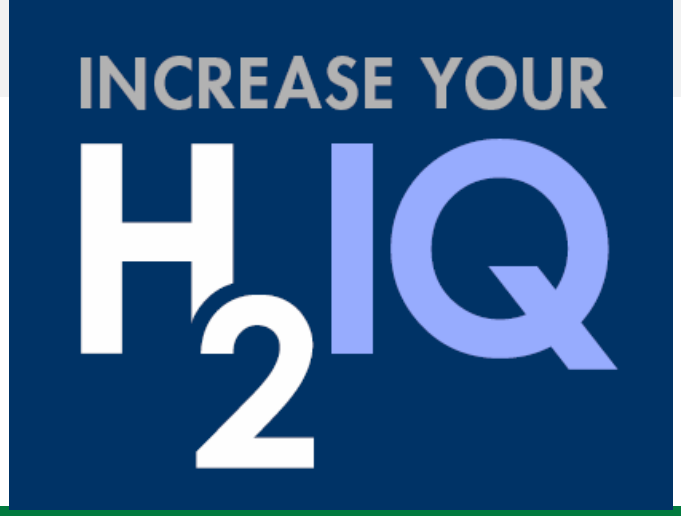


The #H2IQ Hour

Today's Topic:

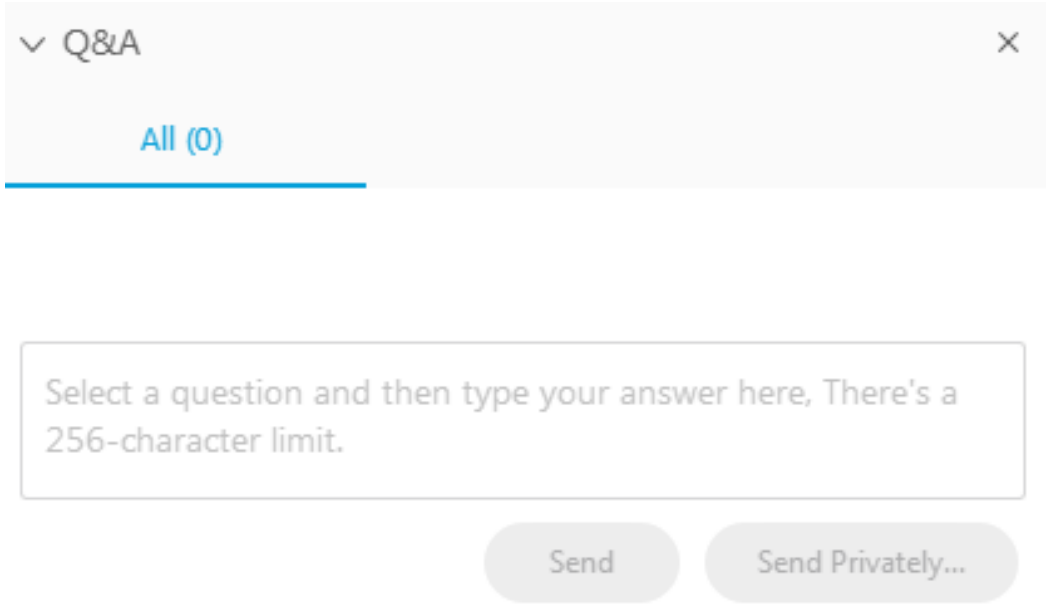
The Latest on EERE's Hydrogen and Fuel Cells R&D Portfolio

This presentation is part of the monthly H2IQ hour to highlight research and development activities funded by U.S. Department of Energy's Fuel Cell Technologies Office (FCTO) within the Office of Energy Efficiency and Renewable Energy (EERE)

The #H2IQ Hour

During Q&A session:

Please type your questions into the **Q&A Box**



U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Update on DOE's Hydrogen and Fuel Cells R&D Portfolio

Dr. Sunita Satyapal, Director, U.S. Department of Energy Hydrogen and Fuel Cells Program, Fuel Cell Technologies Office

H2IQ Hour

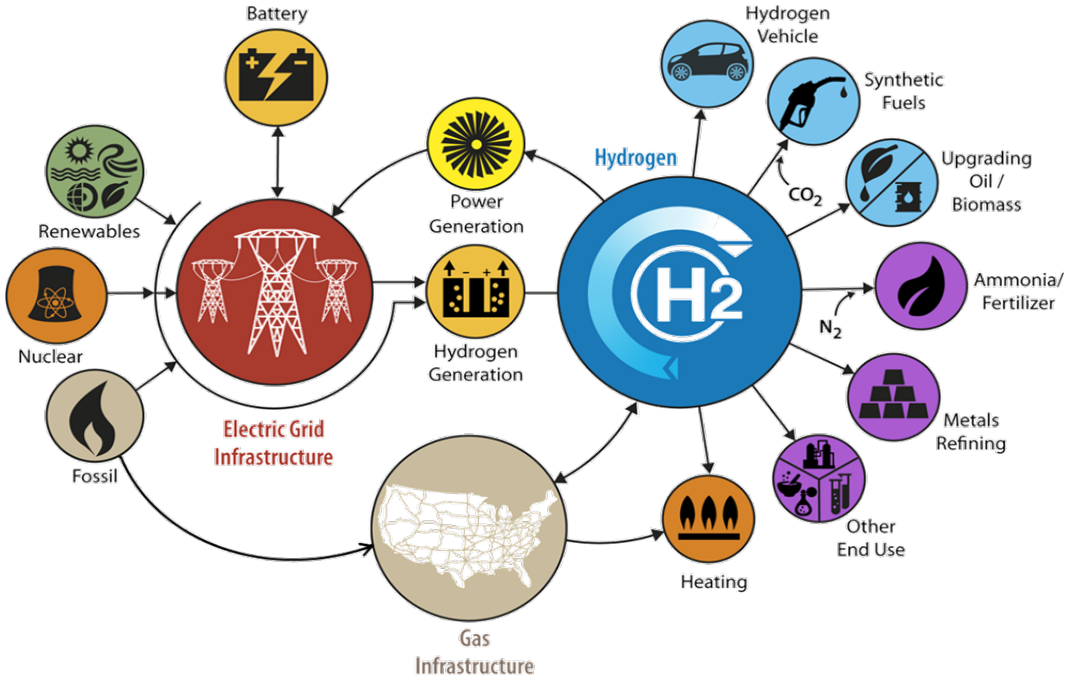
February 18, 2020

Agenda

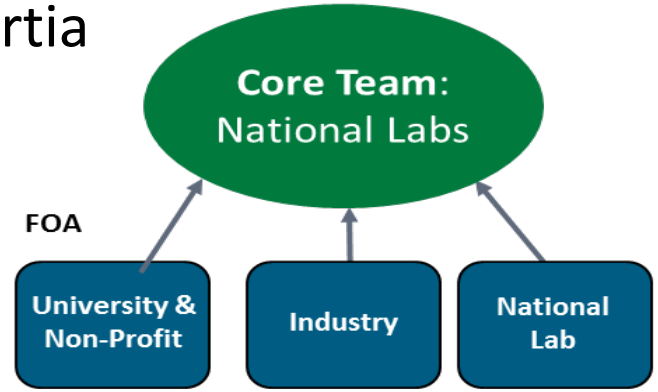
- **Budget Update and Key Priorities**
  - FY2020 Appropriations Plans
- **Recent Activities**
  - Workshops and Target Updates
  - H2@Scale New Demo Projects
- **Collaborations**
  - International Activities
  - Collaboration Announcements
- **Funding Opportunities**
  - Updates and Save the date for upcoming events

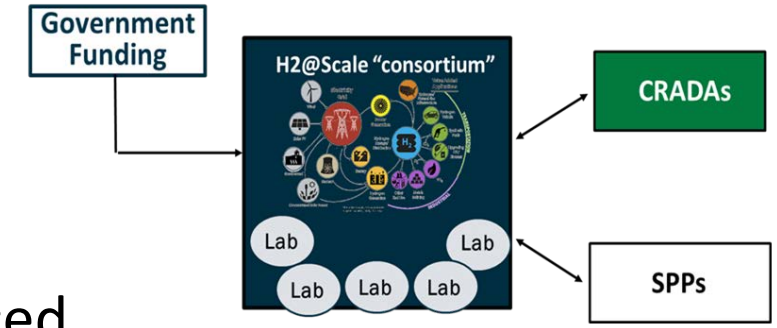
Key Programmatic Area: H2@Scale

H2@Scale: Enabling affordable, reliable, clean, and secure energy across sectors



Includes Early stage R&D: Funding Opportunity Announcements (FOAs) for industry, universities and national labs, including consortia





And includes later stage RD&D:

Leverages private sector for large-scale demos

New H2@Scale demonstration projects announced

Texas, Florida, Midwest, complements California deployments

CRADA = Cooperative Research and Development Agreement
SPP- Strategic Partnership Project ('Work for Others')

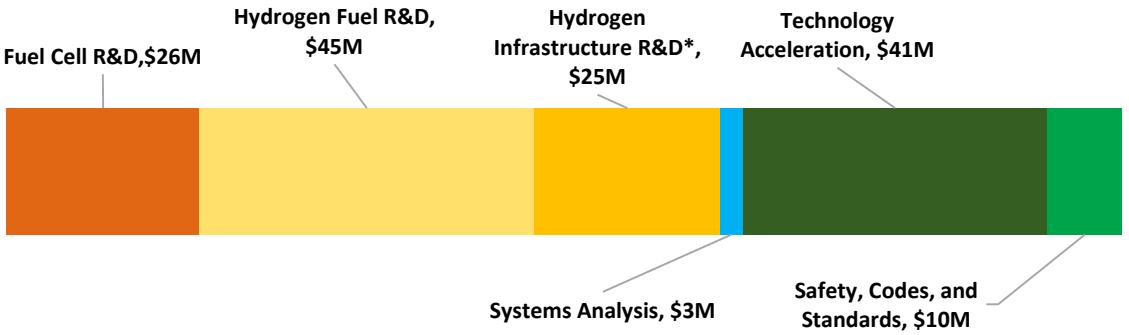
Budget

Fuel Cell Technologies Office (FCTO) within Energy Efficiency and Renewable Energy (EERE)

	FY 2018	FY 2019	FY 2020
Fuel Cell R&D	32,000	30,000	26,000
Hydrogen Fuel R&D	54,000	39,000	45,000
Hydrogen Infrastructure R&D*	-	21,000	25,000
Technology Acceleration	19,000	21,000	41,000
Safety, Codes, and Standards	7,000	7,000	10,000
Systems Analysis	3,000	2,000	3,000
Total	**$115,000**	**$120,000**	**$150,000**

*Will be moved under Hydrogen Fuel R&D in FY 2021

FCTO – Hydrogen and Fuel Cells Breakdown FY 2020



*Will be moved under Hydrogen Fuel R&D in FY 2021

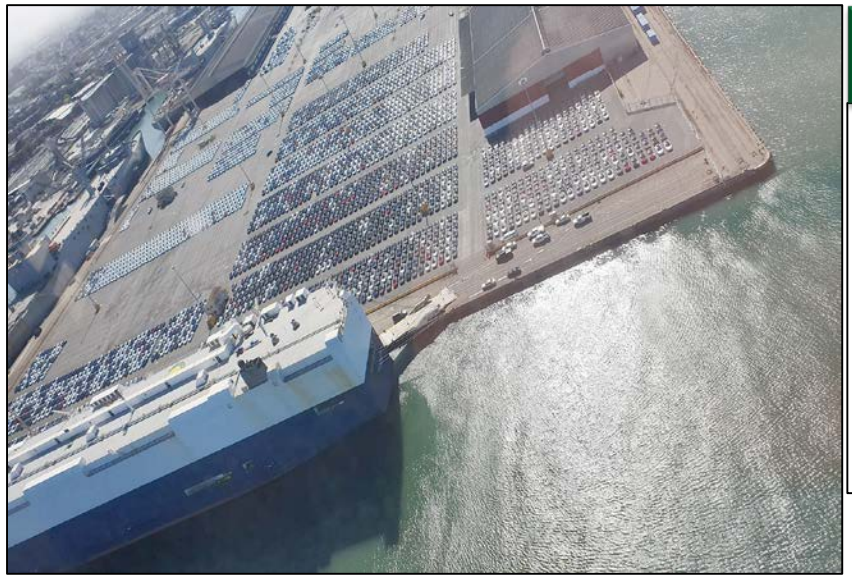
DOE Hydrogen and Fuel Cells Appropriations

DOE Office	Funding (in thousands)
EERE (FCTO)	$150,000
Fossil Energy (SOFC)	$30,000
Nuclear Energy	$11,000*

* For coordination between NE and EERE FCTO on nuclear to hydrogen
Office of Science, Basic Energy Sciences Funding is for FY18 ~ $19 million for projects relevant to H2 and fuel cells (e.g. catalysis, etc.); FY 20 TBD For coordinated project with EERE
ARPA-E- Funding based on specific program selected each year; FY20 TBD


Interest growing
in
End use applications across sectors
Heavy duty vehicles, steel manufacturing, ammonia, energy storage, liquid fuels, critical loads, natural gas blending, exports, and more

Opportunities Identified in H2@Ports, H2@Rail, H2@Datacenters Workshops



H2@Datacenters

- Collaboration between DOE, industry, end users
- RD&D & techno-economic assessment needs
  - Prime or backup power for critical loads of data centers
  - Scenario development to enable cost effective fuel cells and hydrogen storage
  - Potential additional revenue streams

H2@Ports

- Collaboration between DOE, DOT - Maritime Administration, FCH JU, European Commission, global industry, end users and ports, states
- RD&D & techno-economic assessment needs
  - Power system options and TCO
  - Cluster approach to increase scale
  - Regulations and standards

H2@Rail

- Collaboration between DOE, DOT -Federal Railroad Administration, global industry, end users, states
- RD&D & techno-economic assessment needs
  - Prime power system development
  - Rail system operations and TCO
  - Regulations, safety, codes, standards

TCO: Total cost of ownership

Workshop details available at: https://www.energy.gov/eere/fuelcells/workshop-and-meeting-proceedings

Targets to Guide Long Term R&D for Heavy-Duty Vehicles

Fuel Cell Truck Targets Developed to Enable Comparable Total Cost of Ownership with Diesel Trucks

https://www.hydrogen.energy.gov/pdfs/19006_hydrogen_class8_long_haul_truck_targets.pdf

Table 1. Technical System Targets: Class 8 Long-Haul Tractor-Trailers

Characteristic	Units	Targets for Class 8 Tractor-Trailers	
		Interim (2030)	Ultimate[9]
Fuel Cell System Lifetime[1,2]	hours	**25,000**	**30,000**
Fuel Cell System Cost[1,3,4]	$/kW	**80**	**60**
Fuel Cell Efficiency (peak)	%	**68**	**72**
Hydrogen Fill Rate	kg H_2/min	**8**	**10**
Storage System Cycle Life[5]	cycles	**5,000**	**5,000**
Pressurized Storage System Cycle Life[6]	cycles	**11,000**	**11,000**
Hydrogen Storage System Cost[4,7,8]	$/kWh ($/kg H_2 stored)	**9 (300)**	**8 (266)**

Developed through industry workshop, input and analysis on long term stretch goals to guide R&D community

Compressed Gas Storage for Medium and Heavy Duty Transportation Workshop

Key Areas of Participant Interest

Carbon Fiber Cost

- Precursor cost is the largest component
- Strength remains an important quality
- Processing refinements could yield marginal gains

Overall Cost of Storage/Station

- Storage designs influence station hardware and operation:
  - Storage temperature limits while fueling
  - Chillers required to reach -40°C
  - Cold effects on reliability

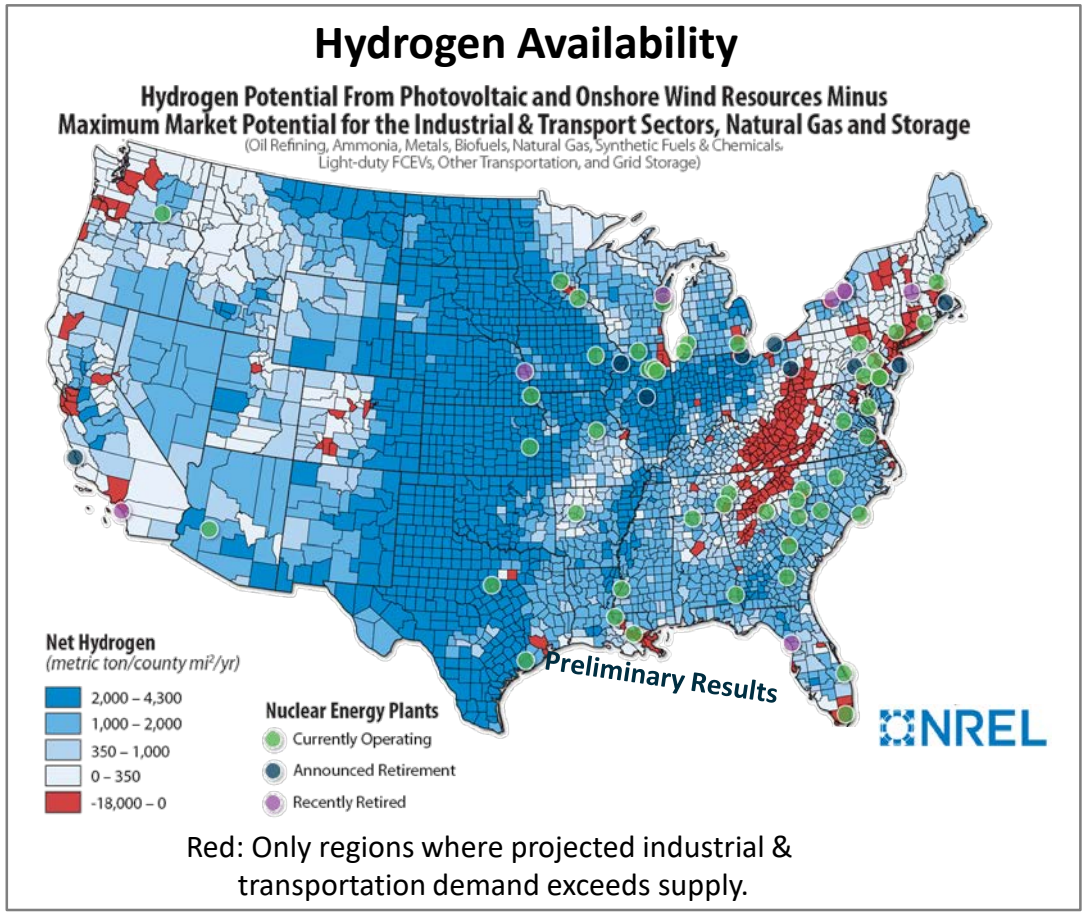
Balance of Composite

- Alternative resin systems:
  - Cost reduction
  - Thermal resistance
  - Fiber/resin integration
- Fiber winding pattern/translation efficiency

For workshop presentations and summary report visit https://www.energy.gov/eere/fuelcells/compressed-gas-storage-medium-and-heavy-duty-transportation-workshop

Examples of Activities to Enable H2@Scale

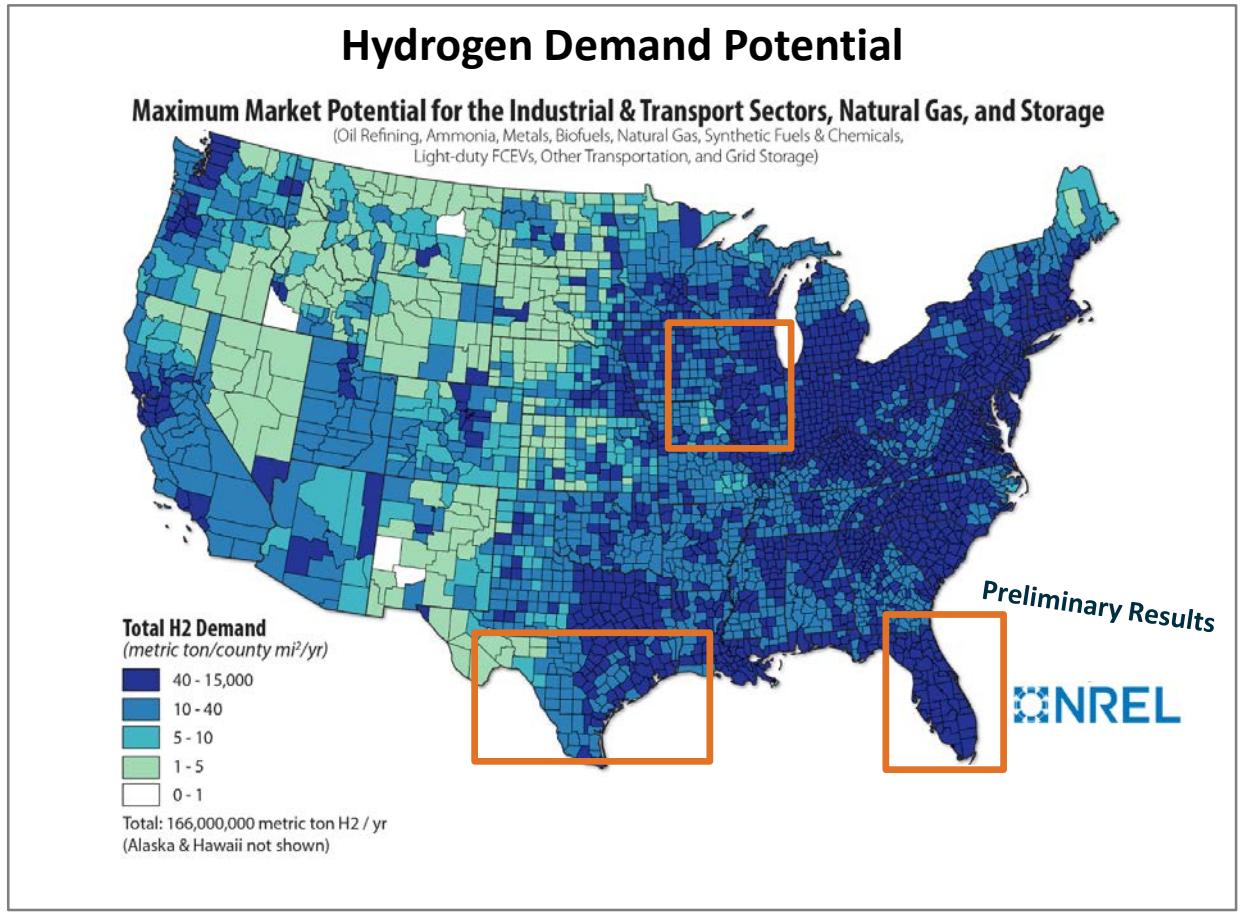
Assessing resource availability.
Most regions have sufficient resources.



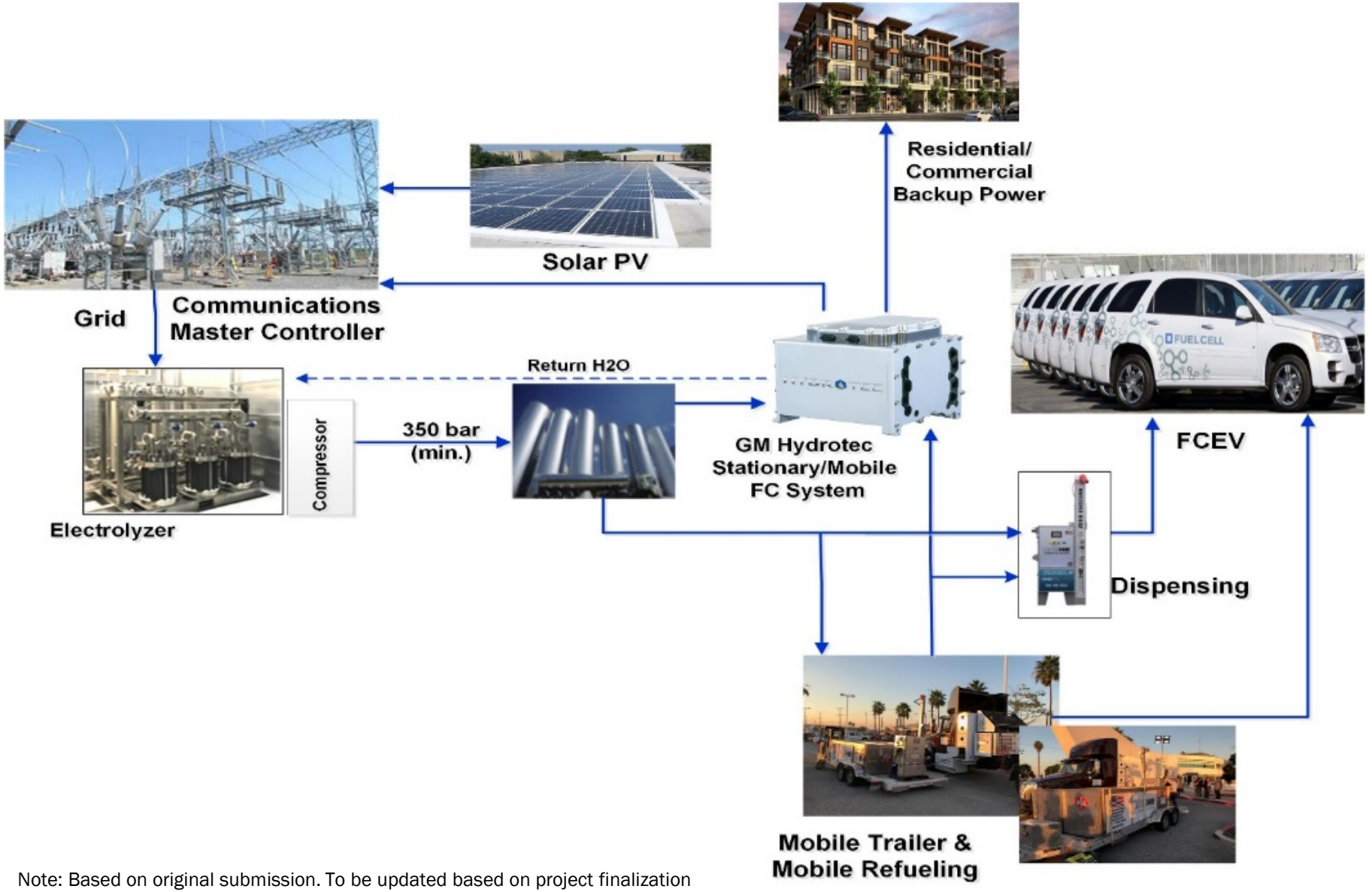
Red: Only regions where projected industrial & transportation demand exceeds supply.

4 new H2@scale demonstration projects in Texas, Florida and Midwest.

Includes 1 project by Office of Nuclear Energy



Example of H2@Scale Project: Integrated Hydrogen Production and Consumption for Improved Utility Operations – Orlando, FL



Partners

Giner ELX Inc

Orlando Utilities Commission

General Motors

OneH2

UCF-FSEC

Duration

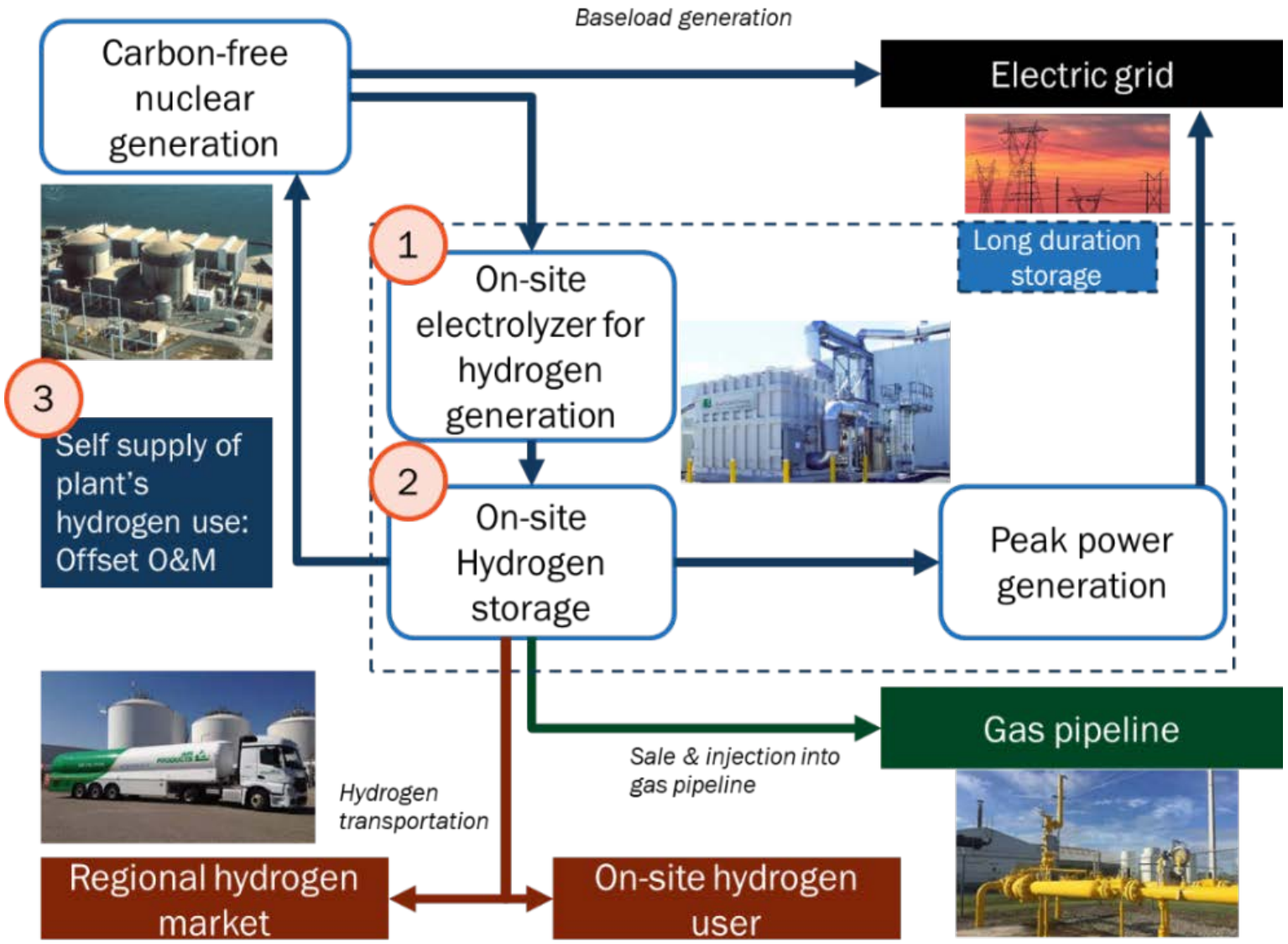
36 Months

Total budget

~$8.5M

Note: Based on original submission. To be updated based on project finalization

Example of H2@Scale Project: Electrolyzer Operation at Nuclear Plant and In-House Hydrogen Supply



Partners

Exelon & Nel Hydrogen
INL
NREL
ANL

Duration

36 months

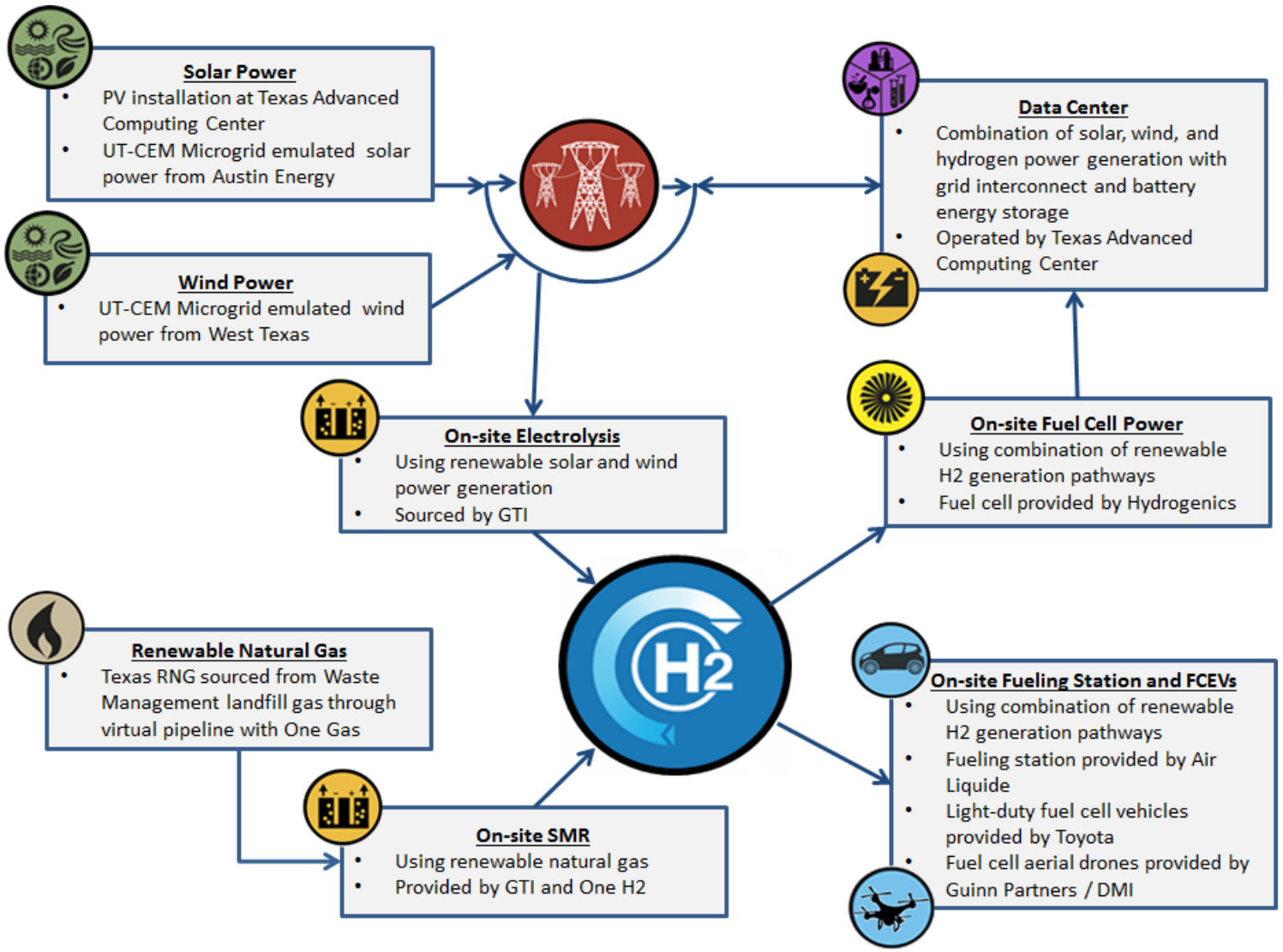
Total budget

$7.2M

Note: Based on original submission. To be updated based on project finalization

Example of H2@Scale Project: Demonstration and Framework for H2@Scale in Texas and Beyond

Integration Concepts Being Considered



Partners

Frontier Energy
University of Texas at Austin
GTI
Toyota
Air Liquide
Waste Management
OneH2
Hydrogenics

Duration

36 Months

Total budget

$12.7M

Note: Based on original submission. To be updated based on project finalization


Collaboration

IPHE: A Government Partnership on Hydrogen & Fuel Cells, working along with other global initiatives

The International Partnership for Hydrogen and Fuel Cells in the Economy

Enabling the global adoption of hydrogen and fuel cells in the economy

Elected Chair and Vice-Chair, 2018

Working Groups: Education & Outreach
Regulations, Codes, Standards & Safety

Top Priorities

- SHARE INFORMATION
- INFORM FUTURE GOVERNMENT RD&D
- FOSTER COLLABORATION

Mission Innovation Hydrogen Challenge 2017

Clean Energy Ministerial New Hydrogen Initiative Launched 2019

Find IPHE on Facebook, Twitter and LinkedIn
Follow IPHE **@The_IPHE**

www.iphe.net

Formed 2003
19 Countries and EC

Hydrogen Energy Ministerial (HEM)

International Energy Agency (IEA)

Save the Date – March 18: Hydrogen as main topic in upcoming Nuclear Innovation Clean Energy Future (NICE) webinar

Opportunities for Hydrogen

Topic

In the lead up to the June 2020 Eleventh CEM meeting in Viña del Mar Chile, tune in to the webinar and hear how ministers and stakeholders plan to accelerate action to realize hydrogen's potential. Hear from experts from the United States, Canada, Japan and the IEA about new technologies in this arena that advance a clean and integrated systems approach.

When

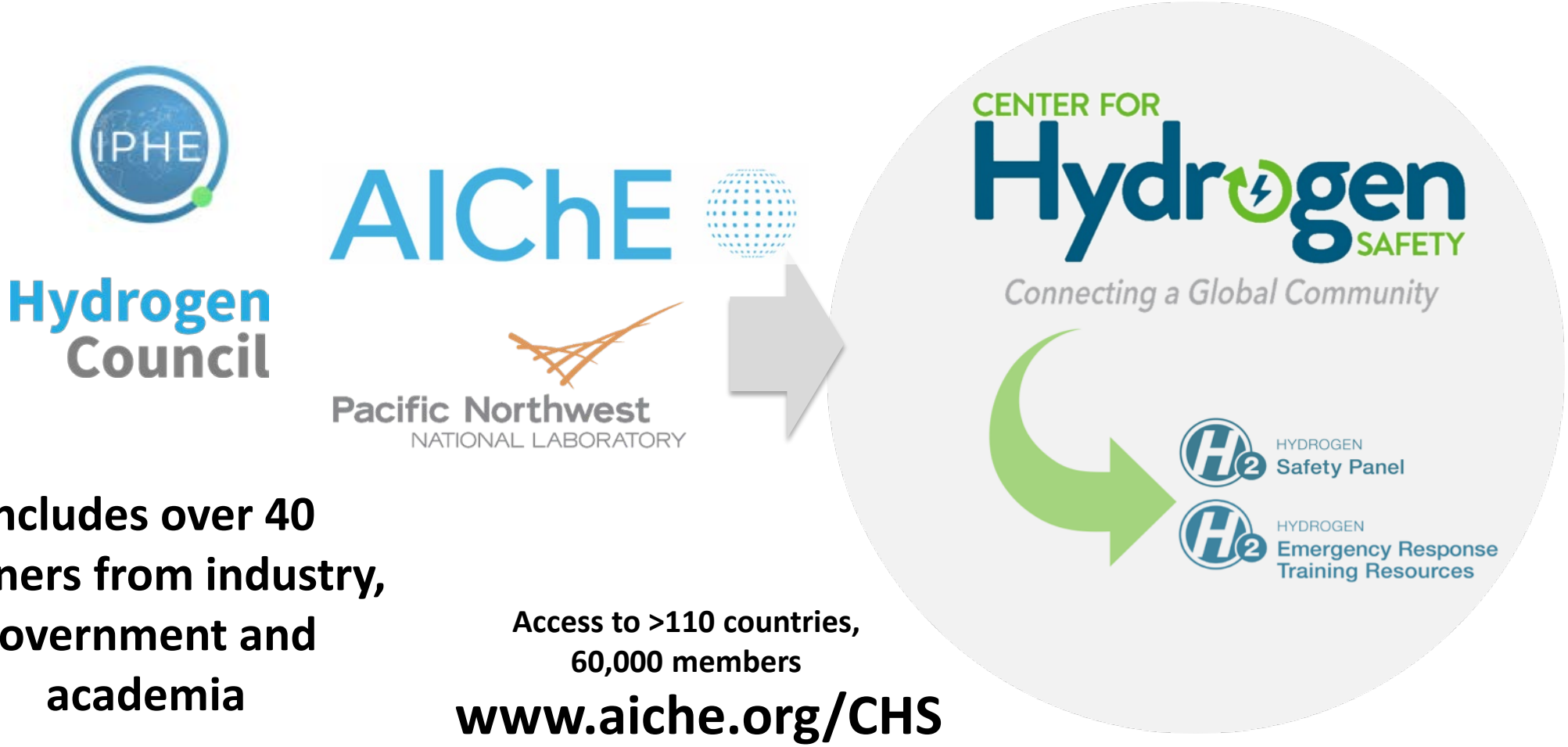
March 18, 2020, 8:00 am – 9:30 am EST

Where To Register

https://attendee.gotowebinar.com/register/8279771562413966605

Example of Collaboration: Global Center for H_2 Safety (CHS)

IPHE Steering Committee action: Increase awareness of safety partnership. Promotes safe operation, handling and use of hydrogen across all applications.



Includes over 40 partners from industry, government and academia

Access to >110 countries, 60,000 members

www.aiche.org/CHS

Announced February 2020: Industry and Government Collaboration Supporting American's Ingenuity and Enabling Technology Validation in Washington D.C.

The $1M H-Prize Challenge Incentivized Innovation in Community H_2 Fueling

The prize-winning SimpleFuel® team developed an electrolyzer-based appliance capable of refueling a 700 bar fuel cell vehicle at a rate of 1 kg-H_2 in less than 15 minutes

U.S. Department of Energy Joins Industry to Collaborate on Transportation Technology Validation and Assessment

FEBRUARY 10, 2020

Home » U.S. Department of Energy Joins Industry to Collaborate on Transportation Technology Validation and Assessment

Hyundai Motor Group Executive Vice Chairman Euisun Chung (left) and Under Secretary of Energy Mark W. Menezes (right)

DOE, Hyundai and SimpleFuel collaboration will include:

- Data collection and validation on **five Hyundai Nexo fuel cell cars**
- Installation of **SimpleFuel unit to support refueling and identify infrastructure R&D gaps**

Funding Opportunities

Nearly $300M in Funding Announced

- **Hydrogen and Fuel Cells - $64M (DE-FOA-0002229)**
  - Concept papers due Feb 25; full applications due April 20.
  - 6 Topics include: electrolyzer manufacturing; carbon fiber for compressed gas tanks; fuel cells and membranes for heavy duty applications; new markets for hydrogen (e.g. steel production); demonstrations for emerging applications (e.g. maritime, data centers), and workforce and training development.
- **Vehicles - $133M (DE-FOA-0002197)**
  - Concept papers due February 21; full applications due April 14.
  - 16 Topics include: advanced batteries and electrification in support of the recently-announced DOE Energy Storage Grand Challenge; advanced engine and fuel technologies, including technologies for off-road applications and alternative fueled engines; lightweight materials; new mobility technologies and alternative fuels technology demonstrations.
- **Bioenergy - $96M (DE-FOA-0002203)**
  - Concept papers due March 5; full applications due April 30
  - 7 Topics include: Scale up of Bench Applications to Biomass to Plastics Recycling to Restore Natural Resources to Scalable CO2 Electrolysis.

Up to $64M announced under H2@Scale
New Markets Funding Opportunity (DE-FOA-0002229 posted online)

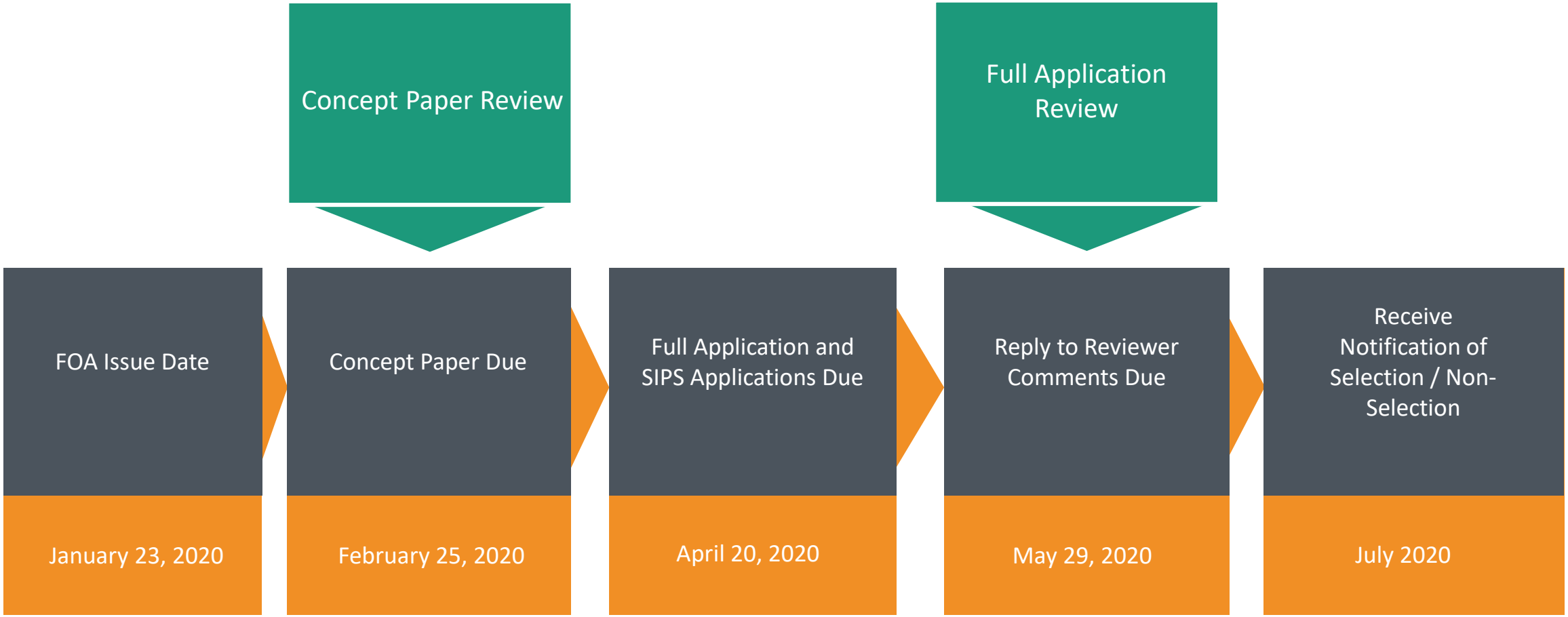
Topic Area	Total Funding Level	Anticipated Number of Awards	Max. Federal Funding per Award	Max. Project Duration (years)	Min Required Non-Federal Cost Share %
Topic 1: Electrolyzer Manufacturing R&D	$15M	Up to 4	$5M	3	20%
Topic 2: Advanced Carbon Fiber for Compressed Gas Storage Tanks	$15M	Up to 3	$9M	5	20%
Topic 3A: Fuel Cell R&D for Heavy-Duty Applications - Membranes for Heavy-Duty Applications	$4M	Up to 4	$1M	3	20%
Topic 3B: Fuel Cell R&D for Heavy-Duty Applications - Domestically Manufactured Fuel Cells for Heavy-Duty Applications	$6M	2 to 3	$3M	3	20%
Topic 4: H2@Scale New Markets R&D- HySteel	$8M	1 to 2	$8M	3	20%
Topic 5A: H2@Scale New Markets Demonstrations -Maritime Demonstrations	$8M	1 to 2	$8M	3	50%
Topic 5B: H2@Scale New Markets Demonstrations - Data Center Demonstrations	$6M	1 to 2	$6M	3	50%
Topic 6: Training and Workforce Development for Emerging Hydrogen Technologies	Up to $2M	1	$2M	5	0%
Total:	Up to $64M	Up to 21			

FOA Application Requirements (DE-FOA-0002229 posted online)

- Applicants must submit a **Concept Paper by 5:00pm ET Feb 25, 2020** to be eligible to submit a Full Application
- To apply to this FOA, applicants must register with and submit application materials through EERE Exchange at https://eere-Exchange.energy.gov, EERE's online application portal

Criteria for Assessing Applications	
Criterion 1: Merit, Innovation, and Impact (50%)	• Merit and Innovation • Impact of Technology Advancement
Criterion 2: Project Research and Market Transformation Plan (30%)	• Research Approach, Workplan and SOPO (Statement of project objectives) • Identification of Risks • Baseline, Metrics, and Deliverables • Market Transformation Plan (NOT applicable to Topic Area 6) • Impact Assessment (applicable ONLY to Topic Area 6)
Criterion 3: Team and Resources (20%)	• Ability to address all aspects of project with high probability of success • Sufficiency of facilities to support the work • Ability to facilitate and expedite further development and commercial deployment of deliverables • Level of participation by project participants • Reasonableness of the budget and spend plan

FOA Timeline



Expected Timeframe for Award Negotiations: July – September 2020

Opportunity for Funding through Nuclear Energy FOA

Nuclear Energy (DE-FOA-0001817)

- **Concept papers due Feb 28**
- To apply, go to:

https://www.id.energy.gov/NEWS/FOA/FOAOpportunities/FOA.htm

- Frequently Asked Questions: www.id.doe.gov

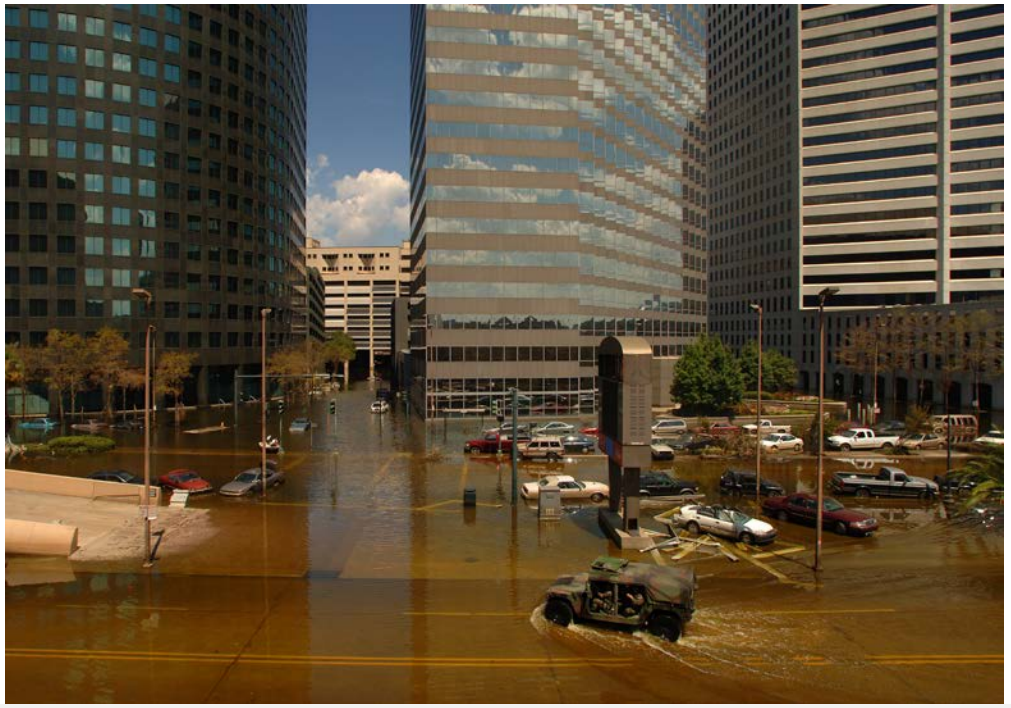
How Hydrogen and Nuclear Synergize

- Heat and electricity from reactors can produce hydrogen to be used as a fuel or industrial commodity, in energy storage, or for other industrial purposes
- Hydrogen can optimize nuclear production when generation exceeds load on the grid
- To learn more about synergies between hydrogen and nuclear, go to **https://www.energy.gov/ne/articles/could-hydrogen-help-save-nuclear**

Interagency Collaboration to Enable Technology in Emergency Relief

U.S. Department of Energy and U.S. Army Issue Solicitation to Develop H2Rescue

FEBRUARY 3, 2020



Press Release
https://www.energy.gov/eere/fuelcells/articles/us-department-energy-and-us-army-issue-solicitation-develop-h2rescue

Opportunity Number and Due Date to Apply to Solicitation
W81EWF20FOA0001 - March 31, 2020

- Example of **interagency collaboration** (DoD and DOE)
- **Up to $1M** (requires equal match of industry contributions)
- Truck to **run on fuel cell/battery and hydrogen** and provide **power, heat and potable water**

DOE-wide STEM Initiative

Student Internship Opportunities

Minority Educational Institution Student Partnership Program Internships (MEISPP)

- 8 – 10 week summer internships with DOE and national laboratories
- Helps students gain professional and technical career experience while working side-by-side with an assigned mentor
- Includes lodging, round trip airfare, and student stipends

EERE Student Volunteer Internship Program (SVIP)

- Internships throughout the year at its Washington, D.C. Headquarters (HQ) and the Golden Field Office (GFO) located in Golden, Colorado
- Academic credit and/or stipends for federal internships at some colleges and universities
- Does not include lodging, round trip airfare, and student stipends

For eligibility & instructions:

MEISPP

https://www.energy.gov/diversity/services/minority-education-and-community-development/minority-educational-institution-0

SVIP

https://www.energy.gov/eere/education/eere-student-volunteer-internship-program-svip

Potential Career Opportunities in Hydrogen and Fuel Cells

Opportunity Title	URL	Opportunity #	Org	Deadline
Development of Advanced Multi-Physics Modeling Techniques for Solid Oxide Fuel Cells-FRP	https://www.zintellect.com/Opportunity/Details/NETL-2019-FRP-Hackett-2	NETL-2019-FRP-Hackett-2	NETL	Mar 31 2020 11:59 PM EST
Fuel Cells Technologies Office (FCTO) opportunity in Hydrogen Storage	https://www.zintellect.com/Opportunity/Details/DOE-EERE-STP-FCT-2020-1801	DOE-EERE-STP-FCT-2020-1801	FCTO	Open till filled (target: mid 2020)
FCTO Hydrogen Infrastructure Technologies Opportunity	https://www.zintellect.com/Opportunity/Details/DOE-EERE-STP-FCT-2020-1802	DOE-EERE-STP-FCT-2020-1802	FCTO	Open till filled (target: mid 2020)
FCTO Opportunity in Fuel Cell Research and Development	https://www.zintellect.com/Opportunity/Details/EERE-STP-FCT-2019-1800	EERE-STP-FCT-2019-1800	FCTO	Open till filled (target: mid 2020)

Fellow roles in:

- Hydrogen storage (e.g. composite materials, carbon fiber)
- Hydrogen infrastructure R&D (e.g. materials compatibility)
- Hydrogen fuel R&D (e.g. hydrogen production)

Areas:

- Engineering
- Chemistry, Materials
- Project Management
- Safety, codes, standards

For More Info:

DOE Fuel Cell Technologies Office
fuelcells@ee.doe.gov

Oak Ridge Institute for Science and Education
https://orise.orau.gov/stem/internships-fellowships-research-opportunities/index.html

Information and Resources

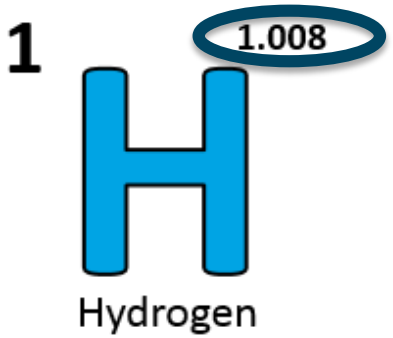
INCREASE YOUR H2IQ

H2tools.org

Mark your calendars in advance: National Hydrogen & Fuel Cell Day

October 8 or 10/08

(Held on its very own atomic- weight-day)



Save the Date

May 19-21, 2020

DOE AMR

(Annual Merit Review)

Washington DC

Download resources for free at:
energy.gov/eere/fuelcells/downloads/increase-your-h2iq-training-resource

www.hydrogen.energy.gov

Sign up to receive hydrogen and fuel cell updates

www.energy.gov/eere/fuelcells/fuel-cell-technologies-office-newsletter

Learn more at: energy.gov/eere/fuelcells

Thank You

Dr. Sunita Satyapal
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Sunita.Satyapal@ee.doe.gov

Looking for more info?

#H2IQ

www.energy.gov/fuelcells
www.hydrogen.energy.gov