

Overview of DOE's Hydrogen Program

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Regional Webinar on Hydrogen Regulatory Frameworks

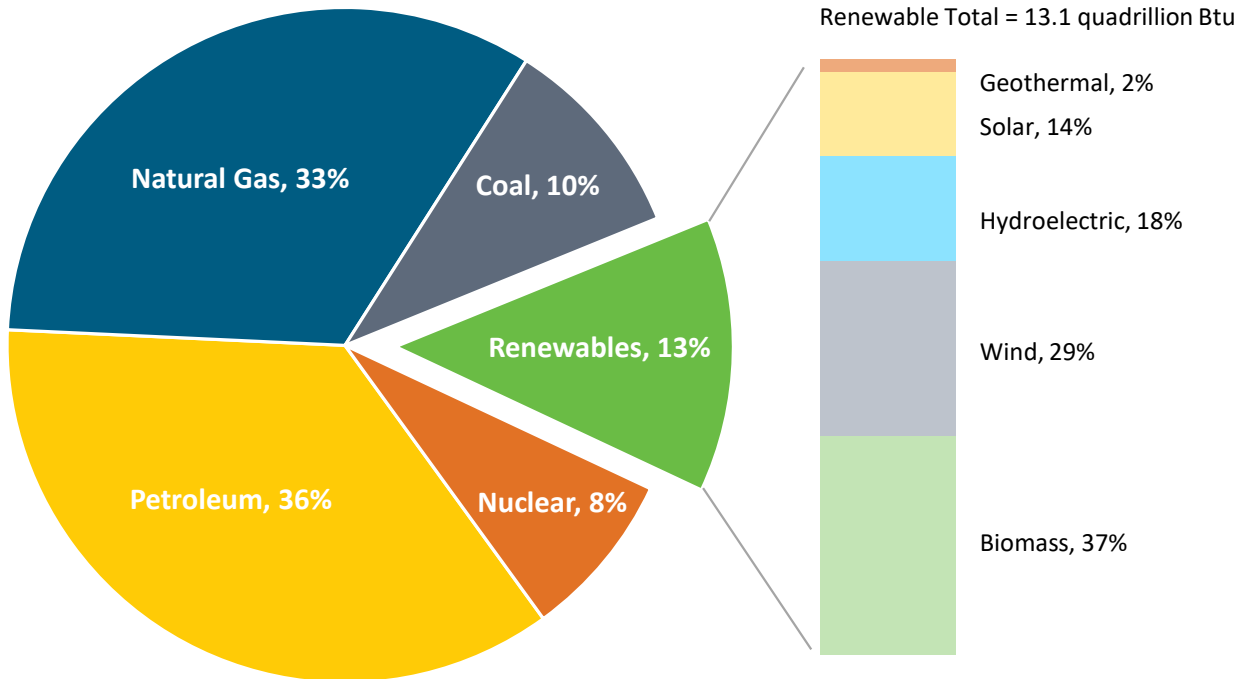
December 10, 2024



U.S. Energy Landscape and Key Goals

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

Total = 100.4 quadrillion British thermal units (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

EJ: Environmental Justice

U.S. DOE Hydrogen Program

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

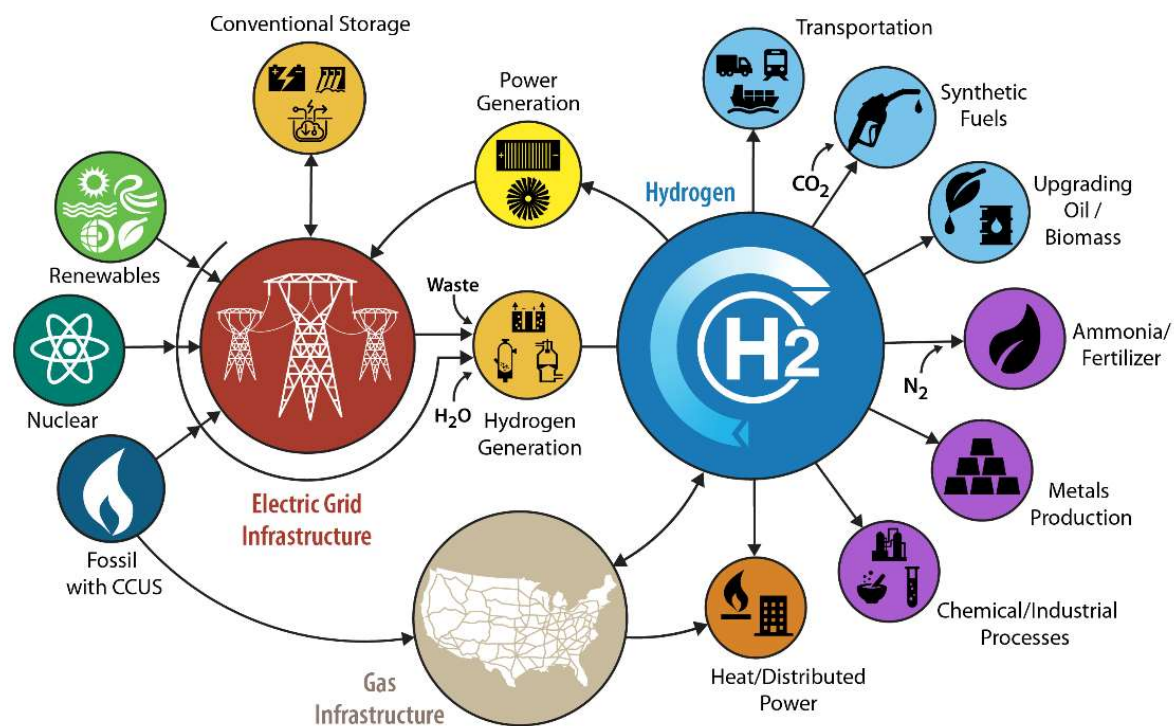
Hydrogen Program

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**

Inflation Reduction Act

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



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

Inflation Reduction Act (IRA) – Examples of H₂ and Fuel Cell Incentives

Clean Hydrogen Production Tax Credit (45V) up to \$3/kg

| Carbon Intensity (kg CO ₂ per kg H ₂)* | Max Tax Credit (\$/kg H ₂) |
|---------------------------------------------------------------|----------------------------------------|
| 4–2.5 | \$0.60 |
| 2.5–1.5 | \$0.75 |
| 1.5–0.45 | \$1.00 |
| 0.45–0 | \$3.00 |

Qualified Commercial Clean Vehicles Credit (45W)

Creates a **new 30% credit** for commercial fuel cell electric vehicles through 2032, capped at **\$40,000**:

- Class 1–3 vehicles: **\$7,500 tax credit** for purchase of qualified clean vehicles
- Class 4 and above: **\$40,000 tax credit**

Alternative Fuel Refueling Property Credit (30C)

Tax credit up to 30% of the cost of alternative fuel refueling property up to **\$100,000**

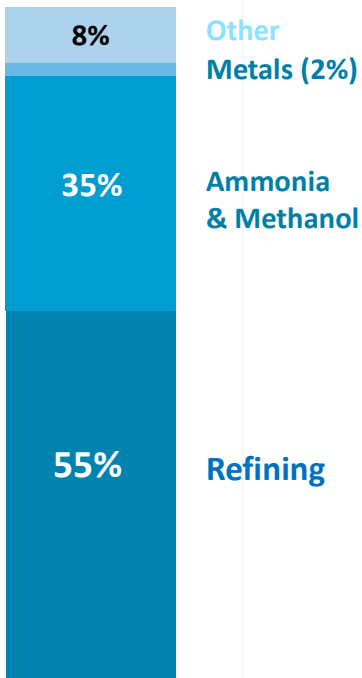
* Well-to-gate, using GREET

View more at: www.energy.gov/eere/fuelcells/financial-incentives-hydrogen-and-fuel-cell-projects

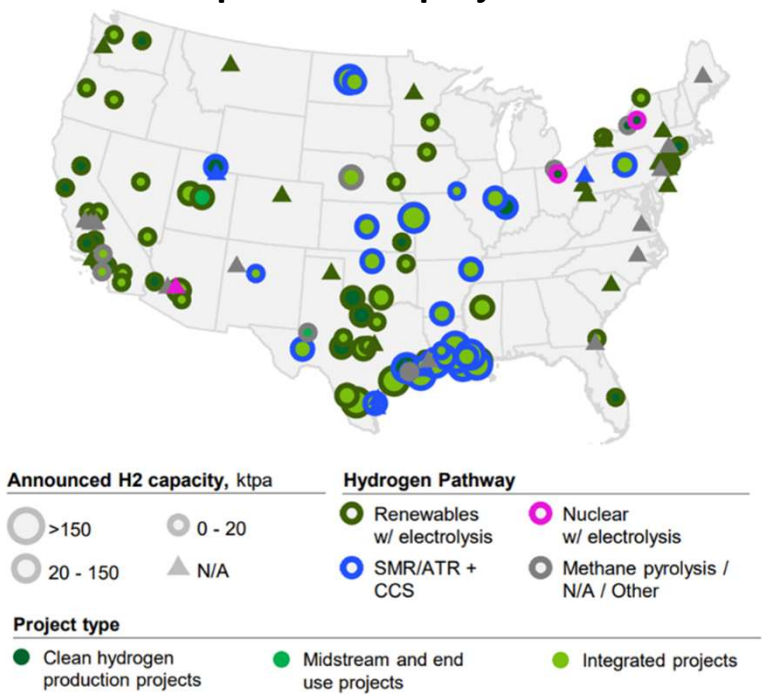
Snapshot of Hydrogen and Fuel Cells in the U.S.

- 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

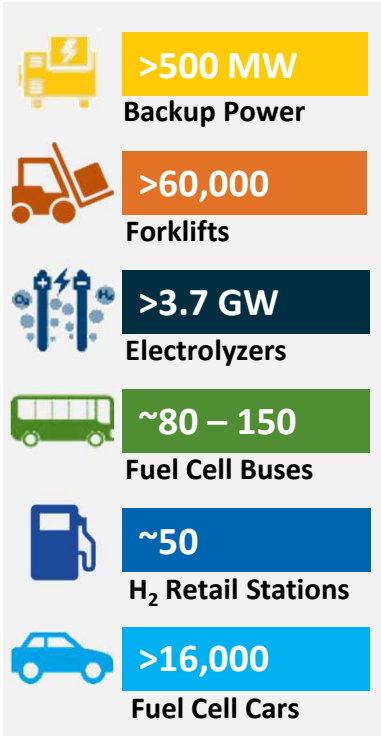


Current publicly announced clean hydrogen production projects*



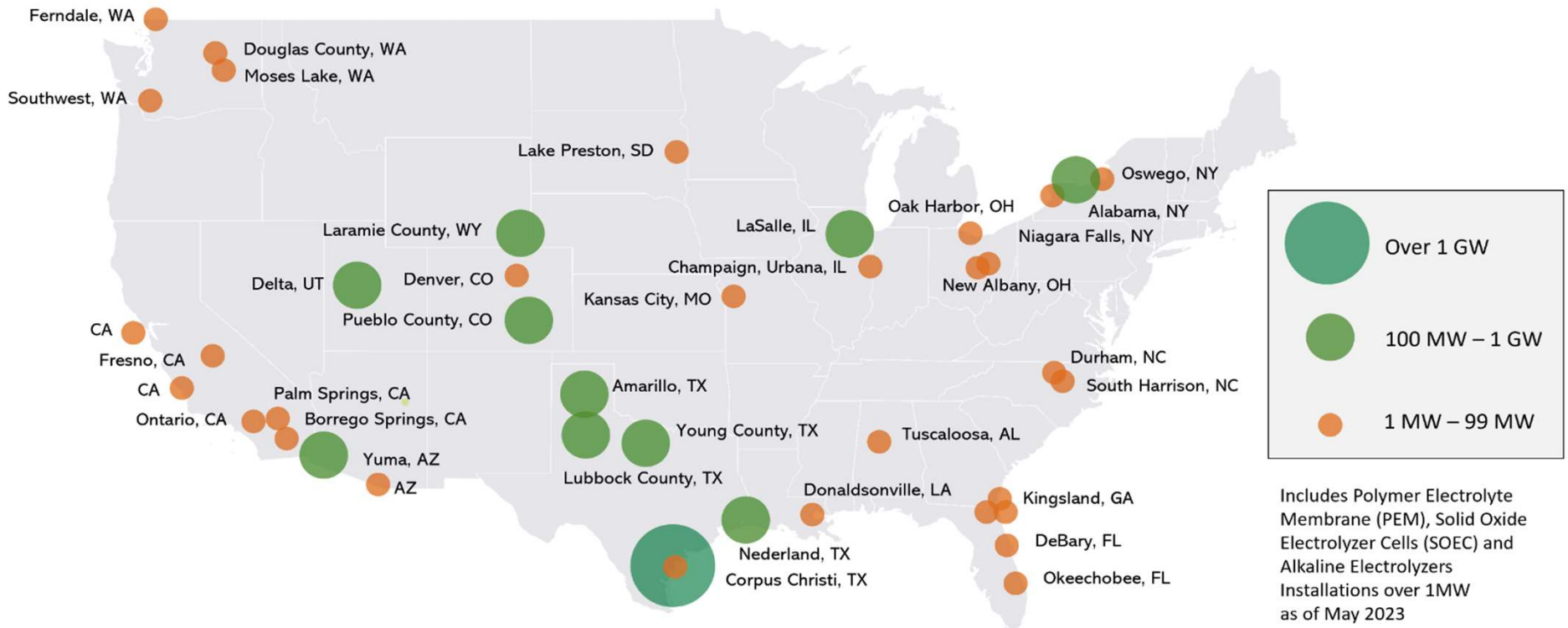
*as of EOY 2022, DOE Commercial Liftoff Report

Examples of Deployments



New Announcement: Planned and Installed Electrolyzer Capacity in the U.S.

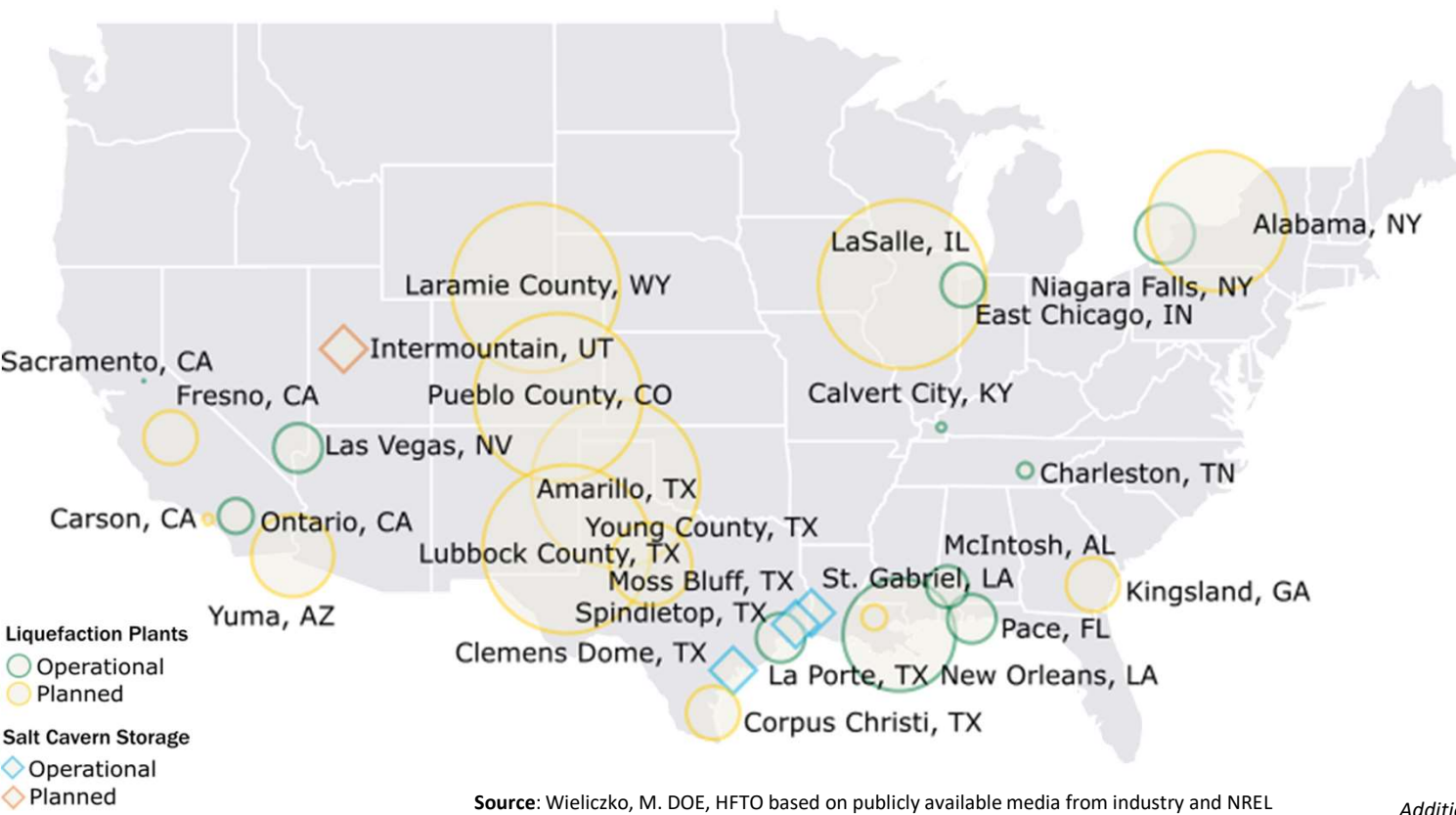
Total 3.7 GW in Electrolyzer Capacity 5-fold increase since 2022



Source: Arjona, V., DOE Program Record #23003, June 2023

Existing and Planned Liquefaction and Salt Cavern Storage

~1,020 Tons per Day (tpd) Liquefaction Capacity Expected
>330 GWh Salt Cavern Storage Currently; 150-300 GWh More Planned



Source: Wieliczko, M. DOE, HFTO based on publicly available media from industry and NREL

Operating U.S. Hydrogen Liquefaction Plants
 11 Operating at 5-60 tpd
 289 tpd total capacity

Planned U.S. Hydrogen Liquefaction Plants
 13 Planned at 10-90 tpd
 730 tpd total capacity

U.S. Hydrogen Storage Caverns
 3 Operating
 1 Planned
 4 Total
 100-150 GWh capacity

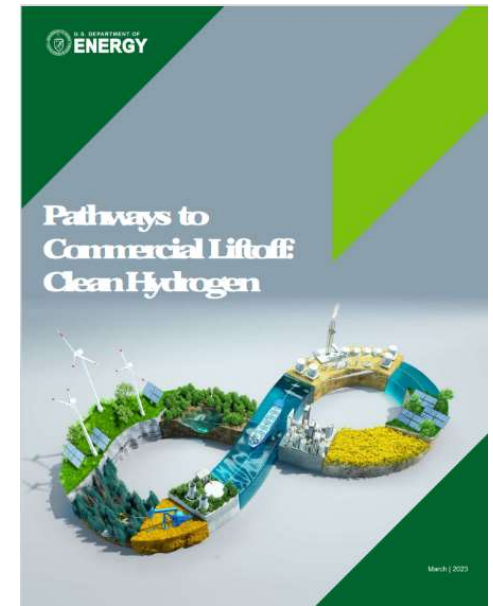
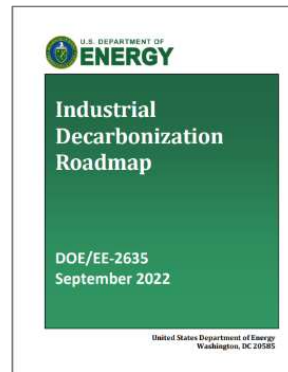
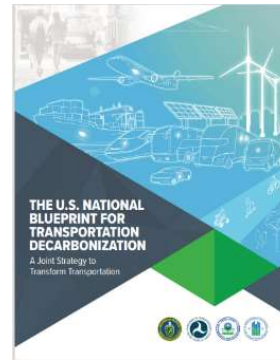
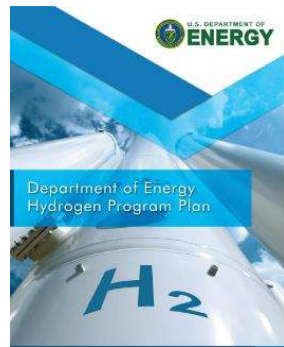
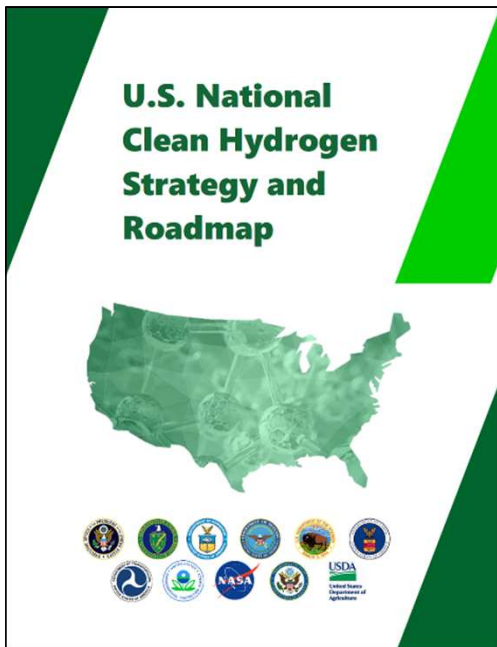
Additional liquefaction plants in Canada: 5 operating + 1 planned

Strategy & Goals



Key Publications

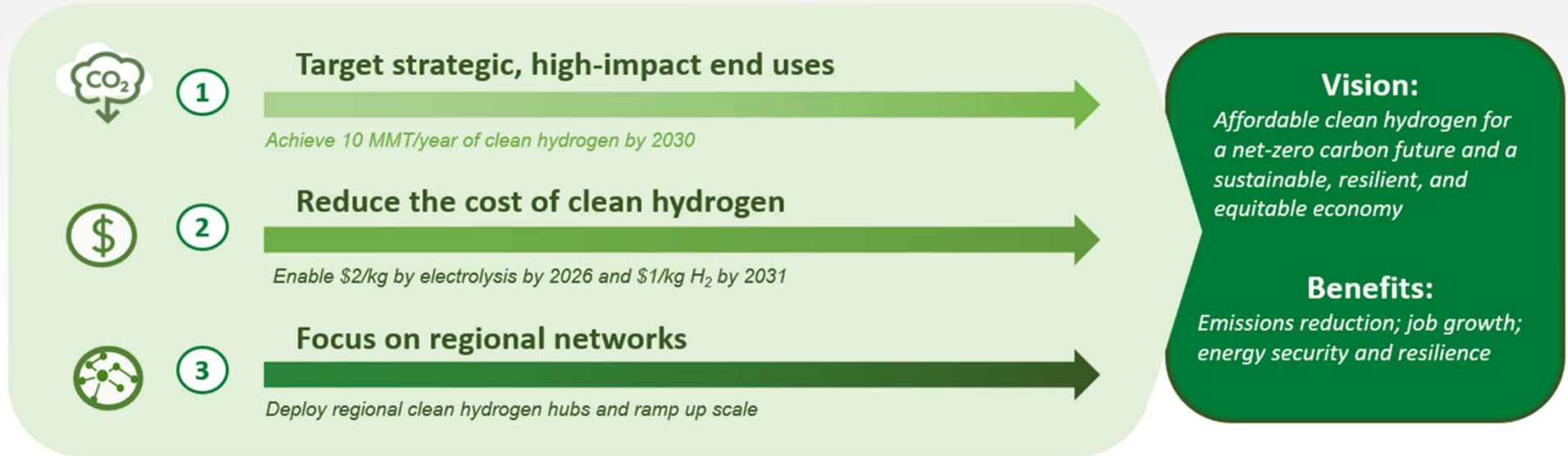
Analysis and guiding documents provide framework for key activities from basic science through deployment



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U.S. National Clean Hydrogen Strategy and Roadmap

Strategy



Enablers

Work with other agencies to accelerate market lift off



Good Jobs and Workforce Development



Safety, codes and standards



Policies and incentives



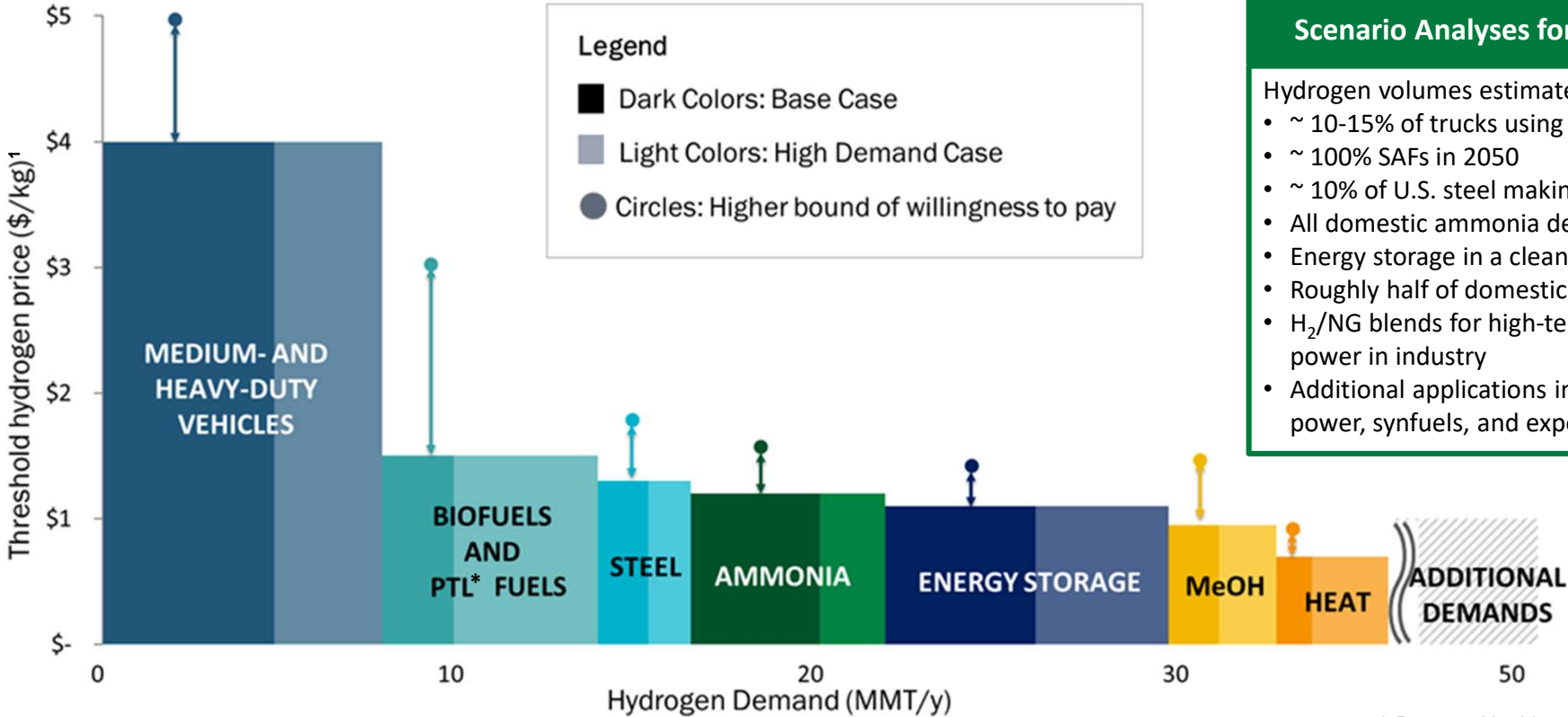
Stimulating private sector investment



Energy and environmental justice

Strategy 1: Target High-Impact Uses of Hydrogen

Clean Hydrogen Demand and Costs for Market Penetration



Scenario Analyses for H₂ Demand**

Hydrogen volumes estimated for:

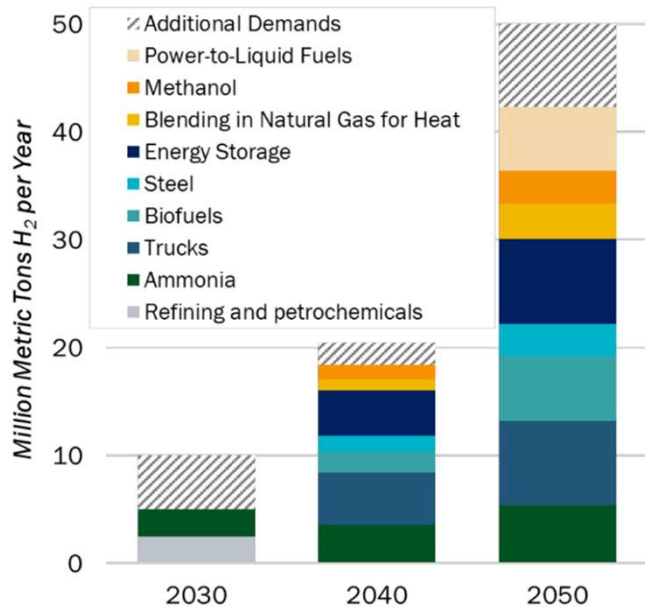
- ~ 10-15% of trucks using fuel cells
- ~ 100% SAFs in 2050
- ~ 10% of U.S. steel making
- All domestic ammonia demand
- Energy storage in a clean grid
- Roughly half of domestic methanol
- H₂/NG blends for high-temp heat and power in industry
- Additional applications include stationary power, synfuels, and export potential

¹Costs include production, delivery, dispensing to the point of use (e.g., high-pressure fueling for vehicle applications)

* Power to Liquid
 ** Volumes dependent on multiple variables

Strategy 1: Target High-Impact Uses of Hydrogen

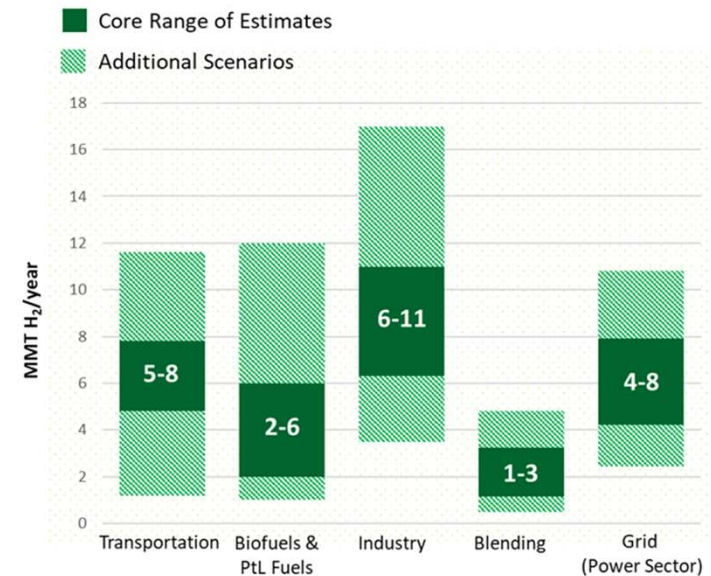
Opportunities for Clean Hydrogen Across Applications



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



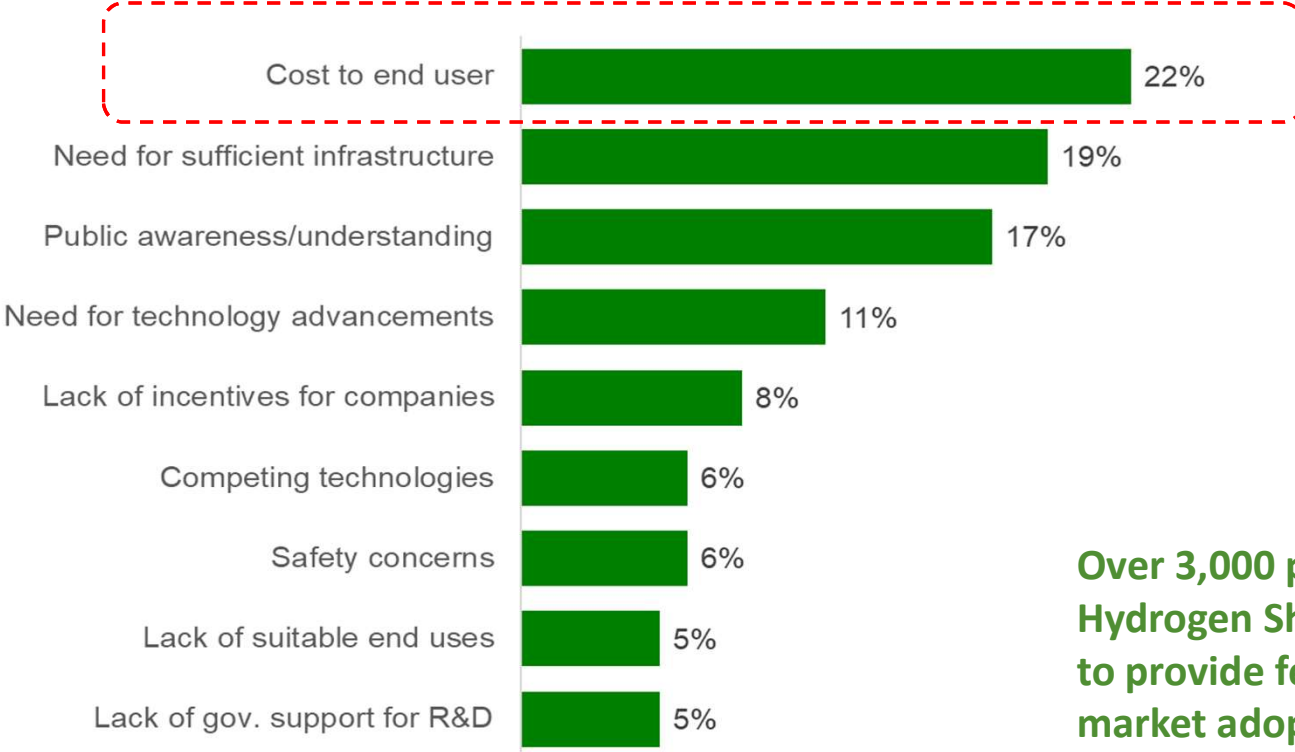
U.S. Opportunity: 10MMT/yr by 2030, 20 MMT/yr by 2040, 50 MMT/yr by 2050; ~10% Emissions Reduction; ~100K Jobs by 2030

- **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

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

Hydrogen Energy Earthshot

“Hydrogen Shot”

“1 1 1”

\$1 for 1 kg clean hydrogen in 1 decade

Launched June 7, 2021
Summit Aug 31-Sept 1, 2021

Thank you

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www.energy.gov/fuelcells
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