U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

# Systems Development & Integration Overview


## Jesse Adams, HFTO – Systems Development & Integration Program Manager


2024 Annual Merit Review & Peer Evaluation Meeting

May 7, 2024 – Arlington, VA

# The Hydrogen and Fuel Cell Technologies Office (HFTO)

**Mission**

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

## HFTO Subprograms

### Hydrogen Technologies

- Hydrogen Production
- Hydrogen Infrastructure

### Fuel Cell Technologies

- Materials & Components
- Systems

### Systems Development & Integration

- Transportation
- Chemical & Industrial Processes
- Energy Storage & Power Generation

### Systems Analysis

### Safety, Codes & Standards

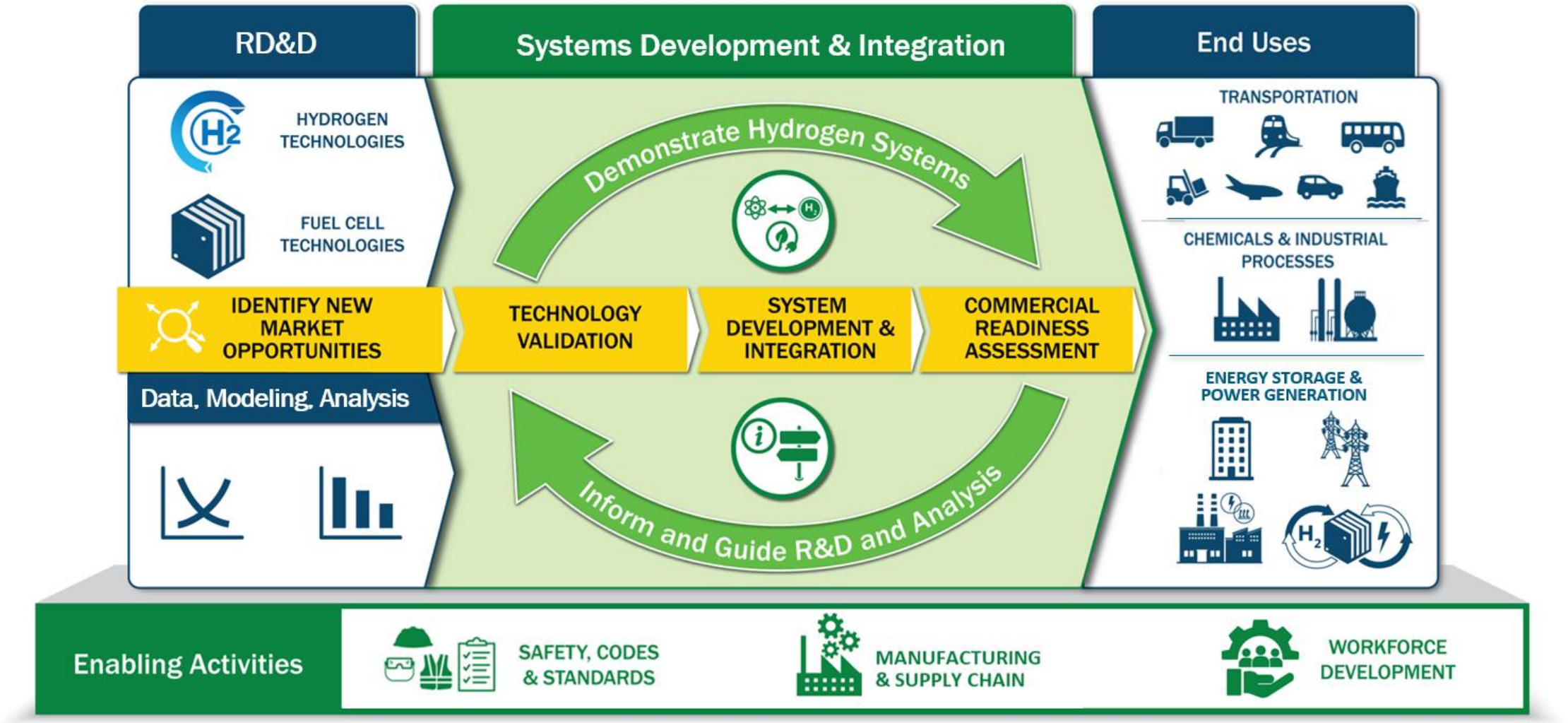
Cross-cutting / Enabling: manufacturing, supply chain, workforce, regional clean $H_2$ networks

*Enabling*

ENERGY earthshots U.S. DEPARTMENT OF ENERGY | Hydrogen


H2@Scale U.S. Department of Energy

# Systems Development & Integration Overview




***Bridging the Gap Between R&D and Deployments with First-of-a-Kind Integrated $H_2$ Demonstrations***

# Systems Development & Integration (SDI): Priorities

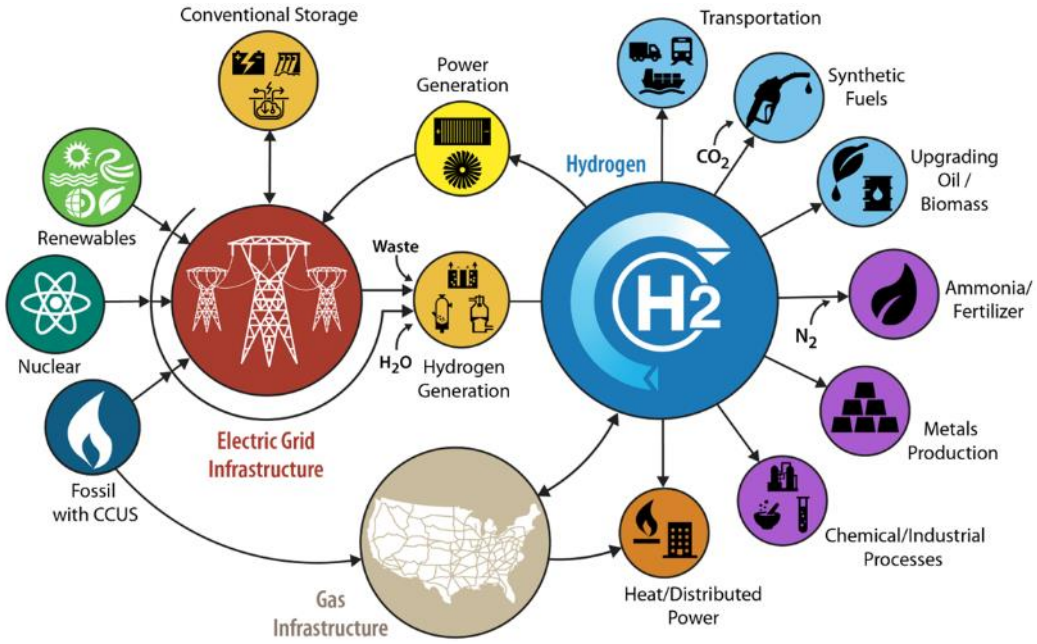
## Current Focus Areas


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

- **Chemical and Industrial Processes** integrating $H_2$ technologies focusing on decarbonization


- **Transportation** & $H_2$ fueling demonstrations

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

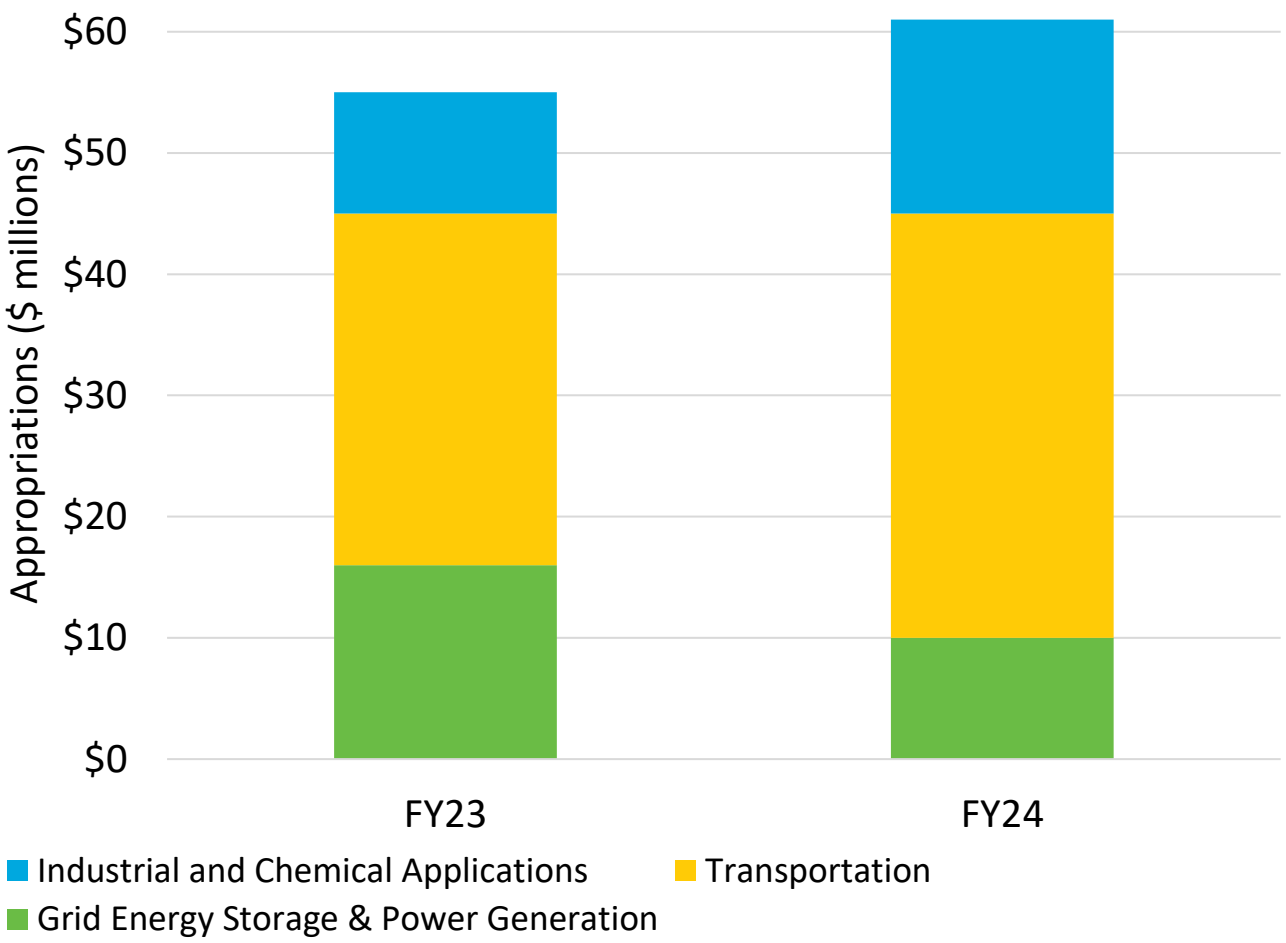



**HFTO-SDI** (TRL ~4-6) serves as **proving grounds for future** deployments (TRL ~6-8+) (i.e., OCED H2Hubs)

# Systems Development & Integration: Budget

**FY23 Appropriations $55 million***

**FY24 Appropriations $61 million***




## Program Direction

**Systems Development & Integration Funding:**

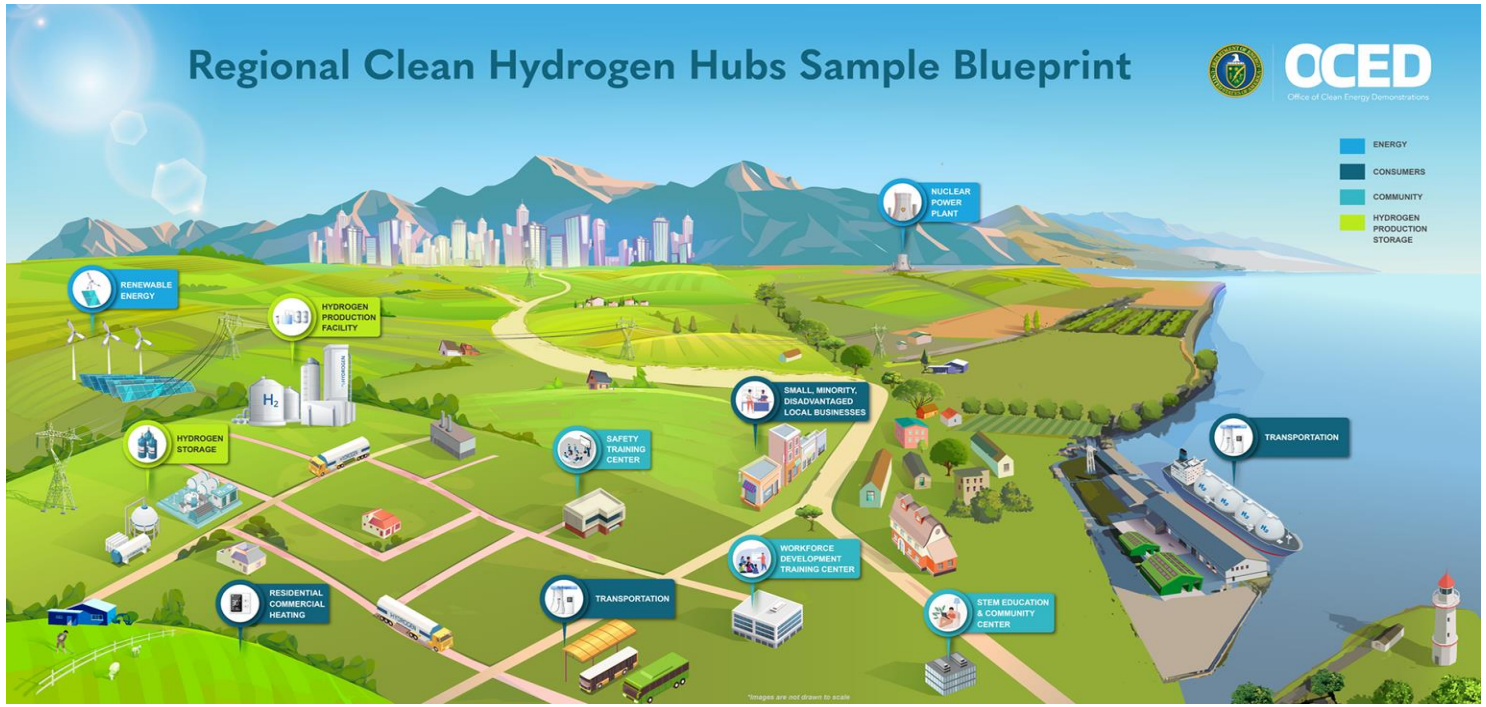
- Industrial & Chemical Applications
  - Steel (Iron ore reduction via integrated SOEC)
  - FOA Topic: Industrial pre-FEED studies to integrate clean $H_2$
- Transportation
  - SuperTruck III
  - FOA Topic: Station of the Future – HD fueling
  - FOA Topic: Port Equipment
  - Fuel Cell System Testing / Validation
- Grid Energy Storage & Power Generation
  - Renewables / Nuclear to $H_2$
  - High Temperature Electrolyzer Validation

**FY25 Request $65 million**

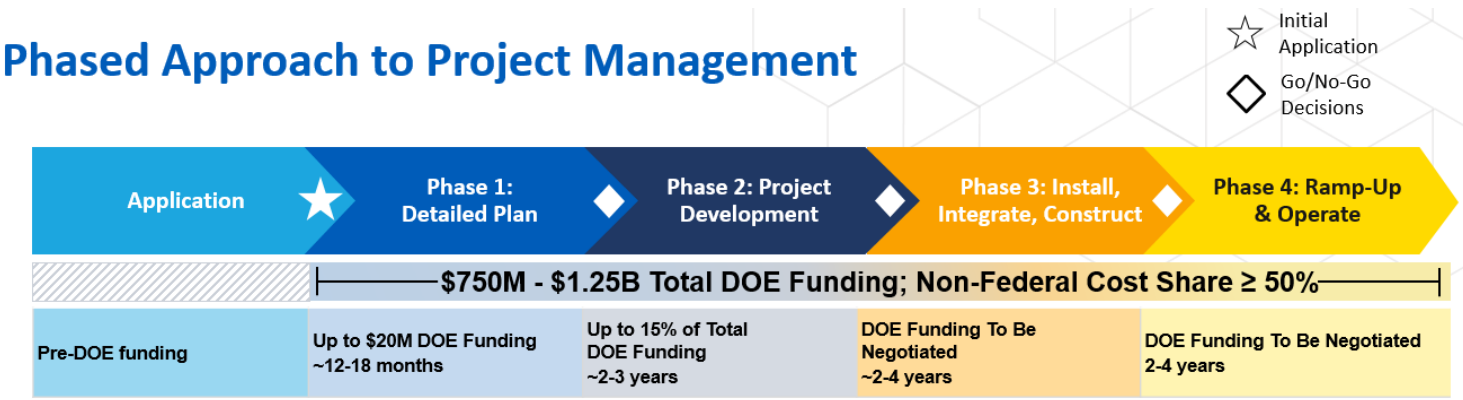
*Safety, Codes, & Standards Budget appropriations not shown here, but is included in SDI budget appropriations ($15M in FY23 & FY24)

# Selected Regional Clean Hydrogen Hubs (H2Hubs)

# H2Hubs: Summary




## Phased Approach to Project Management




**Led by DOE's Office of Clean Energy Demonstrations (OCED) in collaboration w/ HFTO & DOE $H_2$ Program**

- Unprecedented Investment in America's $H_2$ Infrastructure
  - Federal investment of $7 billion (Federal investment will be matched by recipients to leverage a total of nearly $50 billion)
- Accelerating adoption of $H_2$ technologies:
  - Approximately 3 Million Metric Tons of clean $H_2$ Production per Year
- Providing tangible benefits for Americans:
  - Dedicated Dollars for Community Benefits
  - Tens of Thousands of Jobs
  - GHG Reduction of 25 million Metric Tons / Yr.
- Current Status
  - H2Hub selections announced October 2023
  - Awards under negotiation

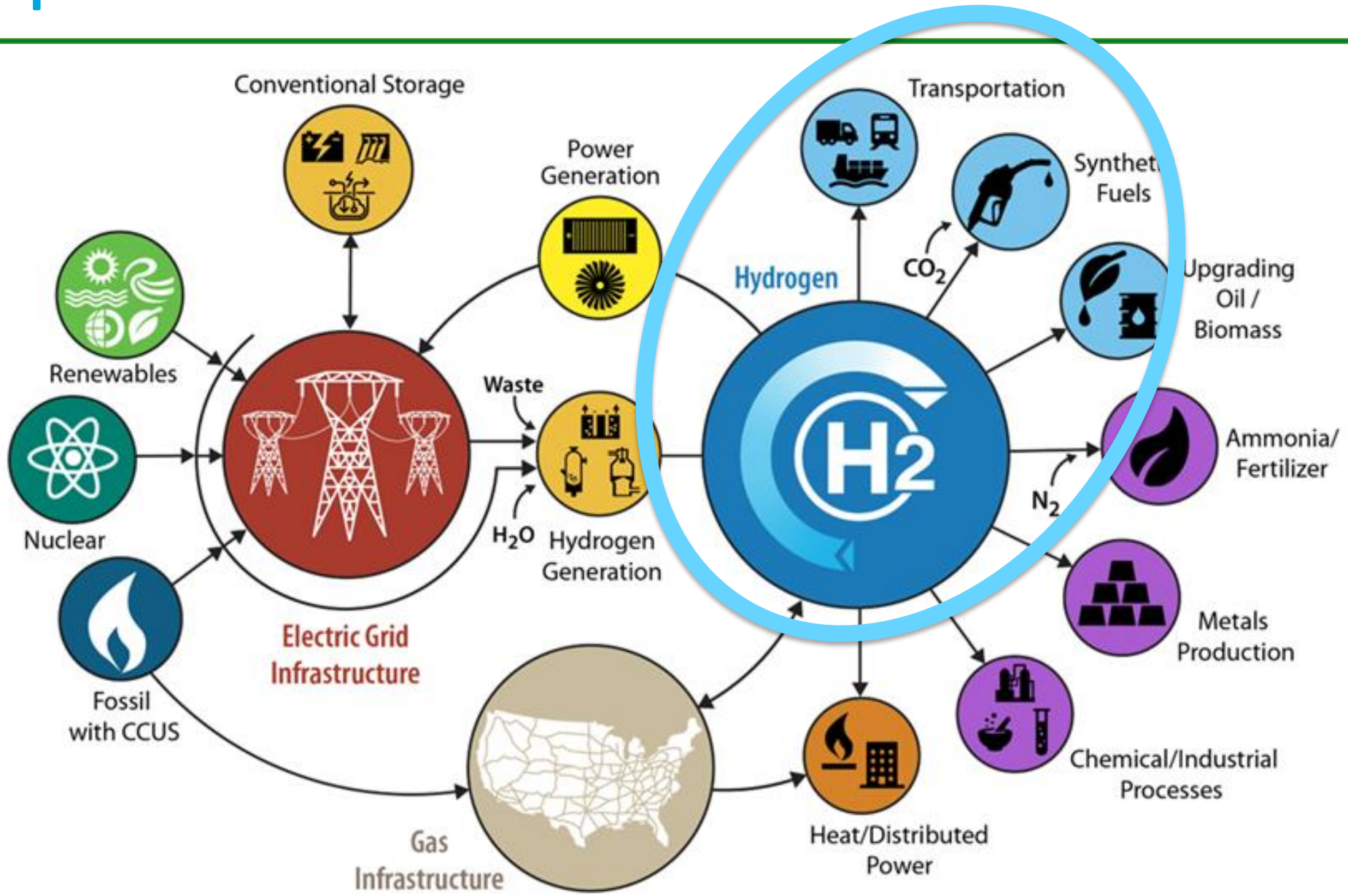
# SDI RD&D will Advance Proposed Technology needed for H2Hub Deployments

| Focus Areas | | ARCH2 | ARCHES | HyVelocity | Heartland | MACH2 | MachH2 | PNW H2 |
|---|---|---|---|---|---|---|---|---|
| Production | **Electrolysis (from Renewable and/or Nuclear Energy)** | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Thermal reforming with carbon capture and storage | ✓ | | ✓ | ✓ | | ✓ | |
| | Biomass gasification with carbon capture | | ✓ | | | ✓ | | |
| Connective Infrastructure | Hydrogen pipelines | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | **Hydrogen refueling stations** | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| | Geologic Hydrogen Storage | ✓ | | | ✓ | | | |
| End Uses | **Electric power generation** | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ |
| | **Industrial (e.g., iron refining/steelmaking, ammonia production, synthetic fuel production, process heat)** | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Residential and commercial heating | | | | | ✓ | | |
| | **Transportation (e.g., MD/HD vehicles, marine, cargo handling)** | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |

**Note:** the proposed activities are subject to change based on award negotiations and during the detailed planning phases (Phases 1 & 2)

**HFTO-SDI performs first-of-a-kind demonstration of technologies to be deployed in the H2Hubs**

# SDI: Transportation



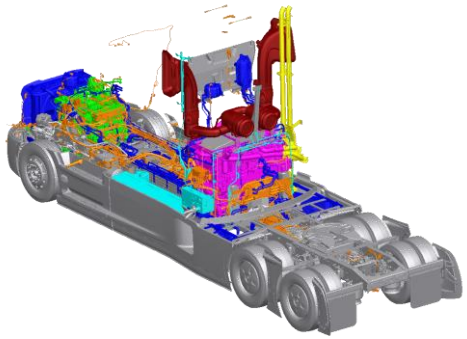
# Hydrogen Fuel Cell Heavy Duty Truck Projects – SuperTruck 3

*Images below are not final product and are subject to change*

## TA056

DAIMLER

Walmart, SCHNEIDER, Linde, MAHLE, MICHELIN



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

**Goals:**

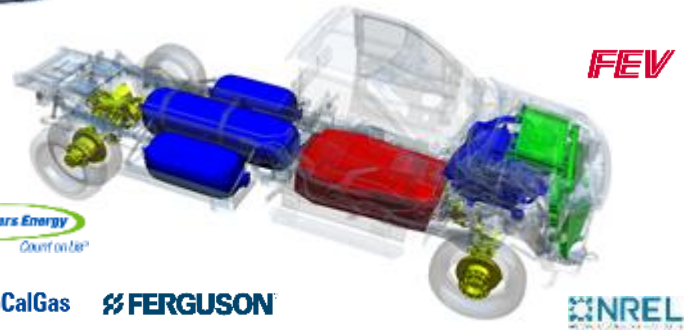
- Demonstrate 2 total (Class 8) HD long-haul fuel cell electric trucks (B-sample & final truck demo)
- 6.0 mi/kg H2 fuel economy
- 600-mile range (onboard $LH_2$ storage)
- 65,000 pounds GVW
- 25k hour lifetime

Key Accomplishments:

- Commissioned fuel cell system
- 1st complete B-sample prototype truck expected in 2024
- sLH2 fueling protocol developed

## TA057

Ford Motor Company



Consumers Energy, SoCalGas, FERGUSON, 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
- Meet or exceed 7.3L gas performance feel

Key Accomplishments:

- Commissioned fuel cell system
- 1st complete vehicle build expected in May 2024
- Over 20 patents filed

## TA058

general motors

Southern Company, nel, Argonne


**Goals:**

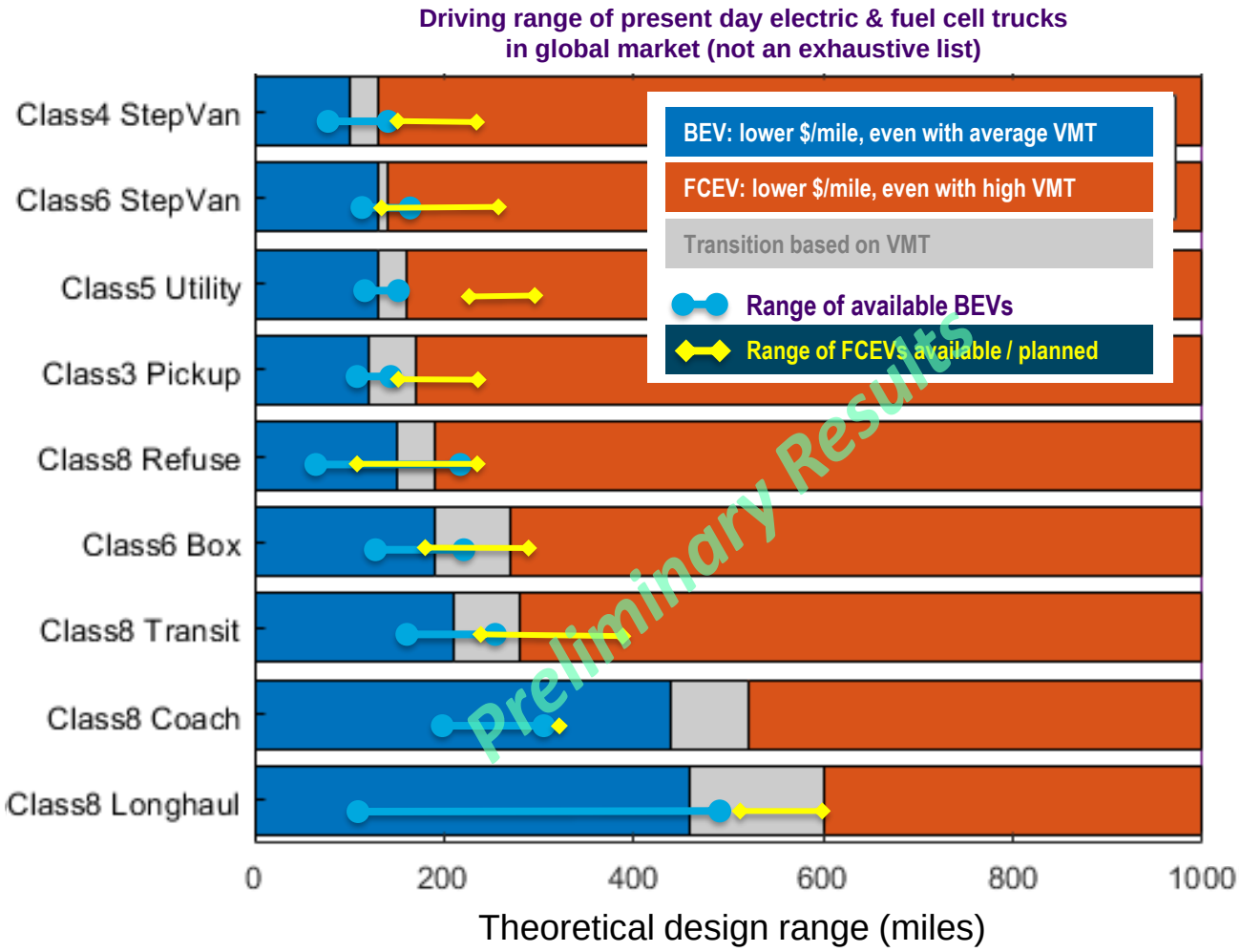
- Demonstrate 8 total (Class 4-6) MD trucks
  - 4 fuel cell & 4 battery electric trucks
- Fuel Cell System Goals:
  - 65% peak efficiency
  - <$80/kW system cost (100K units/yr)
  - 20K-30K hour lifetime
- Demonstrate microgrid w/ electrolyzer & fuel cell ($H_2$ fueling & fast charging)

Key Accomplishments:

- Commissioned fuel cell system
- Early demo fleet build expected in 2024
- Path to >62% peak efficiency & >50% efficiency at full power

# Multiple Solutions will be Required to Decarbonize Commercial Trucks

## ANL – Medium-Duty TCO and Target Development (TA059)




- VMT: vehicle miles travelled (daily VMT is estimated from reported average annual miles assuming 250 days of vehicle usage)
- VIUS: vehicle inventory and use survey

Argonne NATIONAL LABORATORY

**Scenario:**

Cost of ownership estimated based on vehicle price, fuel/energy expenses for average & high levels of VMT

- Assumes all HFTO/VTO 2030 targets are met
- Fuel/Energy costs: \$4/kg $H_2$ , \$0.15/kWh

**Conclusions:**

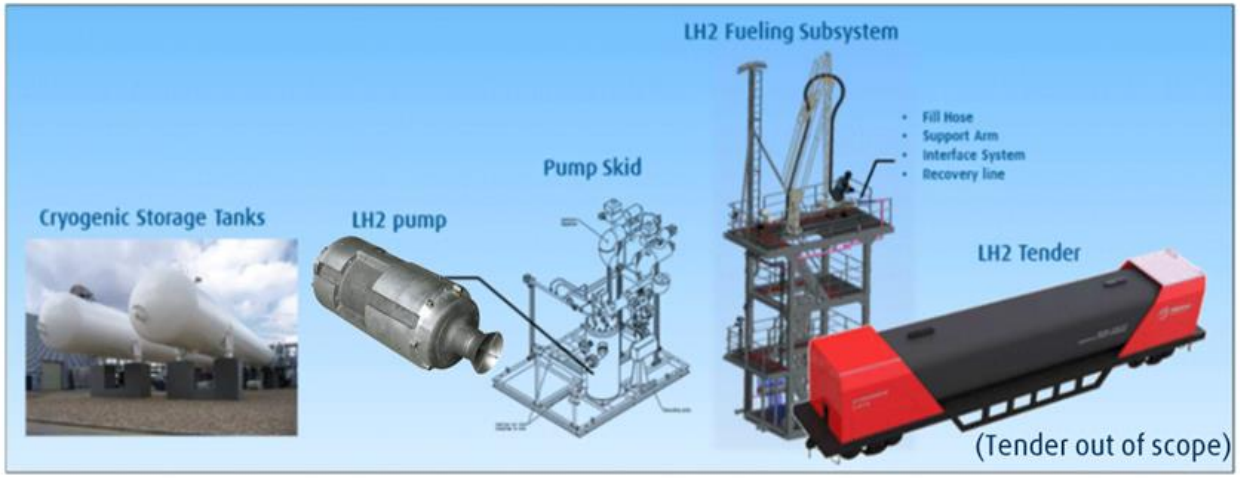
- BEVs are competitive for short range designs. Beyond a certain 'designed range' FCEVs become economically attractive.
- The 'breakeven' range depends on vehicle class, purpose, usage and energy costs
  - Incremental cost of adding a kWh of $H_2$ storage (\$9/kWh) is far lower than the cost of adding a kWh of usable battery energy (\$125/kWh)

Note: VIUS shows averaged daily driving. Fleets must plan for the variations in day-to-day operation & impact of extreme real-world conditions as well.

**DOE is using TCO analysis & VIUS Data to Identify MD Vehicles / Vocations Best Suited for Fuel Cells**

# New Hydrogen Fuel Cell Rail Projects

## Linde – HD Rail LH2 Fueling (SDI016)




**Goals:**

- Demonstrate feasibility of a high flow rate, cost effective and safe transfer of $LH_2$ into a rail tank car + strategy to mitigate the resulting losses
- Design, construct & test in a high fill-rate prototype at industrial scale

Technical Targets:

- Minimum 1200 kg $LH_2$ at 100 kg/min flow rate
- Less than 4% $H_2$ vapor losses in transfer

**Potential Impact:** Project will demonstrate high flow LH2 fueling rates for LH2 tenders for rail applications

## South Coast Air Quality Management District – Rail Freight System* (SDI011)

**Goals:**

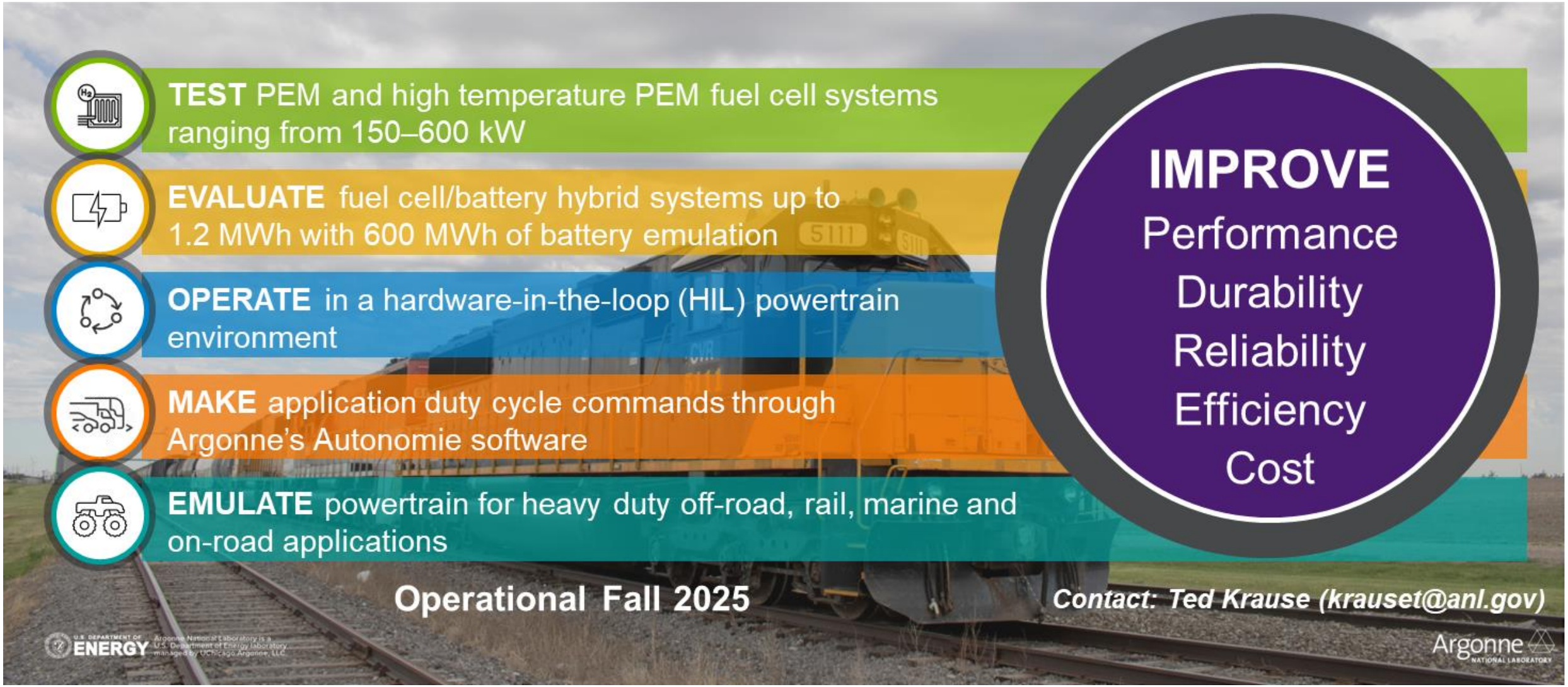
- Demonstrate zero emissions $LH_2$ fuel cell rail technology
  - Design and develop $LH_2$ and fuel cell locomotive system (Wabtec)
- Develop power and drivetrain
  - Increase power throughput
  - Increase tractive effort
- Demonstrate fast refueling, safely handling and use $LH_2$
- Remote monitoring for continuous data analysis
- Start 12-month demonstration in 2027


**Potential Impact:** Initial design of a H2 short haul freight locomotive for demonstration that will be funded by SCAQMD

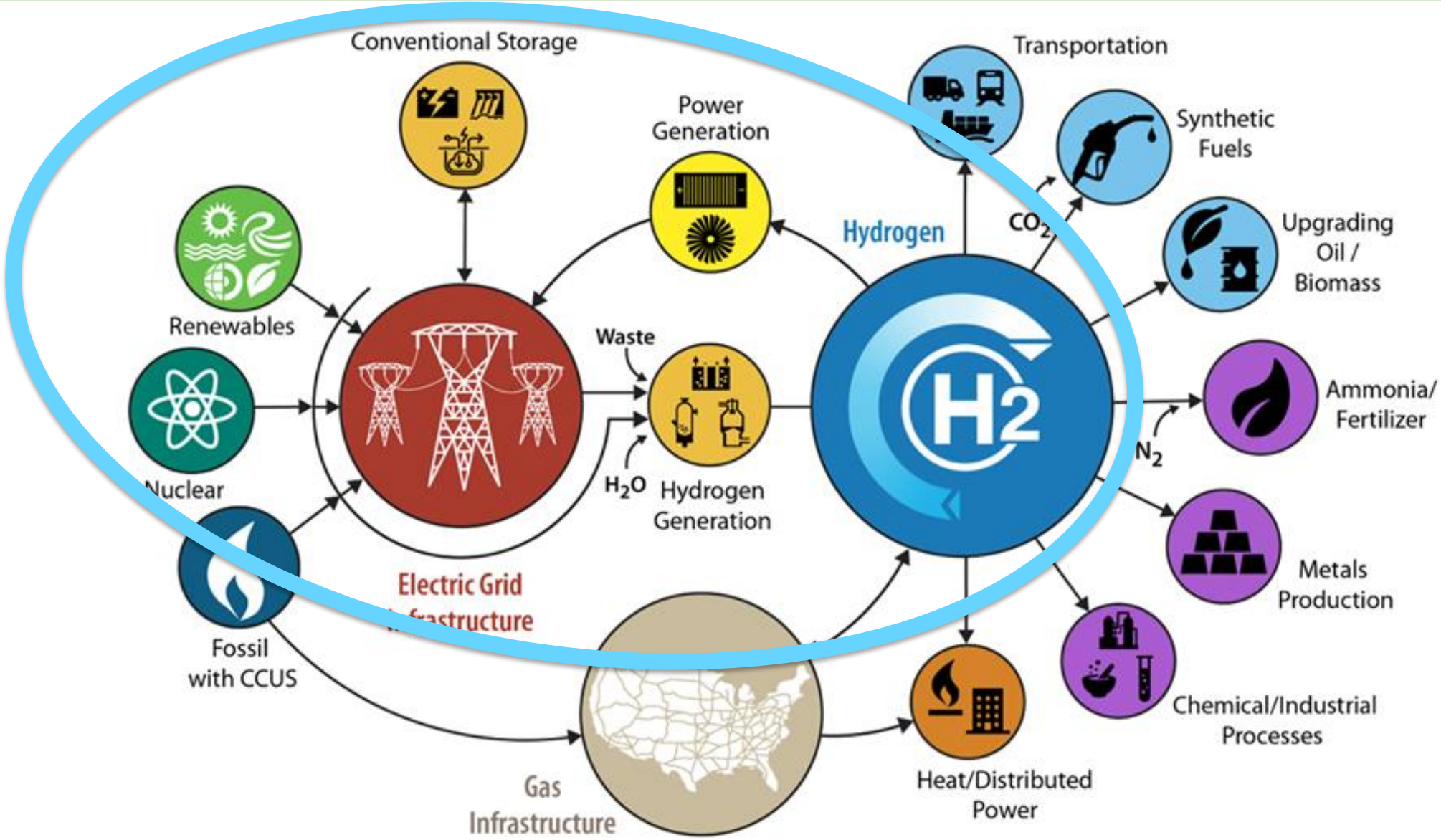
*Congressionally Directed

# New Heavy-Duty Fuel Cell Test Facility – Argonne National Lab

## National Resource for Independent Analysis, Testing & Validation of HD Fuel Cell Systems



# SDI: Grid Energy Storage & Power Generation



# H2@Scale Demonstrations – Proto-Hub (TA037)

## Frontier Energy – Demonstration and Framework for H2@Scale in Texas and Beyond

**Goals:**

- Minimize $H_2$ cost through multiple generation sources
- Co-locate $H_2$ end uses (stationary power & vehicle fueling)
- Develop 5-year $H_2$ Plan (framework study) for Port of Houston and Gulf Coast region


H2@Scale in Texas and Beyond Project

**Hydrogen Research and Demonstration Facility**

Ribbon Cutting Ceremony

Hosted By:

FRONTIER energy

The University of Texas at Austin
Center for Electromechanics
Cockrell School of Engineering

GTI ENERGY

**April 23, 2024**

**Key Accomplishments:**

- Ribbon Cutting Event held on April 23rd!
- All components installed with commissioning underway and first $H_2$ fueling completed
- "A Framework for Hydrogen in Texas" study published

# High Temperature kW Scale Electrolysis Integrated Energy Systems (TA018)

## INL – HTE Stack and System Testing

Status:

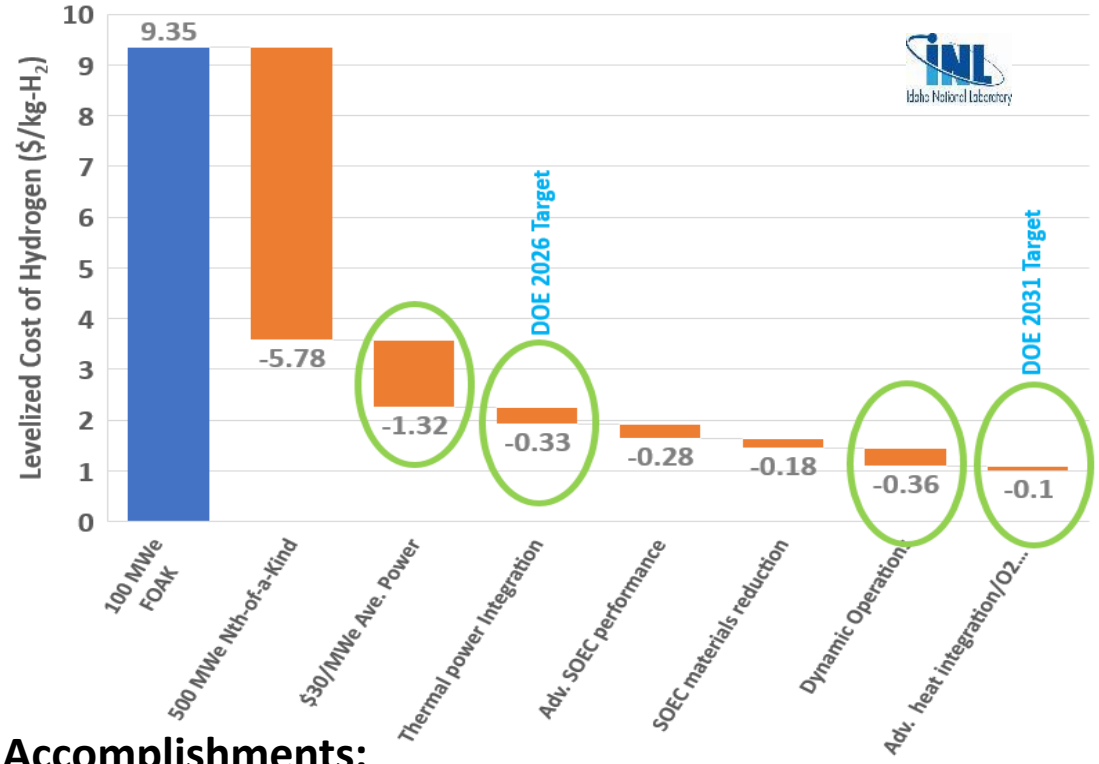
- 100kW Bloom SOEC System: Completed >6500 hours, stable efficiency: 37.7 kWh/kg DC, minimal degradation
- 250kW FCE SOEC System: testing to start this summer
- Also testing Nexceris, OxEon, Denso, and Topsoe stacks
- Plan to use $H_2$ produced for bus fueling / methanol production

**Key Accomplishments:**

- >20,000 hrs cumulative stack / system testing
- Minimal degradation (typically <0.05% / 1000 hrs)

## LCOH for HTE System

Need system / thermal integration development & SOEC material advancement to hit $1/kg




**Key Accomplishments:**

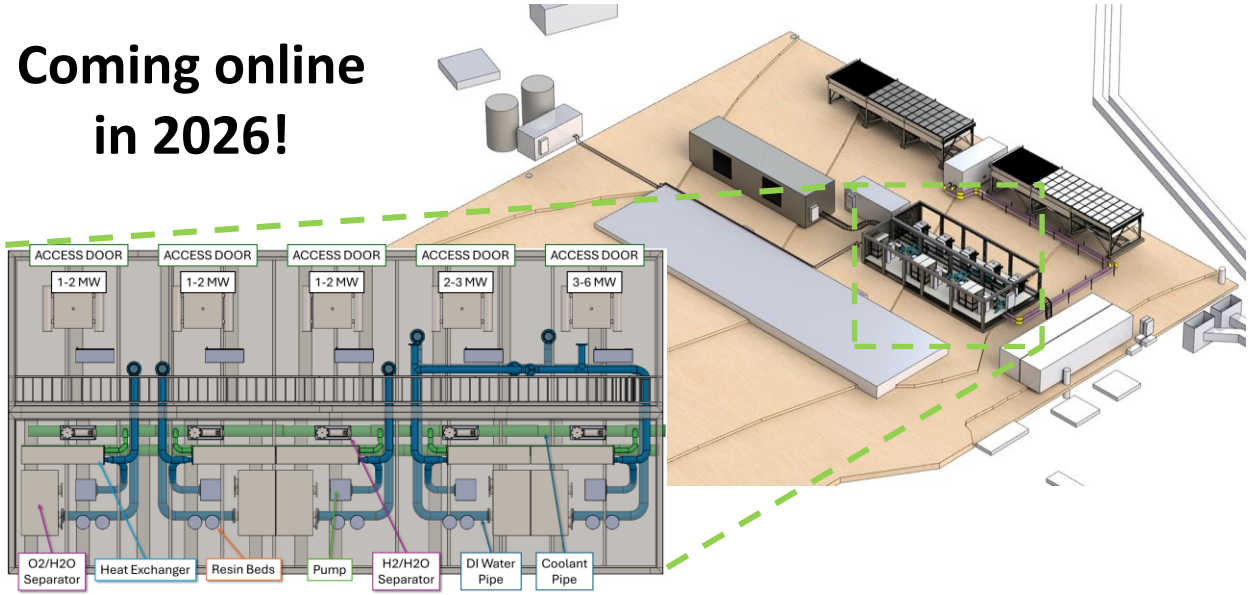
- Pathway to hit $1/kg identified
- Behind the meter NE to $H_2$ design completed (Vistra, Xcel)
- Thermally integrated HTE designs (Westinghouse) & validations (INL / FCE / Bloom) in process

# Expansion to Multi-MW Electrolyzer Stack and System Test Capabilities

## Low-Temperature Electrolyzers – NREL (ELY-BIL001)

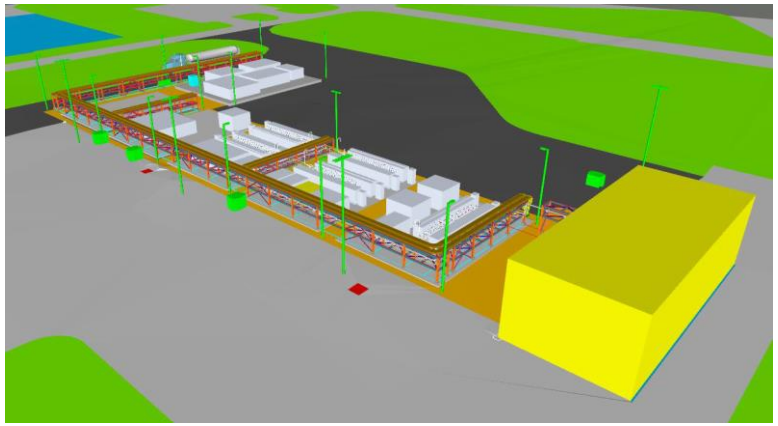
- Expansion of NREL's Flatirons Campus ARIES capability to support industry
- Full system testing **up to 10 $MW_{AC}$**
- Parallel stack testing **up to 6 $MW_{DC}$** in aggregate for PEM and/or alkaline stacks
- Grid integration with renewable energy production and other ARIES assets

**Coming online in 2026!**




## High-Temperature Electrolyzers – INL (SDI006)

- High Temp Test Facility (HTTF) is cornerstone of INL's Energy Technology Proving Ground
- Full, simultaneous HTE systems testing **up to 10 $MW_{AC}$** in aggregate
- Simulated nuclear integration and future physical integration with microreactors
- Multiple $H_2$ end use test possibilities including fueling for INL coach fleet and bio-$CO_2$ capture

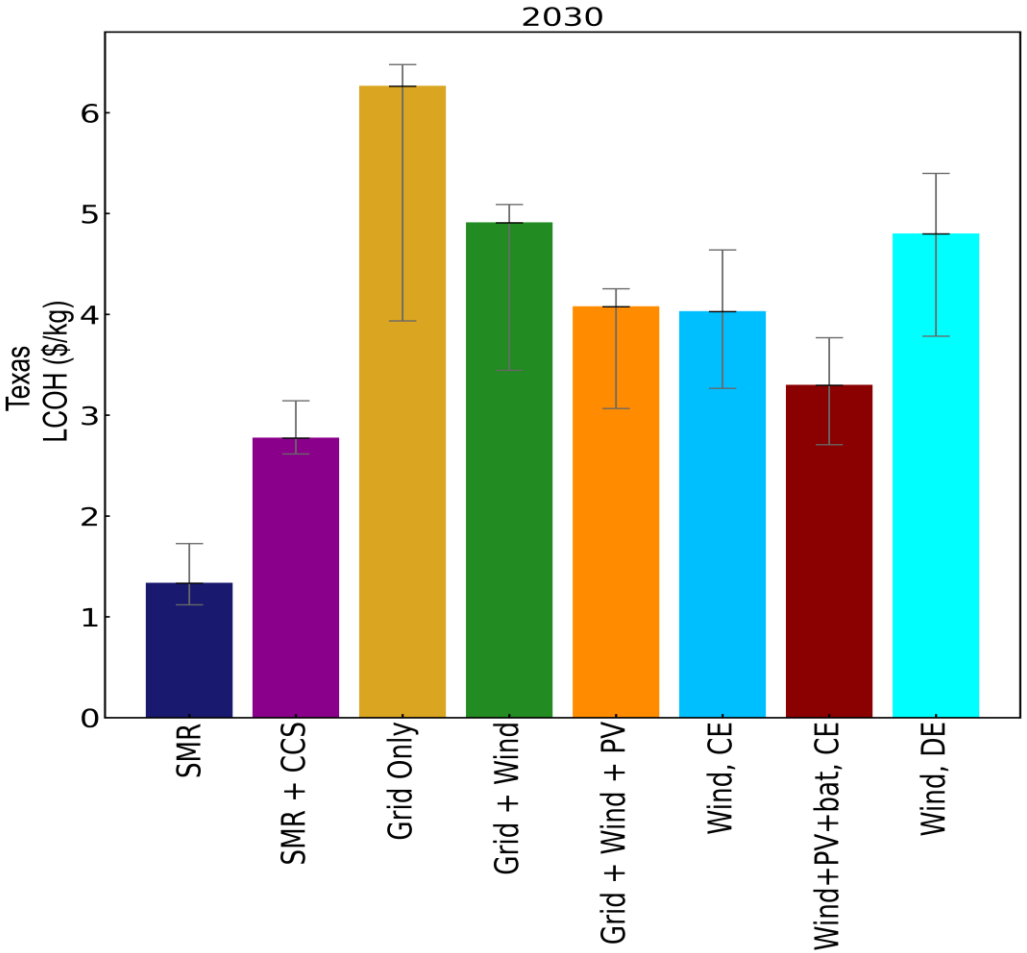


**Coming online in 2025!**

# Fully Integrated Renewables to $H_2$ to Industrial End-Use Analysis

## NREL* - GreenHEART Modeling & Analysis (SDI001)

*NREL led with support from ANL, LBNL, ORNL, and SNL
Project Jointly Funded with DOE Wind Energy Technology Office




"**Source:** Reznicek, E. et al., 2024, *Techno-economic analysis of low-carbon hydrogen production pathways for decarbonizing steel and ammonia production*. Manuscript submitted for publication."

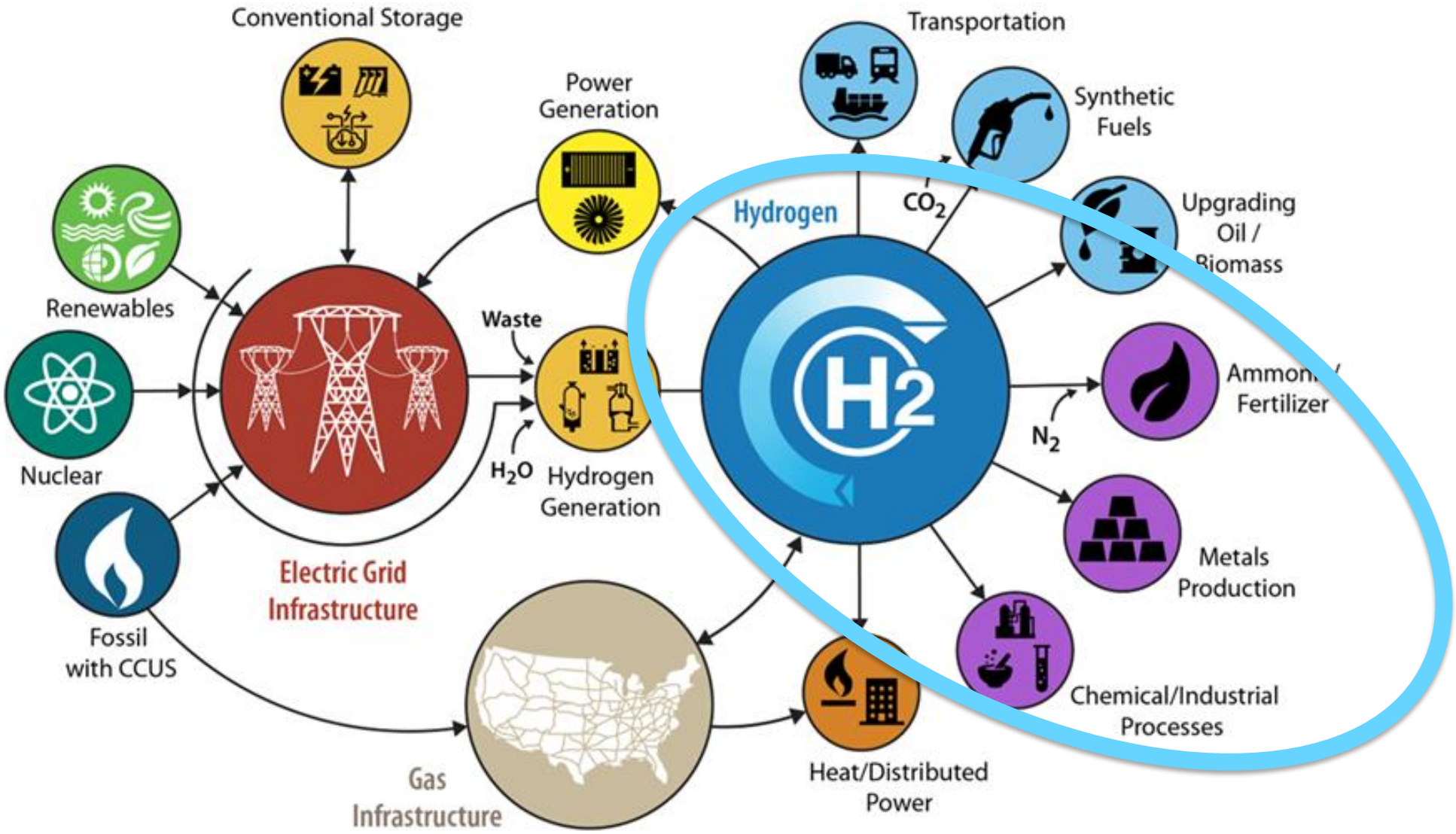
**Goals**:

- Develop reference designs for GW-scale off-grid, behind the meter, hybrid energy systems for co-located renewables to $H_2$ to Industrial processes
- Provide alternative path to decarbonization for hard-to-abate industries
- Identify best location when considering wind, solar, $H_2$ storage, water, etc.

**Key Accomplishments**:

- Reference Design Use Cases Complete for MN, TX, Gulf of Mexico and Pacific (CA)
- Multiple renewable sources + batteries (i.e., wind, solar, battery) provide lowest cost for many locations (higher compacity factor / less H2 storage requirements)
- $H_2$ storage cost can be significant if no geologic storage
- Provides opportunity to build out renewables without having to wait for grid permitting
- Policy may bridge the gap between SMR and clean $H_2$

# SDI: Industrial & Chemical Processes

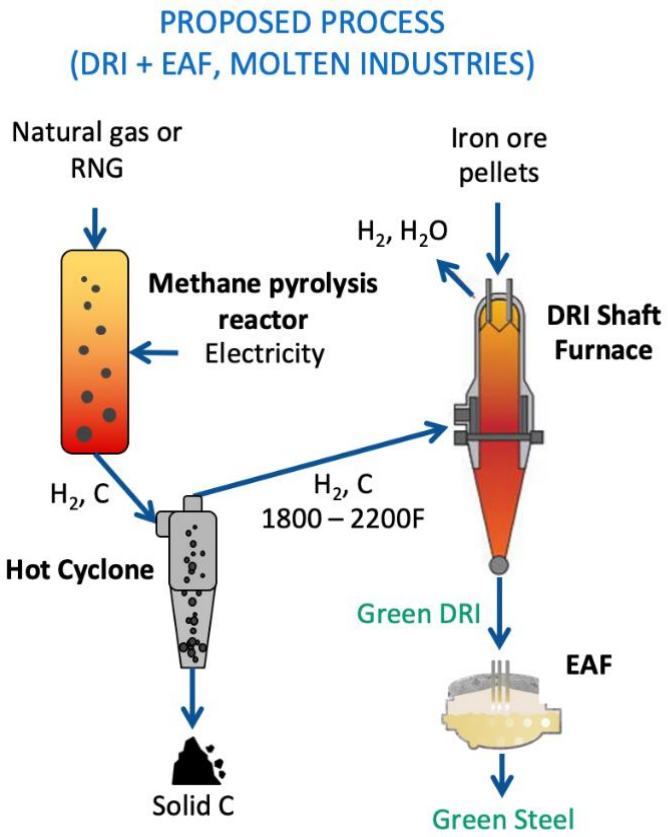


# New Industrial Process Projects

## Molten – Carbon-Neutral Steel Production with Methane Pyrolysis Driven Direct Reduced Iron

**Goals:**
Design, build, & test first thermally integrated methane pyrolysis / Direct Reduction of Iron (DRI) pilot scale system

- Demonstrate use of solid carbon produced by pyrolysis for carburization
- 400 kg/day DRI production demonstration
- >85% reduction in carbon intensity

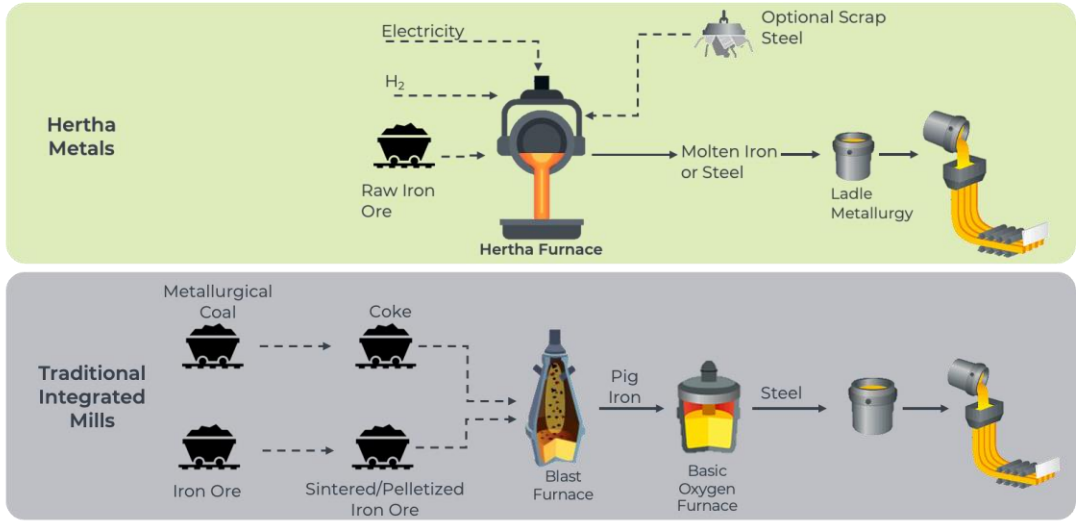



**Potential Impact:** Demonstrate low-carbon steel production with methane pyrolysis

## Hertha Metals, Inc. – Hydrogen-Electric Smelting Reduction for Green Iron & Steel Production (SDI008)

**Goals:**
Develop a pilot-scale technology that converts any grade of direct shipping iron ore (as opposed to only DRI-grade ore)

- 300 kg/day scale with a carbon intensity demonstration
- >90% reduction in carbon intensity (0.1 tons of $CO_2$e/ton of crude steel)



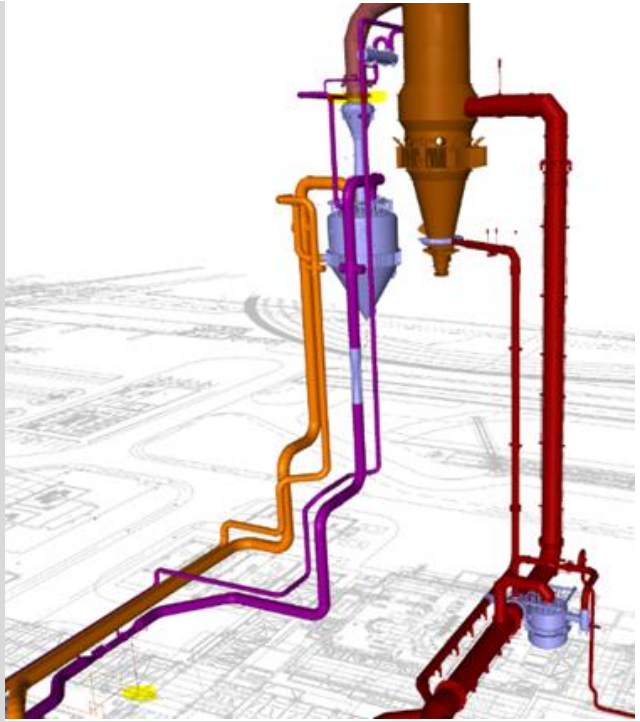

**Potential impact:** Demonstrate low-carbon steel production with novel reactor and lower-grade ore

# New Industrial Process Projects

## U. of Wisconsin – Demonstration of a SOEC Hydrogen Direct Reduction at Toledo, OH steel plant (SDI009)

**Goals:**
Thermally & chemically integrate a HT electrolyzer (250 kW SOEC) able to operate in steam and co-electrolysis to demonstrate potential to reduce $CO_2$ from existing commercial DRI furnace

- DRI production capacity of 1.6 MT/year
- 90% reduction in CO2 emissions
- TRL 4 to TRL 6



- Demonstrate operation for 3600 hr at 250 kW
- Demonstrate LCA and TEA in comparison to incumbent NG DRI

**<u>Potential Impact</u>**: Demonstrate potential (at scale) to integrate SOEC and reduce $CO_2$ emissions of commercial DRI furnace >90%

## OCED Industrial Demos Program -- $1.7+ Billion for Clean $H_2$ End-Uses (examples)

### Hydrogen-Ready Electric Melting Furnace Iron & Steel Retrofit

Install a hydrogen-ready, flex-fuel DRI and 2 electric melting furnaces

- $500 million federal cost share
- Cleveland-Cliffs, Middletown, OH
- 1 million metric ton GHG emission reduction

### Hydrogen-Fueled Zero Emissions Steel Making

Build world-first commercial-scale facility using the HYBRIT® DRI technology with 100% hydrogen

- $500 million federal cost share
- SSAB, Perry County, MS and Montpelier, IA
- 81% GHG emissions reductions

### Baytown Olefins Plant Carbon Reduction Project

Use new burner technologies for ethylene production to enable the use of $H_2$ in place of natural gas across high heat-fired equipment

- $332 million federal cost share
- Exxon Mobil Corp., Baytown, TX

Project descriptions and details available here:
https://www.energy.gov/sites/default/files/2024-03/FINAL%20IDP%20Selection%20National%20Briefing_0.pdf

# FOA Topics Relevant to SDI

| Office | Funding Opportunity | Topic | Total Funding Level | Funding Per Award | Full App Due |
|---|---|---|---|---|---|
| **HFTO** | FY24 HFTO FOA to Advance the National Clean Hydrogen Strategy | **Topic 2**: Standardized Hydrogen Refueling Station of the Future | $30M | $10M | March |
| | | **Topic 3**: Hydrogen Fuel Cell Powered Port Equipment | $10M | $4M | |
| **IEDO (in collaboration w/ HFTO)** | FY24 Energy and Emissions Intensive Industries FOA | **Topic 6**: Innovative Industrial Pre-FEED Studies<br>• **AOI 1**: Integration of Clean Hydrogen in the Industrial Sector<br>• **AOI 3**: Integrated Process Pre-FEED | $5M | $0.5 – $1.5M | June |

Others Related Solicitations:

- $3B EPA's Clean Ports Program - open through May 28
  - Zero-emission technology (Equipment and Infrastructure) at the port which includes H2 and fuel cell technology
  - Requires previous deployment experience; no R&D (https://www.epa.gov/ports-initiative/cleanports)

# SDI: Collaboration Network

## Fostering technical excellence, economic growth and environmental justice

### *Industry Engagement*

- 21st Century Truck Partnership / U.S. DRIVE
- Off-Road Working Group
- FCHEA
- Participated in Numerous Conferences, Workshops & Working Groups

### DOE $H_2$ Program Collaborations

Collaboration across $H_2$ through Joint Strategy Team (JST)

| | | |
|---|---|---|
| DOE OCED | DOE VTO | DOE WETO |
| DOE IEDO | DOE NE | DOE FECM |
| DOE Joint Office | DOE MESC | DOE BETO |

### DOE Cross-Cutting Initiatives

Industrial Decarbonization, Long Duration Storage, Floating Offshore Wind, Clean Fuels & Products, Industrial Heat, Grid Modernization

### *Cross-Agency Collaborations*

- Hydrogen Interagency Task Force (HIT) 14 government departments & agencies, 280+ participants
- Modal Action Plans: Rail, Marine, Off-Road, M/HD Trucks (DOE, DOT, EPA, HUD)
- IAA Fuel Cells for Fast Charging (Army-GVSC, Navy-NRL)

### *U.S. Regional and International Collaborations*

| | | | | | | |
|---|---|---|---|---|---|---|
| Project Coordination across ~20 U.S. States | Mission Innovation – Zero Emission Shipping | Mission Innovation – Clean H2 | International Offshore Wind to H2 Working Group | IEA Wind and H2 Tasks: Renewable Hybrid System Collaboration | Japan's Ministry of Economy, Trade, and Industry | National Research Council-Canada |

# SDI: Highlights and Milestones

| FY2023 | FY2024 | FY2025 |
|---|---|---|
| Regional Clean H2Hubs: Concept Paper reviews complete; Full Applications received 4/7/23 & reviews in process (in collaboration w/ OCED) | Regional Clean H2Hubs: Select & Help Negotiate 7 H2Hubs (in collaboration w/ OCED) | Regional Clean H2Hubs: HFTO will support Phase 1 detailed Project Planning as Technical Advisor on OCED Integrated Project Teams |
| Demonstrated Integrated (behind-the-meter) 1.25 MW Electrolyzer Installation at Nuclear Plant (Constellation) | Design 10MW Low & High Temperature Electrolysis Validation Facilities (NREL & INL) | Complete procurement and construction for 10 MW HT Electrolyzer test facility at INL |
| Completed Integration & Commissioning of 1.25MW Electrolyzer and 1MW Fuel Cell Systems (NREL – ARIES) | Test 250kW HT Electrolysis System using Fully Emulated Nuclear Integrated Test Stand (INL/FCE) | Commissioning of Heavy-Duty Fuel Cell Validation Facility (ANL) |
| Initiated Design of Full Thermal Integration at a Nuclear Plant with HT Electrolyzer in Collaboration with NE (Westinghouse) | Demonstrate Directed Connected Wind Turbine to LT Electrolyzer $H_2$ Production (NREL – ARIES) | Operation of ~10 Fuel Cell SuperTruck 3 Prototypes in Final Configuration with Fleet Partners |
| Demonstrated 15 Fuel Cell Electric MD Delivery Trucks Operating in Disadvantaged Community (CTE) | Completed >20,000 cumulative hours of HT electrolysis stack / system testing with minimal degradation observed (INL) | Rail: Develop High-Rate Liquid Hydrogen Fueling for HD Rail (Linde) & Design H2 Fuel Cell Power Short Haul Rail Locomotive (SCAQMD, Wabtec) |
| Completed design, fabrication & testing of Class 7 H2Rescue Disaster Relief Truck (DOD, DHS, Cummins) | Demonstrated 1.5 MW $H_2$ Fuel Cell for Data Center Resiliency (Caterpillar, Microsoft) | Initiate Retrofit a Komatsu Mine Haul Truck with a Prototype LH2 Storage System |
| Kicked-off of I-10 $H_2$ Fueling Corridor Study in Collaboration with EERE-VTO (GTI) | Prototype Commissioning of multiple Class 4-8 Fuel Cell Electric Trucks through SuperTruck 3 (Daimler, GM, Ford) | Start New Integrated DRI/HBI Mill with 250kW SOEC (U. of Wisconsin, Cleveland Cliffs) |
| Developed Reference Design & TEA for Direct Coupled Wind to H2 to Industrial End-Use (NREL) | Began design of Heavy-Duty 600kW Fuel Cell Validation Facility (ANL) | Host $H_2$ Clean Steel Workshop with Association for Iron & Steel Technologies (AIST) in Germany |
| Demonstrated 1 tonne/wk Reduction of Iron with $H_2$, enabling 90%+ emissions reduction (MS&T) | Launched Hydrogen Interagency Taskforce (HIT) | Award projects for 3 FOA topics: Station of the Future, Port Equipment, and IEDO Industrial Pre-FEED Studies |
| Selected New $H_2$ Related Industrial Decarb Projects in Collaboration with EERE-IEDO (Molten & Hertha) | Initiated Interagency Project Demonstrating Fuel Cells for BEV Fast Charging (DOD, DHS, GN) | |

# Systems Development & Integration Team

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# Join Our Clean Energy Workforce Today

***Stop by the table outside Independence Ballroom at lunch today to learn more!***

EERE is driving the clean energy revolution by funding the innovation that's building the technologies that will forever change the way energy is generated and consumed. So now is a great time to become a **Clean Energy Champion** by joining EERE today!

Together we strive to:

- **Build the clean energy economy in a way that benefits all Americans.**
- **Create good paying jobs for the American people.**
- **Overcome the technological, economic, and institutional barriers to the development of hydrogen and fuel cells.**
- **Make renewable energy cost-competitive with traditional sources of energy.**
- **Increase access to domestic, clean transportation fuels.**
- **Reduce the carbon footprint of buildings.**
- **And so much more.**

EERE is committed to building a clean energy workforce with skilled professionals from diverse backgrounds. If interested in learning more about **becoming a Clean Energy Champion & joining the Clean Energy Revolution, stop by our booth to speak with our EERE Talent Acquisition representatives today!**

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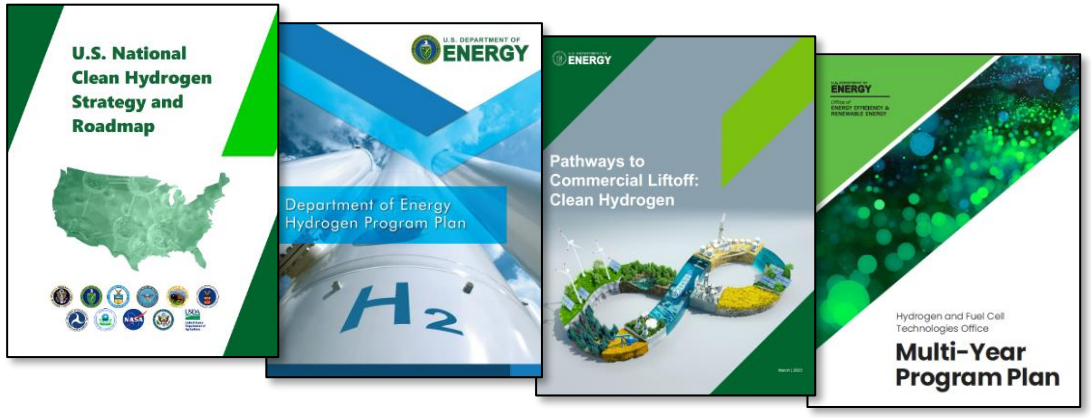
# Resources and Opportunities for Engagement

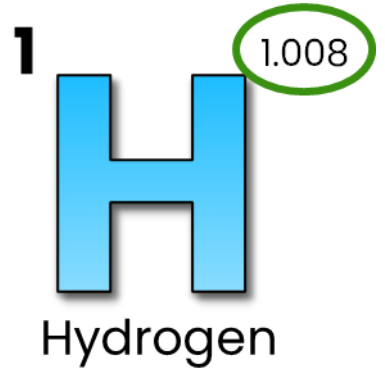
## Key Publications

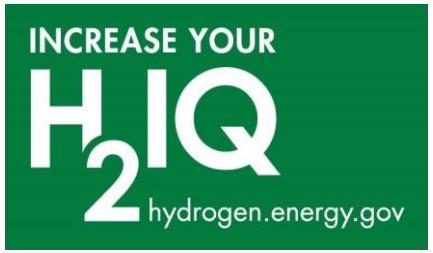



www.hydrogen.energy.gov

## Hydrogen and Fuel Cells Day October 8

- Held on hydrogen's very own atomic weight-day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# Session Preview

# Tuesday Session: SDI

| Tuesday, May 7th | | | |
|---|---|---|---|
| SDI000 | Systems Development & Integration: Subprogram Overview | HFTO | Jesse Adams |
| TA056 | Ultra-Efficient Long-Haul Hydrogen Fuel Cell Tractor | Daimler | Darek Villeneuve |
| TA057 | High Efficiency Fuel Cell Application for Medium Duty Truck Vocations | Ford | Stan Bower |
| **Break (10:30 AM - 11:00 AM)** | | | |
| TA058 | Freight Emissions Reduction via Medium Duty Battery Electric and Hydrogen Fuel Cell Trucks with Green Hydrogen Production via a New Electrolyzer Design and Electrical utility Grid Coupling | GM | Jacob Lozier |
| SCS031 | Heavy Duty Fueling Methods and Components | NREL | Shaun Onorato |
| **Lunch ( 12:30 PM - 1:45 PM)** | | | |
| TA016 | Fuel Cell Hybrid Electric Delivery Van | CTE | Steve Clermont |
| TA059 | MDV TCO and Target Development | ANL | Ram Vijayagopal |
| TA065 | Total Cost of Ownership (TCO) Analysis of Hydrogen Fuel Cell in Off Road Heavy-Duty Applications - Preliminary Results | ANL | Rajesh Ahluwalia |
| **Break (3:15 PM - 3:45 PM)** | | | |
| TA001 | MEA Manufacturing R&D | NREL | Peter Rupnowski |
| TA029 | Autonomous Hydrogen Fueling | Plug Power | Karen Swider Lyons |
| TA063 | High Efficacy Validation of Hydride Mega Tanks at the ARIES LAB (HEVHY METAL) | NREL | Katherine Hurst |

- 6 parallel sessions
- SDI session runs all 3 days
- <u>Tuesday: Transportation Focused</u>
  - SuperTruck 3
  - HD Fueling
  - MD demos & analysis
  - Misc projects related to MEA manufacturing & bulk H2 storage

# Wednesday Session: SDI, Interagency Session, SDI-Posters

| Wednesday, May 8th | | | |
|---|---|---|---|
| TA048 | ARIES / Flatiron Facility - Hydrogen System Capability Buildout | NREL | Daniel Leighton |
| TA037 | Demonstration and Framework for H2@Scale in Texas and Beyond | Frontier | Rich Myhre |
| TA030 | Demonstration of Integrated Hydrogen Production and Consumption for Improved Utility Operations | Orlando | Paul Brooker |
| **Break (10:30 AM - 11:00 AM)** | | | |
| TA062 | Validation of Interconnection and Interoperability of Grid-Forming Inverters Sourced by Hydrogen Technologies in View of 100% Renewable Microgrids | NREL | Kumaraguru Prabakar |
| SDI002 | Hybrid Energy Systems, Microgrid in Underserved Communities (Borrego Springs) | NREL | Kumaraguru Prabakar |
| SDI001 | Integrated Modeling, TEA, and Reference Design for Renewable Hydrogen to Green Steel and Ammonia | NREL | Steve Hammond |
| **Lunch (12:30 PM - 1:45 PM)** | | | |
| TA018 SDI004 | High Temperature Electrolysis, Stack, and Systems Testing/Hydrogen Coach Bus Fueling Demonstration | INL | Micah Casteel |
| TA028 | Demonstration of Electrolyzer Operation at a Nuclear Plant to Allow for Dynamic Participation in an Organized Electricity Market and In-House Hydrogen Supply | Constellation | Uugi Otgonbaatar |
| TA039 | Solid Oxide Electrolysis System Demonstration | FCE | Hossein Ghezel-Ayagh |
| **Break (3:15 PM - 3:45 PM)** | | | |
| NE001 | LWR Integrated Energy Systems Interface Technology Development & Demonstration | Vistra Corp. | Greg Michael |
| TA044 | System Demonstration for Supplying Clean, Reliable and Affordable Electric Power to Data Centers using Hydrogen Fuel | Caterpillar | Paul Wang |
| TA051 TA060 | Offshore Wind to Hydrogen - Modeling, Analysis, Testing, and International Collaboration Work | NREL | Genevieve Saur |
| TA064 | Hydrogen Production, Grid Integration, and Scaling for the Future | NREL | Sam Sprik |

| Wednesday, May 8th \| Poster Session \| 5:30 PM - 7:00 PM | | | |
|---|---|---|---|
| TA043 | SOEC Stack Development and Manufacturing | PNNL | Olga Marina |
| TA061 | Optimal Wind Turbine Design for H2 Production | NREL | Chris Bay |
| SDI008 | Hydrogen-Electric Smelting Reduction for Green Iron & Steel Production | Hertha Metals Inc | Daniel Bullard |
| SDI009 | Demonstration of a SOEC Hydrogen Direct Reduction (HDR) at the Toledo, Ohio Steel Plant | University of Wisconsin-Madison | Luca Mastropasqua |
| SDI010 | Scaled Solid Oxide Co-Electrolysis for Low Cost Syngas Synthesis from Nuclear Energy | GE Research | Paul Glaser |
| SDI013 | Port Demand Assessment - MARAD Co-Fund / Hydrogen for Maritime and Rail Fuel Cell Technologies | SNL | Leonard Klebanof |
| SDI015 | LTE Electrolyzer Data Collection | NREL | Sam Sprik |
| SDI016 | High Rate Liquid Hydrogen Fueling for HD Rail | Linde Engineering North America | Sean Kelly |
| SDI017 | HTE Electrolyzer Data Collection | INL | Michah Casteel |

- Wednesday: Non-Transportation Focused
  - Systems Integration w/ Nuclear & Renewables
  - Microgrids / Power Electronics
  - Fuel Cells Powering Data Centers
  - Data Collection & Analysis
- Wednesday Evening: SDI Posters
- Wednesday: Interagency Session
  - DOT Panel
  - Liftoff Report
  - Joint projects with DOD

# Thursday Session: Systems Development & Integration

| Thursday, May 9th | | | |
|---|---|---|---|
| TA053 | Grid-Interactive Steelmaking with Hydrogen (GISH) | Missouri S&T | Ronald Omalley |
| TA052 | Solid Oxide electrolysis Cells (SOEC) Integrated with Direct Reduced Iron (DRI) Plants for Producing Green Steel | UCI | Jack Brouwer |
| **Break (10:30 AM - 11:00 AM)** | | | |
| OCED001 | California Hydrogen Hub - Alliance for Renewable Clean Hydrogen Energy Systems | ARCHES | Angelina Galiteva<br>Scott Brandt<br>Adam Weber |
| OCED002 | Pacific Northwest Hydrogen Hub | PNW H2 | Chris Green |
| OCED003 | Midwest Hydrogen Hub - Midwest Alliance for Clean Hydrogen | MachH2 | Neil Banwart |
| **Lunch (12:30 PM - 1:45 PM)** | | | |
| OCED004 | Heartland Hydrogen Hub | HH2H | Chad Wocken |
| OCED005 | Appalachian Regional Clean Hydrogen Hub | ARCH2 | Shawn Bennett |
| OCED006 | Mid-Atlantic Clean Hydrogen Hub | MACH2 | Joe Colella<br>Manny Citron |
| OCED007 | Gulf Coast Hydrogen Hub - HyVelocity H2Hub | HyVelocity | Ted Barnes |

- <u>Thursday:</u>
  - Industrial – Iron / Steel Production
  - All 7 H2Hubs!

# 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
- 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

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