



U.S. DEPARTMENT OF
ENERGY

U.S. National Clean Hydrogen Strategy Opening Remarks

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U.S. Department of Energy

Summer 2023

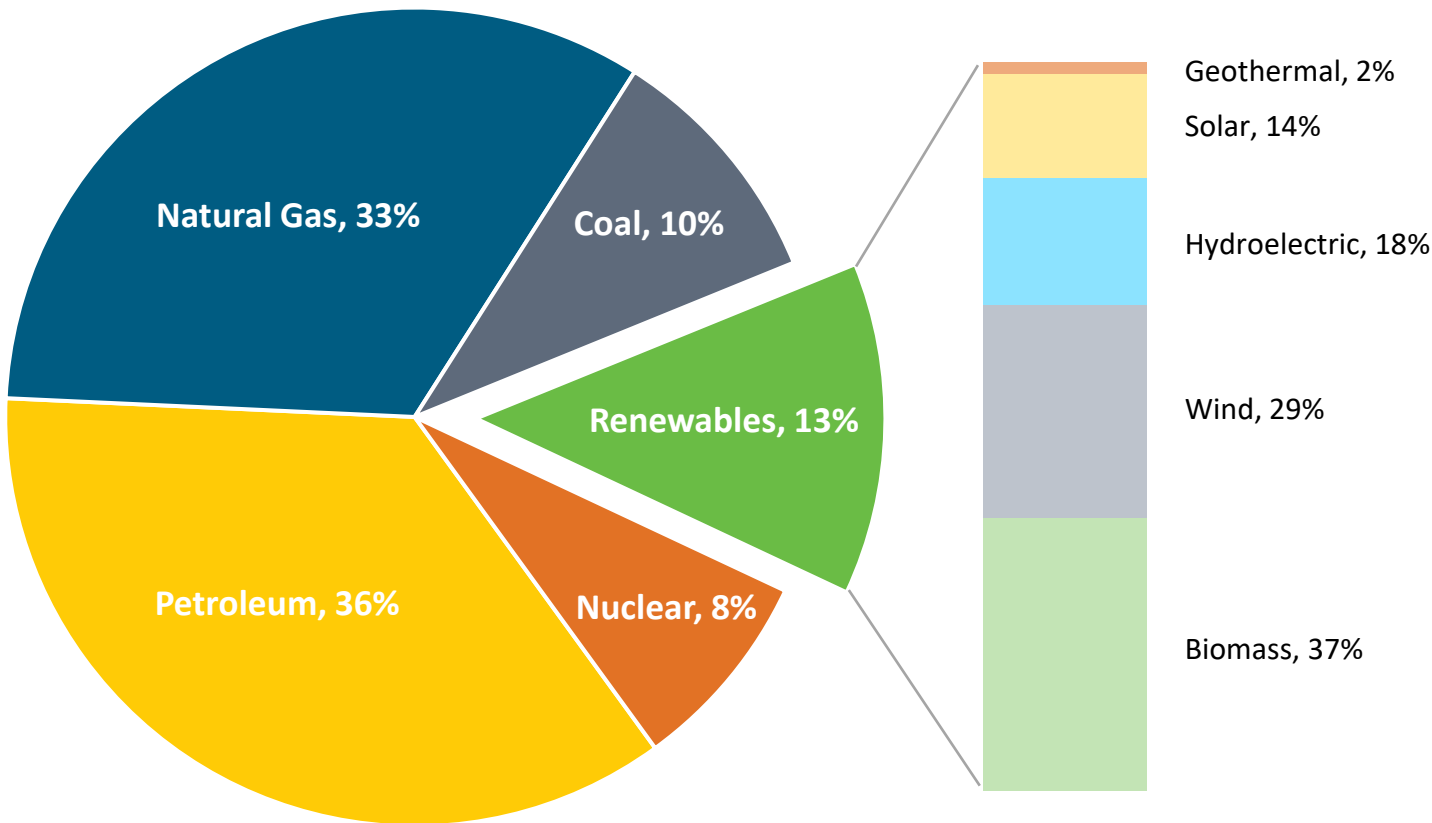


U.S. Energy Landscape and Key Goals

U.S. primary energy consumption by energy source, 2022

Total = 100.4 quadrillion
British thermal units (Btu)

Total = 13.1 quadrillion Btu



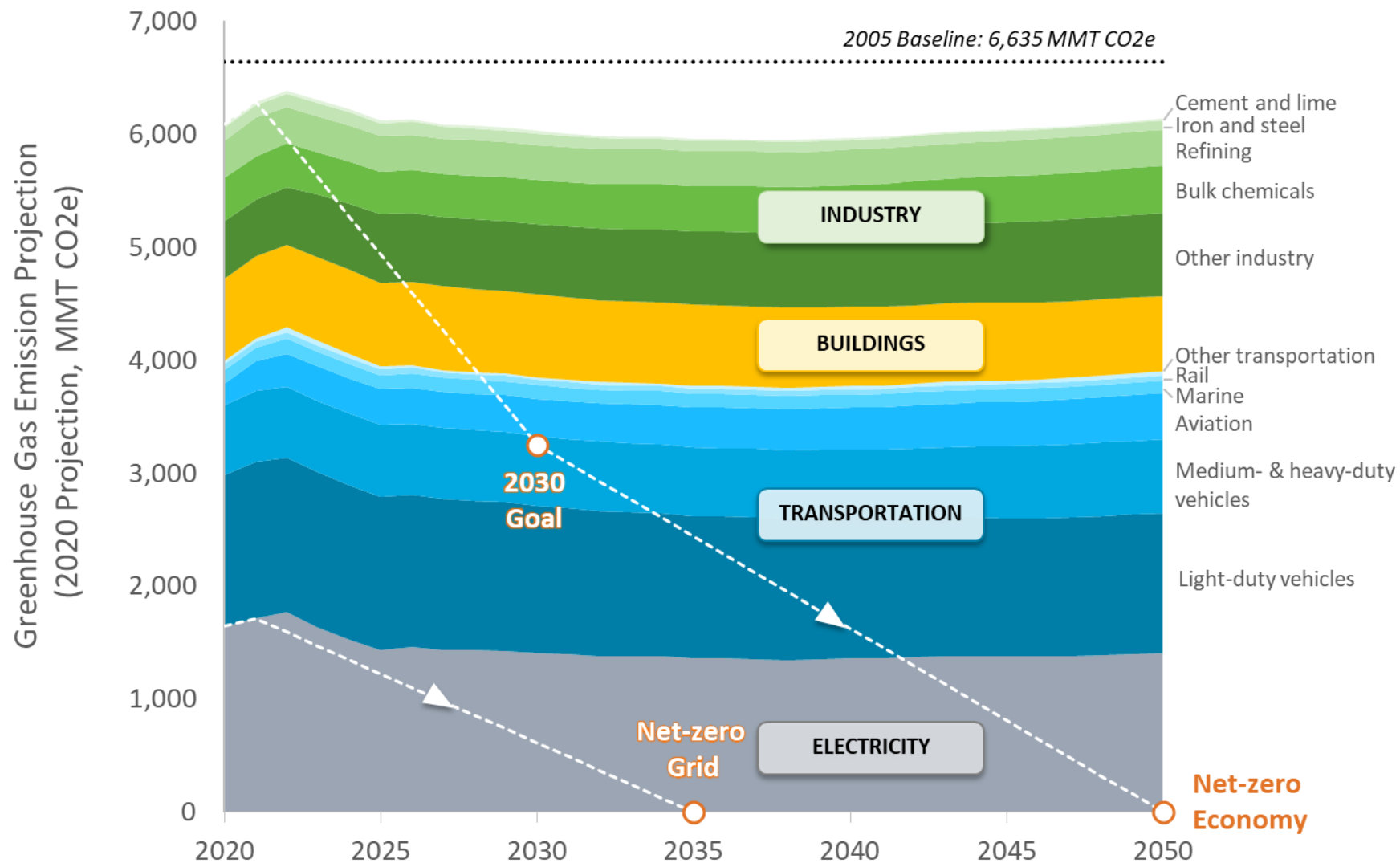
Note: Sum of components may not equal 100% because of independent rounding
Source: Data collected from U.S. Energy Information Administration, May 2023, *Monthly Energy Review*, preliminary data

Administration Goals include:

- Net-zero emissions economy by 2050 and 50–52% reduction by 2030
- 100% carbon-pollution-free electric sector by 2035

Priorities: Ensure benefits to all Americans, focus on jobs, Justice40: 40% of benefits in disadvantaged communities

Carbon Dioxide Emissions by Sector



Source: National Clean Hydrogen Strategy and Roadmap based on Annual Energy Outlook 2021

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

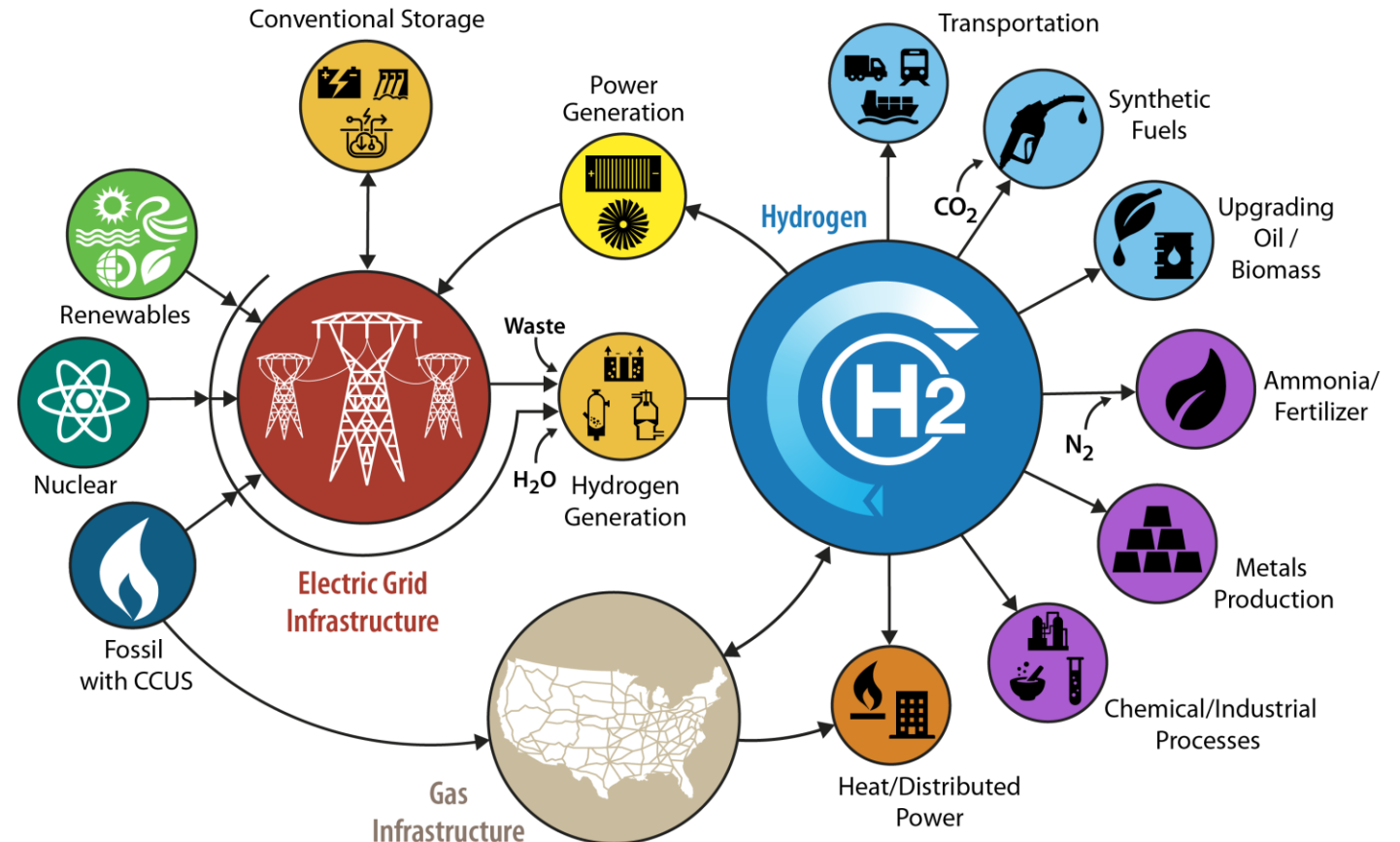
Hydrogen Program

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

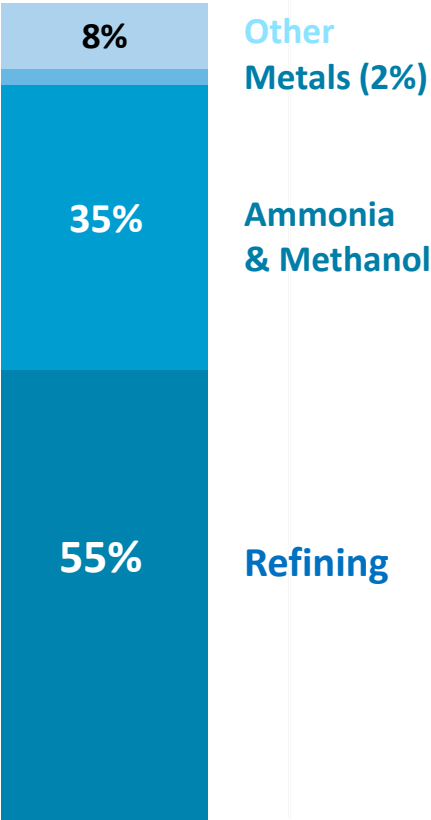
H2@Scale vision: Enables clean-energy pathways across sectors



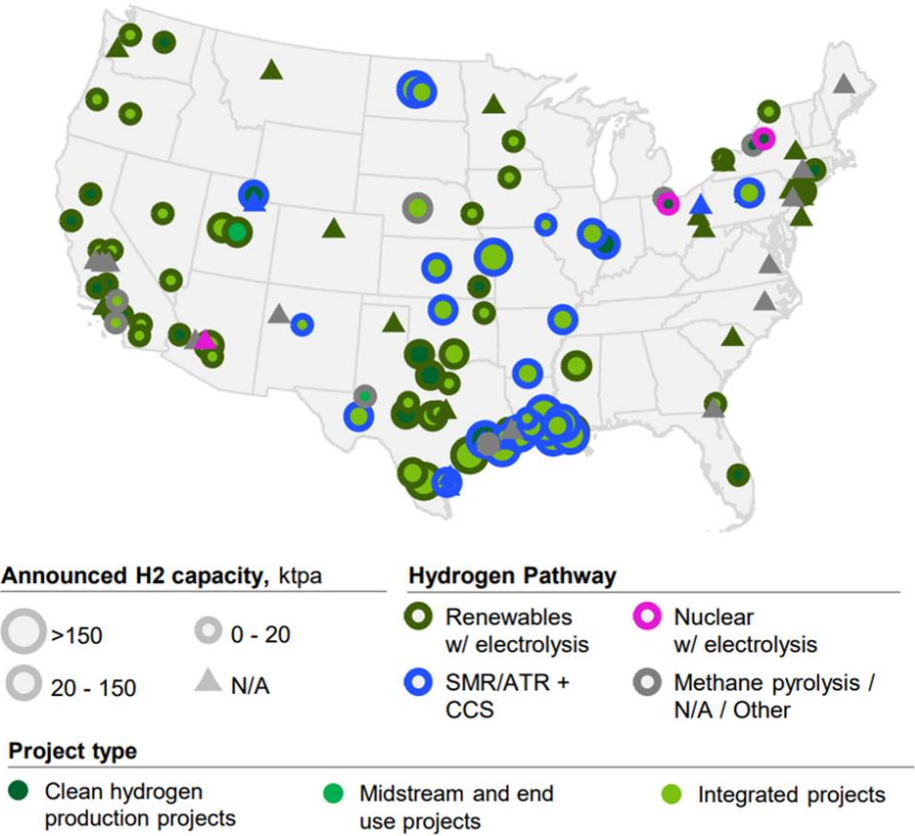
Snapshot of Hydrogen and Fuel Cells in the U.S.

- 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

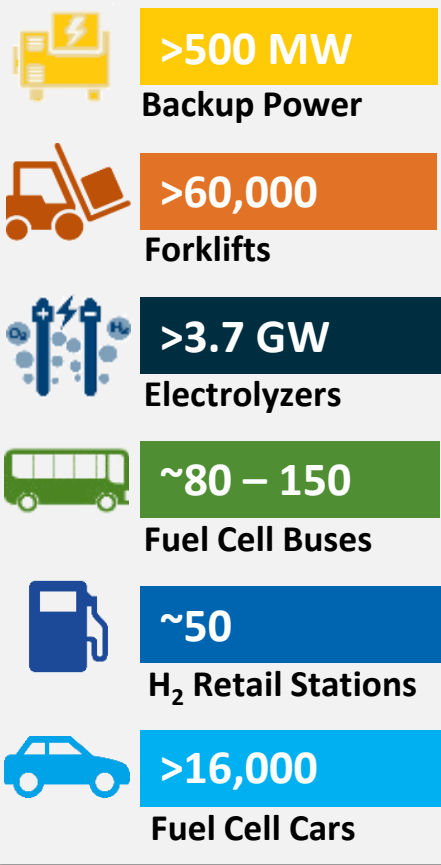


Current publicly announced clean hydrogen production projects*



*as of EOY 2022, DOE Commercial Liftoff Report

Examples of Deployments



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**

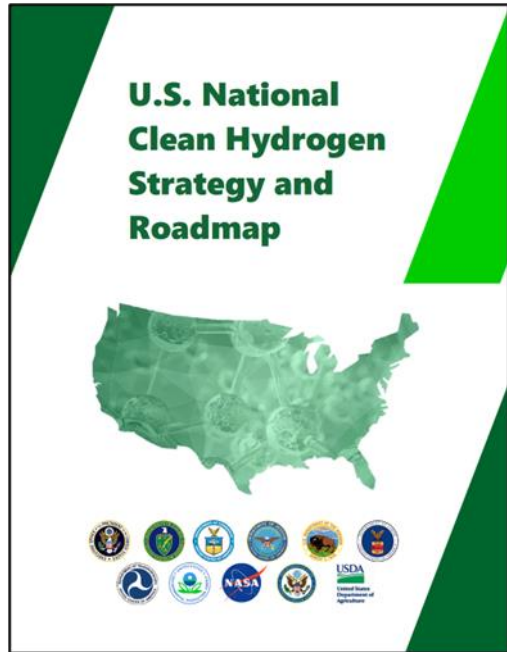


President Biden Signs the Bipartisan Infrastructure Bill into law on November 15, 2021. Photo Credit: Kenny Holston/Getty Images

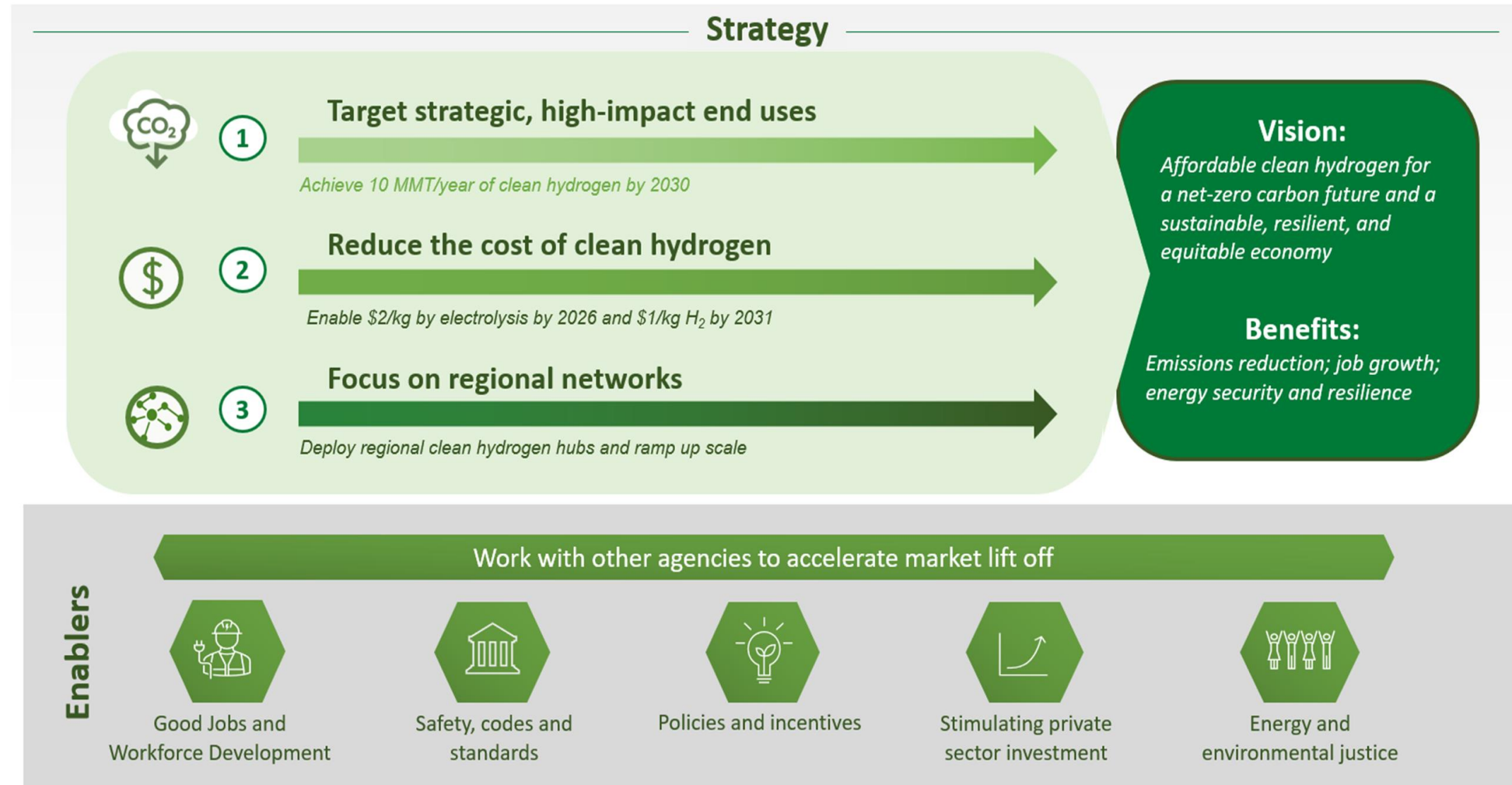
Inflation Reduction Act

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

U.S. National Clean Hydrogen Strategy and Roadmap



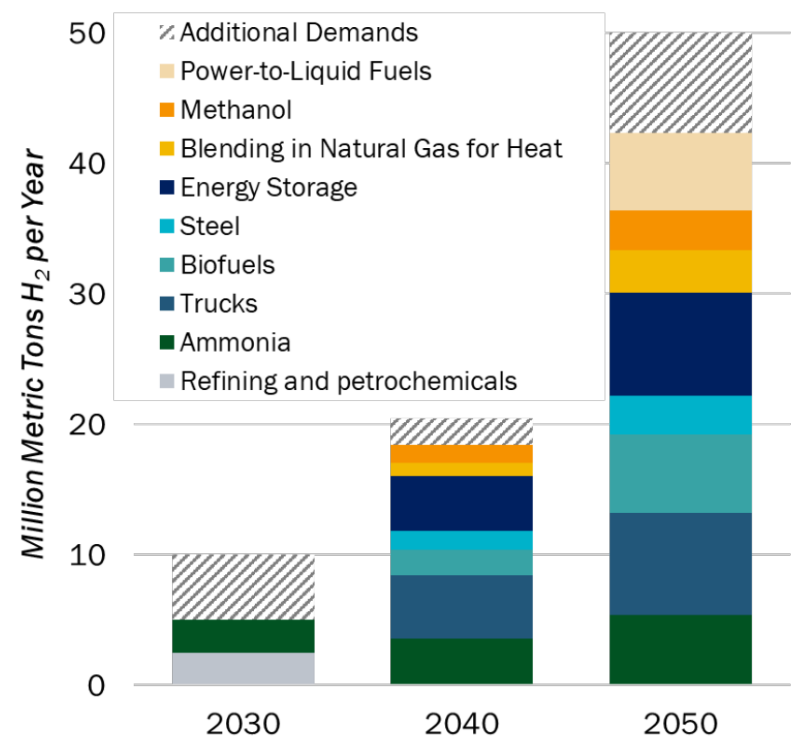
Released June 5, 2023



[U.S. National Clean Hydrogen Strategy and Roadmap - Bing video](#)

National Opportunity for Clean Hydrogen

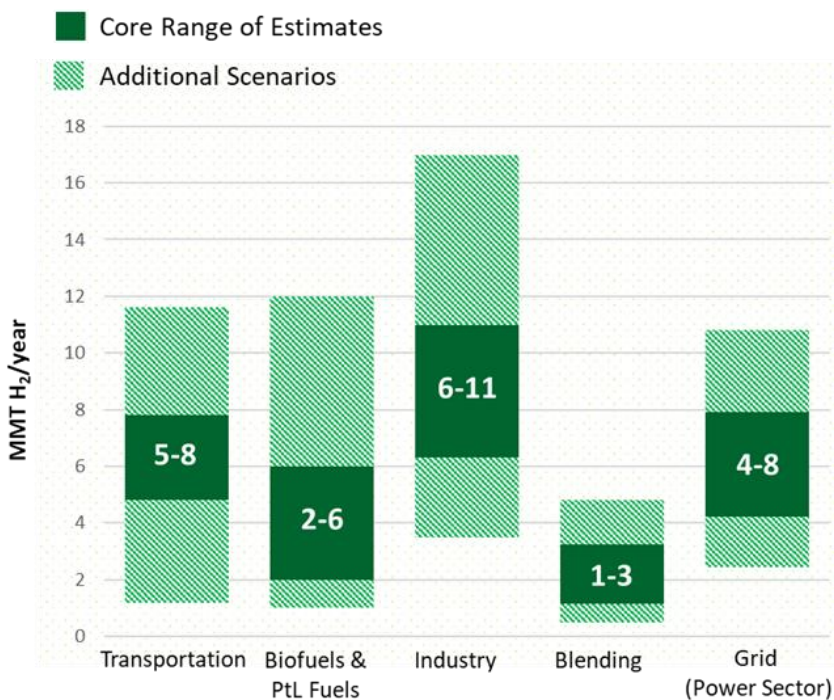
Opportunities for Clean Hydrogen Across Applications



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

DOE Hydrogen Activities across RDD&D – Examples

Research and Development

Basic and applied research through individual projects and consortia

 **Hydrogen Consortia Examples**



FOA

Core Team:
National Labs

University & Non-Profit

Industry

National Lab



MILLION MILE
FUEL CELL TRUCK

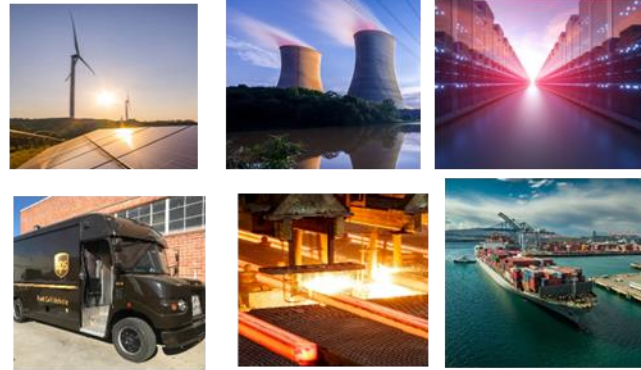


Basic science user facilities, theory, modeling

Technology Integration, Validation, Demos

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

Examples:



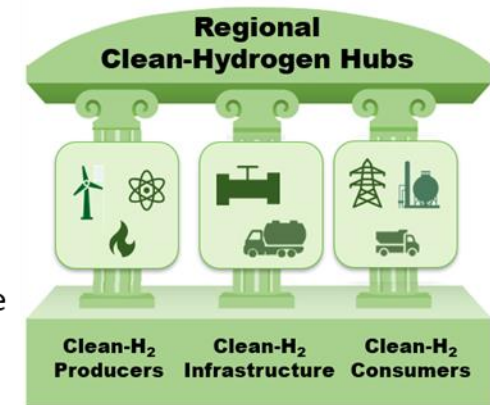
Renewables and nuclear to H₂, 15 delivery trucks in disadvantaged area, 3 Super Truck projects, data center, fueling for passenger ferry, energy storage, H₂ for steel

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



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

Hydrogen Energy Earthshot

“Hydrogen Shot”

“1 1 1”

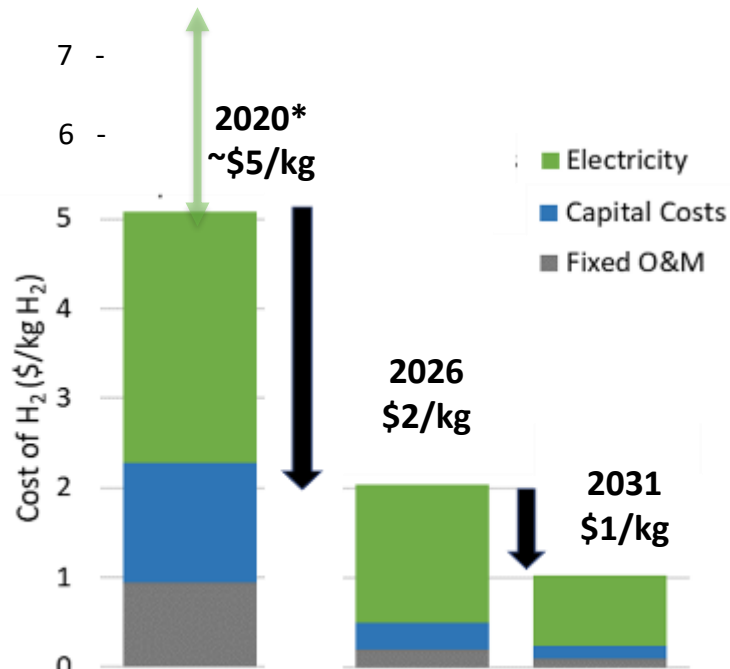
\$1 for 1 kg clean hydrogen in 1 decade

**All pathways included:
Electrolysis, Thermal Conversion,
Advanced Pathways**

How to reduce cost? Examples across multiple pathways

Strategies and scenarios being developed to reduce cost and emissions across pathways

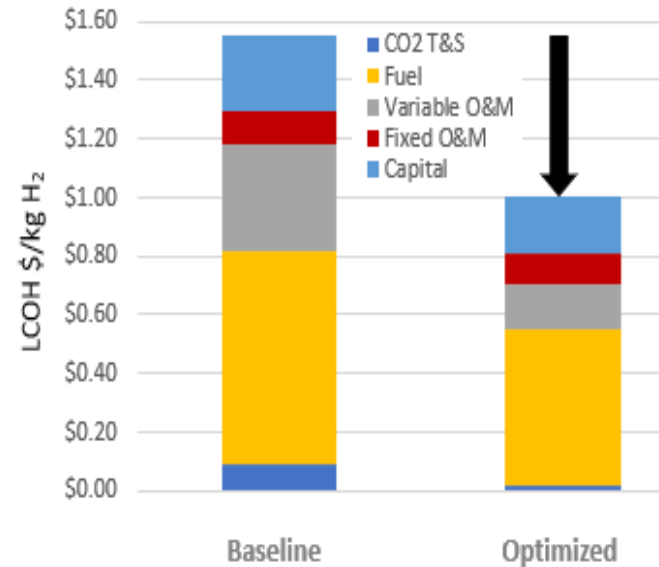
H₂ from Electrolysis



- Reduce electricity cost, improve efficiency and utilization
- Reduce capital cost >80%, operating & maintenance cost >90%

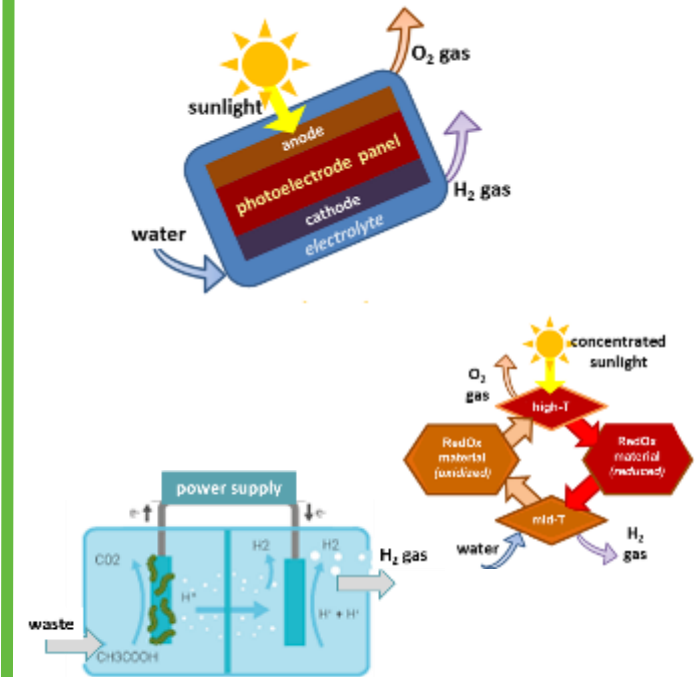
Thermal Conversion

Example: Natural Gas Conversion + CCUS



- Reforming; pyrolysis; air separation; catalysts; carbon capture and storage (CCS); upstream emissions

Advanced Pathways



- Photoelectrochemical (PEC), thermochemical, biological, etc.

*2020 Baseline: PEM (Polymer Electrolyte Membrane) low volume capital cost ~\$1,500/kW, electricity at \$50/MWh. Pathways to targets include capital cost <\$300/kW by 2025, <\$150/kW by 2030 (at scale). Assumes \$50/MWh in 2020, \$30/MWh in 2025, \$20/MWh in 2030



Collaboration

Energy and Environmental Justice

***Diversity, Equity, Inclusion, and
Accessibility***

Examples of International Collaboration

Collaborating through multiple global and bilateral partnerships—key priority is creating coordinated framework to leverage activities, identify gaps, and avoid duplication to accelerate progress



**CEM Global Ports Coalition with EC
Numerous Bilaterals on Hydrogen
Hydrogen Council, IRENA, and more**



H₂ Production Analysis (H2PA)

To facilitate international trade
Common analytical framework for
GHG emissions footprint

Regulations, Codes, Standards, Safety and Education & Outreach Working Groups

www.iphe.net

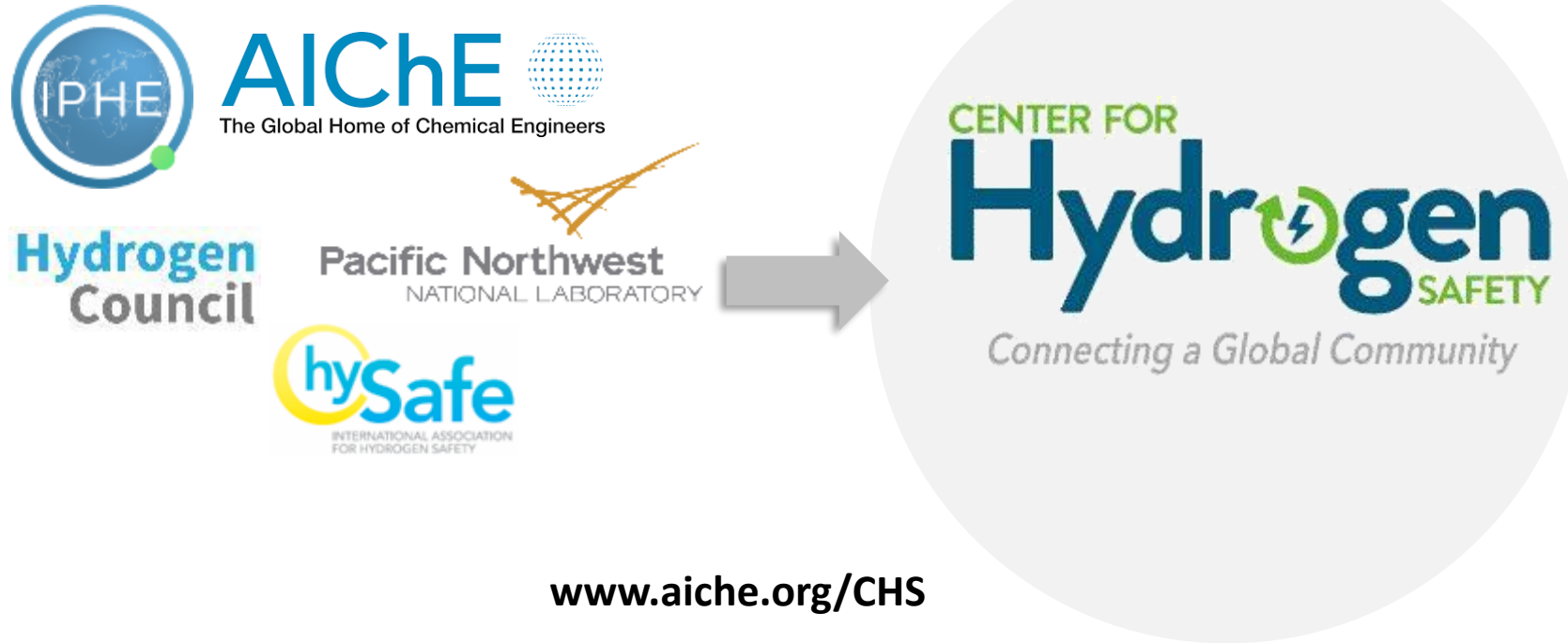
Early Career Network With >40 countries



Breakthrough Agenda in collaboration with other partnerships is mapping activities across global H₂ initiatives to identify gaps, focus areas, and prioritized workstreams

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Call to Action: Join the Center for Hydrogen Safety!



Over 100 members from industry, government, and academia—and growing!



New Hydrogen Safety Credential!

Composed of 7 fundamental hydrogen safety e-courses, including:

- Properties & Hazards
- Safety Planning
- System Operation
- Inspection & Maintenance

Resources and Opportunities for Engagement



Save the date!
**2024 DOE Annual
Merit Review and Peer
Evaluation Meeting**
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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