

# Overview of the U.S. DOE HFTO Safety Codes & Standards Activities

**Christine Watson, ORISE Fellow**

Hydrogen and Fuel Cell Seminar, Safety Codes & Standards Session

February 8, 2023

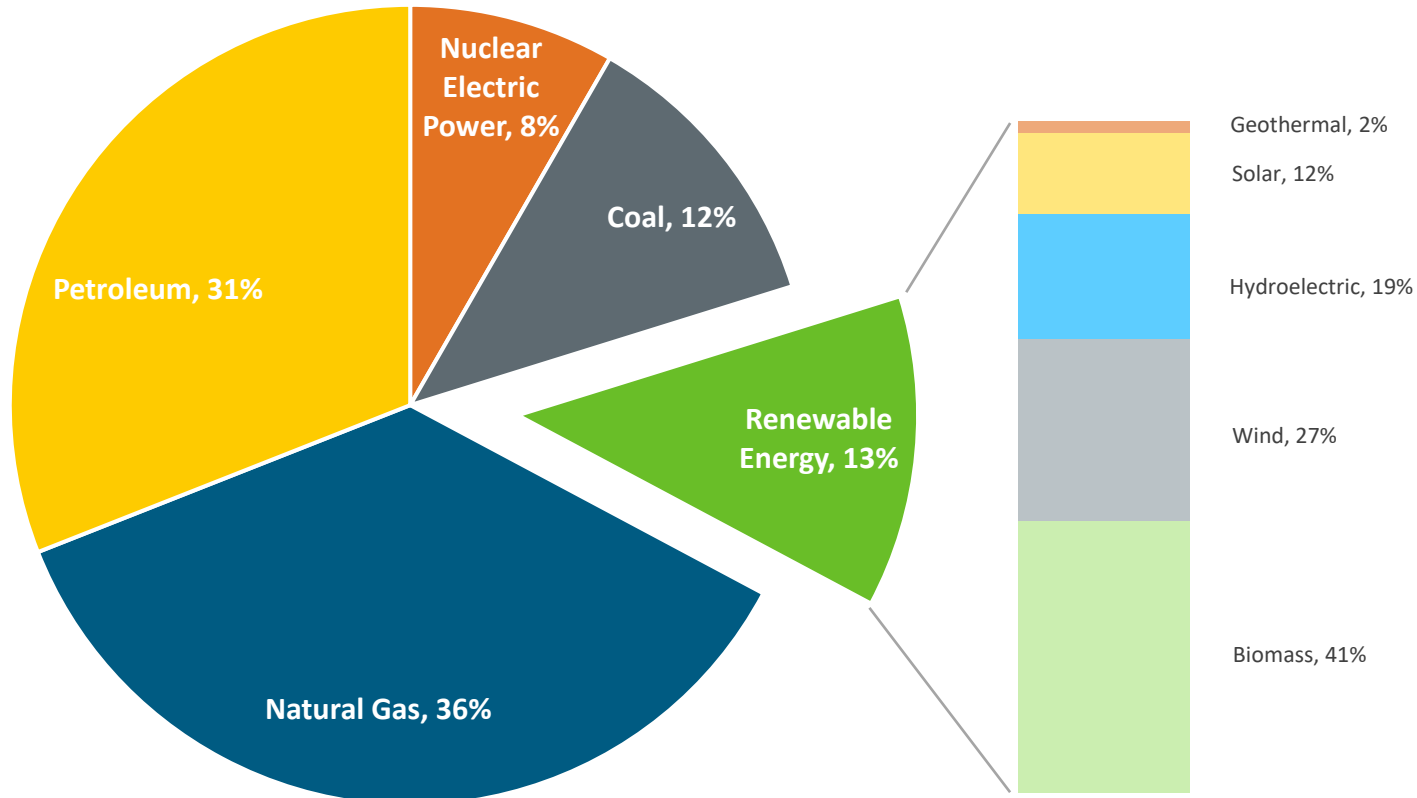


# U.S. Energy Landscape and Key Goals

## U.S. primary energy consumption by energy source, 2021

Total = 97.8 quadrillion  
British thermal units (Btu)

Total = 12.3 quadrillion Btu



**Note:** Sum of components may not equal 100% because of independent rounding  
**Source:** Data collected from U.S. Energy Information Administration, April 2022, *Monthly Energy Review*, preliminary data

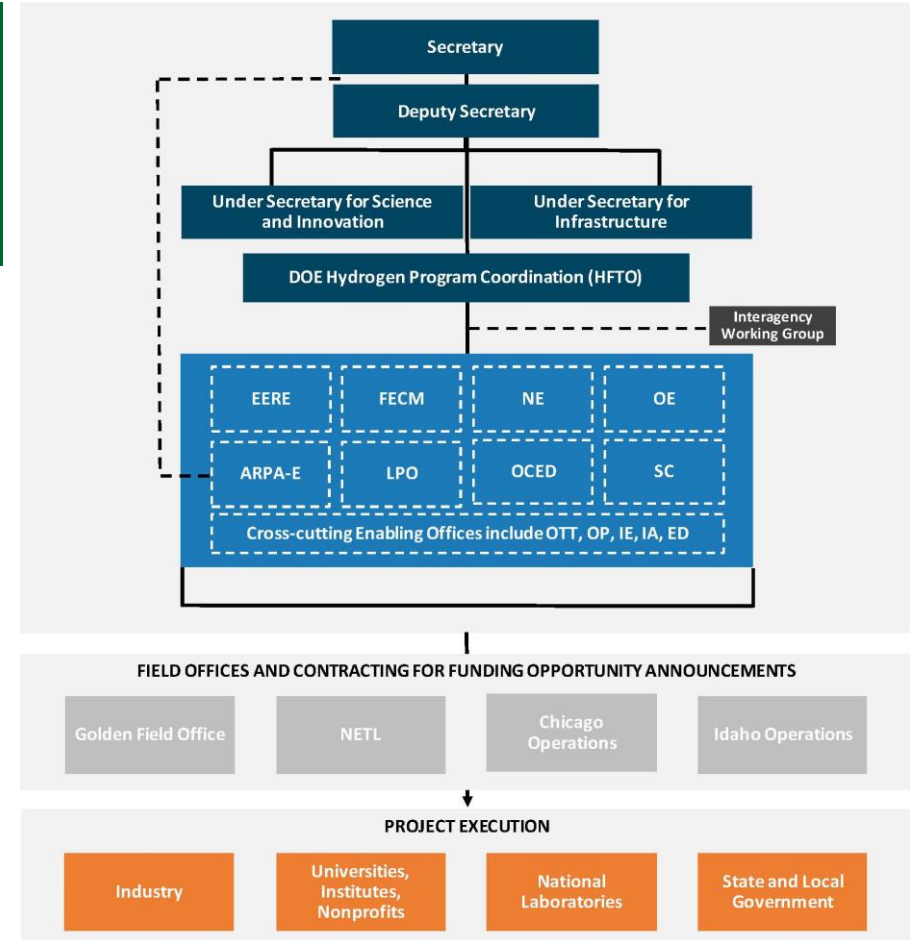
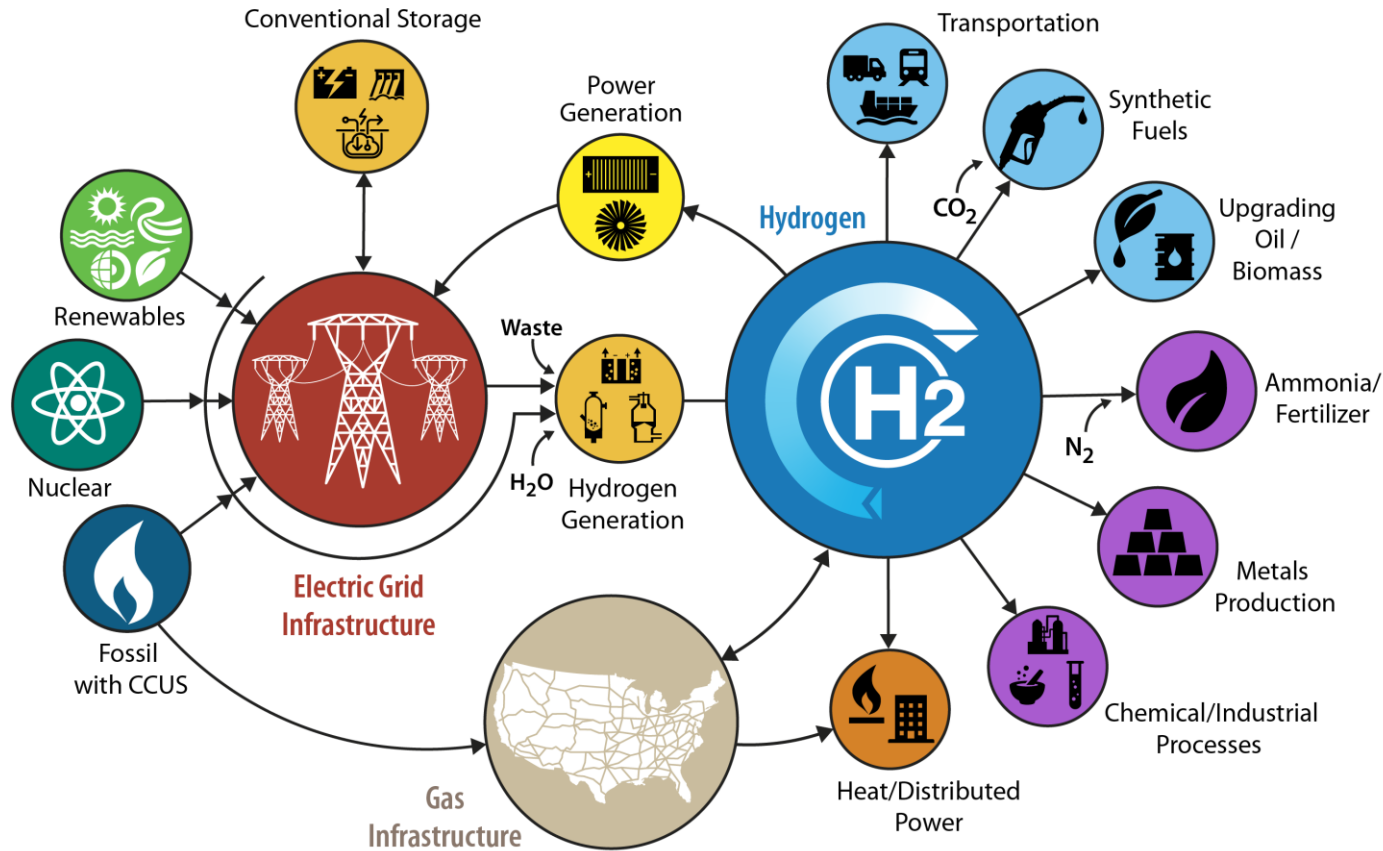
## Administration Goals include:

- **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**

# U.S. DOE Hydrogen Program

Hydrogen is one part of a broad portfolio of activities  
Includes multiple offices and the entire RDD&D value chain from  
production through end use



Coordinated across Offices by DOE Hydrogen and Fuel Cell Technologies Office (HFTO)

[www.hydrogen.energy.gov](http://www.hydrogen.energy.gov)

# Hydrogen Safety: An Overarching Priority

*Enabling the safe deployment of hydrogen and fuel cell technologies*



## Codes & Standards

- **Goal:** Support and facilitate **development and revision of essential codes and standards** to enable widespread deployment of hydrogen and fuel cell technologies  
**Approach:** Conduct **RD&D to provide scientific basis** needed to define requirements in developing and revising codes and standards

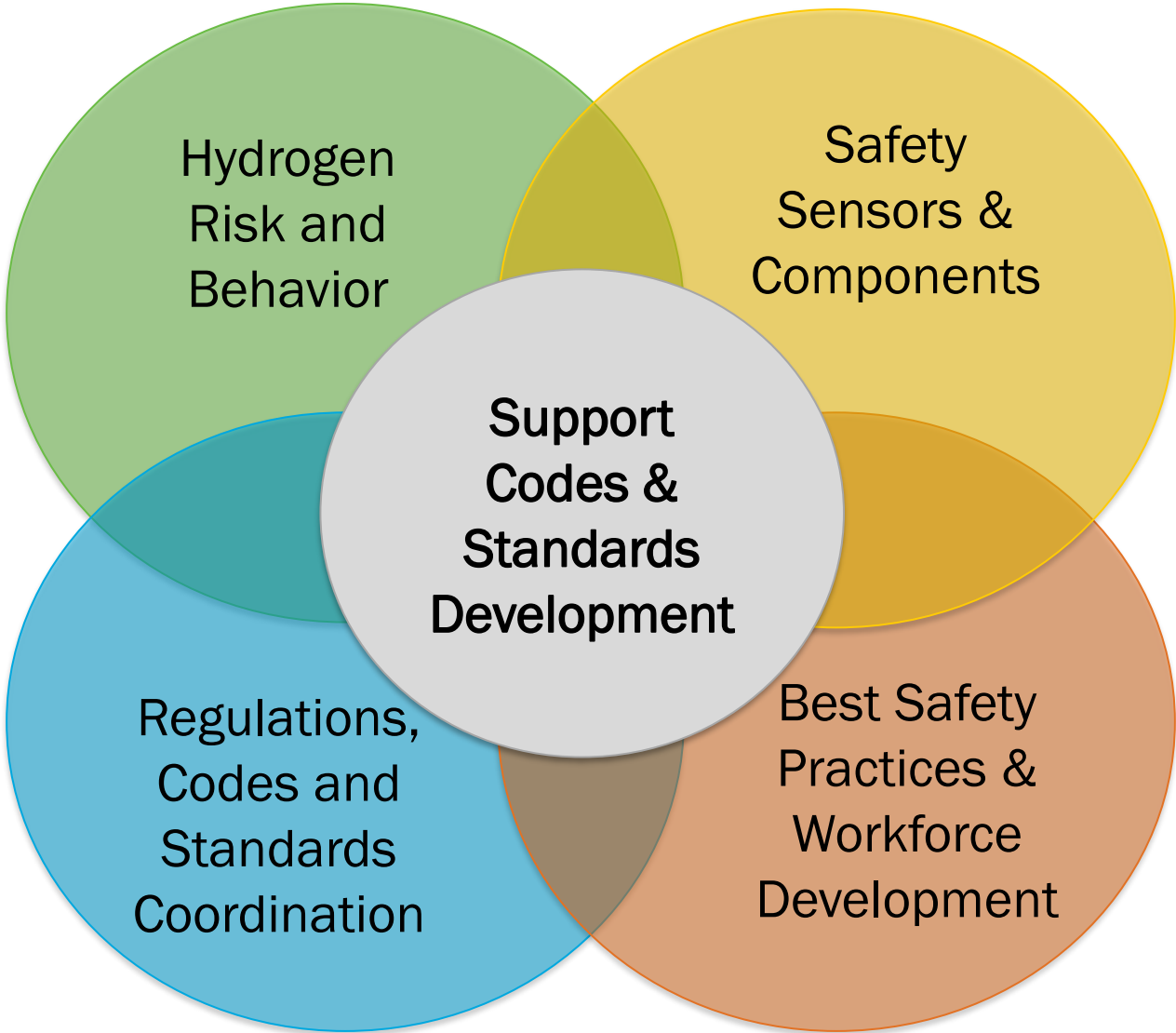


## Safety

- **Goal:** Support **best safety practices** for hydrogen and fuel cell deployments
- **Approach:** Develop and enable **widespread sharing of safety-related information resources** and lessons learned with key stakeholders. Conduct **workforce development** activities with an emphasis on safety practices and culture.



# SCS Portfolio





# Risk and Behavior

# FY23 Projects: Risk and Behavior

## Sandia National Laboratories

- Bulk Storage Behavior & Risk
- Blends Release Behavior
- Ignited Behavior & Mitigation (Hydrogen & Blends)
- **New!** HyRAM+ Blends Capability
- **New!** HD Tunnel/Bridge Risk Reference Scenarios (Collaboration with FHWA)

## Heavy-Duty Risk CRADAs

- **NEW!** **Large-Scale Hydrogen Storage Risk Assessment (PNNL/SNL/Seattle City Light and Port of Seattle):** Risk assessment to inform consideration of hydrogen use for a range of applications, including cargo handling equipment, harbor vessels, and port operations support
- **NEW!** **Risk Assessments of Design and Refueling for Hydrogen Locomotive and Tender (SNL/Wabtec):** Risk assessments on a hydrogen-powered locomotive and tender design, as well as for fuel transfer operations, to support near-term deployment
- **NEW!** **Modeling and Risk Assessment of Hydrogen/Natural Gas Blends (Sandia/PCRI):** Risk assessments of blended hydrogen and natural gas systems compared to that of a pure natural gas system





# Components



# FY23 Projects: Components

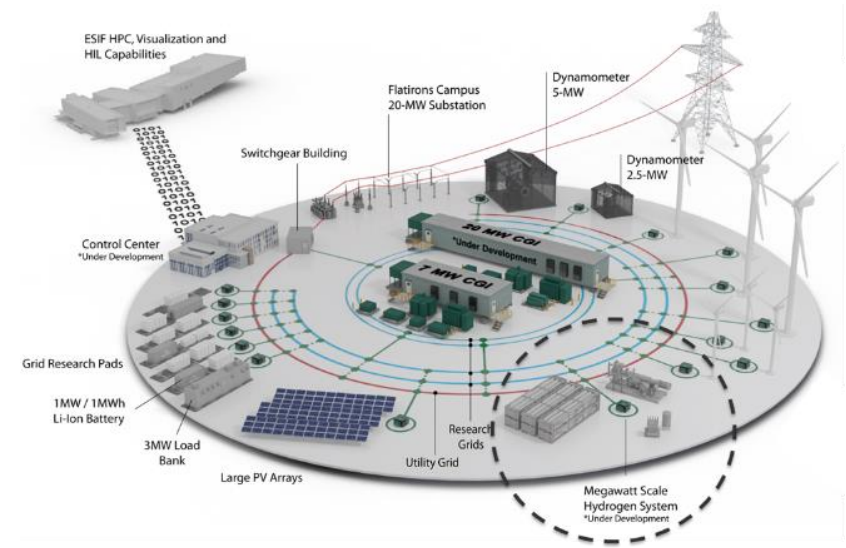
## NREL

- Sensor Performance & Utilization
- Hydrogen Wide Area Monitoring
- **New!** PPB Sensor Validation Capability Development
- **New!** Hydrogen Emissions Measurements at ARIES (in collaboration with NOAA)

## CRADAs

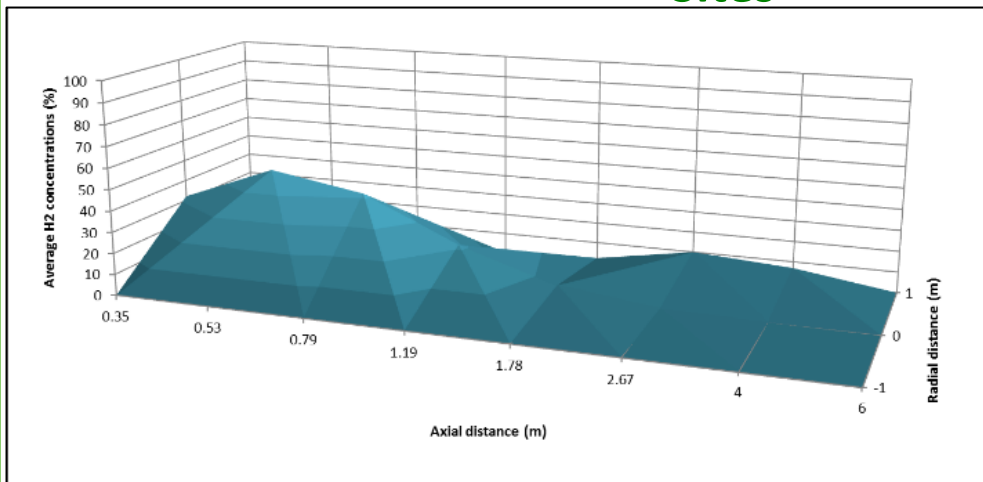
- NREL H35HF MC Method
- **NEW!** Advanced Sensor R&D (NREL/Partners)
- **NEW!** HD Fueling Methods (NREL/Partners)

**NEW! SBIR Phase I Commercialization of Electrochemical Hydrogen Contaminant Detector (Intellisense / LANL)**



# Activities to Monitor Releases & Mitigate the Environmental Impact of H2

## NREL - Smart Distributed Monitoring for Unintended Hydrogen Releases in Enclosures and Outdoor H2@Scale Demonstration Sites



### Goals:

- Lab characterization & validation of several sensor technologies
- Indoor and outdoor modeling, characterization of releases, and sensor deployment guidance



*Controlled LH2 release profiled by NREL's HYWAM point-based sensor apparatus*

## Monitoring the Environmental Impact of Hydrogen

“Clean Hydrogen JU Expert Workshop on Environmental Impact of Hydrogen” (Co-hosted by DOE & European Commission, March 30 - April 1, 2022) identified technical gaps such as:

- Robust sensor and monitoring technology
- Reduction of intentional and unintentional hydrogen releases
- Improved modeling of hydrogen releases & atmospheric impact
- [Workshop Report](#)

### Next Steps:

- Collaboration with NOAA to improve modeling of atmospheric hydrogen and its impact.
- Support R&D activities to address these gaps, including monitoring and mitigation of hydrogen releases from production to end-use



# Safety and Workforce Development

# FY23 Projects: Safety & Workforce Development

## Pacific Northwest National Laboratory

### Hydrogen Safety Panel

- Coordination with Center for Hydrogen Safety
- Safety Training Materials for First Responders, Industry, Academia
- Safety Planning
- **New!** Request Form for HSP Support

[https://h2tools.org/form/request-for-hydrogen-safety-pane](https://h2tools.org/form/request-for-hydrogen-safety-panel)

## Hydrogen Education for a Decarbonized Global Economy (H2EDGE)

- EPRI-led project to address workforce development at all career levels
- Incorporate hydrogen technology and its applications at partnering institutions into educational products
- Develop and deliver professional training courses and university curriculum content
- Develop certifications, credentials, qualifications, and standards for training
- **Opportunities for other universities to participate as affiliate universities:** <https://grided.epri.com/H2EDGE.html>

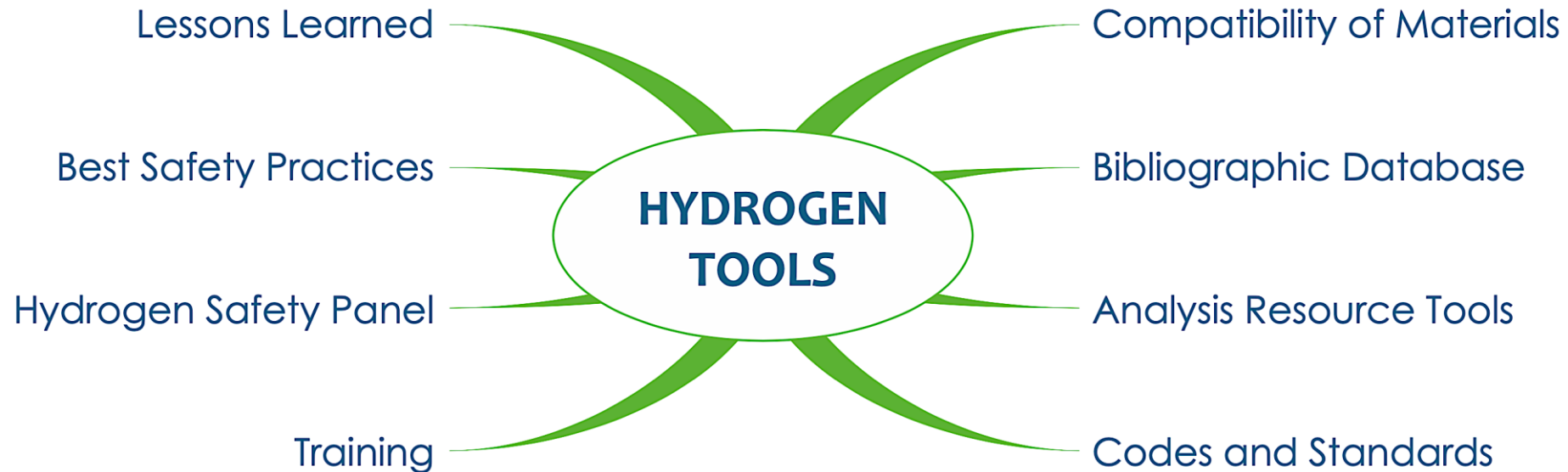


**NEW!** Building Connections between HBCUs and the Hydrogen Industry



# Enabling Deployment Through Safety Knowledge Resources

*Significant hydrogen safety resources in one location: [H2Tools.org](https://www.h2tools.org)*



- Supports implementation of the safe handling practices and procedures
- Aggregates a variety of tools and web-based content on safety of hydrogen
- Informs designers, stakeholders and first responders



**HydrogenTools**

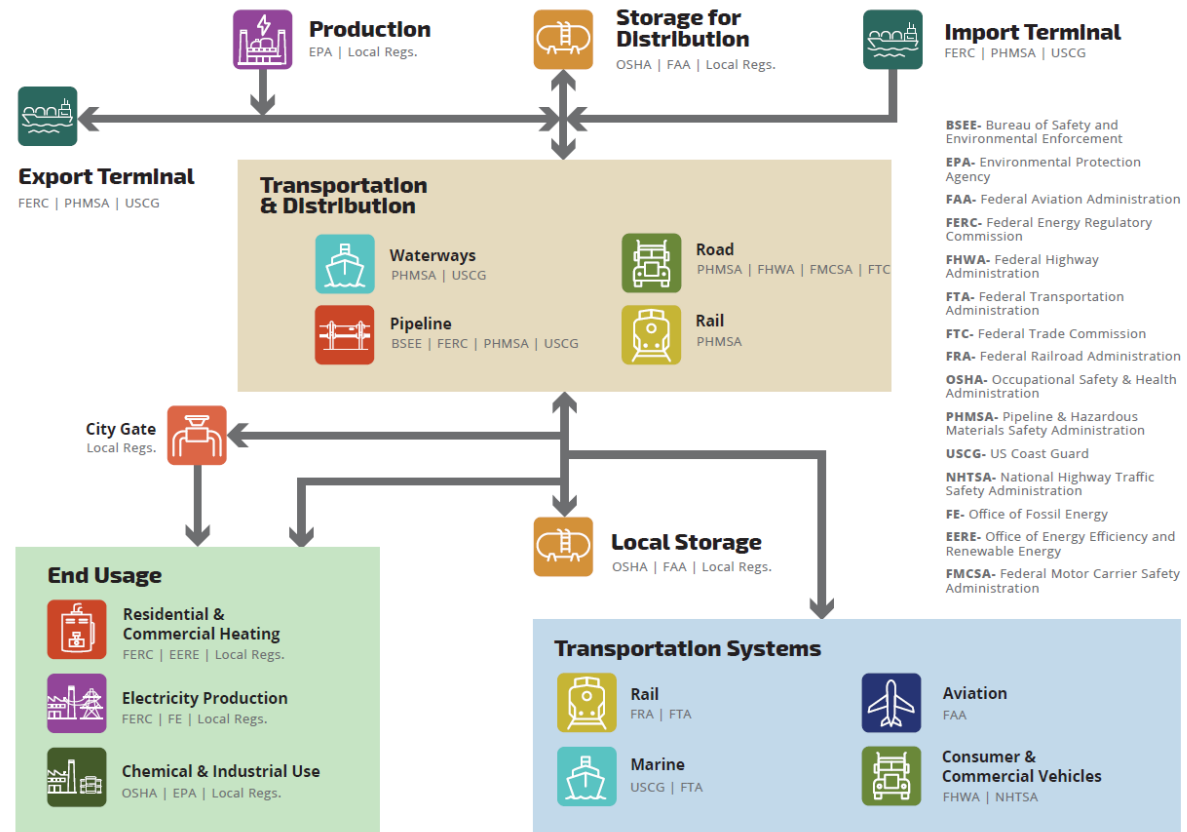


# Regulations, Codes and Standards Coordination

# FY23 Projects: RCS Coordination

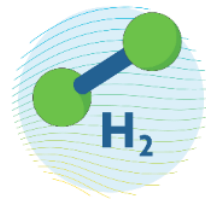
## Sandia National Laboratories

- Materials Testing Protocols and Codes & Standards Coordination
- U.S. Federal Regulatory Map identified major gaps:
  - FERC for pipeline transmission, electricity production, and heating
  - FHWA for bridges and tunnels
  - FRA, USCG, and FAA for rail, maritime, and aviation use
  - Full report available: <https://energy.sandia.gov/programs/sustainable-transportation/hydrogen/hydrogen-safety-codes-and-standards/>



**Next Steps:** Coordinating across agencies to address gaps

# Examples of International Collaborations



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

[www.iphe.net](http://www.iphe.net)

## Regulations, Codes, Standards, and Safety Working Group

- **NEW!** Task Force on Maritime: Regulation, codes and standards gaps and risk analysis needs
- **NEW!** Task Force on Bulk Storage: Risk, gaps and deployment barriers



# IPHE Early Career Network



Calling all hydrogen-enthusiast **STUDENTS**  
(undergraduate & graduate), **POST-DOCS**, and **EARLY  
CAREER PROFESSIONALS** worldwide!

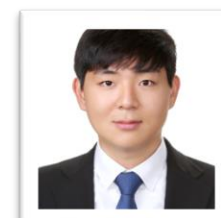
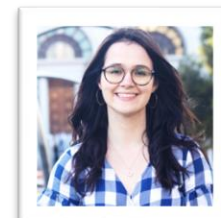
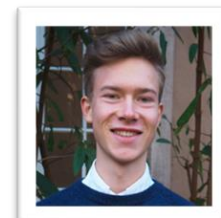
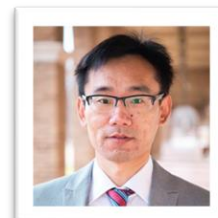
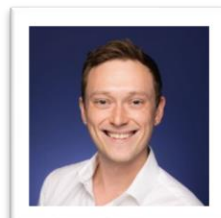
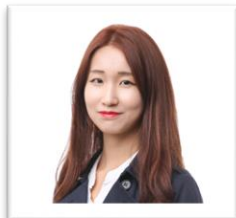
Connect with peers, mentors, scientific researchers,  
industry professionals, and policymakers!

Networking • Career Development • Webinars  
Research • Policy • Leadership • Science

Turkey Malaysia  
Nigeria France Ghana  
Cyprus  
China United Kingdom  
Poland Iceland Romania Netherlands  
Canada Japan India Chile  
South Korea Saudi Arabia  
United States of America  
South Africa Pakistan Colombia  
Denmark Vietnam Egypt Brazil  
Belgium Germany Spain  
Portugal New Zealand Sweden  
Australia Norway  
Russia Argentina Italy  
Malta

230+ members from  
37 countries

[www.iphe.net/early-career-chapter](http://www.iphe.net/early-career-chapter)



2022-2023 Leadership Team

# 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](http://www.zintellect.com) Keyword: Hydrogen Shot**

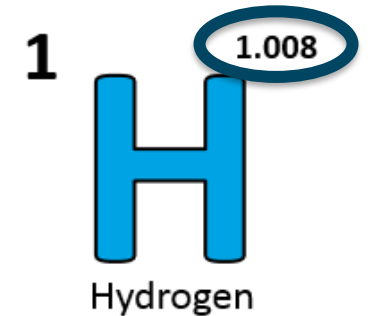
# Resources and Opportunities for Engagement



**Save the date!**  
**2023 DOE Annual Merit Review and Peer Evaluation Meeting**  
**June 5-8, 2023**

**Hydrogen and Fuel Cells Day**  
**October 8**

- Held on hydrogen's very own atomic weight-day



**Join Monthly H2IQ Hour Webinars**  
**Download H2IQ For Free**



**Visit H2tools.Org For Hydrogen Safety And Lessons Learned**

<https://h2tools.org/>



**Sign up to receive hydrogen and fuel cell updates**

[www.energy.gov/eere/fuelcells/fuel-cell-technologies-office-newsletter](http://www.energy.gov/eere/fuelcells/fuel-cell-technologies-office-newsletter)

**Learn more at: [energy.gov/eere/fuelcells](http://energy.gov/eere/fuelcells) AND [www.hydrogen.energy.gov](http://www.hydrogen.energy.gov)**

---

# Thank You

Christine Watson  
ORISE Fellow, Safety, Codes & Standards  
Hydrogen & Fuel Cell Technologies Office  
[Christine.Watson@ee.doe.gov](mailto:Christine.Watson@ee.doe.gov)  
U.S. Department of Energy

[www.energy.gov/fuelcells](http://www.energy.gov/fuelcells)  
[www.hydrogen.energy.gov](http://www.hydrogen.energy.gov)