U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Analysis, Codes & Standards Overview

Neha Rustagi, HFTO – Program Manager

2023 Annual Merit Review and Peer Evaluation Meeting

June 8, 2023 – Arlington, VA

The Hydrogen and Fuel Cell Technologies Office (HFTO)

Mission

Support research, development and demonstration (RD&D) of hydrogen and fuel cell technologies to advance:

- **Clean Energy and Emissions Reduction Across Sectors**
- **Job Creation and a Sustainable and Equitable Energy Future**

Office Sub-Programs

Hydrogen Technologies

- Hydrogen Production
- Hydrogen Infrastructure

Fuel Cell Technologies

- Materials & Components
- Systems

Systems Development & Integration

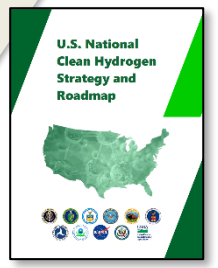
- Transportation
- Industrial and Chemical Applications
- Grid Energy Storage and Power Generation

Data, Modeling, Analysis, Safety, Codes and Standards

Enabling

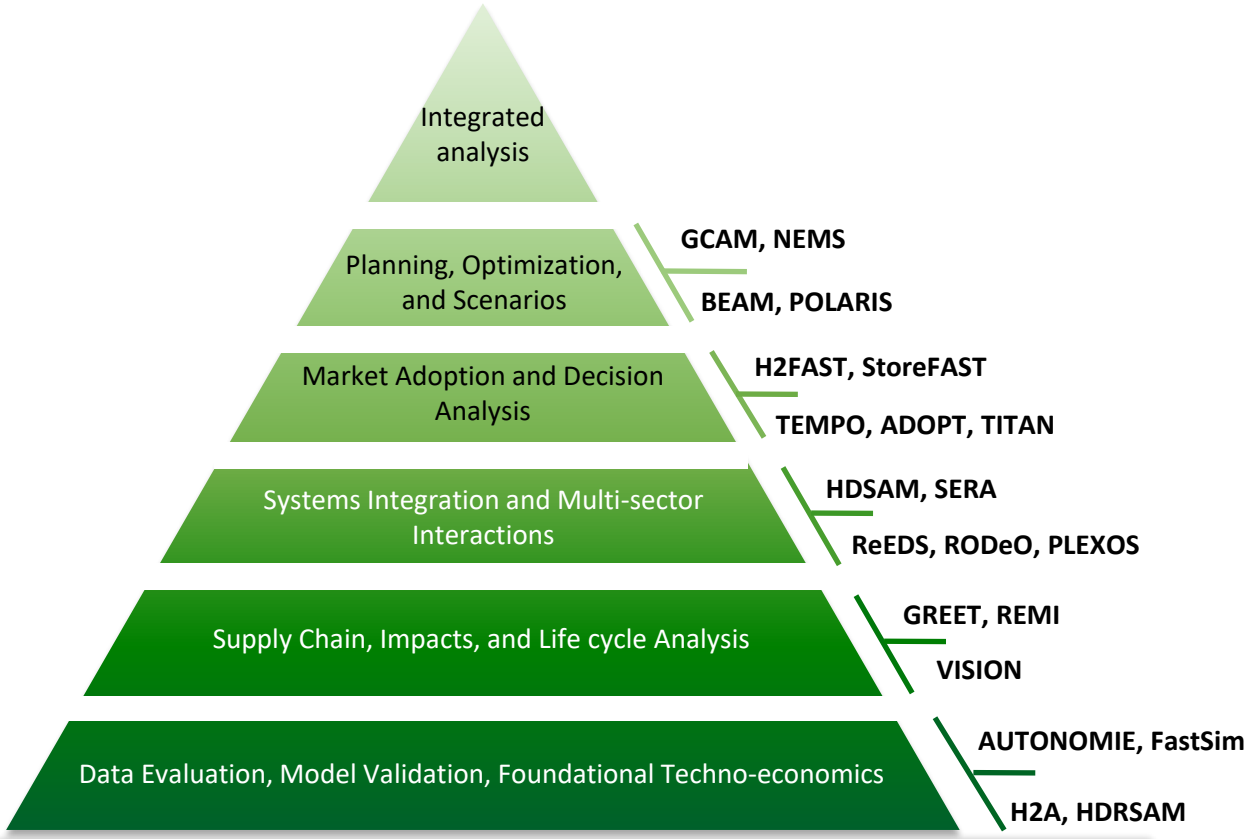
ENERGY earthshots U.S. DEPARTMENT OF ENERGY | Hydrogen

H2@Scale U.S. Department of Energy



Analysis, Codes & Standards Program

Enabling activities to inform research, development, demonstrations and deployments



Systems Analysis identifies priority markets for hydrogen technologies and assesses impacts

Safety, Codes, & Standards informs safe design and operation of technologies, and addresses regulatory and permitting challenges.

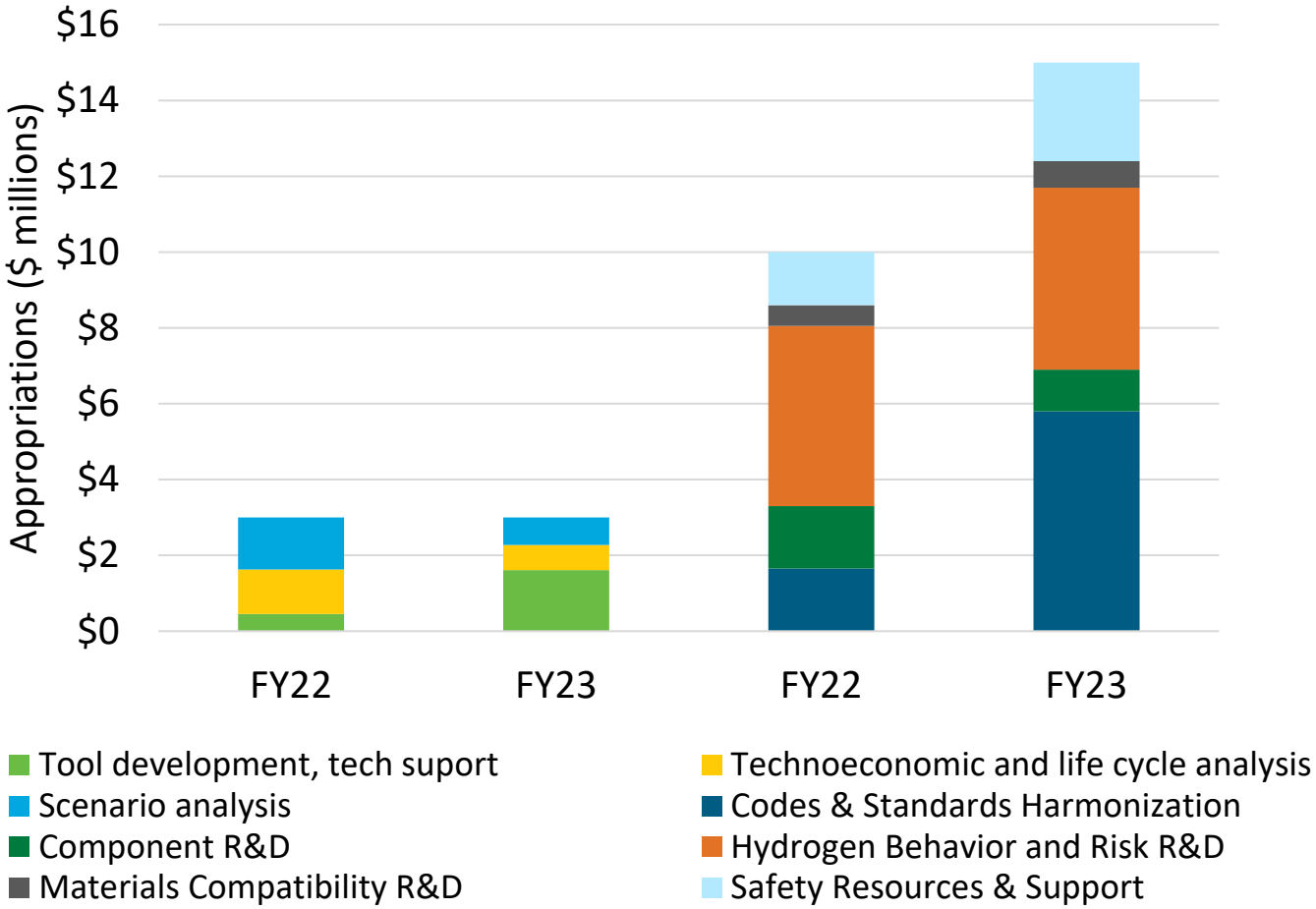
Alignment with U.S. National Clean Hydrogen Strategy & Roadmap

Enabling Activities Supporting All Pillars	2022-2025	2026-2029	2030-2035
Clean Hydrogen Production	Catalyze RD&D in electrolysis, thermal conversion, & new pathways to meet Hydrogen Shot	Demonstrate replicable, scalable production from renewables, nuclear, & fossil and waste with CCS	Deploy gigawatt-scale electrolyzers and develop domestic supply chains	Scale up electrolyzer manufacturing and recycling/reuse capacity	Achieve 10 MMT production capacity and $1/kg target
Delivery and Storage Infrastructure	Identify and prioritize barriers to infrastructure roll out	Initiate supporting infrastructure for regional hubs	Demonstrate advanced and efficient infrastructure components	Develop sustainable regional clean hydrogen networks	Deliver hydrogen at scale
End Uses and Market Adoption	Engage regulators to lay groundwork for strategic adoption across sectors	Initiate transition for hard to decarbonize industries	Deploy regional clean hydrogen hubs	Deploy technologies that lower pollution and provide resiliency	Scale up hydrogen hubs and prepare export opportunities
Enablers	Engage stakeholders; address safety codes and standards; develop critical supply chains	Use and expand workforce, talent pools, and apprenticeship programs	Ensure 40% of benefits accrue to disadvantaged communities in hub regions	Demonstrate business cases and activate private capital	Achieve Justice 40, create good-paying jobs, and ensure public health and safety

Systems Analysis & SCS: Budgets

Systems Analysis
$3M FY22, $3M FY23

SCS
$10M FY22, $15M FY23



Program Direction

Systems Analysis (SA)

- User-friendly tools to characterize cost and emissions of real-world deployments
- Cost and emissions analysis of additional hydrogen production technologies
- Inclusion of hydrogen in energy market models to include H_2 demand scenarios in strategic sectors to enable net zero by 2050

FY24 Request : $3 million

Safety, Codes, & Standards (SCS)

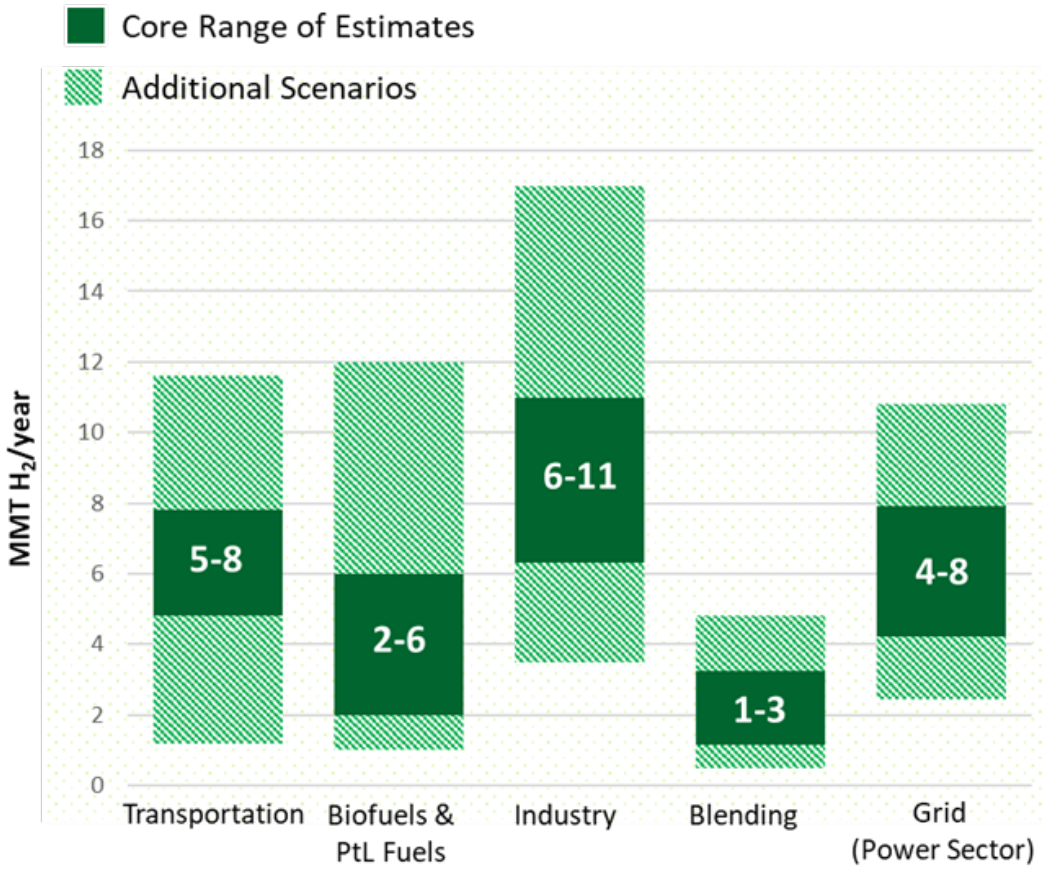
- Approaches to streamline permitting
- Resources on current codes & standards & safety best practices
- Codes & standards R&D (release behavior, sensors)

FY24 Request: $10 million

Systems Analysis Focus Areas

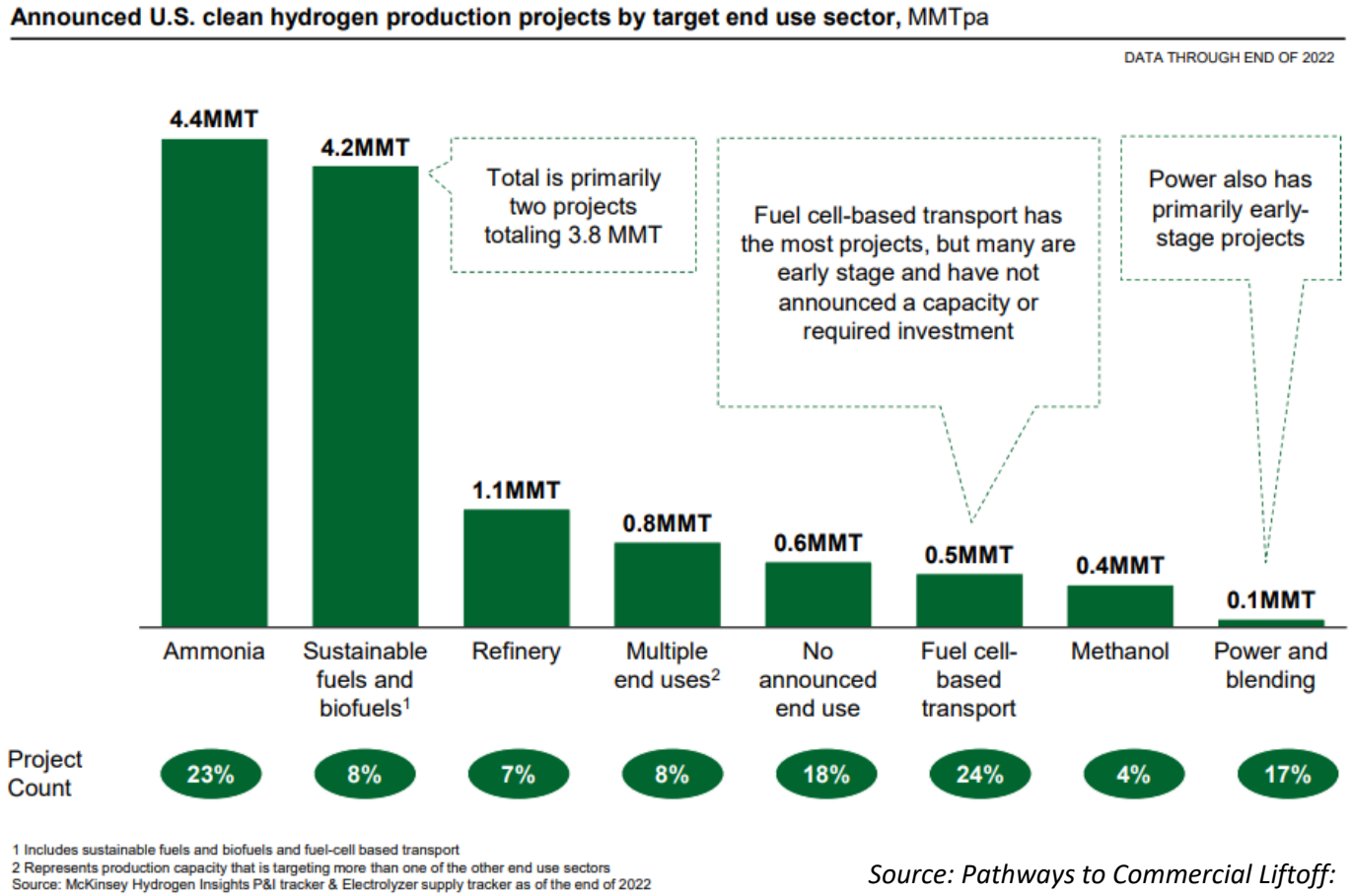
Analyses focused on near-term and future costs, emissions, and market potential

Potential Hydrogen Demands in 2050



Source: National Clean Hydrogen Strategy and Roadmap

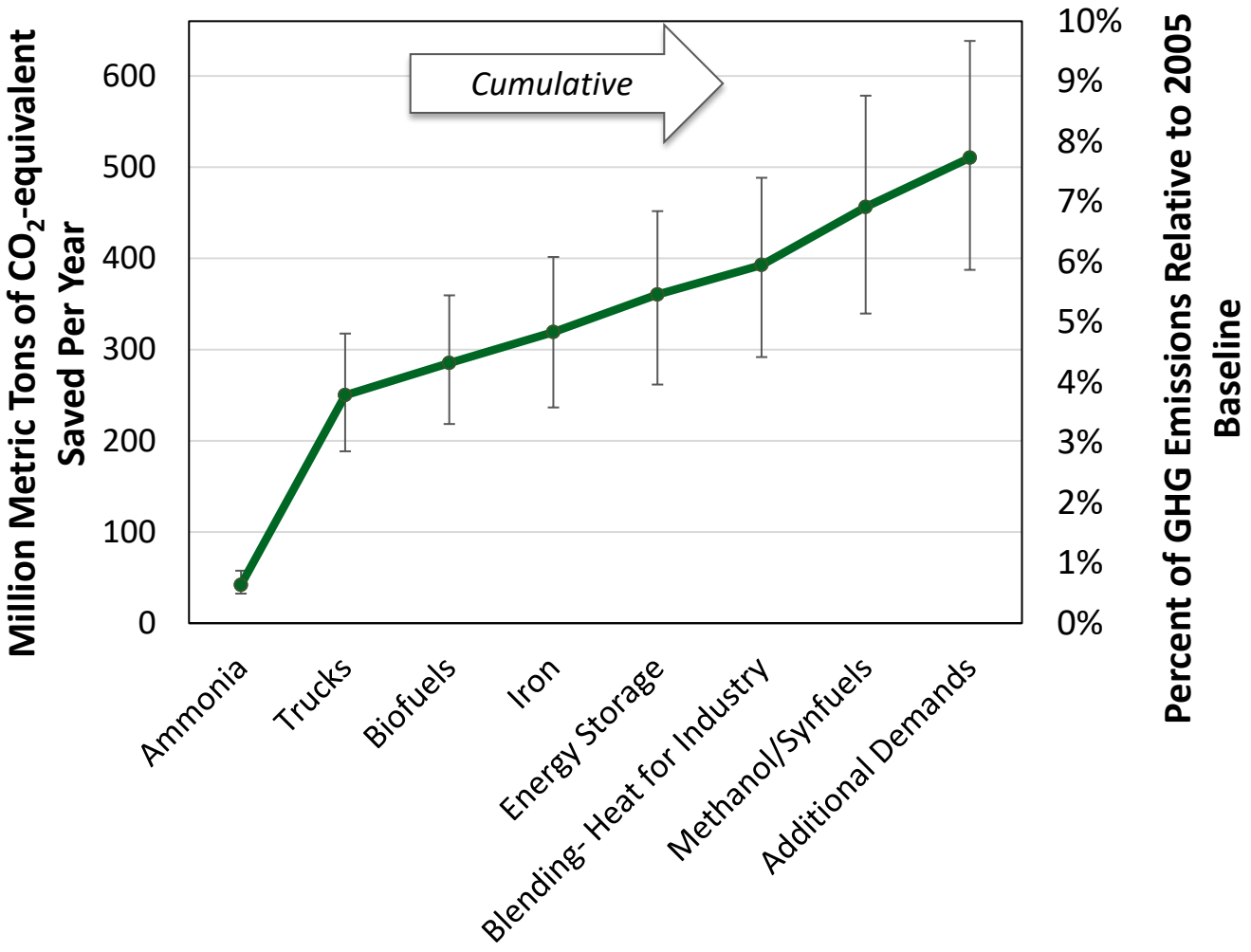
Announced Hydrogen Deployments



1 Includes sustainable fuels and biofuels and fuel-cell based transport
2 Represents production capacity that is targeting more than one of the other end use sectors
Source: McKinsey Hydrogen Insights P&I tracker & Electrolyzer supply tracker as of the end of 2022

Source: Pathways to Commercial Liftoff: Clean Hydrogen

Activities Identifying Priority Sectors for Hydrogen



By 2050, clean hydrogen can enable ~10% reduction in emissions relative to 2005

Analyses in FY23 focused on quantifying benefits and impacts of H_2

Ongoing and future analysis aimed at:

- **Launch of web-based GREET module**
- Cost and emissions of new H_2 production technologies
- Development of sustainability criteria
- Assessments of indirect impacts
- Harmonize methods of life cycle analysis internationally
- Advancing market models (e.g. GCAM, NEMS) to quantify hydrogen demand in net zero economy

User-friendly Analysis Tools

New Tools to Characterize User-Defined Systems

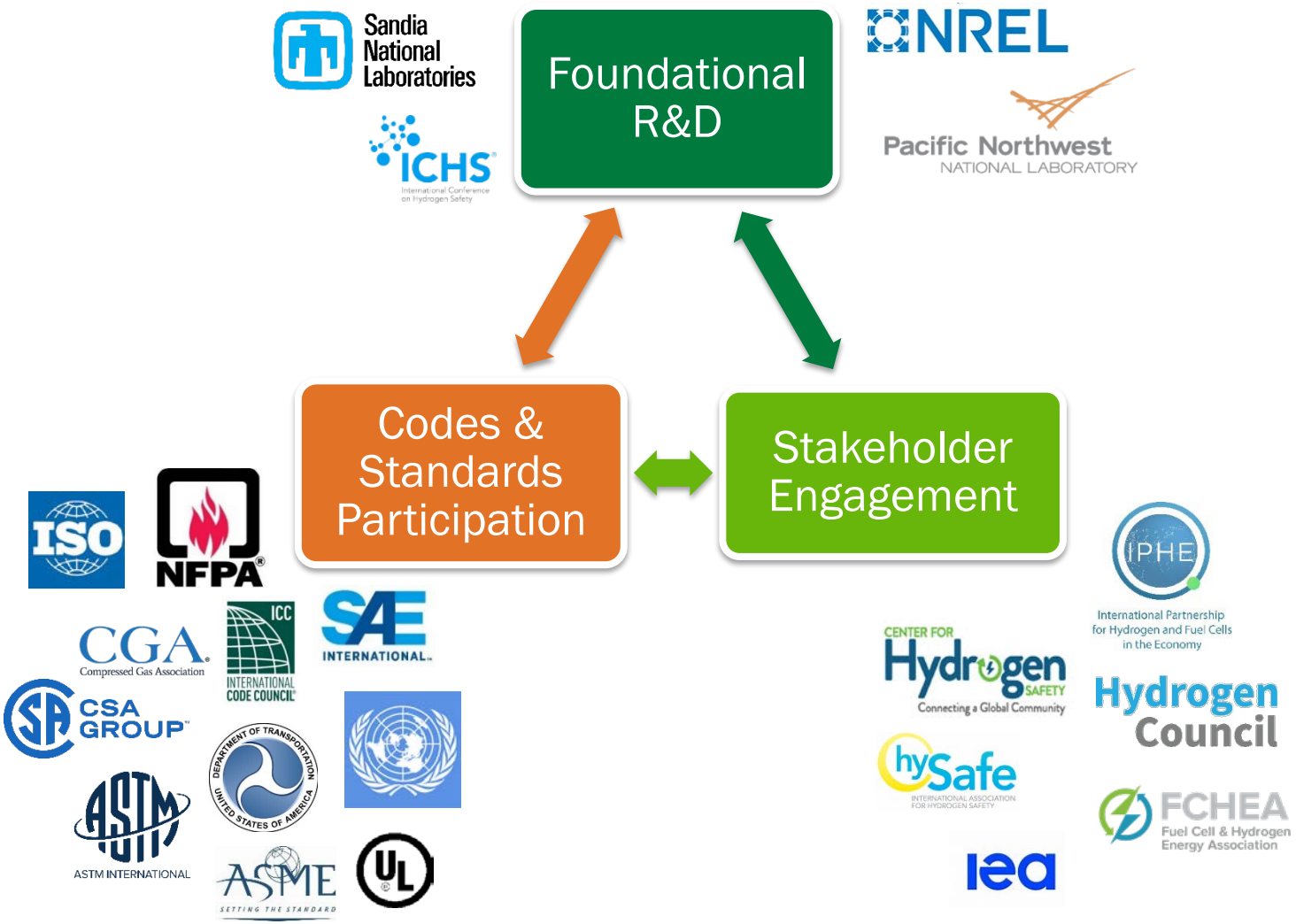
- GREET Hydrogen Interface (Argonne National Laboratory) characterizes well-to-gate emissions of hydrogen production
- H2A Lite launched by National Renewable Energy Laboratory to characterize cost of hydrogen production

Ongoing Activities

- GREET Train the Trainer Program: Fellowships in life cycle analysis
  - Interested applicants with experience in LCA can learn more at www.zintellect.com (Keyword: GREET train)
- ISO Code Committee on life cycle analysis of hydrogen production and infrastructure
- Development of sustainability criteria for hydrogen deployments (NREL, Mission Innovation)

Safety, Codes, and Standards Focus Areas

Collaborative Ecosystem



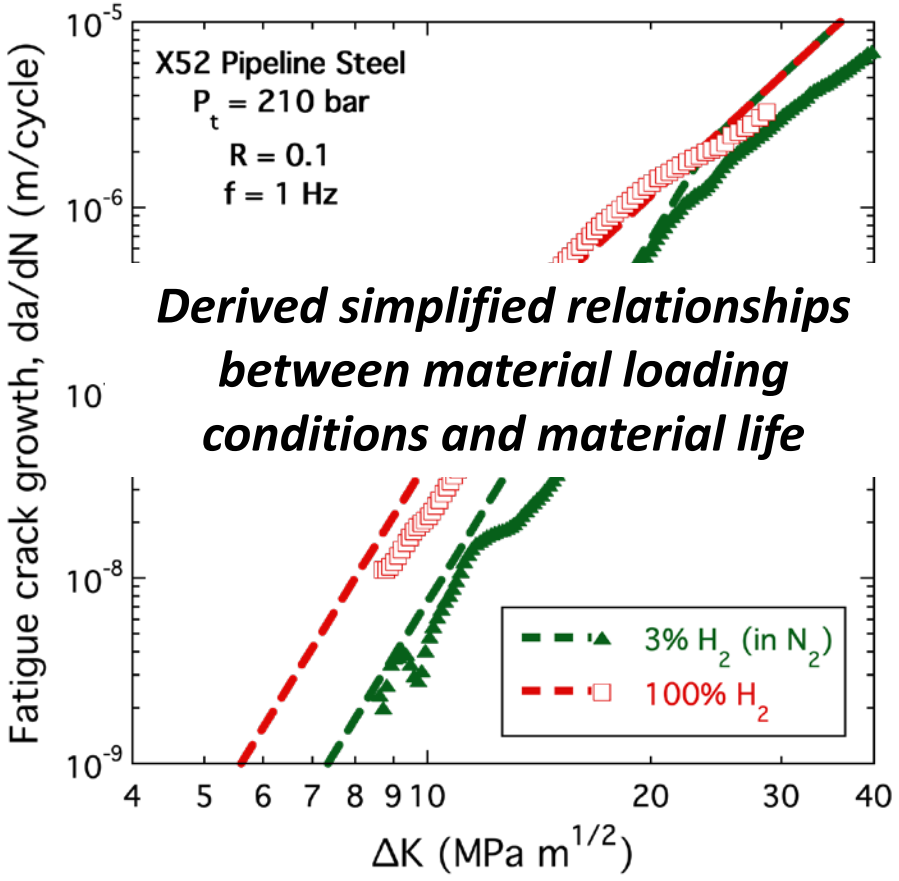
Activities Focused on Cross-Cutting Challenges

- Identifying and addressing regulatory challenges
- Harmonization of codes & standards
- Advancement of sensor technologies
- Risk & Behavior R&D
- Materials compatibility R&D
- Safety Resources & Support

Foundational RD&D to Inform Codes and Standards

Sandia National Laboratories

Reducing testing burden associated with new pipeline steels (SCS005)



Derived simplified relationships between material loading conditions and material life

Reducing setback distances from LH_2 Bulk Storage (SCS010 & SCS011)

HyRAM+
Hydrogen Plus Other Alternative Fuels Risk Assessment Models

- **Modeling and simulations using HyRAM+ in collaboration with industry led to revision of NFPA-2 liquid bulk storage setback distances**
- **Technical justification published in 2023 and will inform future work**

Understanding Indirect Impacts of Hydrogen Releases

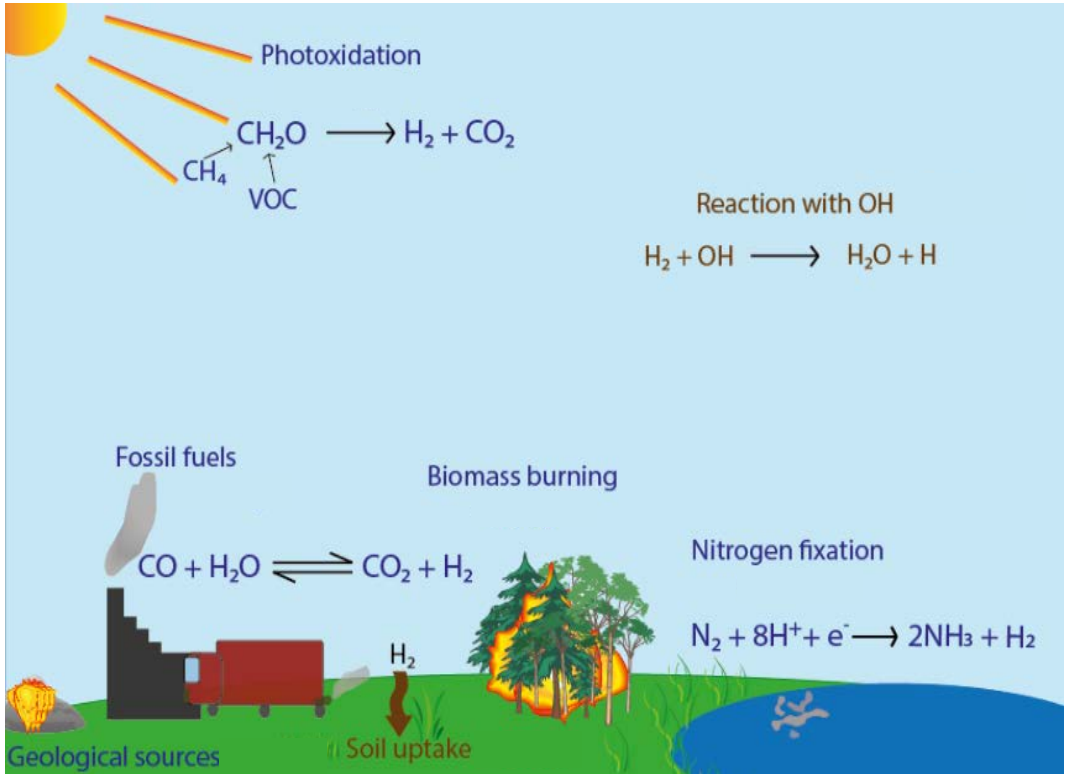
Understanding H_2 as an Indirect GHG

Interagency Agreement with NOAA Climate Program Office

- **$2.2M funding over 3 years for analysis and data collection**
- Improve hydrogen cycle modeling
- Better understand rates of hydrogen uptake in soil
- Develop more precise estimates of indirect warming impacts

Recent Activities to Measure H_2 Releases

- Data collection at NREL on leak rates and sensor performance (SCS001 & SCS021)
- **FY22 $8.6M funding announced for R&D on ppb-level sensors**
- FY23 SBIR topic on leak quantification technologies (2 projects selected)



Estimates of GWP of hydrogen as an indirect GHG require addressing uncertainty around atmospheric and soil sinks

Image Source: Sand, M., Myhre, G., Sandstad, M., & Skeie, R.B. (2020). "Atmospheric Impacts of Hydrogen as an Energy Carrier".

NEW! SCS Technical Assistance Program

Lab Technical Assistance for Small U.S. Projects where Timely Support is Essential

Projects that integrate information sharing and inform near-term deployment activities encouraged

Example Activities Include

PNNL

- Assist incident investigations
- Support questions from AHJs
- Inform and review outreach materials on hydrogen safety
- Present topical webinars
- Provide virtual training

Please contact: hsp@h2tools.org

For ongoing support in safety topics, please explore the Center for Hydrogen Safety

SNL

- Conduct risk assessments
- Develop models and diagnostics for measuring behavior of hydrogen releases and flames
- Answer questions regarding hydrogen-metal material interactions

Please contact:

H2_SCS_Technical_Assistance@sandia.gov

NREL

- Evaluate hydrogen sensors
  - Metrological performance (in air/nitrogen)
  - Use in pure hydrogen and natural gas blends
- Support performance testing of hydrogen contaminant detectors

Please contact: HSRD@groups.nrel.gov

Examples of International Collaborations

CLEAN ENERGY MINISTERIAL
Advancing Clean Energy Together

IEA

HYDROGEN INITIATIVE
AN INITIATIVE OF THE CLEAN ENERGY MINISTERIAL

CLEAN HYDROGEN MISSION

MISSION INNOVATION

hySafe
INTERNATIONAL ASSOCIATION FOR HYDROGEN SAFETY

CENTER FOR Hydrogen SAFETY
Connecting a Global Community

FCH
FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

IPHE
The International Partnership for Hydrogen and Fuel Cells in the Economy
Enabling the global adoption of hydrogen and fuel cells in the economy

Hydrogen Production Analysis (H2PA) Task Force

New white Paper Describing Best Practices Associated with Emissions Published in 2022

Regulations, Codes, Standards, and Safety Working Group

Final reports from Bulk Storage and Marine Task Forces coming soon!

www.iphe.net

Hydrogen Shot Fellowship

The U.S. Department of Energy (DOE) is looking for talented, bright, early career professionals to partner with DOE Hydrogen Program Managers working to achieve the Hydrogen Energy Earthshot goal of $1 per 1 kilogram in 1 decade (“1 1 1”).

Are you graduating soon or just starting your career in hydrogen?

Do you want to help make clean hydrogen affordable for all?

The Hydrogen Shot Fellowship might be the opportunity you’re looking for!

Apply today at: www.zintellect.com Keyword: Hydrogen Shot

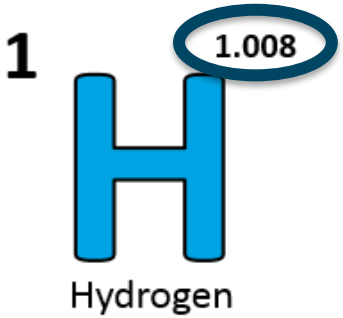
Resources and Opportunities for Engagement

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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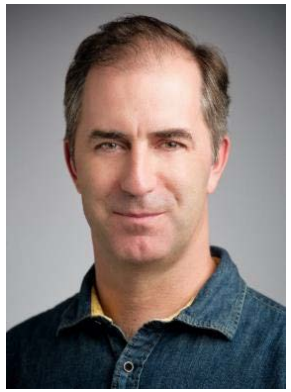
Learn more at: energy.gov/eere/fuelcells AND www.hydrogen.energy.gov

The Dream Team!

Systems Analysis Sub-Program Team



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Ongoing projects will be presented in the Analysis, Codes & Standards track on June 8

Safety, Codes & Standards Sub-Program

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Vacancies for feds, fellows, and contractors!

Session Logistics

General Information

- This meeting is a review, not a conference
  - **Questions will be taken first from reviewers**, and then from other audience members as time allows
  - Remote reviewers are reminded to enter their questions in CHAT
  - Remote general attendees can enter questions or comments into Q&A
- The schedule will be strictly followed so that reviewers can move between sessions
- Presentations are 20 minutes followed by 10 minutes Q&A

Thank You, Reviewers!

Your input on our Program and subprograms helps guide our decisions.

Thank you for your thoughtful, objective, and timely feedback!

Thank you!

Neha Rustagi

Analysis, Codes and Standards Program Manager

Hydrogen and Fuel Cell Technologies Office

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www.energy.gov/fuelcells

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