Hydrogen Stakeholder Webinar
National Clean Hydrogen Strategy and Roadmap and Interagency Coordination

August 18, 2023
Welcome Remarks

Deputy National Climate Advisor to the President

Mary Frances Repko
Introduction

Deputy Secretary of Energy David Turk
National Clean Hydrogen Strategy and HIT Deep Dive

Dr. Sunita Satyapal
Director, Hydrogen and Fuel Cell Technologies Office, DOE
DOE Hydrogen Program Coordinator,
and HIT Director
U.S. National Clean Hydrogen Strategy and Roadmap

**Strategy**

1. **Target strategic, high-impact end uses**
   - Achieve 10 MMT/year of clean hydrogen by 2030

2. **Reduce the cost of clean hydrogen**
   - Enable $2/kg by electrolysis by 2026 and $1/kg H₂ by 2031

3. **Focus on regional networks**
   - Deploy regional clean hydrogen hubs and ramp up scale

**Vision:**
Affordable clean hydrogen for a net-zero carbon future and a sustainable, resilient, and equitable economy

**Benefits:**
Emissions reduction; job growth; energy security and resilience

**Enablers**
- Good Jobs and Workforce Development
- Safety, codes and standards
- Policies and incentives
- Stimulating private sector investment
- Energy and environmental justice

**Work with other agencies to accelerate market lift off**
Guiding Principles

Enable deep decarbonization through strategic, high-impact uses

Grow sustainable jobs

Catalyze innovation and investment

Foster diversity, equity, inclusion

Spur domestic manufacturing and robust supply chains

Advance energy and environmental justice

Guiding principles

These principles must be applied to ensure a sustainable, resilient, and equitable clean hydrogen economy

Approach holistically

Enable affordability and versatility
Strategy 1: Target High-Impact Uses of Hydrogen

Clean Hydrogen Demand and Costs for Market Penetration

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

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

* Power to Liquid
** Volumes dependent on multiple variables
Strategy 1: Target High-Impact Uses of Hydrogen

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

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

- Cost to end user: 22%
- Need for sufficient infrastructure: 19%
- Public awareness/understanding: 17%
- Need for technology advancements: 11%
- Lack of incentives for companies: 8%
- Competing technologies: 6%
- Safety concerns: 6%
- Lack of suitable end uses: 5%
- Lack of gov. support for R&D: 5%

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

Launched June 7, 2021

Strategy also includes hydrogen delivery and storage
Strategy 3: Focus on Regional Networks and Ramp Up Scale

Build Regional Networks through “Clean Hydrogen Hubs”

Foundational Enablers:
- Workforce development
- Safety, codes, and standards
- Policies and incentives
- Stimulating private sector investment
- Meaningful stakeholder engagement
- Energy and environmental justice

Examples of Stakeholder and RFI Input:
- Pacific Northwest
- Central U.S.
- Great Lakes
- New England
- Appalachia
- Southwest
- Alaska and Hawaii
- Gulf Coast
Analysis of Potential Supply Resources and Underground Storage

Source: NREL, Lab analysis, National Strategy

Source: SHASTA, NETL
### Actions and Timelines

#### 2022-2025
- **Clean Hydrogen Production**: Catalyze RD&D in electrolysis, thermal conversion, & new pathways to meet Hydrogen Shot
- **Delivery and Storage Infrastructure**: Identify and prioritize barriers to infrastructure roll out
- **End Uses and Market Adoption**: Engage regulators to lay groundwork for strategic adoption across sectors
- **Enablers**: Engage stakeholders; address safety codes and standards; develop critical supply chains

#### 2026-2029
- **Clean Hydrogen Production**: Demonstrate replicable, scalable production from renewables, nuclear, & fossil and waste with CCS
- **Delivery and Storage Infrastructure**: Initiate supporting infrastructure for regional hubs
- **End Uses and Market Adoption**: Initiate industrial projects and develop offtake agreements
- **Enablers**: Develop and expand workforce, talent pools, and apprenticeship programs

#### 2030-2035
- **Clean Hydrogen Production**: Deploy gigawatt-scale electrolyzers and develop domestic supply chains
- **Delivery and Storage Infrastructure**: Demonstrate advanced and efficient infrastructure components
- **End Uses and Market Adoption**: Deploy regional clean hydrogen hubs
- **Enablers**: Ensure 40% of benefits flow to disadvantaged communities impacted by DOE-funded clean H₂ projects

- **Achieve Justice 40, create good-paying jobs, and ensure public health and safety**
- **Scale up hydrogen hubs and prepare export opportunities**
- **Deliver hydrogen at scale**
- **Achieve 10 MMT production capacity and $1/kg target**
Whole-of-Government Approach

HIT

Hydrogen Interagency Task Force
Hydrogen Interagency Task Force (HIT) across 11 Agencies

The Energy Policy Act of 2005 authorized the establishment of an interagency task force on hydrogen and fuel cells. 42 U.S.C. 16155. Agencies have been collaborating under the existing IWG and are working to expand collaboration by developing a Hydrogen Interagency Taskforce. More details will be available on www.hydrogen.gov.
HIT Working Group Structure and Focus Areas

<table>
<thead>
<tr>
<th>Supply and Demand at Scale</th>
<th>Infrastructure, Siting, Permitting</th>
<th>Analysis and Global Competitiveness</th>
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</thead>
<tbody>
<tr>
<td>• Enabling large scale production and demand creation</td>
<td>• Siting, permitting, pipelines, storage, and infrastructure</td>
<td>• National strategy and commercial liftoff analysis</td>
</tr>
<tr>
<td>• Financing, incentives, and compliance tools for commercial scale up</td>
<td>• Harmonized codes and standards</td>
<td>• Impacts and gap assessments (technoeconomic analysis, incentives, resource/water availability, emissions, jobs, manufacturing, etc.)</td>
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<tr>
<td>• Metrics for deployment and USG as offtaker</td>
<td>• Interoperability and global standardization</td>
<td>• Intellectual property and global landscape assessment</td>
</tr>
<tr>
<td>• Supply chains and resiliency (critical materials, strategic reserve)</td>
<td>• Safety, emissions (including secondary), sensors, risk mitigation, environmental impact</td>
<td>• Export market analysis</td>
</tr>
<tr>
<td>• R&amp;D to accelerate cost reductions and end use commercialization (JST interface)</td>
<td>• Environmental review and best practices (NEPA, etc.)</td>
<td>• Systems integration and optimization</td>
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</tbody>
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Enable National Goals: 10 MMT/yr supply and end use by 2030, 20 MMT/yr by 2040, 50 MMT/yr by 2050

Working Groups

Crosscutting Teams

DOE JST Tech Teams: Production, Delivery, Storage, Conversion, Applications, H2 Hubs

Workforce, Equity, and Justice

DOE Joint Strategy Team (JST) Tech Teams will include agency members as appropriate. Each team includes expertise in manufacturing and knowledge management.
### Hydrogen Joint Strategy Team

#### Administration Goals
- Net Zero by 2050
- 50-52% emissions reductions by 2030
- Clean Grid by 2035
- Justice 40

#### Hydrogen Key Priorities
- WG to address Key Priorities:

#### Crosscutting Pillars
- Collaboration across offices to address RDD&D in:

#### Research Areas and Key Targets
- Hydrogen Shot $1/kg clean H2 by 2031
- Application specific targets include:
  - $2/kg H2 delivery
  - $9/kWh H2 storage
  - $80/kW fuel cells for HDVs, 80,000 hr durability, etc.
- H2 Hubs specific WG

#### Catalyzing Market Lift Off
- Regional Clean Hydrogen Hubs ($8B under BIL) will jumpstart market liftoff

### Decarbonization
- Low-Cost Clean Hydrogen Production
- Safe, Low-Cost Delivery and Storage Infrastructure
- Enable End Use Applications at Scale

### Infrastructure Modernization
- Low-Cost, Durable, and Efficient Fuel Cells & Low NOx Turbines

### Equity and Energy Justice
- Climate Adaptation and Mitigation

### Crosscutting Challenges
- Production
- Delivery & Storage
- Conversion
- Applications and Lift Off

Multiple offices across DOE and coordination across agencies
Hydrogen: Arctic Perspective

Dr. Erin Whitney
Director of the Arctic Energy Office, DOE
Example: Alaska Hydrogen Working Group

- Led by the Arctic Energy Office, which coordinates cross-cutting DOE work in Arctic to address energy, science, and national security.
- Covers green shipping corridor, Iceland-Alaska knowledge sharing, clean methanol production, engine permitting, and more.
- Drafting an opportunities report for the State of Alaska, with NREL tech support.

Email: arcticenergy@hq.doe.gov  Website: energy.gov/arctic
(You can find us on LinkedIn, Facebook, and X/Twitter too!)
Hydrogen: Deploy and Liftoff

Todd Shrader
Director, Project Management,
Office of Clean Energy Demonstrations, DOE
Regional Clean Hydrogen Hubs

OCED and Industry awardees will build 6-10 regional clean H2Hubs across the country to create networks of hydrogen producers, consumers, and local connective infrastructure to accelerate use of hydrogen.

- Feedstock diversity
- End use diversity
- Geographic diversity
- Employment and training
- Connecting diverse parties to facilitate clean energy business interactions
- Understanding the role clean hydrogen could play in the energy transition
- Real-world context for hydrogen demand and supply
- De-risking technical questions (e.g., sensors, storage, transport) that will allow industry to use higher blended rates of hydrogen

Current Status
- Released funding announcement in September 2022
- Held webinar with encouraged/discouraged applicants in January 2023
- Full applications received April 7, 2023
- Selections in Fall 2023
Hydrogen lacks the bankable demand needed to move from announcements to steel in the ground.

To reach FID, investors require offtake agreements and financeable structures.

Recent federal incentives may not create adequate demand to drive national hydrogen market formation; additional policy and regulatory actions are needed.

Today, investments in production outpace offtake, and many offtakers are hesitant to sign long-term contracts.

North American direct hydrogen investments through 2030 in $Billions

Stakeholder Feedback Examples
Key findings of the Clean Hydrogen Liftoff Report

PTC reduces production costs to kick-start the transition from high carbon intensity (CI) to low CI hydrogen for existing uses.

DOE H2Hubs and open access infrastructure will move use cases into the money that would otherwise not take-off.

In addition to industrial/chemicals use cases, heavy-duty transportation will be critical for market lift-off.

Without sustained long-term offtake or merchant markets, domestic market acceleration could be slowed.

H2 Liftoff Report: About the Pathways Reports - Pathways to Commercial Liftoff (energy.gov)
Hydrogen: Inter-Agency Collaboration

Dr. Sunita Satyapal
HIT Director
# Cross Agency Hydrogen Activities - Examples

<table>
<thead>
<tr>
<th>Partners</th>
<th>Examples of Collaborations &amp; Focus Areas</th>
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<tbody>
<tr>
<td>DOT, DOE</td>
<td>Pipelines, buses, marine, fueling corridors</td>
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<tr>
<td>DOD, DOE, DHS across services</td>
<td>H2Rescue Truck, vehicles, infrastructure, UAVs, UUVs, soldier power, microgrids, and more</td>
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<tr>
<td>DOE, USPS</td>
<td>FC lift trucks and hydrogen infrastructure</td>
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<tr>
<td>NASA, DOE, NSF</td>
<td>Cryogenics/LH2, fuel cells, electrolyzers, storage, DOE consortia (NSF)</td>
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<tr>
<td>DOC (NIST), DOE</td>
<td>Metering, diagnostics, supply chain, blends, standards</td>
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<tr>
<td>EPA, DOE, et al</td>
<td>Proposed rulings (EPA), emissions analysis, ports</td>
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<tr>
<td>USDA</td>
<td>REAP and rural community programs</td>
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![Additional Federal Agency Hydrogen and Fuel Cell Funding - FY 22 & 23](chart.png)
Environmental Protection Agency (EPA)

Stephanie Grumet
Senior Policy Advisor
Office of Air Quality Planning and Standards
EPA Regulatory Proposals and Ports Program Drive Hydrogen Demand

EPA is introducing hydrogen as a decarbonization measure across multiple sectors.

Proposed Rule to Control Air Pollution from New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards
EPA considered H₂ fuel cell technology for select applications that travel long distances or carry heavy loads.

Proposed Carbon Pollution Standards for Fossil Fuel-Fired Power Plants: one path to BSER for new and existing turbines include:
- 30% cofiring low-GHG H₂ by 2032
- 96% cofiring low-GHG H₂ by 2038

$3 billion Clean Ports Initiative authorized by IRA
EPA will provide funding for zero-emission port equipment, technology and to help ports develop climate action plans.

https://www.epa.gov/inflation-reduction-act/clean-ports-program
Department of Transportation
Pipeline and Hazardous Materials and Safety Administration

Mary McDaniel
Acting Director
Engineering & Research Division
DOT Rulemaking Initiatives

Rupture Detection and Valve Final Rule Published 4/8/2022

- Improve the timeliness of rupture identification, response, and mitigation of safety, greenhouse gas, and environmental justice impacts.
- Establishes requirements for rupture-mitigation valve spacing, maintenance and inspection, and risk analysis.
- Requires operators to identify ruptures and close valves to isolate the ruptured segment as soon as practicable, not to exceed 30 minutes from rupture identification.

Leak Detection and Repair Notice of Proposed Rule 5/18/2023

- Applies to nearly 3 million miles of pipelines; all underground natural gas storage, and LNG facilities.
- Reduce intentional and unintentional emissions from new and existing pipelines.
- Requires operator to provide for the timely identification and repair of all leaks.
Hydrogen Research

Technology Development
- Solutions for Predicting/Monitoring Hydrogen Gas Loss

General Knowledge
- Review of Integrity Threat Characterization Resulting from Hydrogen Gas Pipeline Service

Technology Development
- Advancing Hydrogen Gas Leak Detection Tools when Blended with Natural Gas Pipeline Operations

General Knowledge
- Determining Requirements for Repurposing Existing Pipelines to Transport Blended & Pure Hydrogen

Technology Development
- Validate Existing or Develop New Hydrogen Leak Detection Sensors Compatible with Hydrogen-Natural Gas Blends
Hydrogen: The Equity and Environmental Justice Perspective

Dr. Sunita Satyapal
Stay tuned for more information on Community Benefits Plans, Mapping Tools, and upcoming activities.
Hydrogen: Upcoming Events and Ways to Engage
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www.hydrogen-americas-summit.com
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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Questions?