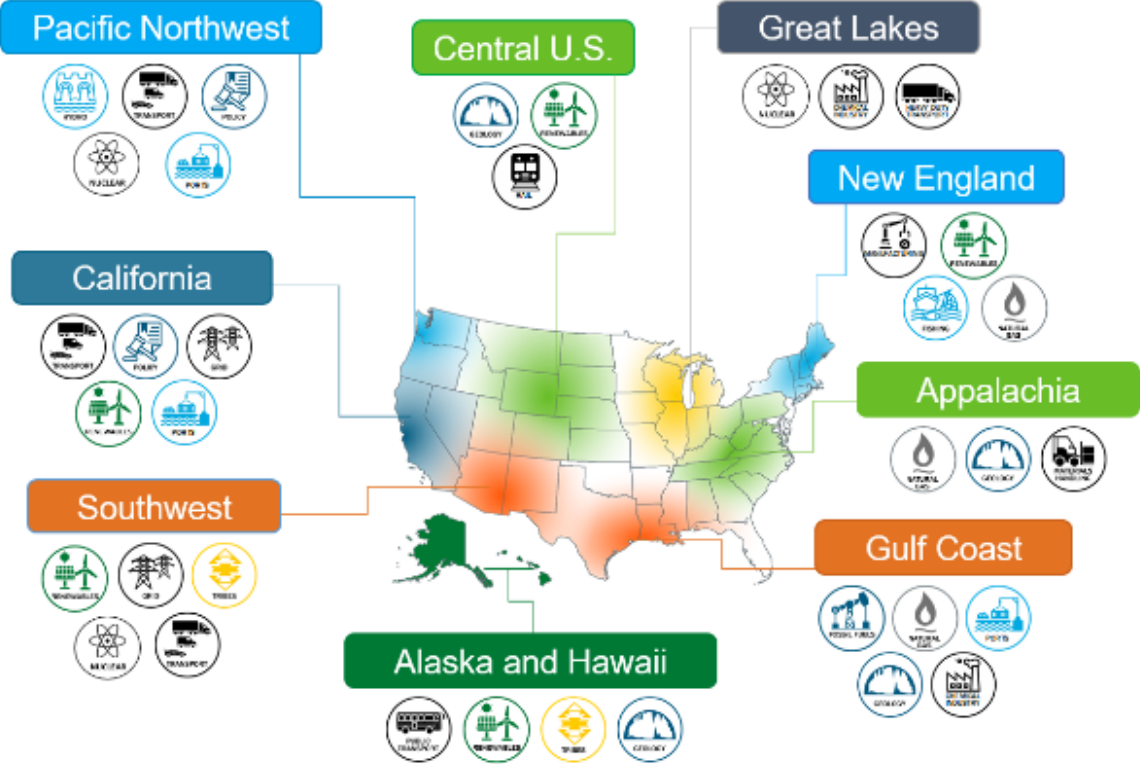
Strategy also includes delivery and storage infrastructure cost reduction

Strategy 3: Focus on Regional Networks and Ramp up Scale

Build Regional Networks through “Clean Hydrogen Hubs”

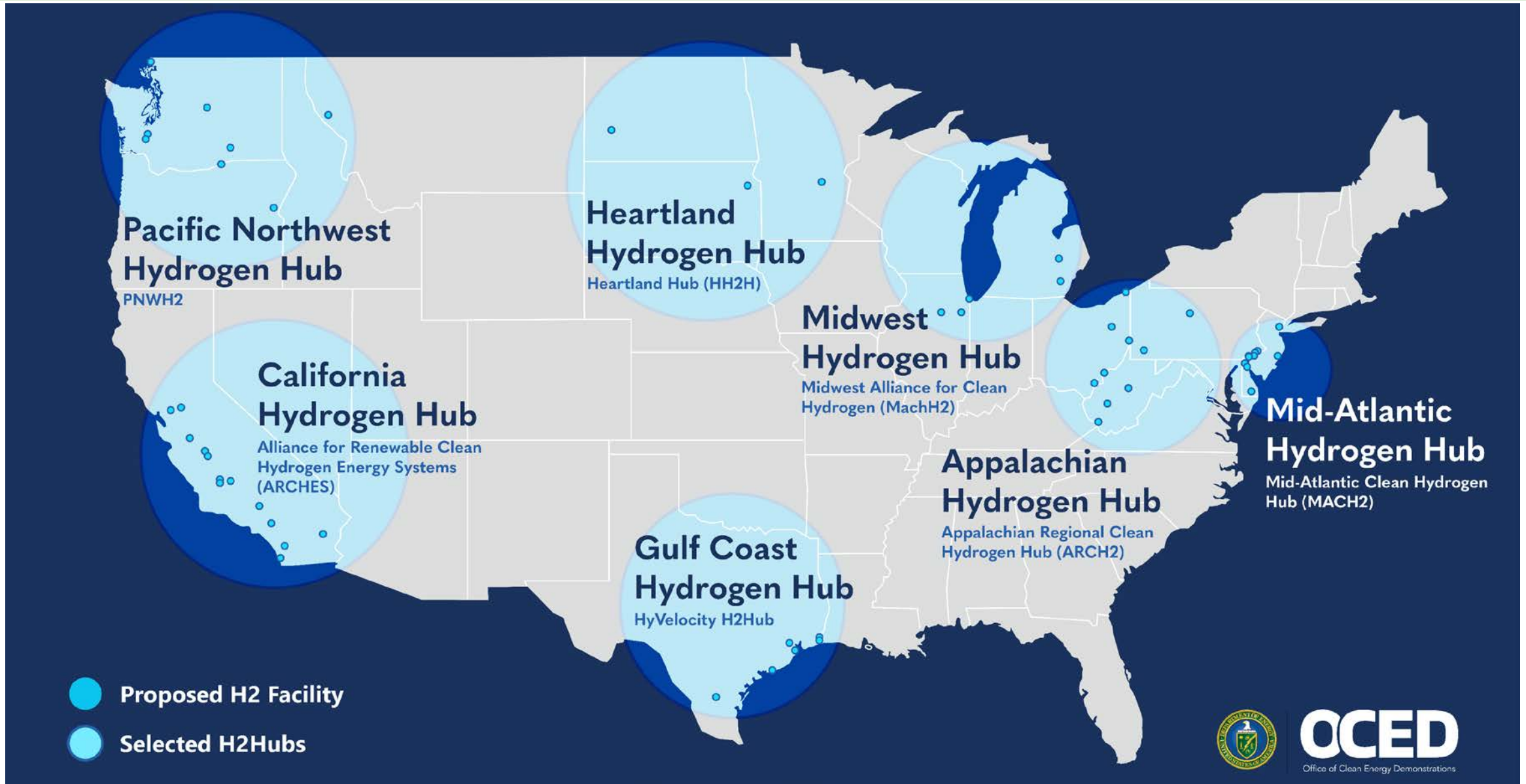


Examples of Stakeholder and RFI Input



Demand side strategy for Hubs announced

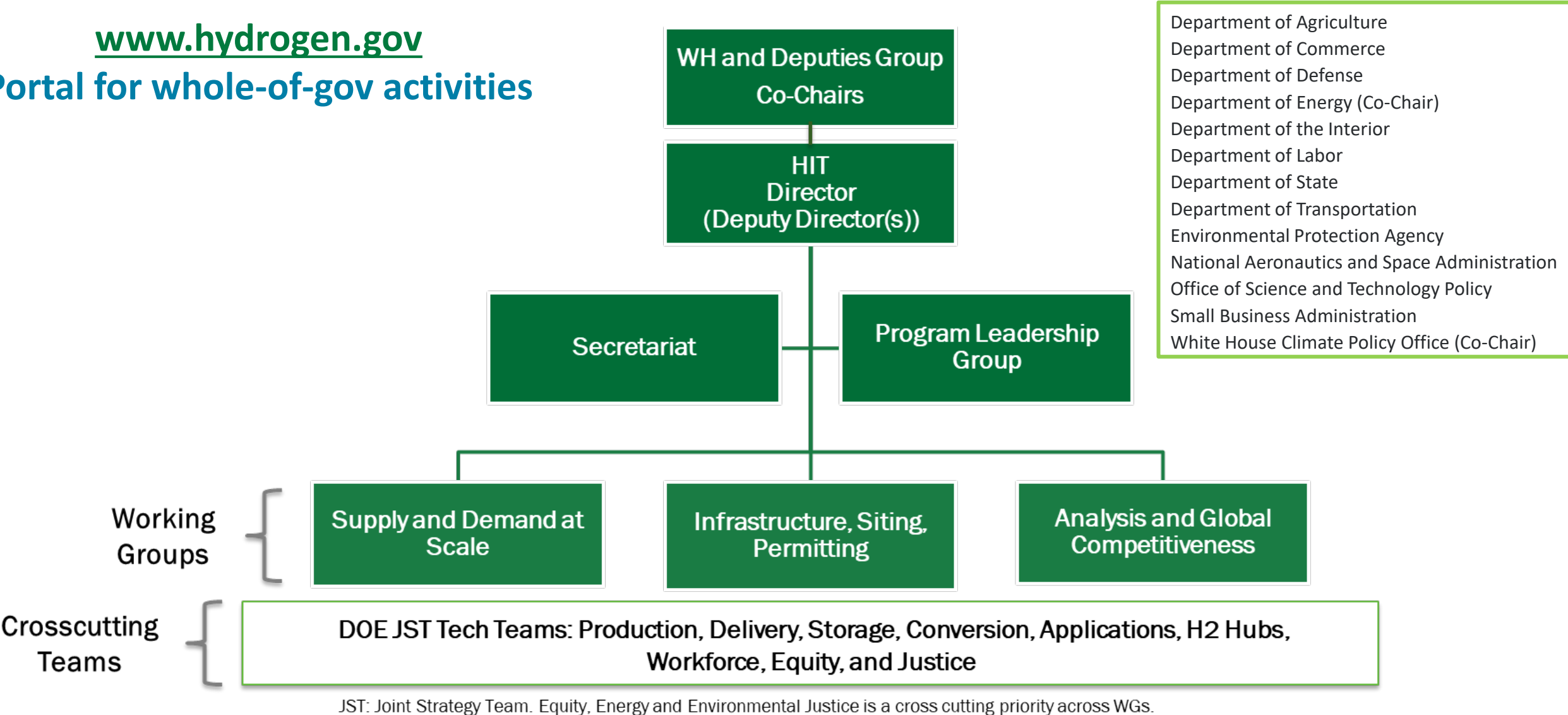
President Biden Announces \$7B for 7 H₂ Hubs – October 13, 2023



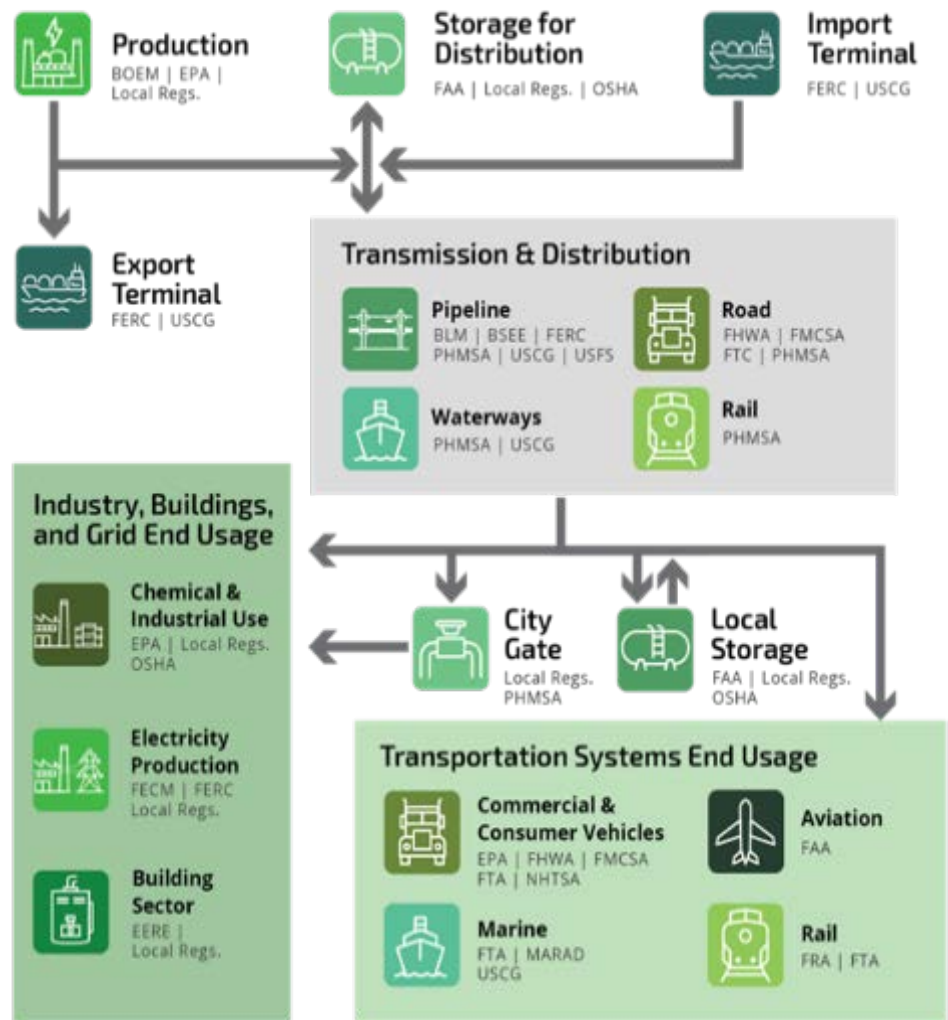
Hydrogen Interagency Task Force (HIT) across 11 Agencies

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Portal for whole-of-gov activities



Key USG Focus Areas for Cross-Agency Collaboration and Coordination



National Clean Hydrogen Strategy and Roadmap

Enable National Goals: 10 MMT/yr supply and use by 2030, 20 MMT/yr by 2040, 50 MMT/yr by 2050

Supply and Demand at Scale	Infrastructure, Siting, Permitting	Analysis and Global Competitiveness
<ul style="list-style-type: none">• Enabling large scale production and demand creation• Financing, incentives, and compliance tools for commercial scale up• Metrics for deployment and USG as offtaker• Supply chains and resiliency (critical materials, strategic reserve)• R&D to accelerate cost reductions and end use commercialization (JST interface)	<ul style="list-style-type: none">• Siting, permitting, pipelines, storage, and infrastructure• Harmonized codes and standards• Interoperability and global standardization• Safety, emissions (including secondary), sensors, risk mitigation, environmental impact• Environmental review and best practices (NEPA, etc.)• Pipeline and blending test facilities	<ul style="list-style-type: none">• National strategy and commercial liftoff analysis• Impacts and gap assessments (technoeconomic analysis, incentives, resource/water availability, emissions, jobs, manufacturing, etc.)• Intellectual property and global landscape assessment• Export market analysis• Systems integration and optimization

Clean Hydrogen Production, Delivery, Storage, Conversion, Applications, H2 Hubs

Workforce, Equity, and Justice

DOE Hydrogen Activities across RDD&D – Examples

Research and Development

Basic and applied research through individual projects and consortia

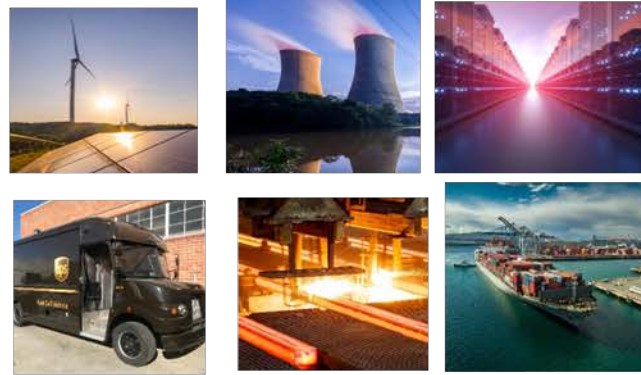
Consortia Examples



Technology Integration, Validation, Demos

1st of a kind demonstrations and systems integration to de-risk deployments

Examples:



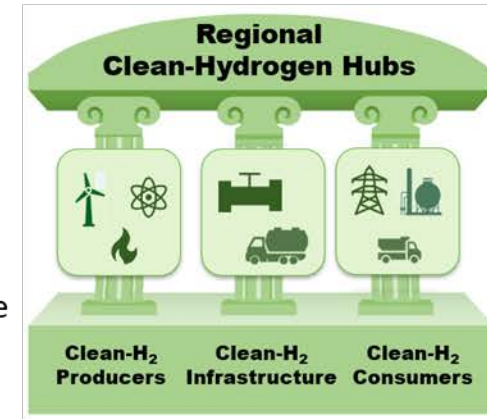
Renewables and nuclear to H₂, 15 delivery trucks in disadvantaged area, 3 Super Truck projects, data center, fueling for passenger ferry, energy storage, H₂ for steel

Deployment and Financing

H2 Hubs, loan guarantee program, workforce development

Example:

\$8 billion for at least 4 hubs:
Renewables, fossil w/CCS, nuclear; multiple end-uses



Including demand strategy (~\$1B)

2 new loan guarantee projects (\$1.5B total) on pyrolysis and large-scale electrolysis, H₂ energy storage and power generation

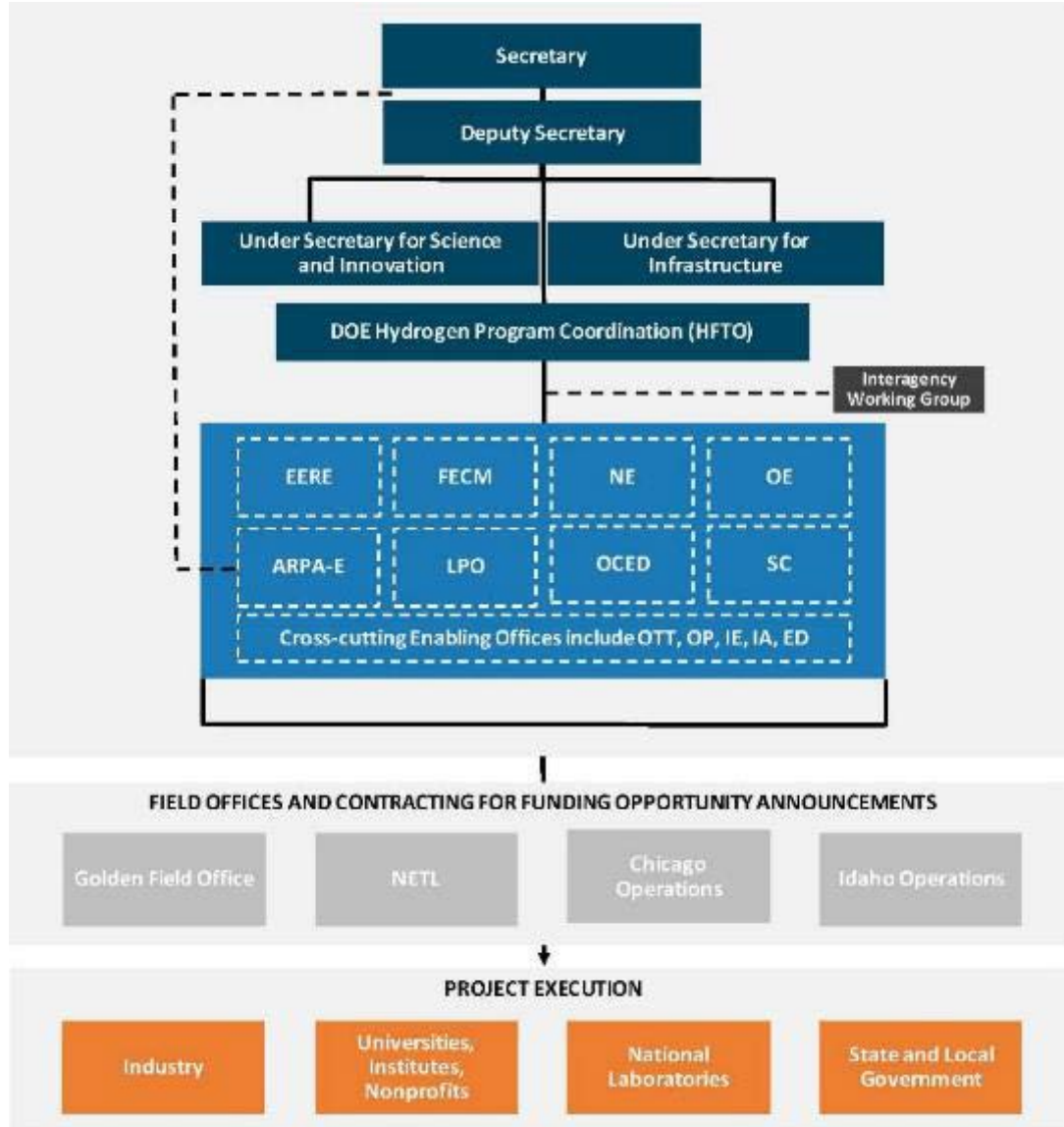
Enabling Activities

- Analysis and tools
- Safety, codes & standards
- Manufacturing
- Workforce development

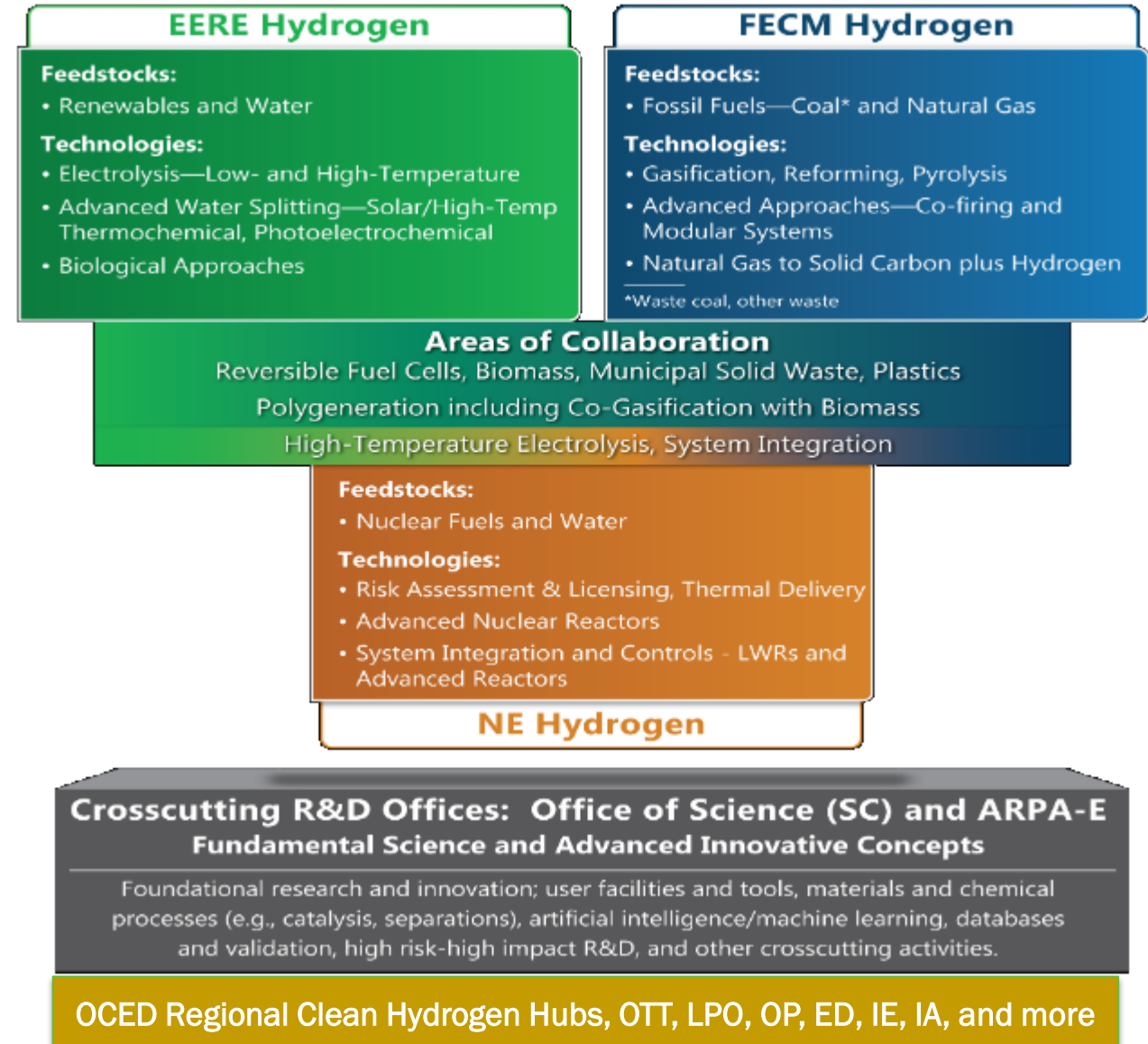


H₂ Matchmaker

The U.S. DOE Hydrogen Program – Coordinated across Offices

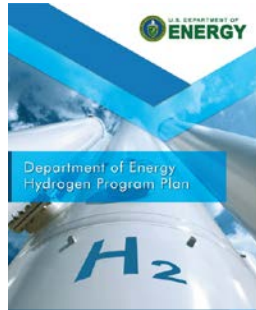
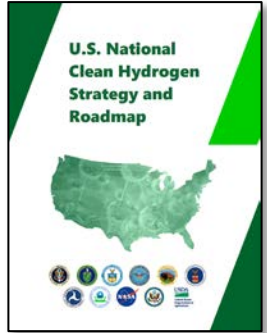


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Resources and Opportunities for Engagement

Key Publications



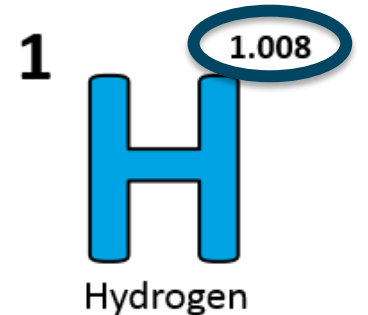
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Save the date!

**2024 DOE
Annual Merit
Review May 6-9,
2024**

**Hydrogen and Fuel Cells Day
October 8**

- Held on hydrogen's
very own atomic
weight-day



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Thank you

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And
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