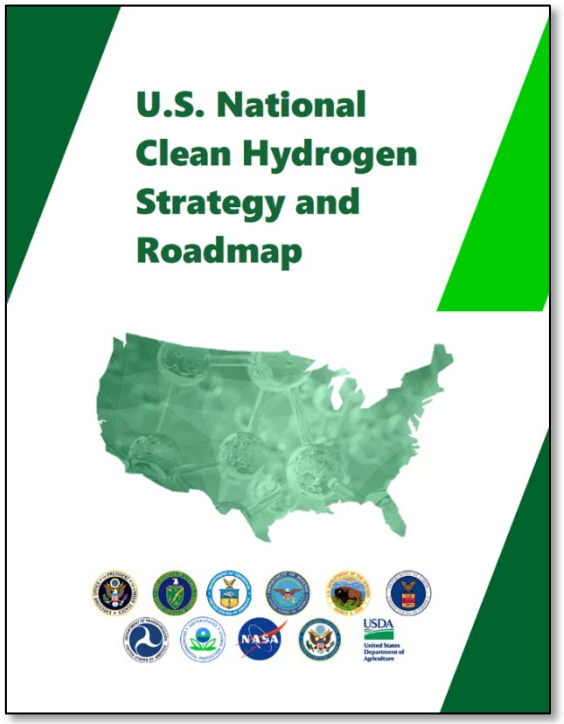
U.S. DEPARTMENT OF ENERGY

Hydrogen Interagency Task Force

AMR Interagency Session: Opening Remarks by Sunita Satyapal

HIT Working Group Panel

U.S. National Clean Hydrogen Strategy and Roadmap



www.hydrogen.gov

Released June 5, 2023

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 H_2 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

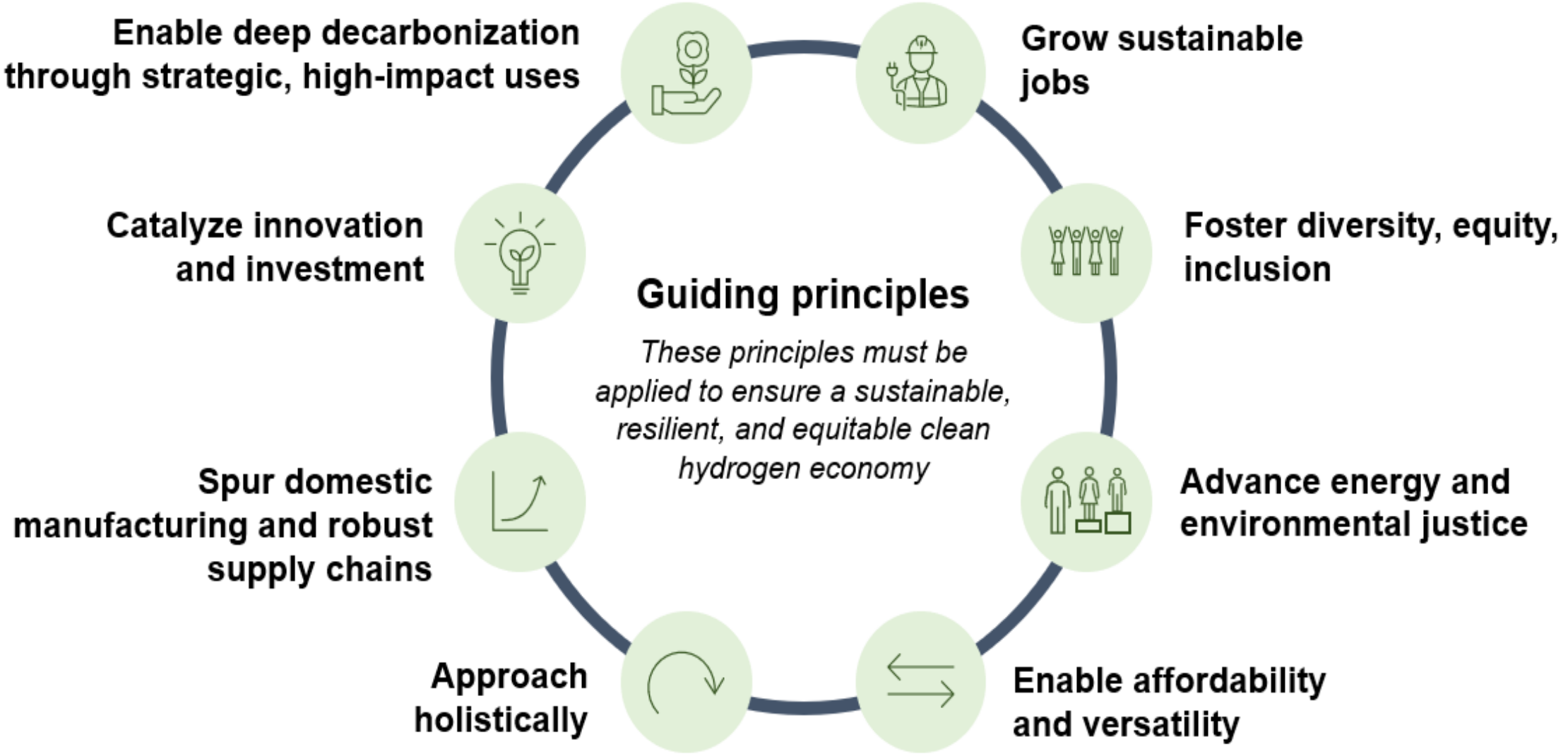
Enablers

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

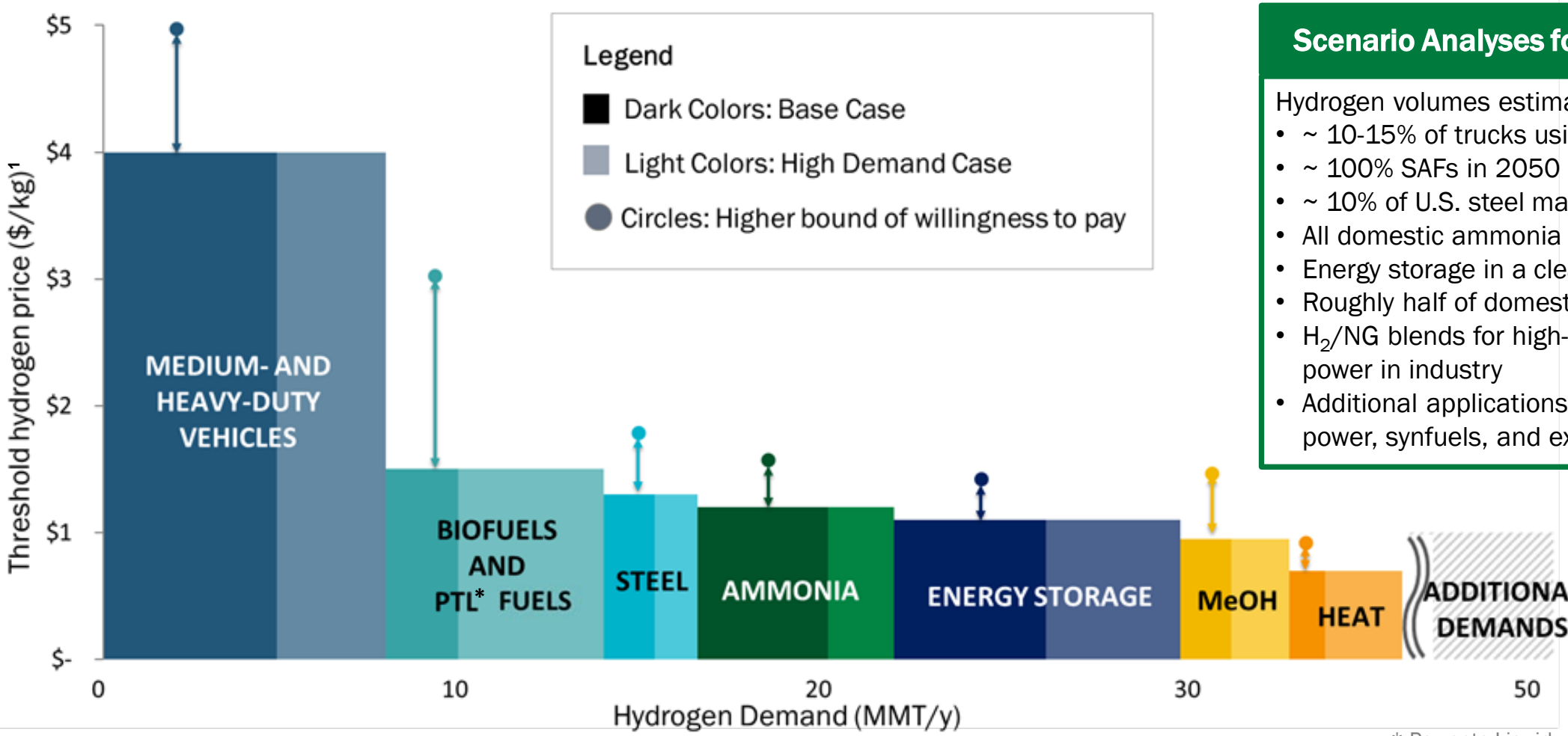
U.S. Opportunity: 10MMT/yr by 2030, 20 MMT/yr by 2040, 50 MMT/yr by 2050. ~10% Emissions Reduction. ~100K Jobs by 2030.

Guiding Principles



Strategy 1: Target High-Impact Uses of Hydrogen

Clean Hydrogen Demand and Costs for Market Penetration



Scenario Analyses for H_2 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
- H_2/NG blends for high-temp heat and power in industry
- Additional applications include stationary power, synfuels, and export potential

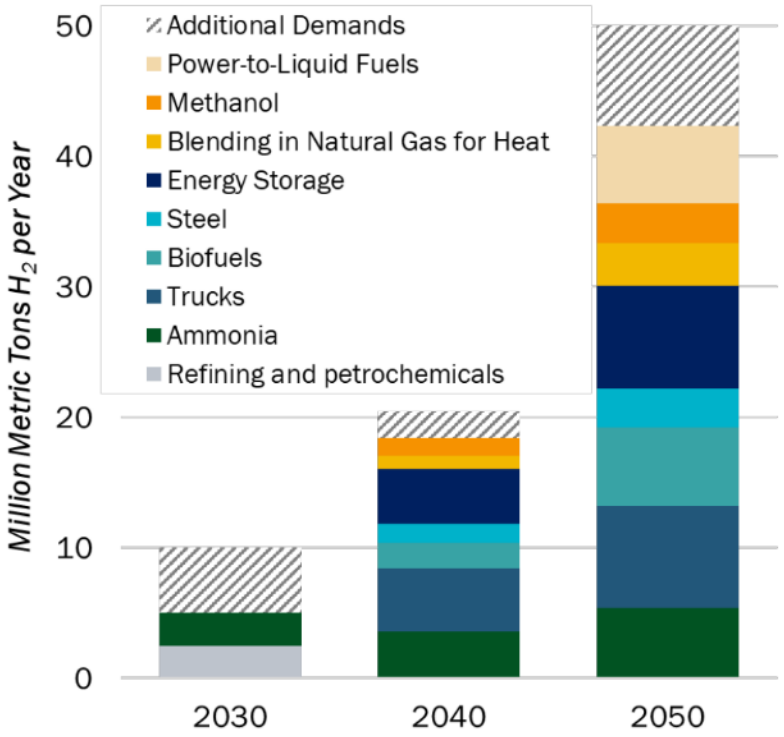
[1]Costs include production, delivery, dispensing to the point of use (e.g., high-pressure fueling for vehicle applications)

* Power to Liquid

** Volumes dependent on multiple variables

Strategy 1: Target High-Impact Uses of Hydrogen

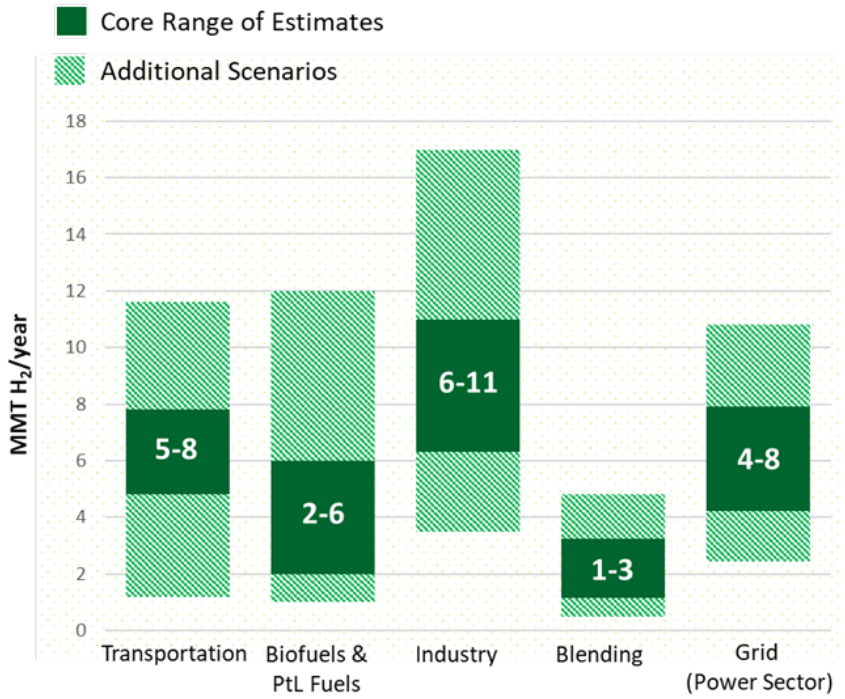
Opportunities for Clean Hydrogen Across Applications



Clean Hydrogen Use Scenarios

- Catalyze clean H_2 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 H_2**
- **Higher range: ~ 36–56 MMT H_2**

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

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

HIT Key Activities and Priorities

Completed – 2023

- ✓ Launched National Strategy (6/23)
- ✓ Launched HIT (Charter 8/23)
- ✓ $7B for 7 Hubs (POTUS-10/23)
- ✓ NPRMs – Tax Credits (45V), GHGs
- ✓ Demand strategy selection
- ✓ Pipeline Safety R&D Forum (11/23)
- ✓ Initial USG Demand Mapping
- ✓ Joint Workshops, Annual Merit Review
- ✓ New projects ($8M) – sensors for leakage, initiated climate studies
- ✓ Initial EJ Listening sessions
- ✓ New RD&D FOAs across value chain (>$1B)

Key Priorities – 2024

- All Hubs awarded; Map to potential demand for offtake
- Fueling corridors; Ports IRA funding strategy for deployments

- Rule activities; Guidance, final rules, verification strategy. Cost updates, initiate exports, resource/water analysis
- New manufacturing projects; Recovery & Recycling consortium

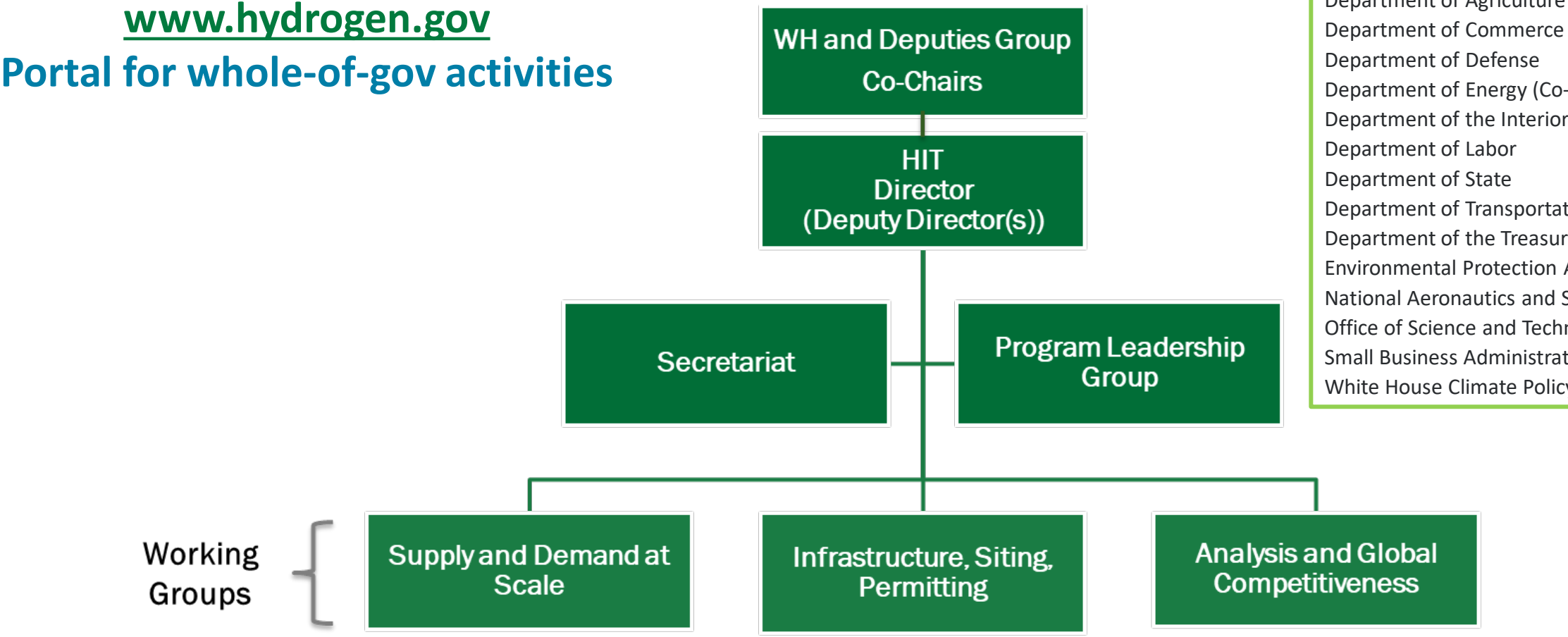
- Identify regulatory requirements and responsibilities across local, state, and federal levels and gaps; infrastructure RD&D needs
- New awards for best practices in siting, permitting, safety

- New projects with communities on lessons learned, best practices
- Develop strategies with industry for responsible deployment
- Develop metrics for impacts on EJ communities
- Initiate workforce strategy, assessment of skill gaps

Industry and Stakeholder Engagement for HIT Priorities

Hydrogen Interagency Task Force (HIT) across Agencies

www.hydrogen.gov
Portal for whole-of-gov activities



Department of Agriculture
Department of Commerce
Department of Defense
Department of Energy (Co-Chair)
Department of the Interior
Department of Labor
Department of State
Department of Transportation
Department of the Treasury
Environmental Protection Agency
National Aeronautics and Space Administration
Office of Science and Technology Policy
Small Business Administration
White House Climate Policy Office (Co-Chair)

JST: Joint Strategy Team. Equity, Energy and Environmental Justice is a cross cutting priority across WGs.

WG Structure and Focus Areas

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

Working Groups

Supply and Demand at Scale

- 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)

Infrastructure, Siting, Permitting

- 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

Analysis and Global Competitiveness

- 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

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. Manufacturing and knowledge management included within each team.

HIT Working Groups Panel Moderator - Pete Devlin, HIT Secretariat

- **Working Groups and Crosscutting Team**
  - Supply and Demand,
    - Oliver Fritz - DOD, Ben Gould - DOE
  - Infrstructure, Siting, Permitting
    - Kandilarya Barakat and Mary McDaniel - DOT PHMSA, Laura Hill - DOE
  - Analysis and Global Competitiveness
    - Neha Rustagi - DOE, Stephanie Grumet - EPA, Maureen Clapper - DOC
  - Workforce and Energy Justice Crosscutting Team
    - Emily Loker, Kelly Crawford, Sara Wylie - DOE

HIT WG – Supply and Demand at Scale

Co-Leads: Oliver Fritz (DoD) and Ben Gould (DOE)

Goal: Develop demand and clean hydrogen supply strategy, enable offtake to catalyze market, and achieve national goals of 10 MMT/year supply and end use by 2030, 20 MMT/year by 2040, 50 MMT/year by 2050

WG Scope

- Enabling large scale demand creation
- Financing, incentives, and compliance tools for commercial scale up
- Metrics for deployment and USG as offtaker
- Ensuring supply chains and resiliency
- RD&D to accelerate cost reductions and end use commercialization (JST interface)

Actions and Milestones

(aligned with *U.S. National Clean Hydrogen Strategy & Roadmap*)

2023 – 2025

- Develop alignment across agencies to leverage funding opportunities and avoid duplication
- Develop first of its kind inter-agency demonstrations of hydrogen end-use and production
- Engage in analysis and workshops to develop opportunities for procurement to meet agency mission and GHG objectives

2026 – 2029

- Connect H_2 hub production to firm offtake with USG partners
- Develop plan and guidance documents for agency procurement of hydrogen and fuel cell technologies

Near Term Objectives

- Quantify potential USG H2 end uses and prioritize options – *Completed by Q3FY24*
- Compare H_2 Hub supply with USG installation maps to identify potential offtake by region – *Completed by Q4FY24*
- Joint TEAs on cost/benefits of resilient energy and mobility at USG installations – *Kickoff Q4FY24*

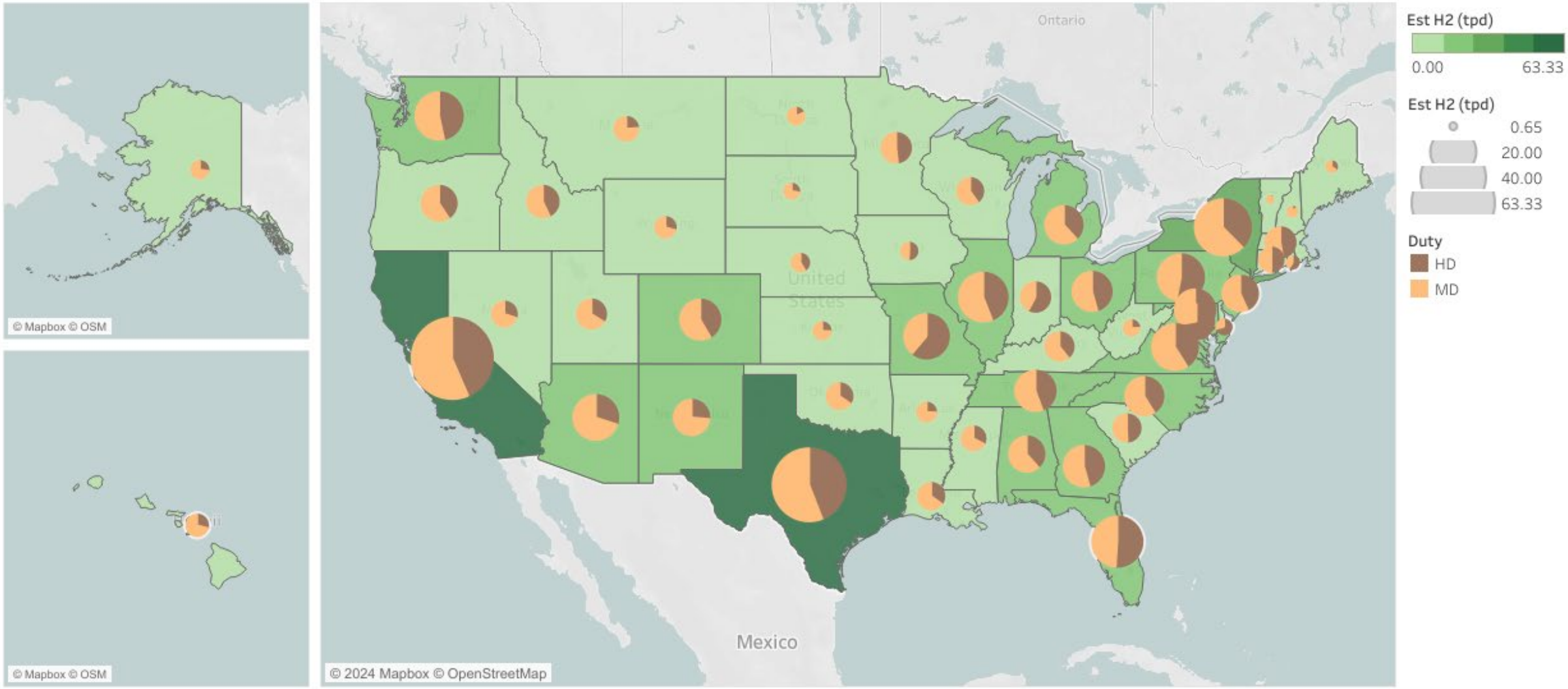
Membership

Co-Leads: DoD, DOE

Members: EPA, DOT (FRA, FAA, FTA, MARAD), DOC, ARMY, USMC, USAF, USDA, NAVY, NASA, USCG, DHS, GSA, NIST, NPS, SBA, USPS

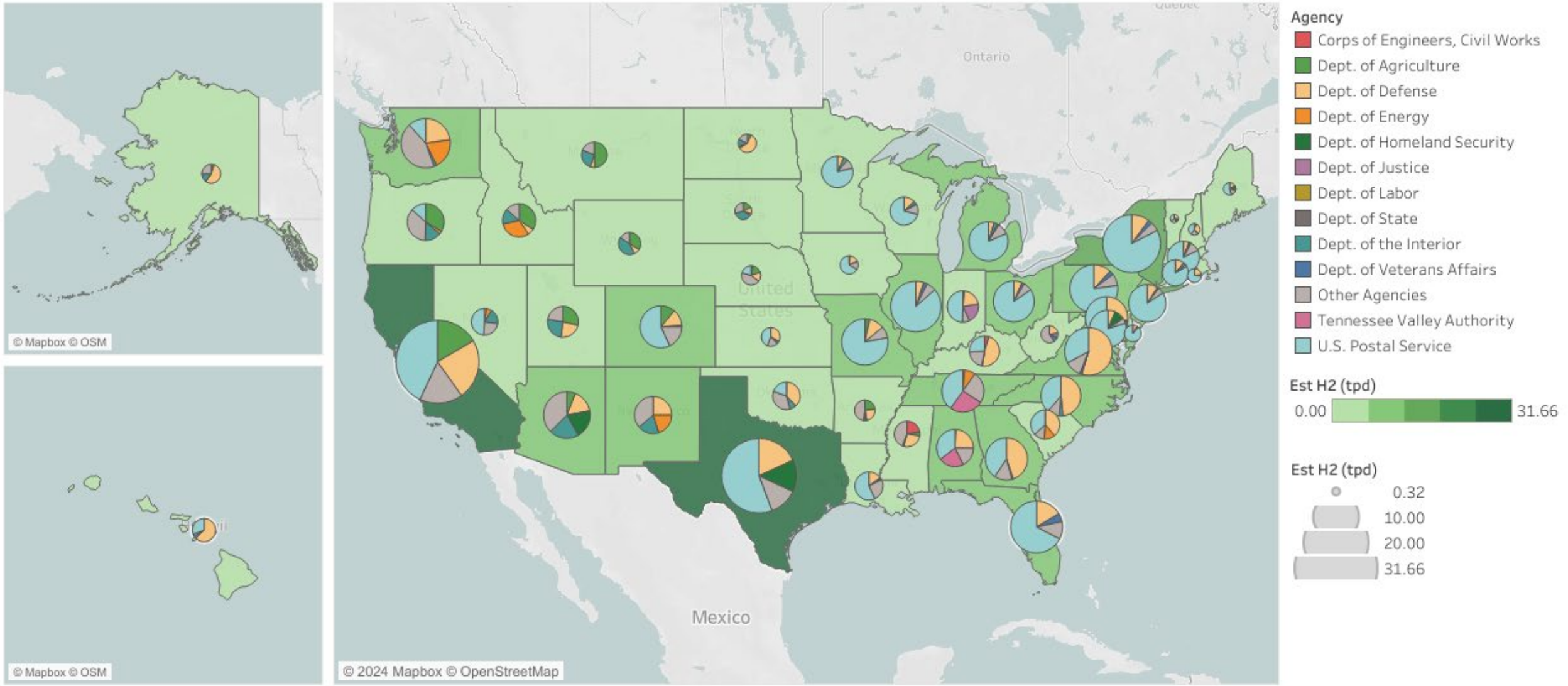
USG Medium- and Heavy-Duty Vehicles by State

Supply and Demand at Scale WG



USG Medium- and Heavy-Duty Vehicle Usage by Agency and State

Supply and Demand at Scale WG



HIT WG – Infrastructure, Siting, and Permitting

Co-Leads: Laura Hill (DOE – HFTO), Mary McDaniel (DOT – PHMSA), Kandilarya Barakat (DOT – PHMSA)

Goal: Address federal regulatory barriers to infrastructure deployment, siting, and permitting to enable national goals of 10 MMT/year supply and end use by 2030, 20 MMT/year by 2040, 50 MMT/year by 2050

WG Scope

- 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

Actions and Milestones

(aligned with *U.S. National Clean Hydrogen Strategy and Roadmap*)

2023 – 2025

- Lay regulatory groundwork for large-scale clean hydrogen deployments across production, processing, delivery, storage, and end-use*
- Develop streamlined guidance on hydrogen pipeline and large-scale project permitting with stakeholder engagement and addressing environmental, energy, and equity priorities*

2026 – 2029

- Enable international harmonization of codes and standards related to hydrogen technologies
- Address regulatory challenges to increase electrolyzer access to renewable and nuclear energy
- Develop national guidance for hydrogen blending limits*

Membership

Co-Leads: DOE HFTO, DOT PHMSA
Members: DOC (ITA, NIST), DOD (USCG), DOE (EJE, FECM, HFTO, OCED, OP), DOI (BOEM), DOL (OSHA), DOT (FAA, FHWA, FRA, FTA, MARAD, NHTSA, PHMSA), EPA, FERC, NASA, WH-CEQ, NRC

** In partnership with Workforce, Equity and Justice Team*

Infrastructure, Siting and Permitting WG Near Term Objectives

- Identify regulatory requirements and responsibilities for deployment across local, state, and federal levels and any gaps. – *Complete January 2024*
- Hold forum on pipeline safety R&D. Document results of PHMSA's, DOE's, other federal agencies, and international R&D on hydrogen and hydrogen blends. – *Complete October 2023*
- Develop lessons learned and best practices on siting, permitting, safety, and infrastructure. – *Ongoing, End CY 2024*
- Identify potential and existing standards and regulatory requirements for hydrogen and blends for pipelines, storage, and infrastructure. – *Expected September 2024*
- Develop interagency plan to address access restrictions for FCEVs in tunnels, bridges, and other enclosed public infrastructure. – *Ongoing, End CY 2024*

Infrastructure, Siting, and Permitting WG Progress

- Completed initial effort to document the jurisdiction of WG member agencies

Infrastructure:

- Conducted DOT PHMSA held Pipeline Safety R&D forum in October 2023
- PHMSA Research Announcement 10, released in April, with 14 research topics including several specific to hydrogen
- Held Hydrogen Infrastructure Priorities to Enable Deployment workshops
  - January – Denver, CO
  - February – Alexandria, VA.
- Formed subgroups on pipelines and ammonia to address key gaps in R&D and regulatory structure

View the PHMSA Research Announcement Here:

Siting and Permitting:

- DOE HFTO FOA includes $6M for Enabling Permitting and Safety for Hydrogen Deployment
- Formed subgroup (with Workforce, Equity and Justice cross-cut team) to identify and address key hurdles related to permitting of large projects (e.g., NEPA)

HIT – Analysis and Global Competitiveness

Co-Leads: Maureen Clapper (DOC), Neha Rustagi (DOE), Stephanie Grumet (EPA)

Goal: Address modeling gaps for national strategy & supply chain vulnerabilities, aligned with achieving national goals of 10 MMT/year supply and end use by 2030, 20 MMT/year by 2040, 50 MMT/year by 2050

WG Scope

- National strategy and commercial liftoff analysis
- Impact and gap assessments
- Intellectual property and global landscape assessment.
- Export market analysis
- Systems integration and optimization
- Supply chain analysis

Actions and Milestones

(aligned with *U.S. National Clean Hydrogen Strategy and Roadmap*)

2023 – 2025

- Assess pathways from lifecycle, sustainability, cost, regional, and equity perspectives to prioritize strategies, determine gaps, and inform interim goals.
- Publish case studies on pathways, emissions, and cost and update GREET capabilities for user-friendliness, transparency, and additional pathways in support of 45V.

2026 – 2029

- Complete robust modeling and improve data collection to quantify climate impacts of hydrogen leakage.
- Develop best practices and guidance to assess life cycle emissions of real-world deployments of clean hydrogen and inform “guarantees of origin” and certification schemes.
- Develop and implement sustainability frameworks and NEPA best practices.

Membership

Co-Leads: DOC, DOE, EPA
Members: DHS, DOC, DOE, DOL, EPA, FERC, DOT- MARAD, NASA, SBA, State, USPS

Analysis and Global Competitiveness WG Near Term Objectives

- Establish RD&D effort on H_2 as an indirect greenhouse gas – *2023, Ongoing*
- Update cost and Commercial Liftoff assessments – *June 2024*
- Conduct supply chain and resiliency analysis – *September 2024*
- Increase resolution of regional information on supply chain in GREET, such as upstream methane – *December 2024*
- Conduct impact assessments on regional water supply and other regional resources – *Ongoing, March 2025*
- Initiate export analysis to identify opportunities and cost – *Ongoing*
- Characterize impacts of incentives and demand-side policies on cost, demand; identify scenarios to meet national goals – *September 2025*
- Develop verification best practices and strategy to ensure clean hydrogen – *June 2025*

Analysis and Global Competitiveness WG Year in Review…

2023 – 2024 Accomplishments

- Completion of analyses and modeling tools with interagency engagement, including-
  - Annual Technology Baseline (ATB)– Transportation (DOE, EPA)
  - Cost assessment of hydrogen fueling infrastructure (DOE, EPA)
- Launch of R&D to improve estimates of global warming potential of hydrogen (DOE/DOC-NOAA)
  - Completed preliminary estimates of change in atmospheric hydrogen over past decades
- Launch of Supply Chain Working Group!

Ongoing Activities

- Analysis to identify export opportunities for clean hydrogen technologies (DOC)
- Enhancement of life cycle analysis models to account for new pathways and variability in real-world assumptions (DOE)
- Rulemaking activities (e.g. New Source Performance Standards for new combustion turbines), which can create demand for hydrogen. (EPA)
- Development of best practices for verification of life cycle emissions (DOE)

HIT – Workforce and Energy Justice Crosscutting Team

Co-Leads: Sara Wylie, Emily Loker, & Kelly Crawford (DOE) in coordination with DOL and other agencies

Goal: Enable a safe, healthy, affordable, sustainable, and resilient clean hydrogen economy by focusing on energy and environmental justice and job quality and meet national goals of 10 MMT/year clean hydrogen and end use by 2030, 20 MMT/year by 2040, 50 MMT/year by 2050

Crosscutting Team Scope

- Develop ways for HIT WGs to identify and help address environmental and energy justice (EEJ) concerns.
- Serve as a resource for equity and labor issues for all WGs/sub-teams
- Create education, engagement, outreach materials, and workforce development strategies
- Identify lessons learned and best practices

Membership

Co-Leads: DOE- EJE, HFTO, OCED, OP, DOL

Members: DOI, EPA, CEQ

Actions and Milestones

(aligned with *U.S. National Clean Hydrogen Strategy & Roadmap*)

2022 – 2025

- Incorporate Community Benefits Plans (CBPs) into funding opportunities
- Develop, update and release HIT-approved educational materials including Common Concerns voiced by communities
- Develop ways to increase community engagement
- Develop recommendations on equitable siting, permitting, and safety
- Define, collect, share regional EEJ priorities
- Define job qualifications, quality, advancement, recruitment strategies for hydrogen workforce: underrepresented communities & apprenticeship programs

2026 – 2029

- Develop and implement Community Benefit Agreements for funded projects
- Develop registered apprenticeship(s) for H2 workforce
- Conduct hydrogen impact assessments on regional water supply and other regional resources

Workforce and Energy Justice Crosscutting Team Near Term Objectives

- Initiate projects *with* communities to identify lessons learned and best practices for CBPs, siting, permitting, and infrastructure – *November 2023*
- Develop strategies *with* industry to advance responsible deployments – *October 2024*
- Develop metrics to measure efficacy and impacts of activities on EJ communities – *June 2024*
- Initiate workforce assessment and skills gaps – *April 2024*
- Develop strategy to work with unions to create/expand registered apprenticeship programs for hydrogen technologies

Please Provide Feedback on Hydrogen Interagency Task Force

Based on the Hydrogen Interagency Taskforce (HIT) presentations and discussion at the Annual Merit Review (AMR), please answer the following questions.

Are the goals and activities of the HIT and its working groups clear and well defined?

Do the activities appear to be focusing on the most important priorities to enable the National Strategy?

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Where do you see the greatest challenges in clean hydrogen technologies from supply through end use in RDD&D?

- How significant are challenges for off-takers?
- How significant are challenges for supply and cost of clean hydrogen?
- How significant is manufacturing scale up to achieve the National Strategy's goals?
- How significant is hydrogen infrastructure (pipelines, storage, liquefaction, etc.)?
- How significant are environmental and/or environmental justice issues (including emissions)?
- How significant is certification/verification of clean hydrogen?
- How significant are issues related to siting and permitting for large deployments?
  - Safety, codes, and standards?
- Please describe other challenges to clean hydrogen technologies.