U.S. DEPARTMENT OF
ENERGY
Office of
ENERGY EFFICIENCY &
RENEWABLE ENERGY

Technology Acceleration Overview

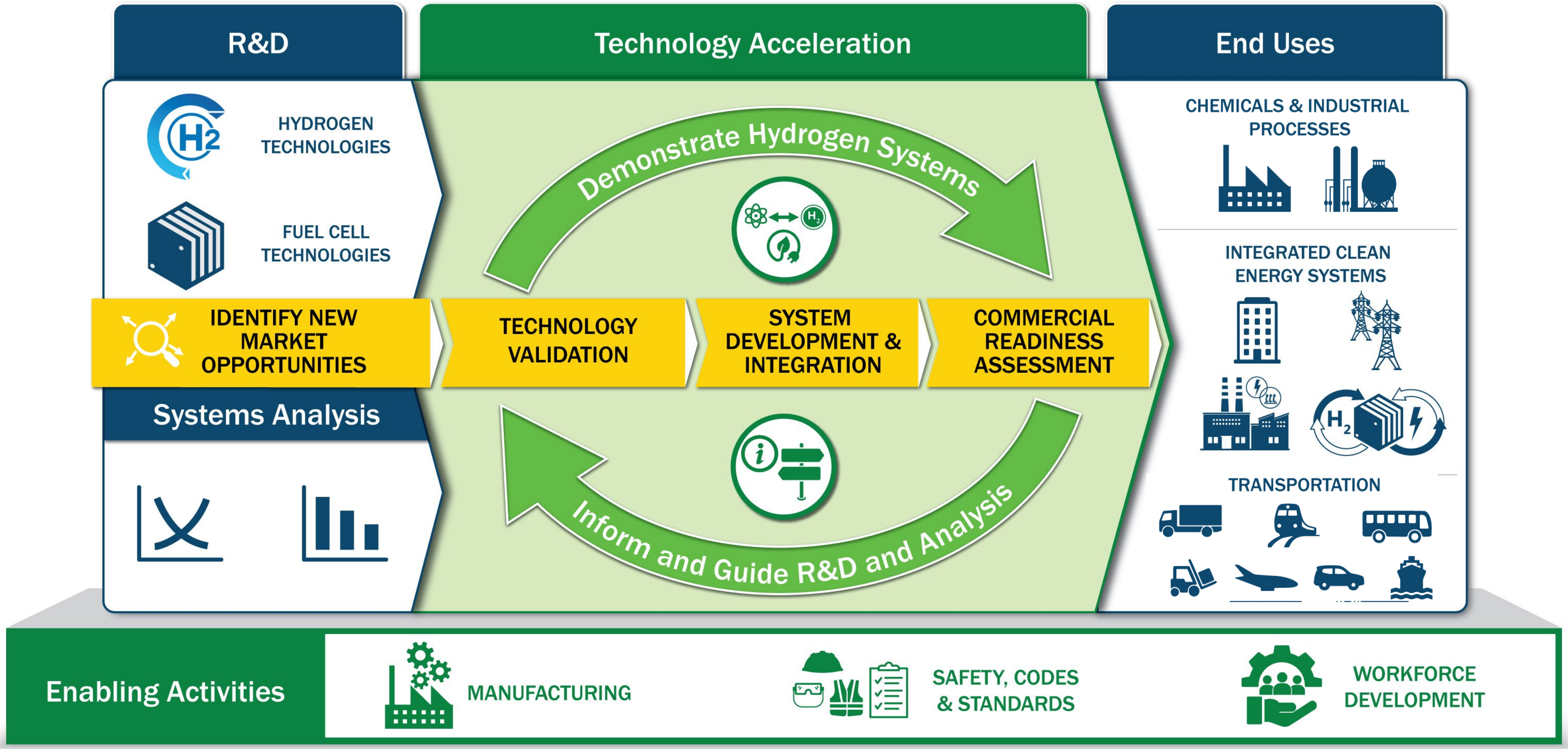
Jesse Adams, HFTO - Technology Acceleration Program Manager

2022 Annual Merit Review and Peer Evaluation Meeting

June 6, 2022 – Washington, DC




Technology Acceleration Subprogram Overview



Technology Acceleration Subprogram & Priorities

Current Focus Areas

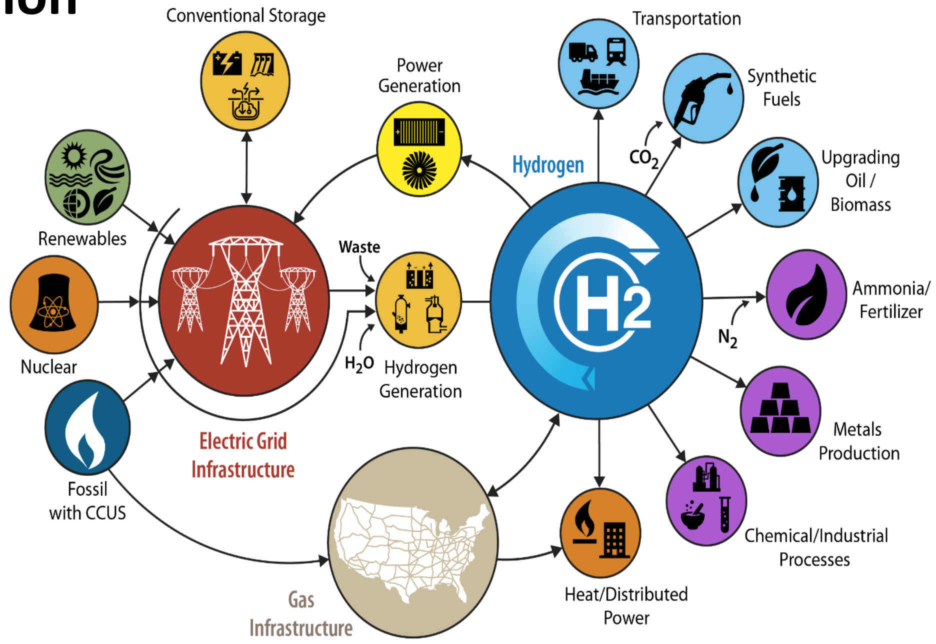
- **Grid Energy Storage & Power Generation** including hybrid approaches

- **Chemical and industrial Processes** integrating H_2 technologies focusing on decarbonization

- **Transportation** and H_2 fueling demonstrations

- **Enabling Activities:** manufacturing, safety codes & standards, and workforce development

Demonstrate H_2 & fuel cell integration to accelerate market adoption and reduce GHG emissions **to enable H2@Scale vision**



HFTO Technology Acceleration (TRL ~4-6) serves as **proving grounds for future OCED H2Hub** deployments (TRL ~6-8+)

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

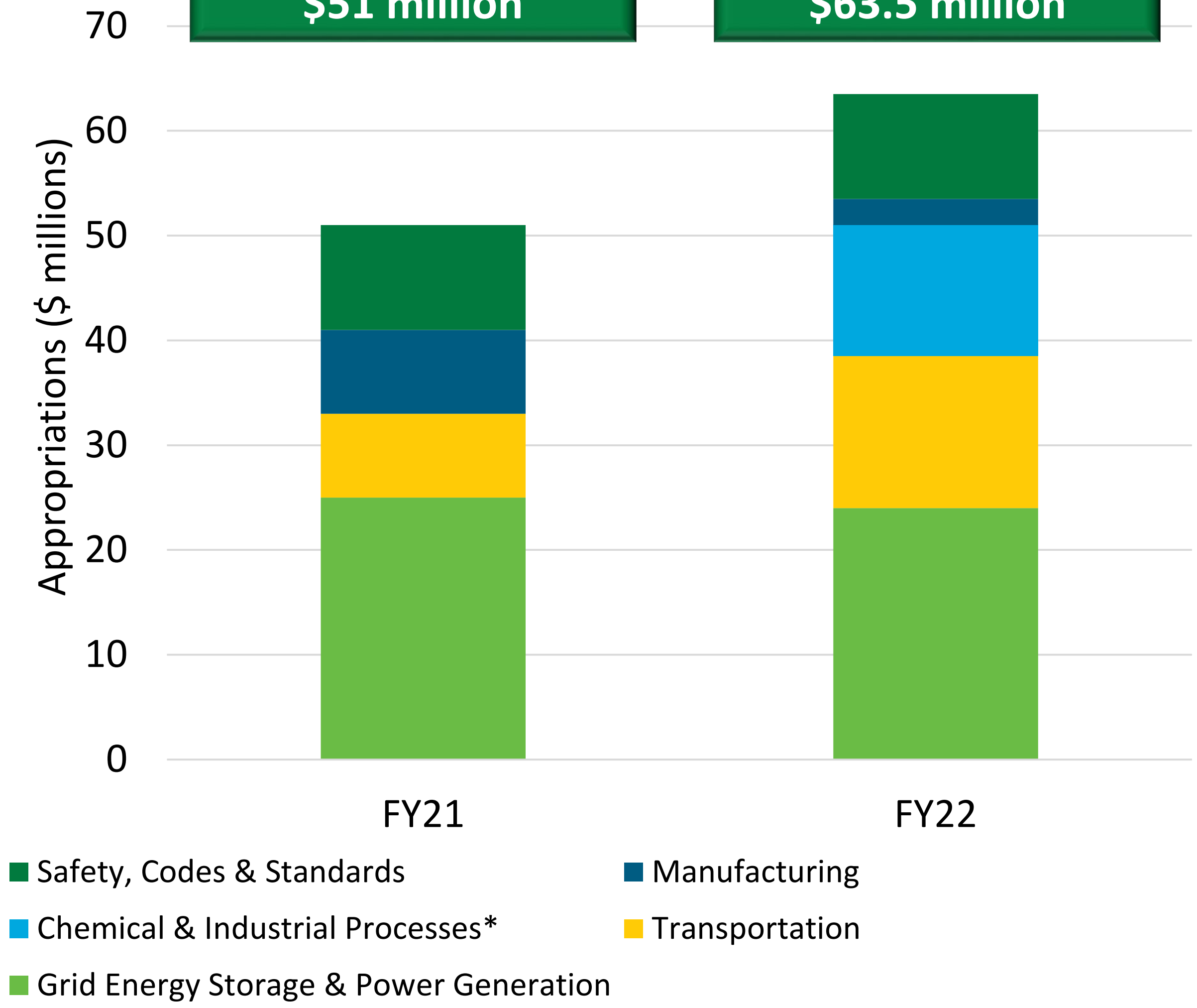
Safety

- **Goal**: Identify and develop **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

Technology Acceleration (System Development & Integration)

FY21 Appropriations
$51 million

FY22 Appropriations
$63.5 million



**Includes $10M to fulfill congressional language requirement in coordination with AMO*

Program Direction

Tech Acceleration Funding:

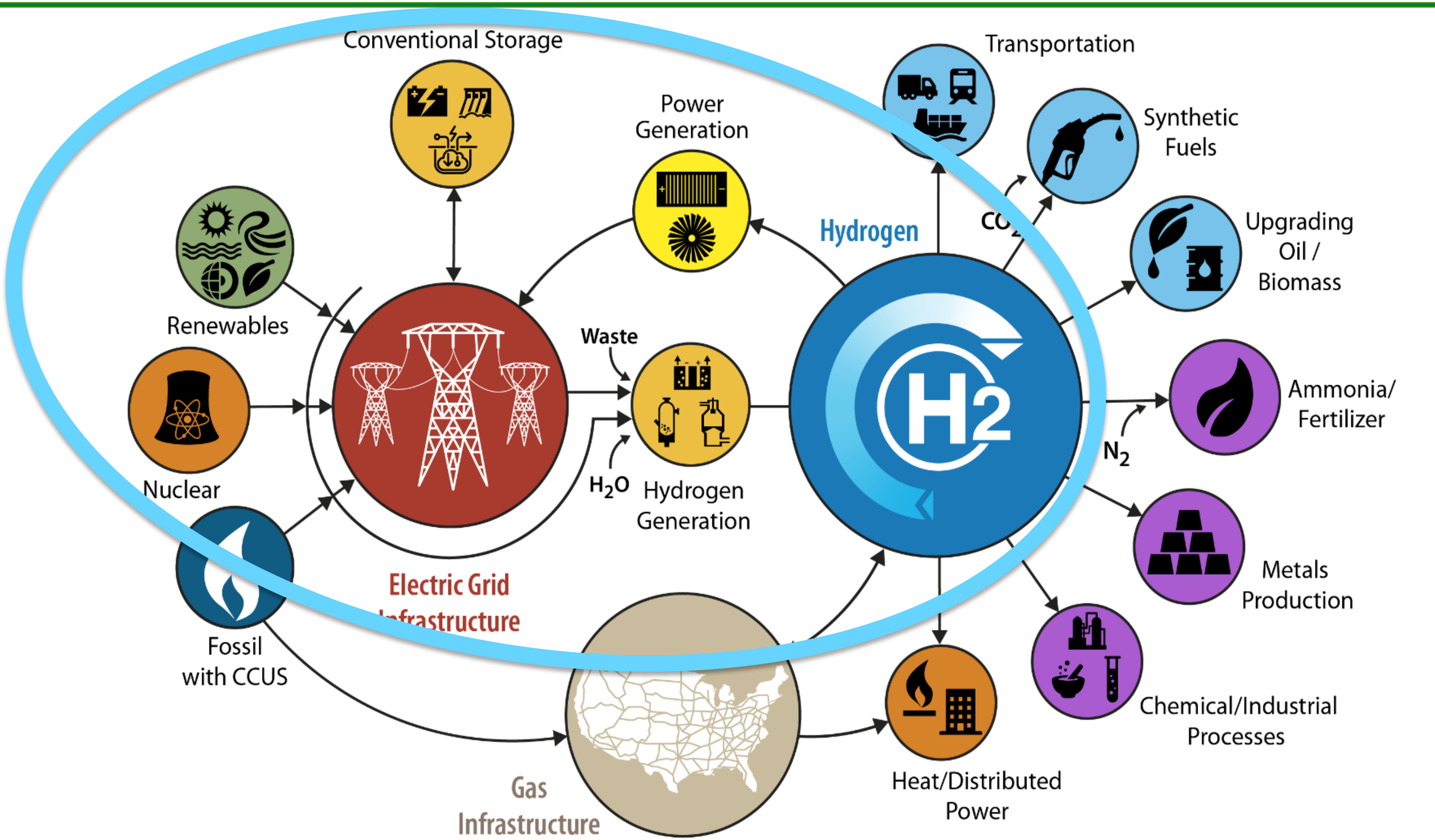
- Grid Energy Storage & Power Generation
  - Wind to H_2 microgrids
- Transportation
  - SuperTruck III & HD fueling
- Chemical & Industrial Processes
  - Steel & Ammonia
- Enabling Activities (Manufacturing)
  - Continue QA/QC work, BOP standardization & Increase Supply Chain
- Enabling Activities (Safety, Codes & Standards)
  - Focus beyond vehicles (e.g., bulk storage) & Sensors

FY23 Request
$87 million

Clean H2Hubs**
$8 billion over 5 years

***Through OCED, in collab with HFTO and all H2 programs*

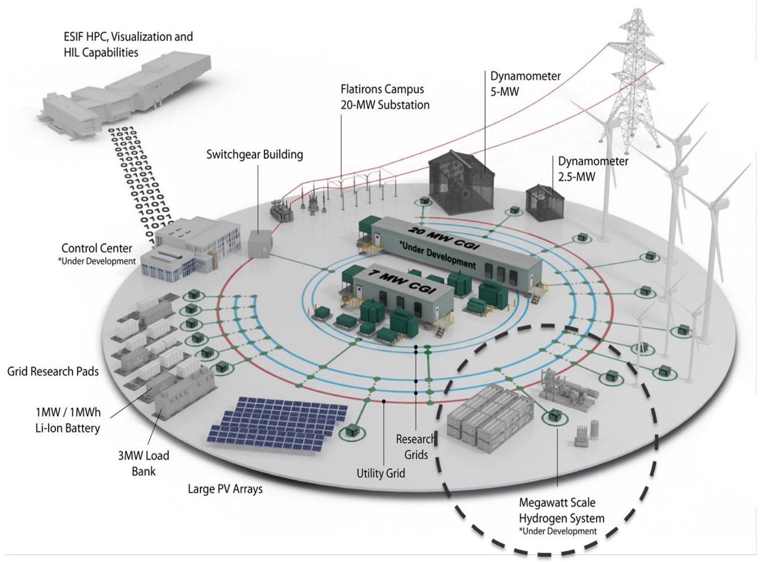
Technology Acceleration: Grid Energy Storage & Power Generation



Technology Acceleration: Grid Energy Storage & Power Generation

Enabling & Demonstrating Integrated Hydrogen Energy Systems

NREL – Advanced Research on Integrated Energy Systems (ARIES) (TA048)



Goals:

- Integrate 1.25MW PEM electrolyzer, 600 kg H_2 storage & 1MW fuel cell
- Provide test bed to demonstrate system integration, grid services, energy storage, direct renewable H_2 production & end uses

Key Accomplishments:

- Overall site design & safety reviews complete
- Hybrid Controller developed to enable integration with Controllable Grid Interface (CGI), ARIES platform and virtual emulation environment
- All key pieces of equipment delivered or pending delivery
- Systems integration in progress

2021 H2@Scale CRADA Call supporting ARIES

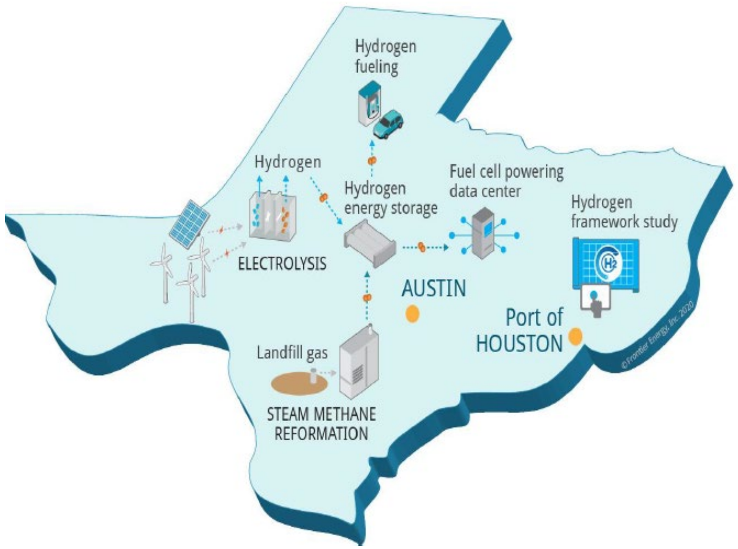
Projects selected under H2@ARIES Lab Call – Integrated Hydrogen Energy System Testing/Validation:

- **NREL, GE Renewable Energy, Nel Hydrogen:** Optimal wind turbine design for H_2 production (TA061)
- **NREL, SoCalGas, University of California Irvine:** Validation of interconnection & interoperability of grid-forming inverters sourced by H_2 technologies in view of 100% renewable microgrids (TA062)
- **NREL, GKN Powder Metallurgy, SoCalGas:** Metal hydride bulk (520 kg H_2) storage system coupled with electrolysis and fuel cell systems (TA063)
- **NREL, EPRI:** Optimize H_2 production via PEM electrolysis with grid integration and variable renewables (TA064)

Technology Acceleration: Grid Energy Storage & Power Generation

Demonstration of H2@Scale: Different Regions, Hydrogen Sources & End Uses

Frontier Energy – Demonstration and Framework for H2@Scale in Texas and Beyond (TA037)



Goals:

- Minimize H_2 cost through multiple generation sources
- Co-locate H_2 end uses (stationary power & vehicle fueling)
- 5-year H_2 Plan for Port of Houston

Key Accomplishments:

- Site plans/layout & engineering complete
- Began site construction (installation of utilities)
- Major equipment/systems procured (delivery pending in 2022)
- Port of Houston H_2 Framework – conducted workshops & completed preliminary TEA modeling

Caterpillar – Demonstration of H_2 Fuel Cell at a Data Center (poster - TA044)

CAT CATERPILLAR
Microsoft
BALLARD

Goals:

- Install 1.5MW stationary fuel cell at a Microsoft data center in Cheyenne, WY
- 48 hours of backup power using LH_2 onsite
- Increase confidence & comfort in H_2 / fuel cells for IT industry (document requirements and identify gaps)

Key Accomplishments:

- Completed Techno-Economic Analysis (TEA)
- System and component simulations performed showed power capability similar to diesel gensets for backup power

Technology Acceleration: Grid Energy Storage & Power Generation

Integration of Baseload Nuclear Energy with H_2 Production

Constellation (formerly Exelon) – Demo of Electrolyzer Operation at the Nine Mile Point Nuclear Plant (TA028)

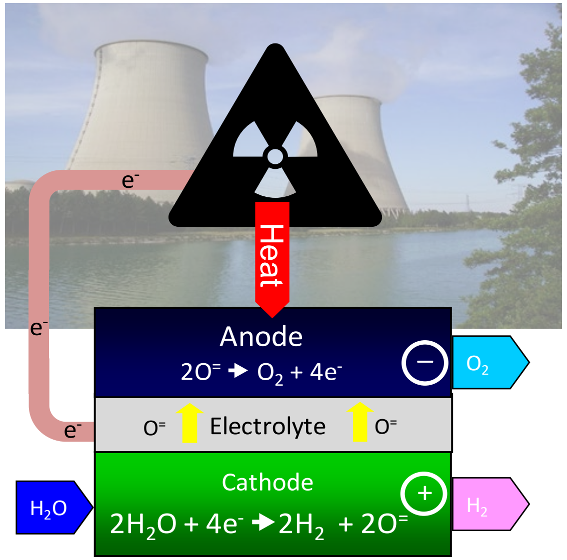
Goals:

- Install 1.25MW PEM electrolyzer at a nuclear power plant
- Provide low-cost supply of in-house H_2 used for cooling
- Simulate scaled-up operation of a larger electrolyzer in nuclear power markets

Key Accomplishments:

- Completed 60% engineering design
- Completed procurement of long lead time items including Nel 1.25MW electrolyzer

FuelCell Energy – Solid Oxide Electrolysis System Demonstration (TA039)



Goals:

- Integrate high temp. 250kW solid oxide electrolyzer (SOEC) with nuclear plant emulator at INL
- Validate high efficiency & low-cost H_2 production from SOEC using electricity & waste heat from nuclear plant
- Increase operating flexibility & profitability by switching between power & H_2 generation

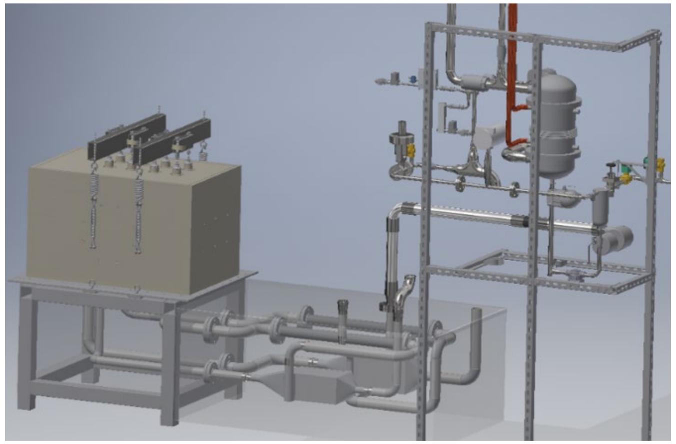
Key Accomplishments:

- Acquisition of all materials & tooling for stack assembly complete
- Initiated stack assembly and factory acceptance testing

Technology Acceleration: Grid Energy Storage & Power Generation

High Temperature Electrolyzer Modeling, Development, Integration and Testing

INL - High Temperature Electrolysis Test Stand (TA018)



50kW test stand integrated with nuclear power plant emulator

Goals:

- Accelerate U.S. solid oxide electrolyzer competitiveness
- Independently validate stack performance
- Provide nuclear simulated integration/ testing

Key Accomplishments:

- Commissioned HTE integrated system facility w/ emulated nuclear thermal energy delivery for large stack & system testing
- Initiated testing of 100kW Bloom HTE system at the integrated system facility
- >7,000 cumulative hours of performance & durability testing completed for multiple OEM SOEC stack sets

PNNL – Electrolyzer Stack Development and Manufacturing (TA043)

Goals:

- Improve the manufacturability, performance and durability of SOEC stacks & components
- Evaluate new cell and stack designs, as well as advanced manufacturing techniques to lower fabrication cost

Key Accomplishments:

- Assembled & tested 11 SOEC stacks (300 cm^2 active area cells)
- Engaged in SOEC manufacturing workshops to identify QA/QC gaps
- Performed post-mortem stack characterization on commercial stacks to identify operational and manufacturing issues

Technology Acceleration: Grid Energy Storage & Power Generation

Wind to H_2 - Electrolyzer Modeling, Development, Integration and Testing

Giner – Low Cost H_2 by Exploiting Offshore Wind & PEM Electrolysis Synergies (TA051)

Goals:
- Develop model to calculate LCOH for OSW (offshore wind) to H_2 w/ integrated electrolyzers
- Determine impact of seawater impurities on PEM performance
- Integrate and test 250 kW PEM electrolyzer with simulated wind turbine output

Key Accomplishments:
- Models predict ~$2.20/kg H_2 from OSW
- Tolerance of baseline Pt & Ir loading for common seawater ions determined
- Design for integrated 250 kW electrolyzer stack with simulated wind turbine input initiated

Alchemr - AEM Water Electrolyzer for H_2 Production from Offshore Wind (TA054)

Goal:
Develop a low-cost anion exchange membrane water electrolyzer (AEMWE) for direct coupling to OSW

Key Accomplishments:
- Demonstrated long-term performance of 5 cm^2 AEMWE cell with non-PGM anode & cathode catalysts at 0.3 A/cm^2, 60 C
- Demonstrated durability of MEA: 400 microvolts/hr degradation over 1000 hrs

NREL - Wind to Hydrogen (TA060)

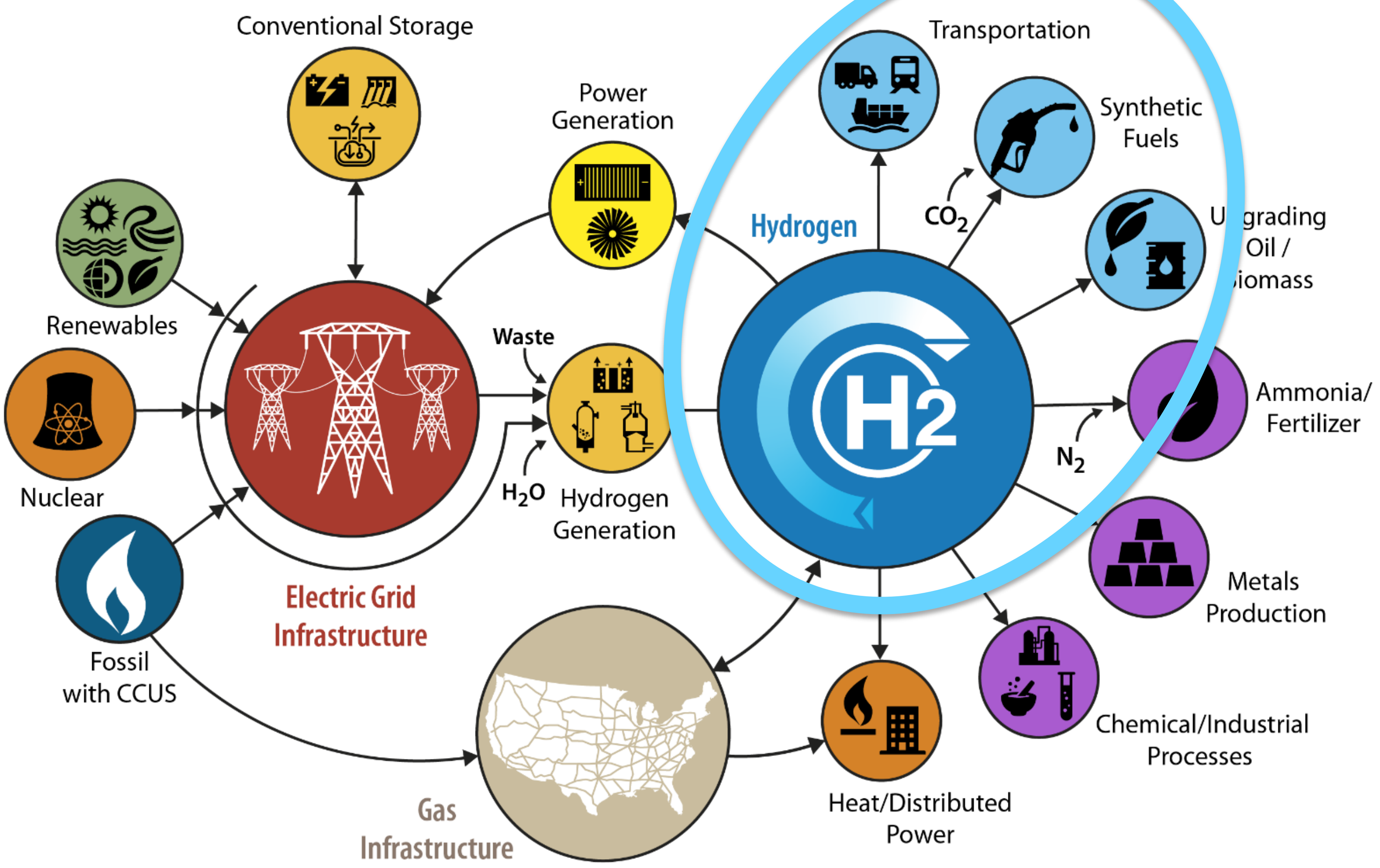
Goal:
Create H_2 *Scenario Analysis* tool for rapid, high-resolution insights into future, optimized, clean H_2 pathways

Key Accomplishments:
- H2OPP tool developed
- Analysis shows potential for renewable H_2 <$2.50/kg in both near & long term

Location info & wind/solar resources	Detailed system design	Location-based cost of H_2
System Sizing Design	Technology Innovation	Hydrogen
REopt: Optimize energy systems; optimal mix of technologies	**H2OPP**: Integrated design of hybrid plants at component level (wind turbine, solar panel, battery, PEM design, performance, and cost)	**H2A**: Hydrogen production analysis

REopt Renewable Energy Integration and Optimization

Technology Acceleration: Transportation



Technology Acceleration: Transportation (Medium / Heavy-Duty)

SuperTruck 3 Demonstrations – Freight Efficiency (>75% GHG Reduction)

DAIMLER

Walmart
SCHNEIDER
Linde
MAHLE
MICHELIN

Argonne National Laboratory
NREL
Oak Ridge National Laboratory
Auburn University
Oregon State University

Goals:
- Demonstrate 2 total (Class 8) HD long-haul fuel cell electric trucks (B-sample & final truck demo)
- 6.0 mi/kg H2 fuel economy
- 600-mile range (onboard LH_2 storage)
- 65,000 pounds GVW

Fleet Operators: Schneider National, Walmart

gm general motors

Southern Company
nel
Argonne National Laboratory

Goals:
- Demonstrate 8 total (Class 4-6) MD trucks
  - 4 fuel cell & 4 battery electric trucks
- Fuel Cell System Goals:
  - 65% peak efficiency
  - <$80/kW system cost (100K units/yr)
  - 20K-30K hour lifetime
- Demonstrate microgrid w/ electrolyzer & fuel cell (H_2 fueling & fast charging)
  - Electrolyzer: >65% efficiency & 10-year lifetime

Fleet Operators: Southern Co, Metro Delivery

The above image is not final product/visual and is subject to change

Ford Motor Company

FERGUSON
Consumers Energy Count on Us
SoCalGas

FEV
NREL

Goals
- Demonstrate 5 total (Class 4-6) MD vocational trucks
- 300+kW net vehicle power, H_2 PEM FC + Li-Ion battery
- 300-mile range (700 bar H_2 storage)
- 10K/20K pounds payload/tow capacity

Fleet Operators: Consumers Energy, Ferguson, SoCalGas

Technology Acceleration: Transportation (Medium / Heavy-Duty)

MD/HD Trucks Demonstrations

CTE – Fuel Cell Hybrid Electric Delivery Van (TA01)

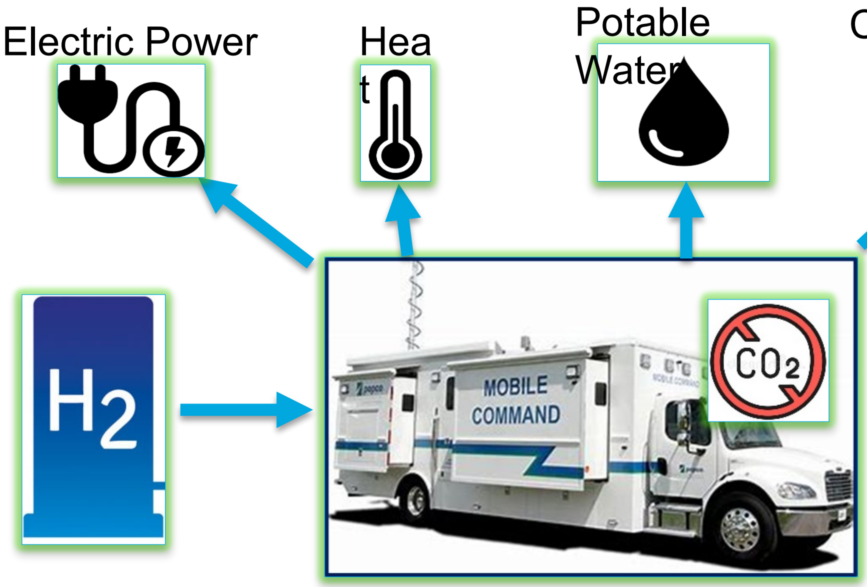
Goal:

Demonstrate hybrid electric delivery vans with fuel cell range extenders (75 to >125 mile range)

Key Accomplishments:

- 10 trucks built and entering service at UPS service centers in Ontario and Gardena, CA
- 5 more trucks in assembly
- **Trucks to operate in disadvantaged community in CA to reduce local air pollution**

Army/DHS/Cummins – H2Rescue (IA001)



US Army Corps of Engineers.

FEMA

Homeland Security

DEVCOM GROUND VEHICLE SYSTEMS CENTER

Goal:

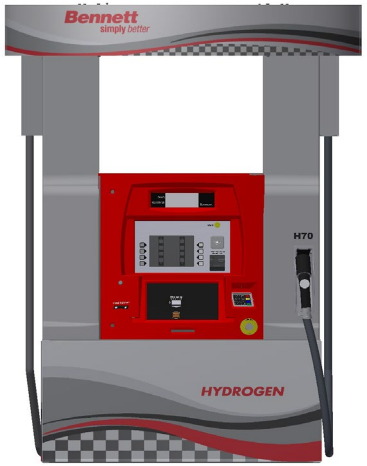
Develop & demonstrate disaster relief truck to provide victim aid, communication support, exportable power & potable water

Key Accomplishments:

- Developed vehicle design specs w/ team members
- Vehicle assembly started

HD Refueling & First of its Kind Maritime Demonstration

Electricore - High Pressure / Flow Rate Dispenser & Nozzle for HD Vehicles (TA049)



Goals:

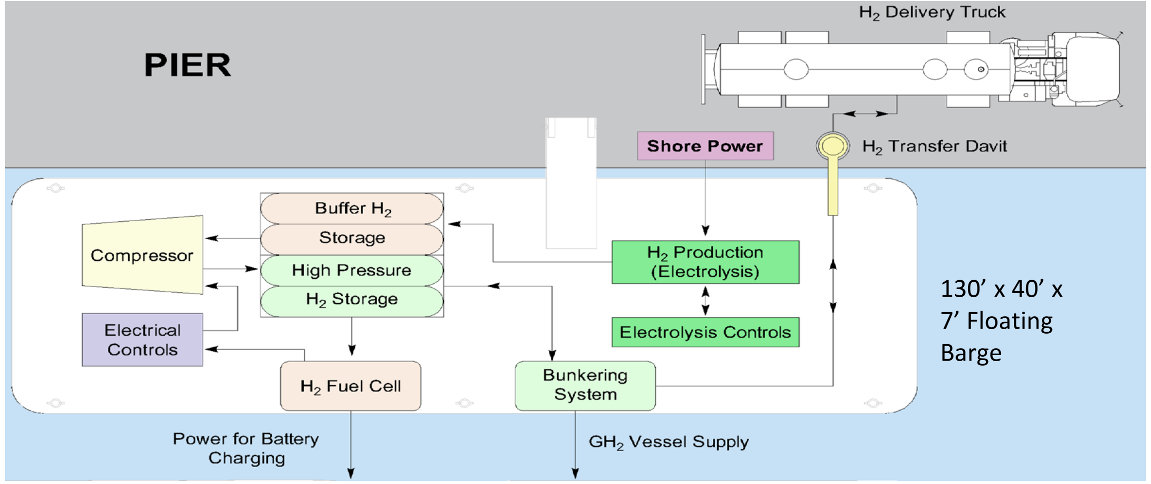
- Develop dispenser & nozzle (receptacle, hose, breakaway) for HD vehicles
- 100 kg in 10 mins at 70 MPa
- Demonstrate system at NREL

Key Accomplishments:

- Completed design work
- Completed manufacturing of prototype nozzle components and procurement of external assembly parts
- Completed setup for dispenser manufacturing

Hornblower – Marine H_2 Demonstration (poster - TA045)

Goal: First of its kind maritime H_2 refueling infrastructure on water (530 kg H2 /day) - onboard a barge at the San Francisco Waterfront



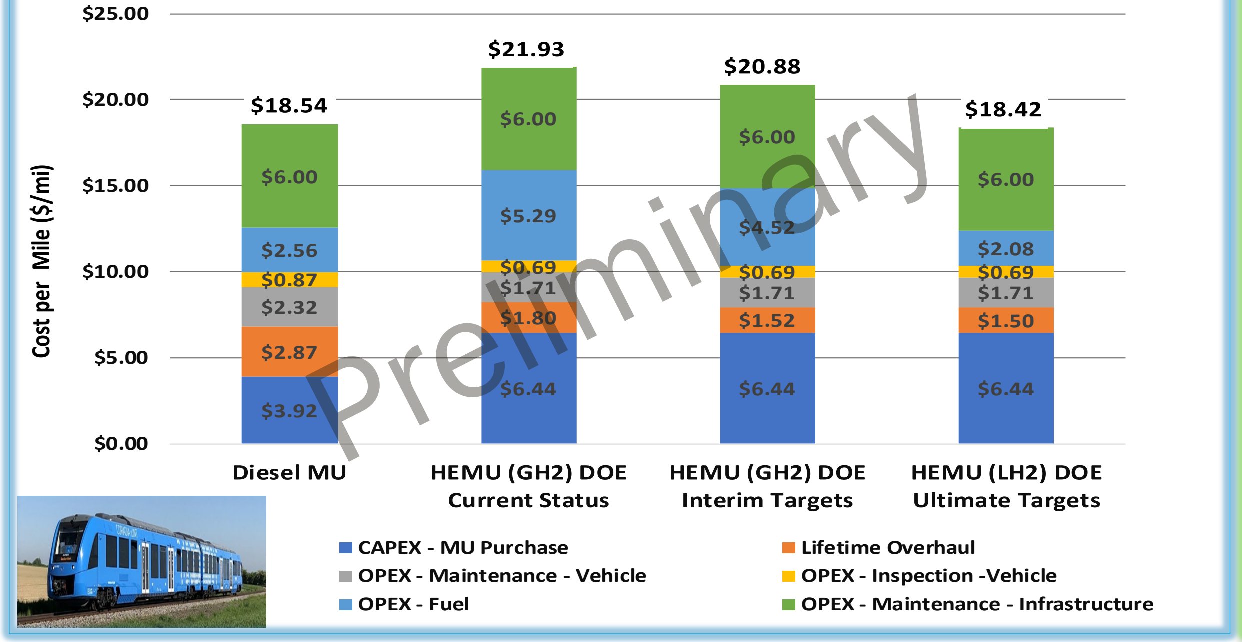
Key Accomplishments:

- Evaluated equipment for marine environment
- H_2 barge design completed

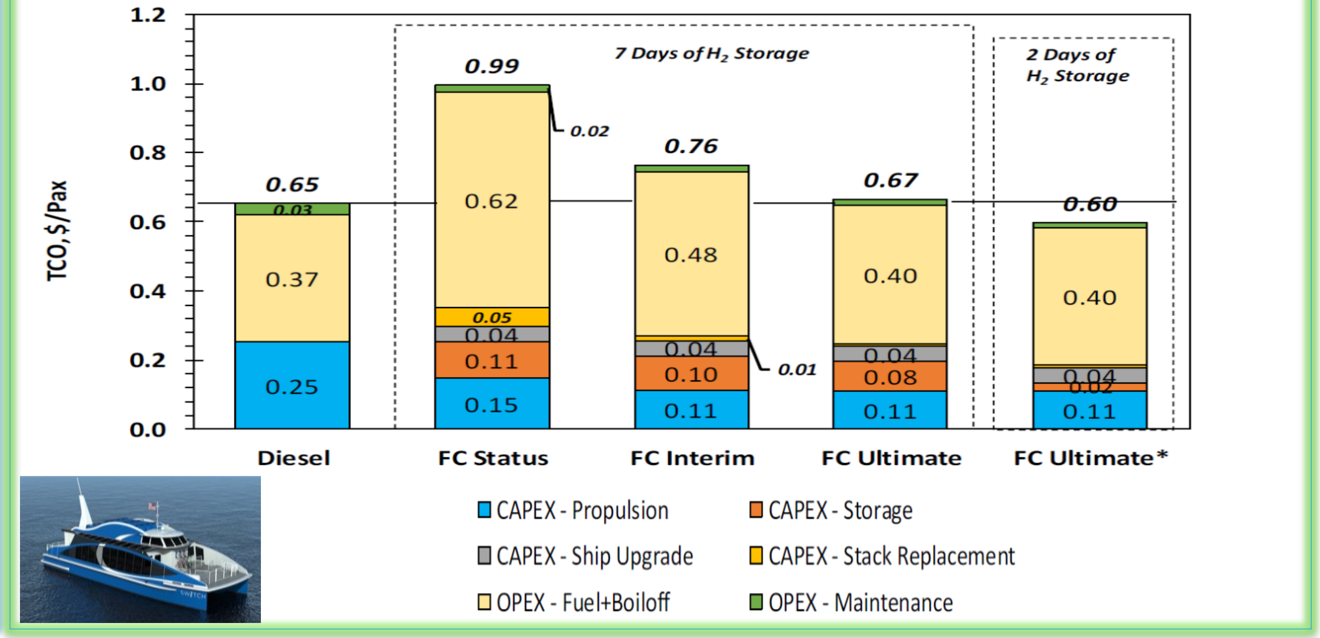
Technology Acceleration: Transportation (Rail and Marine)

Total Cost of Ownership (TCO) / Target Setting for Rail and Marine Applications

ANL - TCO Analysis for Passenger Rail (TA034)



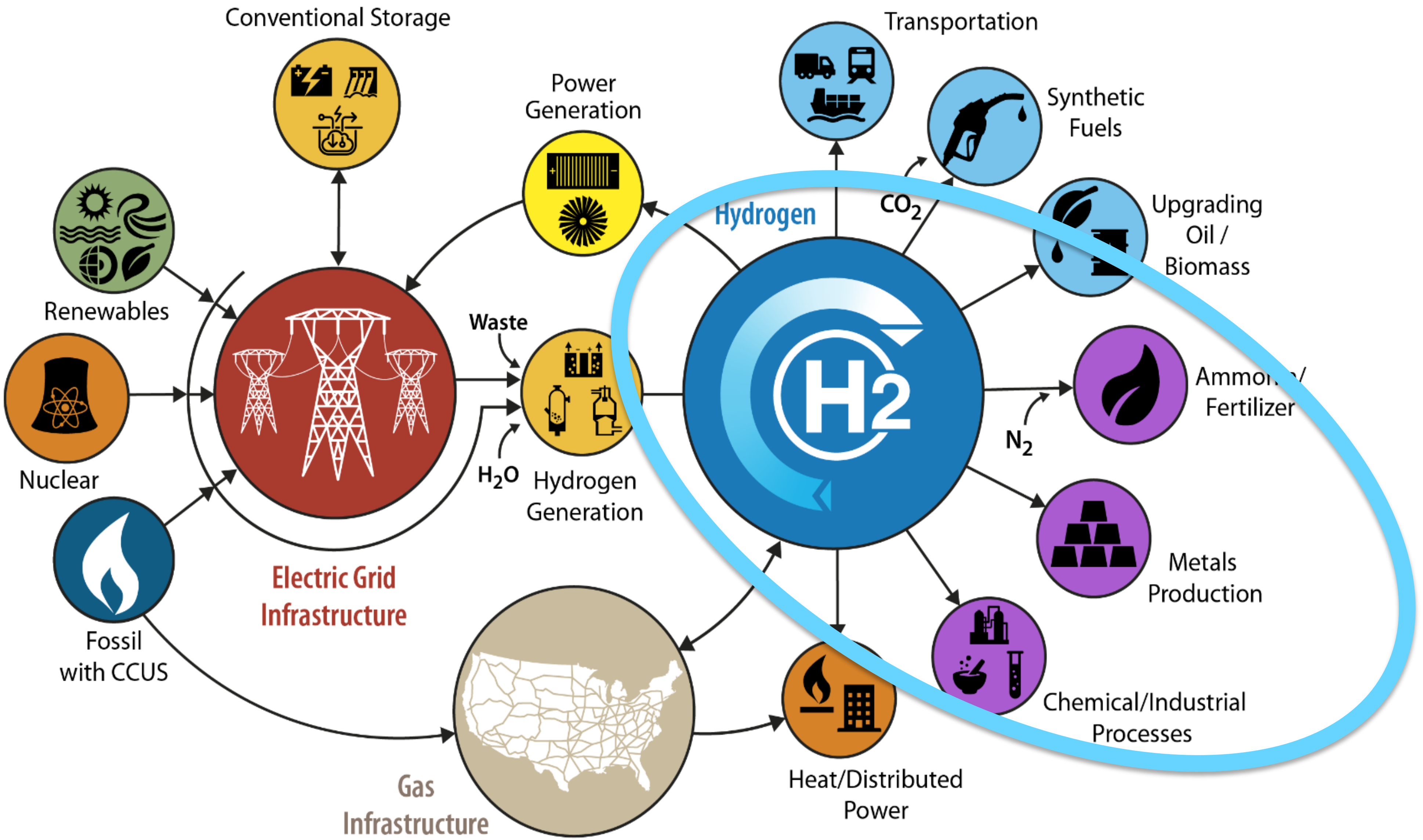
ANL - TCO Analysis for Passenger Ferries (TA034)



Key Results:

- Fuel cost dominates TCO for passenger rail & ferries
- Both applications can be cost competitive with diesel with $60/kW fuel cell CAPEX & H_2 cost of $4.00-3.50/kg H_2
- For ferries, less onboard storage / increased # of refuelings = lower TCO than diesel
- For H_2 Electric Multiple Unit (HEMU) passenger rail, developing LH_2 refueling capability at rail yard is needed to compete with diesel
- DOE intends to release specific targets for both applications

Technology Acceleration: Industrial & Chemical Processes

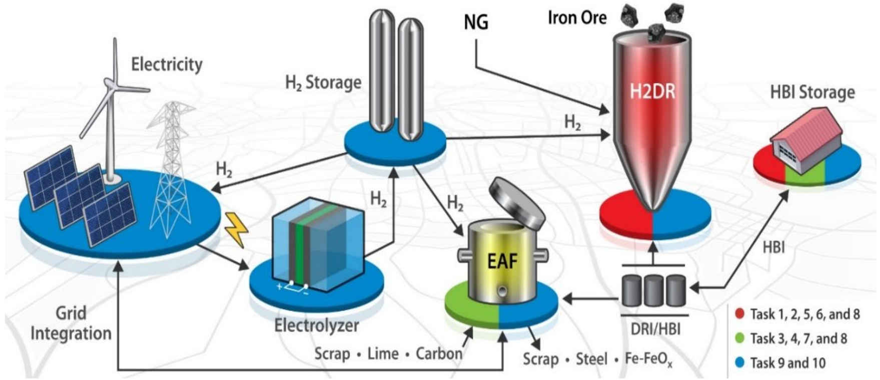


Technology Acceleration: Industrial & Chemical Processes (Steel)

Decarbonizing Iron/Steel Production with Hydrogen (HySteel)

Missouri U. of S&T - Grid Interactive Steelmaking with H_2 (GISH) (TA053)

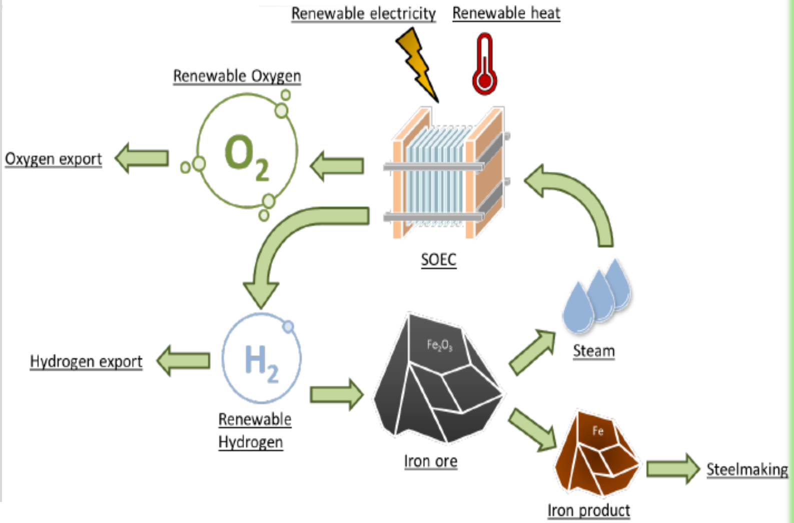
Goals:
- Demonstrate H_2-based direct reduction of iron & steelmaking
- 1 tonne/week iron production using variable H_2/NG content; scalable to 5,000 tonnes/day



Key Accomplishments:
- Preliminary TEA of GISH process
- Kinetic model for H_2, NG & mixed gas reduction, and a DRI melting model developed and verified
- GISH pilot reactor design completed / construction underway (operation expected 7/22)

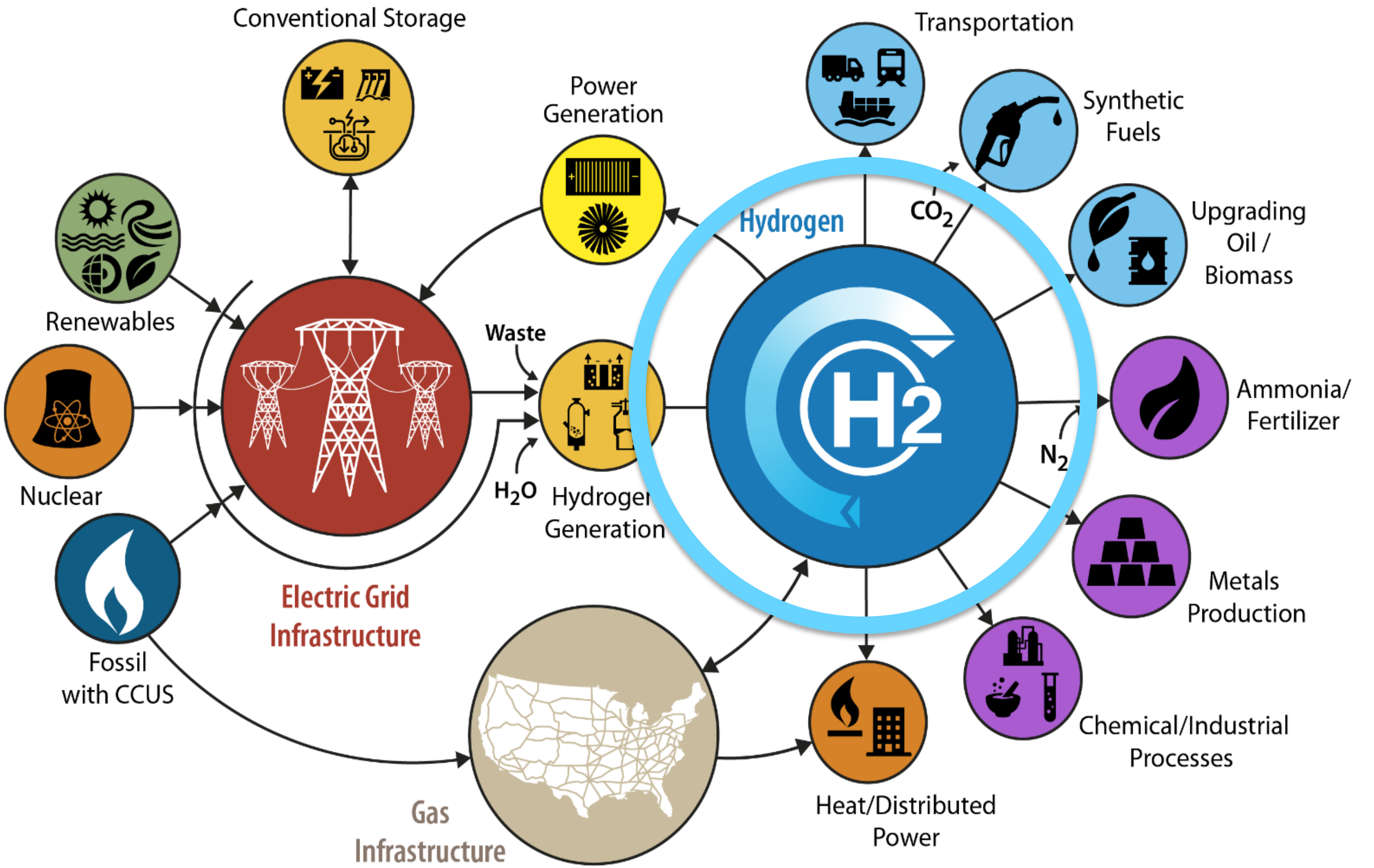
U. of California Irvine - H_2 SOEC integrated with Direct Reduced Iron (DRI) plants (TA052)

Goals:
- Demonstrate a thermally and chemically integrated SOEC system with a DRI plant
- 1 tonne/week equivalent H_2-Direct-Reduction pilot system (design for 2 MT/year)



Key Accomplishments:
- System models show potential energy intensity of <8 GJ/ton (crude steel) compared to 19-20 GJ/ton for traditional blast furnace + basic oxygen furnace
- SOEC modelling predicts electric-to-H_2 efficiency <35 kWh/kg
- SOEC pressurized cell test matrix completed

Technology Acceleration: Enabling Activities

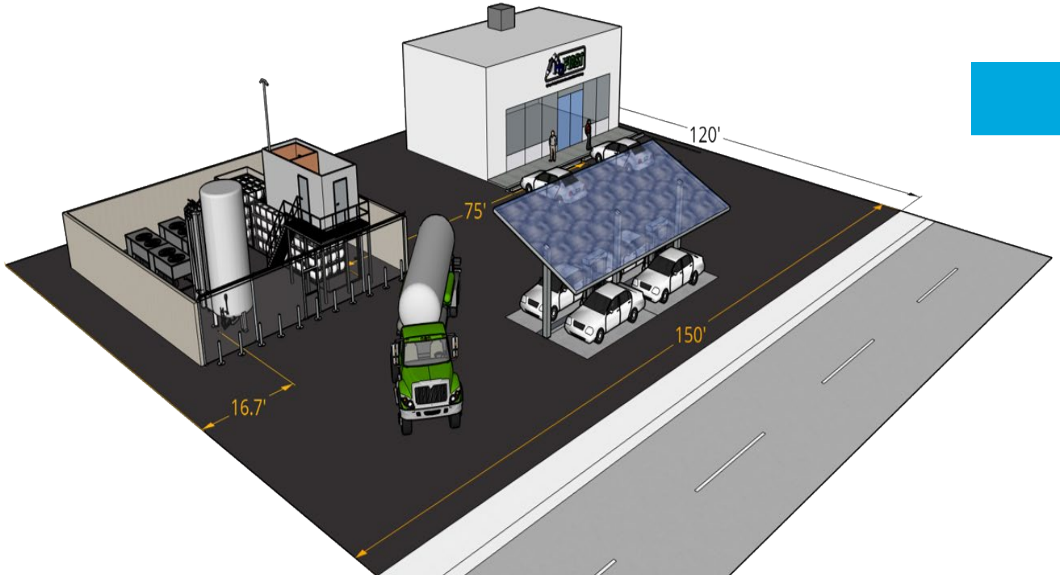


Technology Acceleration: Enabling Activities (Safety, Codes & Standards)

Enabling Codes & Standards: ~40% Reduction in Footprint for Liquid Hydrogen
(NFPA 2, 2023 Edition)

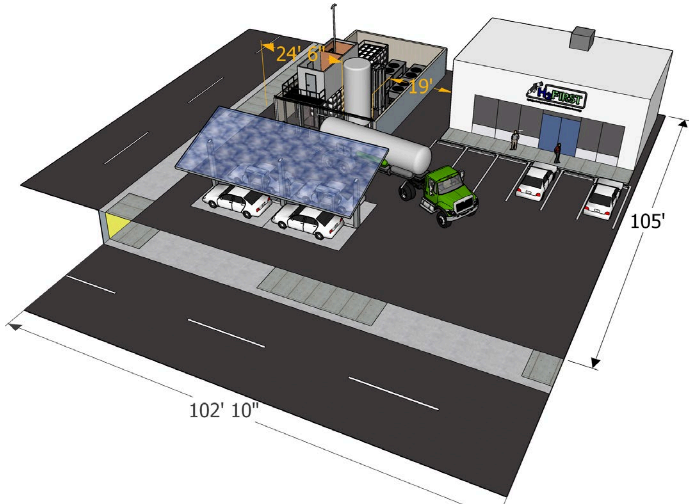
SNL – R&D for Safety, Codes and Standards: H_2 Behavior (SCS010)
SNL – H_2 Quantitative Risk Assessment (SCS011)

Previous (18,000 ft^2)*
2016 Edition NFPA 2



- Distances based on storage volume
- 22 individual exposures (5 distances)
- Non-repeatable basis

Proposed (10,800 ft^2)
2023 Edition NFPA 2



- Distances now based on system pipe size & operating pressure
- 3 exposure groups
- Well-documented, repeatable, revisable basis

Next Steps: Enabling Codes and Standards Accessibility

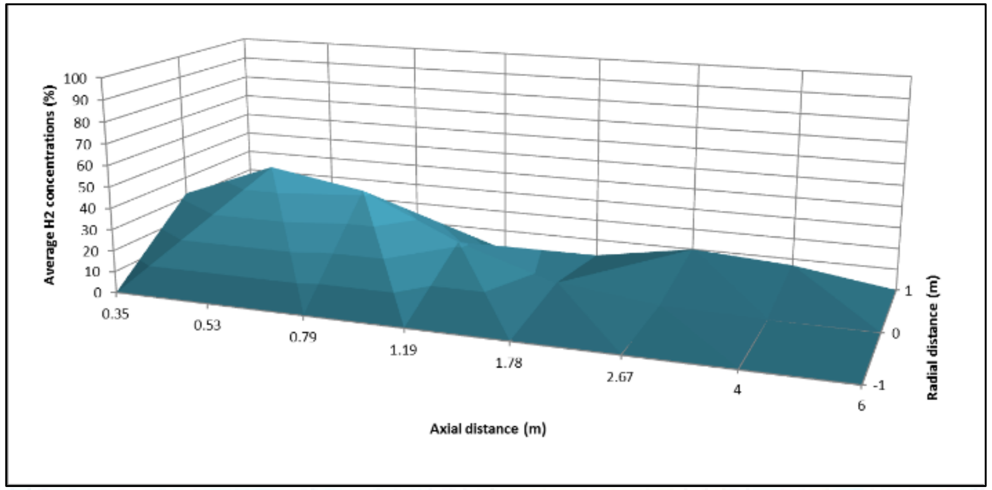
- Improve accessibility of codes & standards that are often seen as complex / difficult to understand
- Develop a tool to connect developers to the appropriate codes & standards

*https://www.hydrogen.energy.gov/pdfs/19005_600kg_day_hydrogen_fueling_station_footprint.pdf

Technology Acceleration: Enabling Activities (Safety, Codes & Standards)

Activities to Monitor, Mitigate, and Understand H_2 Releases

NREL - Smart Distributed Monitoring for Unintended H_2 Releases in Enclosures & Outdoor H2@Scale Demonstration Sites (SCS021)



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

Controlled LH_2 release profiled by NREL's HYWAM point-based sensor apparatus

Monitoring the Environmental Impact of Unintended H_2 Release

***Clean Hydrogen JU Expert Workshop on Environmental Impact of Hydrogen* (Co-hosted by DOE & European Commission, March 31 - April 1, 2022) identified technical needs such as:**

- Reduction of intentional and unintentional H_2 releases
- Robust sensor and monitoring technology
- Improved modeling of H_2 releases & atmospheric impact

Next Steps:
- Collaboration with NOAA to improve modeling of atmospheric H_2 and its impact
- Support R&D activities to address these gaps, including monitoring and mitigation of H_2 releases from production to end-use

Technology Acceleration – Examples of International Collaboration

CLEAN HYDROGEN MISSION

MISSION INNOVATION
accelerating the clean energy revolution

- Clean H_2 collaboration w/ EU, UK, Australia, Chile on H_2 production, storage, distribution and end uses
- End-use (Off-road working group)

Maritime collaboration w/ Denmark, Norway, UK on ships, fuel production, and port infrastructure

IPHE
International Partnership for Hydrogen and Fuel Cells in the Economy

- Co-Chair of IPHE RCSSWG alongside EC-JRC
- Newly restructured to form Task Forces focused on critical topics such as maritime usage, bulk storage, and bridges and tunnels

CENTER FOR Hydrogen SAFETY
Connecting a Global Community

- Strategic partnership with the Center for H_2 Safety
- Over 80 members & growing!

International Working Group for Offshore Wind to H2

- Partnership between U.S. & Netherlands (DOE, NREL, TNO, and Hygro)
- Formed in 2021 as a part of U.S. strategy to engage international partnerships
- FY22 collaboration includes OSW to H_2 TEA & assessment of knowledge gaps for multiple OSW to H_2 pathways

Technology Acceleration Program: Collaboration Network

Fostering technical excellence, economic growth and environmental justice

Industry Engagement
Center for Hydrogen Safety
21st Century Truck Partnership
FCHEA
Hosted Numerous Workshops & Working Groups

DOE H_2 Program Collaborations		
DOE AMO	DOE VTO	DOE WETO
DOE OCED	DOE NE	DOE FECM

DOE Cross-Cutting Initiatives		
Energy Storage Grand Challenge	Cybersecurity	Advanced Manufacturing
Industrial Decarbonization, Grid Modernization		

Cross-Agency Collaborations
DOT (NHTSA, FRA, FHWA, MARAD, PHMSA)
Army GVSC, DHS S&T, Army Corps of Engineers
IAAs (NASA WSTF & NOAA)
IWG (15 government agencies including states)

U.S. Regional and International Collaborations							
Project Coordination across ~20 U.S. States	IPHE (RCSSWG)	FCH-JU	IA- HySafe	Mission Innovation – Shipping, Clean H2	Center for Hydrogen Safety	Bilateral Collaborations	National Research Council- Canada

Technology Acceleration Program: Highlights and Milestones

FY2021	FY2022	FY2023
Awarded World's first Large Scale Fuel Cell Powered Data Center (Caterpillar)	Regional Clean H2 Hubs: Perform Stakeholder Engagement & Issue FOA (in collaboration w/ OCED)	Regional Clean H2 Hubs: Select at least 4 H2Hubs (in collaboration w/ OCED)
Awarded World's First Renewable H_2 Production Refueling Barge (Hornblower)	Utilize ARIES Capabilities to Advance Integration of H_2 Technologies in Energy Systems (NREL)	Demonstrate 1.25 MW Electrolyzer Installation at Nuclear Plant (Constellation)
Kicked off 2 HySteel projects to Demonstrate using H_2 to Decarbonize Iron & Steel Production (UCI and MS&T)	Completed Design & Procurement for 1.25 MW Electrolyzer Installation at Nuclear Plant (Constellation)	Test 250kW HT Electrolysis System using Fully Emulated Nuclear Integrated Test Stand (INL/FCE)
Establishing an Integrated MW-scale H_2 Production, Storage and FC System at ARIES (NREL)	Tested 100kW Integrated HT Electrolysis System using Fully Emulated Nuclear Integrated Test Stand (INL/Bloom)	Initiate Design of Full Thermal Integration at a Nuclear Plant with HT Electrolyzer
Released SuperTruck III FOA	Selected (3) SuperTruck III Projects Focused on M/HD H_2 Fuel Cell Trucks (Daimler, GM, Ford)	Develop Reference Design & TEA for Direct Coupled Wind to H2 to Industrial End-Use
Initiated CRADA Project on High-Flow Fueling Protocol in Concert w/ International PRHYDE project (NREL)	Demonstrate 10 kg/min average H_2 fueling rate for heavy-duty applications (NREL)	Demonstrate 1.5 MW H2 fuel cell for data center resiliency (Caterpillar)
Validated 2 High Temp Electrolyzers from Industry – including a 25kW stack that Surpassed 4,000 hrs with <0.5% Degradation / 1,000 hrs (INL)	Held Workshop & Established International Off-Road Working Group (in collaboration w/ International Mission Innovation – Clean Hydrogen)	Demonstrate 15 Fuel Cell Electric MD Delivery Trucks Operating in Disadvantaged Community (CTE)
Kicked off H2EDGE Workforce Development Project (EPRI)		Begin demonstrating 1 tonne/wk reduction of iron with H2 (UCI/MS&T)
Hosted International Workshop on Quality Control for Electrolysis & Fuel Cells w/ NRC (Canada) & Frauhnhofer ISE (Germany) (NREL)	Performed SCS Gap Assessments for Large Scale H_2 Applications, including Bulk Storage & Rail	Develop tools to improve accessibility of codes & standards to assist permitting of demonstration projects
Released Federal Regulatory Map Report (SNL)	Utilized Bulk Cryogenic H_2 Behavior Validation Data to Enable 40% Reduction in H_2 Station Footprint based on NFPA 2 (SNL)	Study Environmental Impact of Unintended H2 Release, Quantify Background Levels of H2, & Develop Sensors to Measure / Mitigate Release

Regional Clean Hydrogen Hubs

Regional Clean Hydrogen Hubs (H2Hubs) – Bipartisan Infrastructure Law (BIL)

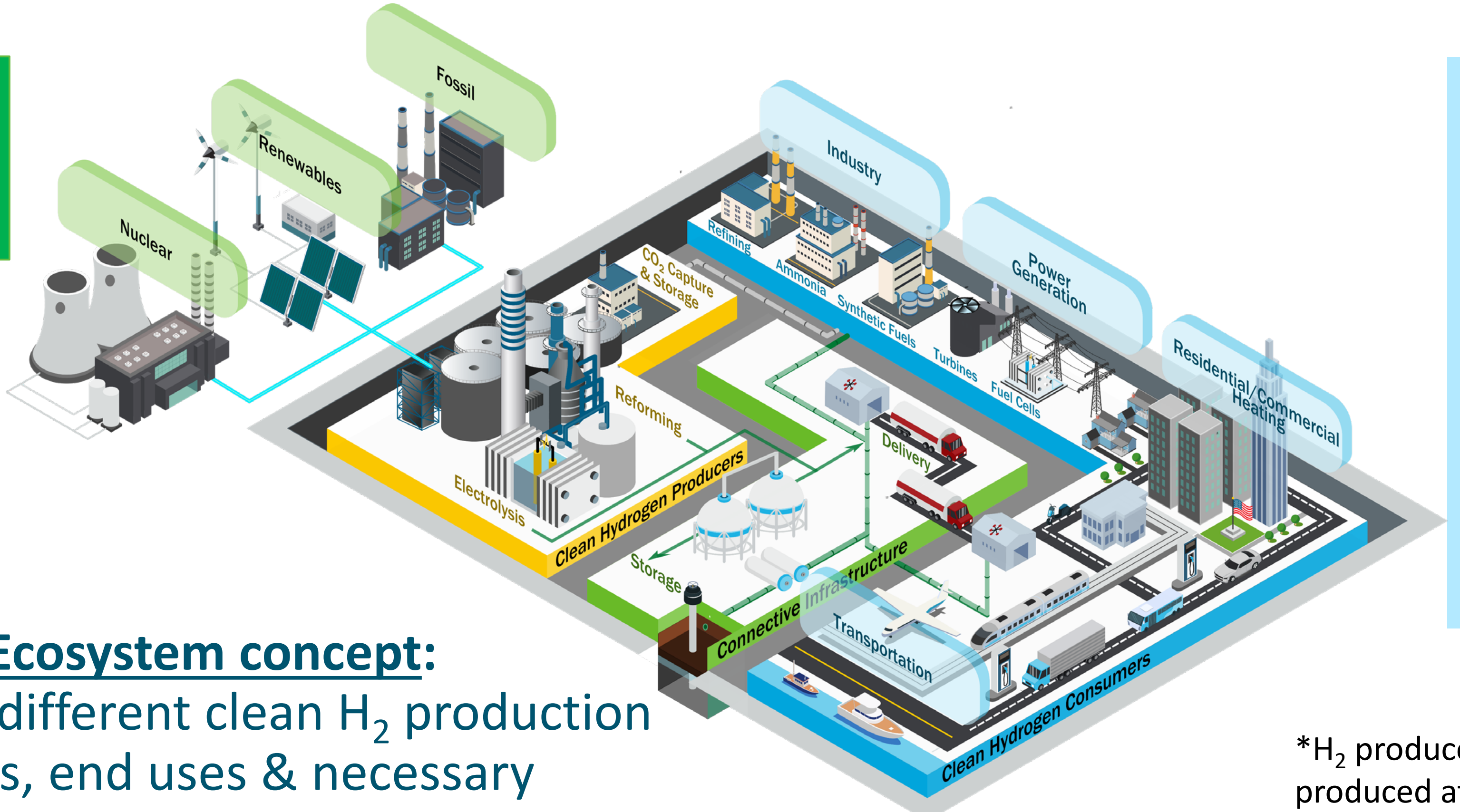
BIL's Stated Purpose: "Establish a program to support the development of **at least 4 regional clean hydrogen hubs** that:

(1) demonstrably aid the achievement of the **clean hydrogen production standard*** developed under section 822(a);

(2) demonstrate the **production, processing, delivery, storage, and end-use** of **clean** hydrogen; and

(3) can be **developed into a national clean hydrogen network** to facilitate a clean hydrogen economy."

$8 Billion over 5 years



Additional Key Items beyond H_2 Technology:

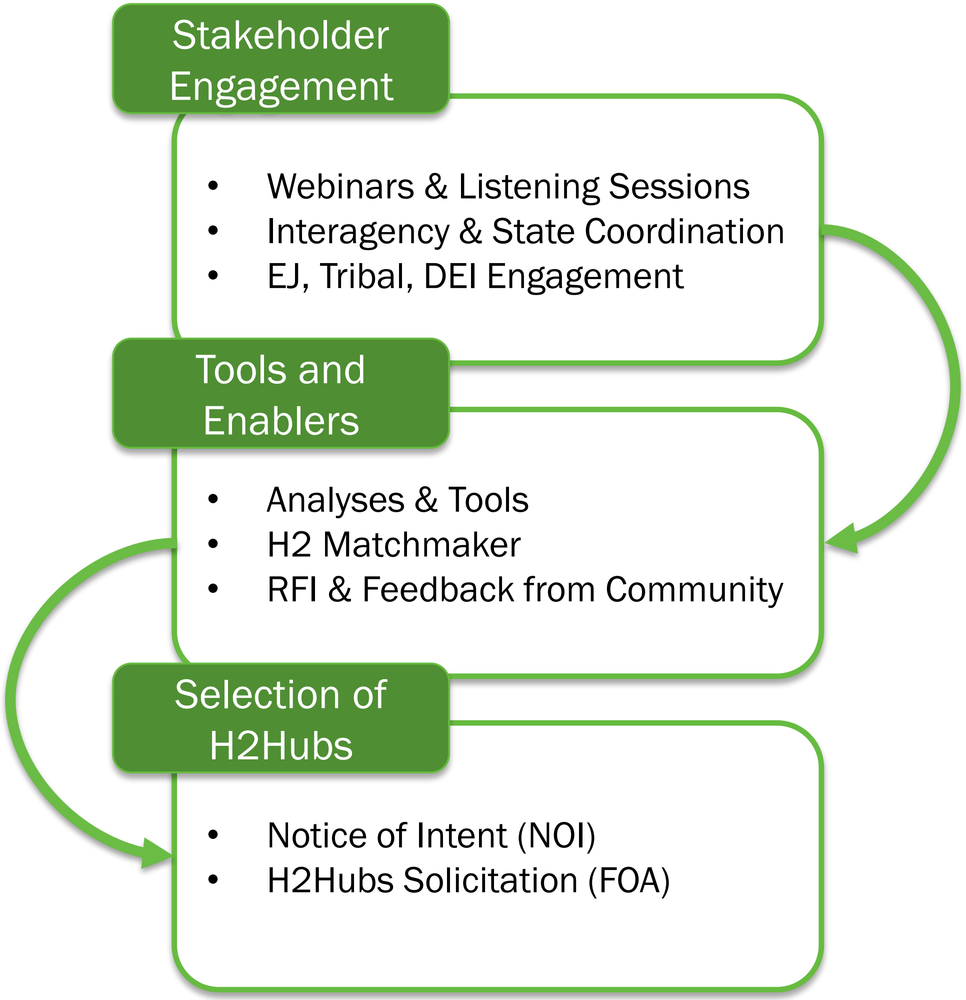
- Environmental Justice
- Community Engagement
- Job Creation
- Workforce Development
- Labor Standards
- Diversity, Equity, Inclusion
- Commercial Sustainability
- U.S. Manufacturing

H_2 Ecosystem concept:
Potential for different clean H_2 production methods, end uses & necessary infrastructure all in close proximity

*H_2 produced with carbon intensity ≤ 2 kg CO_2e/kg H_2 produced at the site of production [Section 40315 of the IIJA42 U.S.C. § 16166(b)(1)(B)]

H2Hubs: Update

- **Public Webinars:** Held 12/8/21* & 2/24/22**
- **Request for Information (RFI):** Issued 2/15/22
  - Over 300 responses / thousands of pages
- **H2 Matchmaker:** Launched 2/15/22
- **EJ & Tribal Listening Sessions:** Feb - May
- **Notice of Intent (NOI):** Released Today!
  - Provides additional details on the planned strategy & requirements
- **Funding Opportunity Announcement (FOA):** Targeting September/October



*https://www.energy.gov/eere/fuelcells/2021-hydrogen-and-fuel-cell-technologies-office-webinar-archives#12082021
**https://www.energy.gov/eere/fuelcells/2022-hydrogen-and-fuel-cell-technologies-office-webinar-archives#02242022

H2Hubs: Key Points from NOI*

**NOI presents preliminary plan that will likely be refined and evolve during the FOA development process*

- **DOE Office of Clean Energy Demonstrations (OCED)** – anticipates issuing FOA in **September/October 2022 timeframe in collaboration with EERE-HFTO and the DOE Hydrogen Program**
- **FOA will solicit applications** covering all 4 phases (8-12 years):
  - Phase 1 – Detailed Project Planning (12-18 months)
  - Phase 2 – Project Development, Permitting, and Financing (2-3 years)
  - Phase 3 – Installation, Integration, and Construction (2-4 years)
  - Phase 4 – Ramp-Up and Sustained Operations (2-4 years)
- **Initial FOA launch:** 6-10 H2Hubs (total of $6-7 billion)
  - **DOE Share:** min range of $400-$500 million / max range of $1-1.25 billion per H2Hub
  - **Cost Share:** min of 50% non-federal cost share
- **H2Hubs must meet or exceed the clean hydrogen production standard** (preference given to H2Hubs that reduce GHG emissions across the full project lifecycle)
- **Minimum** rate of at least **50-100 metric tons (MT) per day** and in-line with proposed project budget
- **H2Hubs will include substantial engagement of local and regional stakeholders** to ensure that they generate local, regional, and national benefits while mitigating any environmental or community impacts

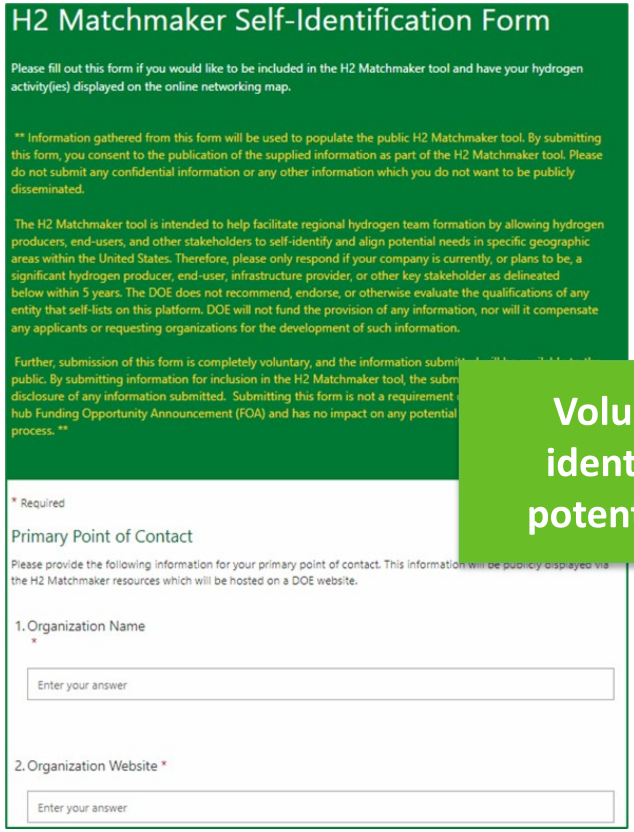
NOI (DE-FOA-0002768):
https://oced-echange.energy.gov

H_2 Matchmaker (https://www.energy.gov/eere/fuelcells/h2-matchmaker)

H_2 Matchmaker aims to facilitate the development of high-quality Hydrogen Hubs

277 Activities Added

- 47 H_2 Producers
- 28 H_2 Consumers
- 80 Infrastructure Providers
- 122 Supporting Stakeholders



H2 Matchmaker Self-Identification Form

Please fill out this form if you would like to be included in the H2 Matchmaker tool and have your hydrogen activity(ies) displayed on the online networking map.

** Information gathered from this form will be used to populate the public H2 Matchmaker tool. By submitting this form, you consent to the publication of the supplied information as part of the H2 Matchmaker tool. Please do not submit any confidential information or any other information which you do not want to be publicly disseminated.

The H2 Matchmaker tool is intended to help facilitate regional hydrogen team formation by allowing hydrogen producers, end-users, and other stakeholders to self-identify and align potential needs in specific geographic areas within the United States. Therefore, please only respond if your company is currently, or plans to be, a significant hydrogen producer, end-user, infrastructure provider, or other key stakeholder as delineated below within 5 years. The DOE does not recommend, endorse, or otherwise evaluate the qualifications of any entity that self-lists on this platform. DOE will not fund the provision of any information, nor will it compensate any applicants or requesting organizations for the development of such information.

Further, submission of this form is completely voluntary, and the information submi... public. By submitting information for inclusion in the H2 Matchmaker tool, the subm... disclosure of any information submitted. Submitting this form is not a requirement ... hub Funding Opportunity Announcement (FOA) and has no impact on any potential ... process. **

* Required

Primary Point of Contact

Please provide the following information for your primary point of contact. This information ... the H2 Matchmaker resources which will be hosted on a DOE website.

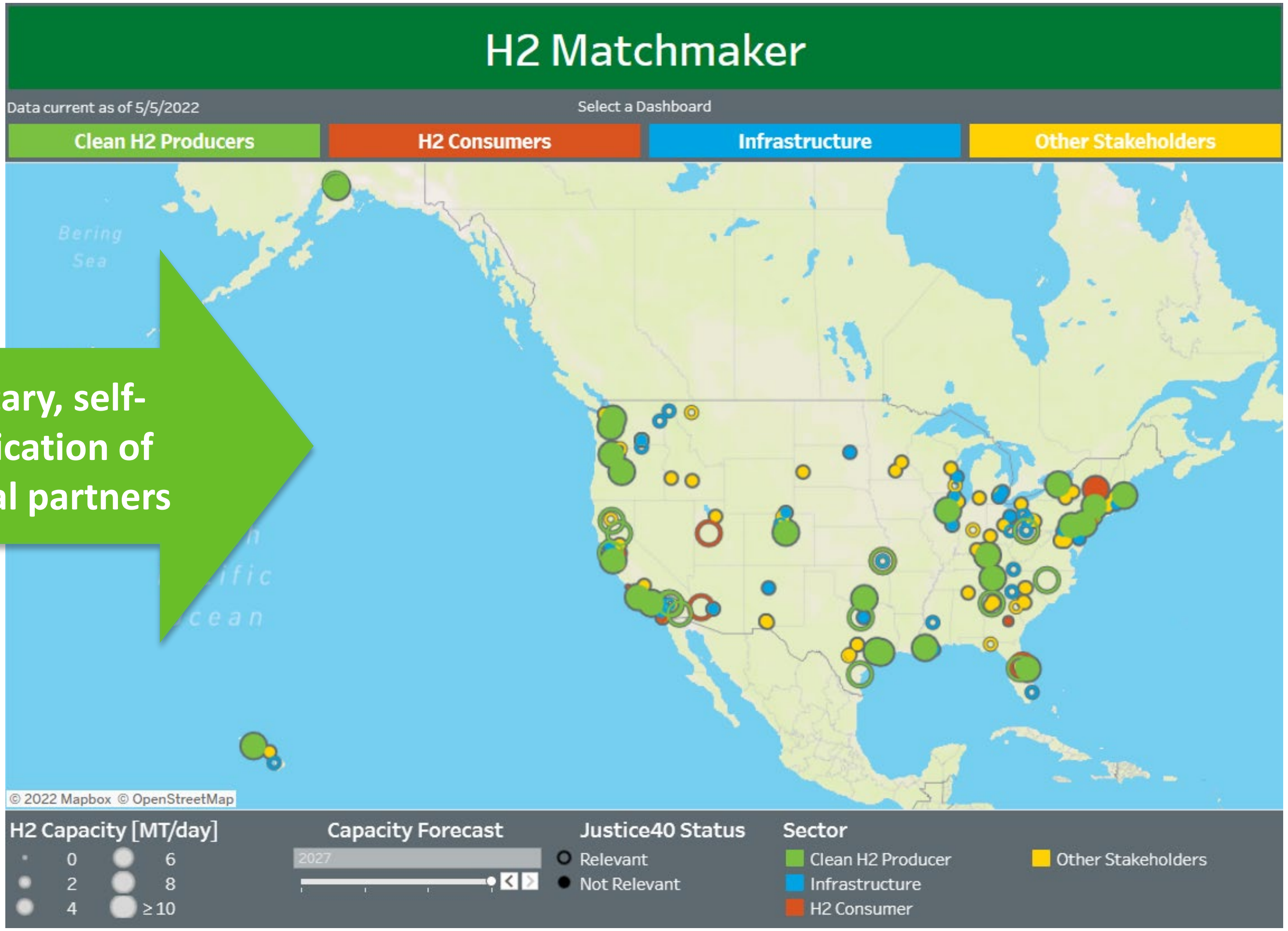
1. Organization Name *

Enter your answer

2. Organization Website *

Enter your answer

Voluntary, self-identification of potential partners



Request from DOE: Help publicize & encourage data entry

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

Technology Acceleration Team – THANKS!

Jesse Adams
Technology Acceleration Program Manager
Jesse.Adams@ee.doe.gov

Technology Managers

Michael Hahn
Michael.Hahn@ee.doe.gov

Brian Hunter
Brian.Hunter@ee.doe.gov

Pete Devlin
Peter.Devlin@ee.doe.gov

Laura Hill
Laura.Hill@ee.doe.gov

Zachary Taie
Zachary.Taie@ee.doe.gov

Open position
Federal

Fellows and Contractors

Kendall Parker
Fellow
Kendall.Parker@ee.doe.gov

Christine Watson
Fellow
Christine.Watson@ee.doe.gov

Open position
Fellow - TA

Open position
Fellow - TA

Karen Harting
Contractor
Karen.Harting@ee.doe.gov

Tara Gedvilas
Contractor
Tara.Gedvilas@ee.doe.gov

Gary Robb
Contractor
Gary.Robb@ee.doe.gov

Backup Slides

Sec 40314 (EPACT Sec. 813): Regional Clean Hydrogen Hubs

- (A) FEEDSTOCK DIVERSITY —
  - at least 1 regional clean hydrogen hub using fossil fuels; 1 using renewables; 1 using nuclear
- (B) END-USE DIVERSITY — at least 1 with end use in
  - electric power generation sector;
  - industrial sector;
  - residential and commercial heating sector; and
  - transportation sector.
- (C) GEOGRAPHIC DIVERSITY —
  - be located in a different region of the United States; and
  - use energy resources that are abundant in that region.
- (D) HUBS IN NATURAL GAS-PRODUCING REGIONS—
  - at least 2 regional clean hydrogen hubs shall be located in the regions of the United States with the greatest natural gas resources.
- (E) EMPLOYMENT—
  - Prioritize those likely to create opportunities for skilled training and long-term employment to the greatest number of residents of the region.
- (F) ADDITIONAL CRITERIA—The Secretary may take into consideration other criteria that, in the judgment of the Secretary, are necessary or appropriate to carry out this title.