U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

U.S. Department of Energy Hydrogen and Fuel Cell Technologies Office Overview

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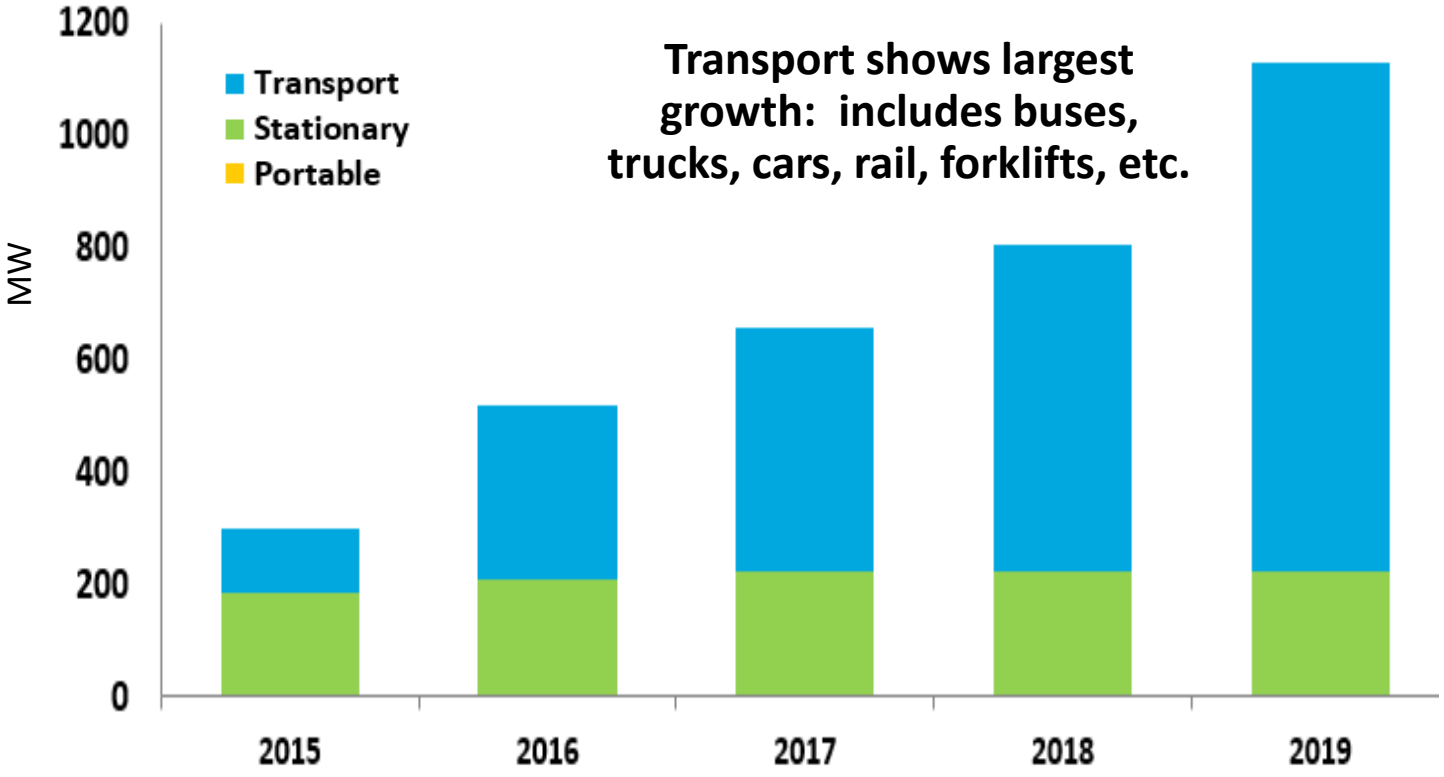
Director, Hydrogen and Fuel Cell Technologies Office

Washington DC– January 2021


Global
Perspectives

Hydrogen and Fuel Cell Technology Growth Worldwide

Global fuel cell shipments surpass 1 GW



Source: E4tech for DOE analysis project

25-fold increase in electrolyzers deployed in the last decade

<1MW in 2010 to >25 MW by the end of 2019

GW scale announcements in 2020

Global FCEVs doubled to >25,200

>12.3K sold in 2019 vs. 5.8K in 2018

470 H_2 fueling stations worldwide

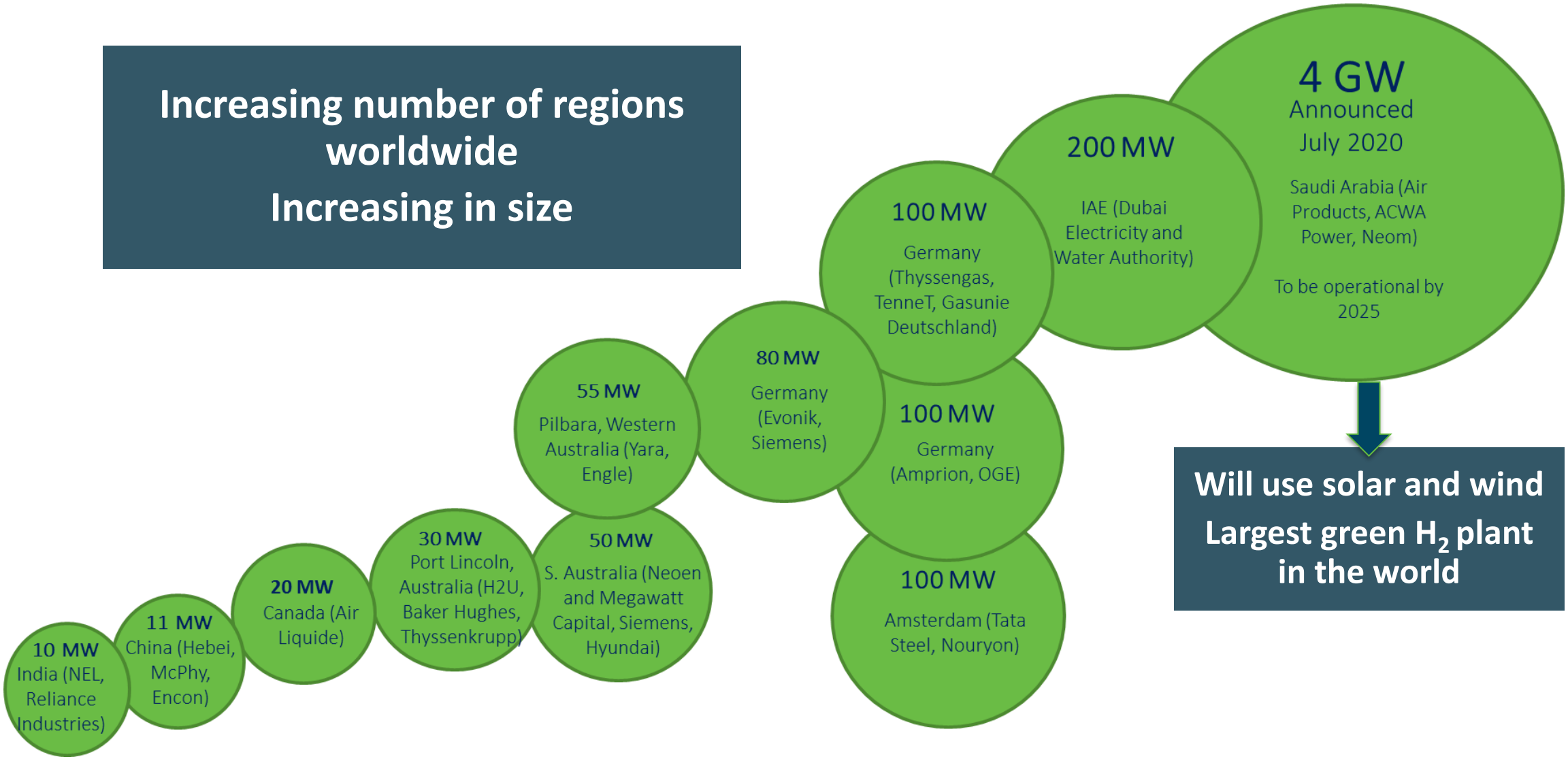
> 20% increase from 2018

Source: IEA (2020), *Hydrogen*, IEA, Paris, https://www.iea.org/reports/hydrogen

Examples of Electrolyzer Deployments and Plans… by 2025

Increasing number of regions worldwide

Increasing in size



Will use solar and wind

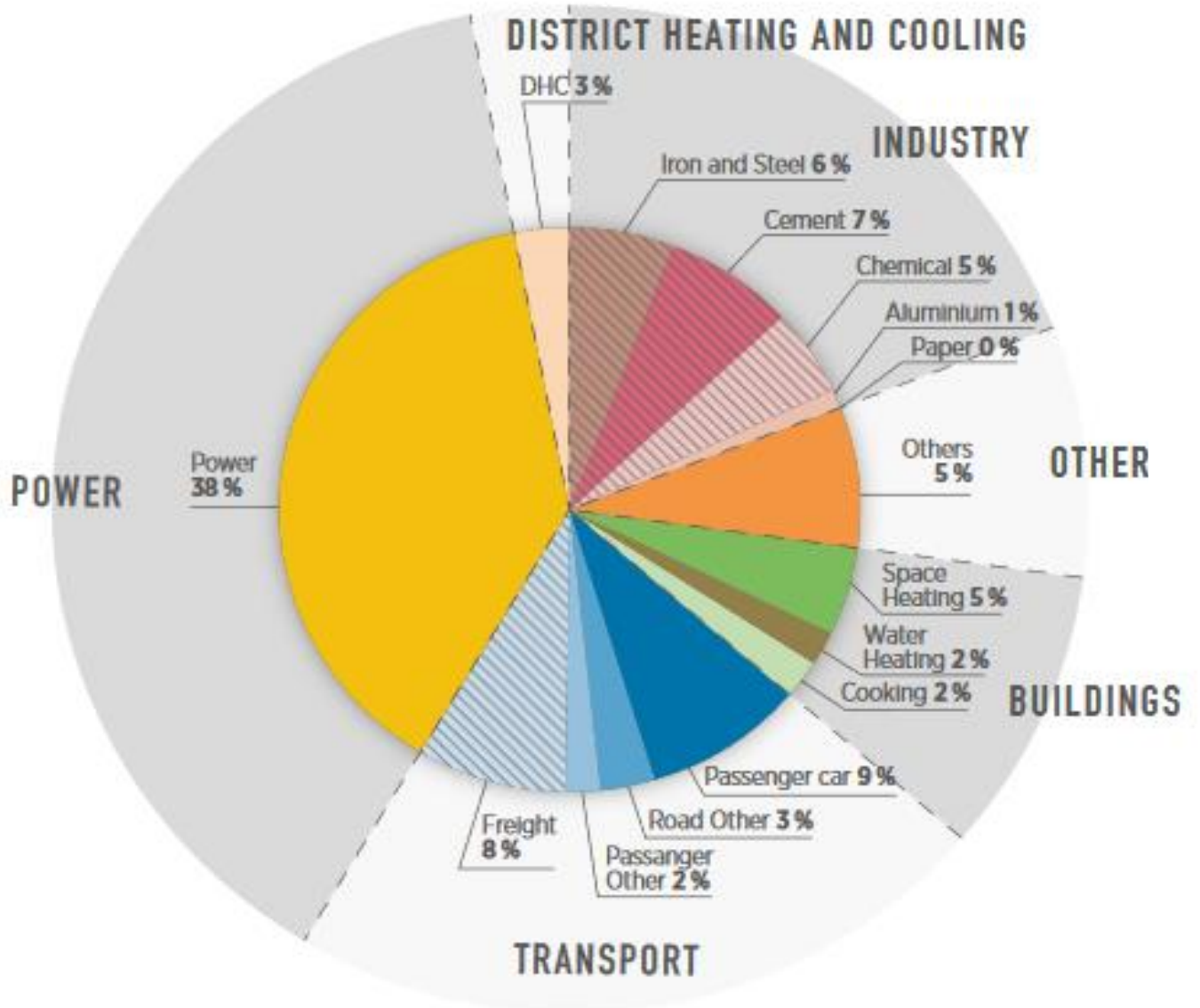
Largest green H_2 plant in the world

Adapted from various sources, including US Hydrogen Industry Roadmap

Global Drivers and Energy Related Carbon Emissions by Sector

Drivers include:

- Emissions reduction
- Energy security
- Economic growth
- Resiliency
- Energy efficiency
- Innovation potential
- Environmental benefits



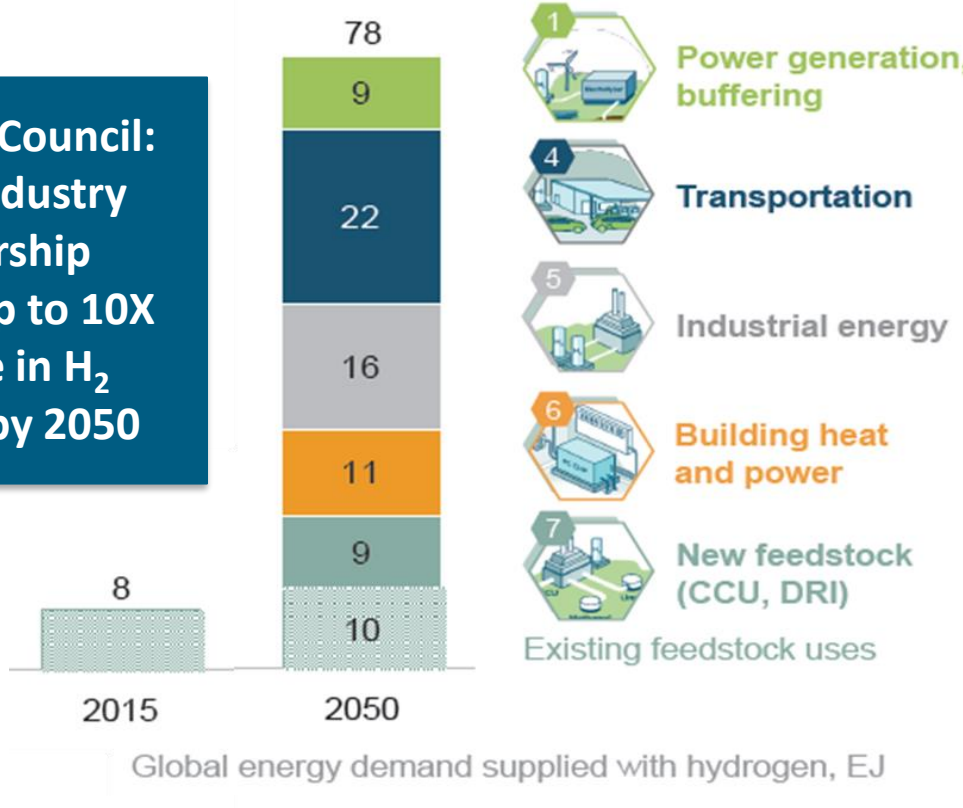
Sectors today with no economically scalable option for deep emission reductions

Source: IRENA, 2017a from: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Sep/IRENA_Hydrogen_from_renewable_power_2018.pdf

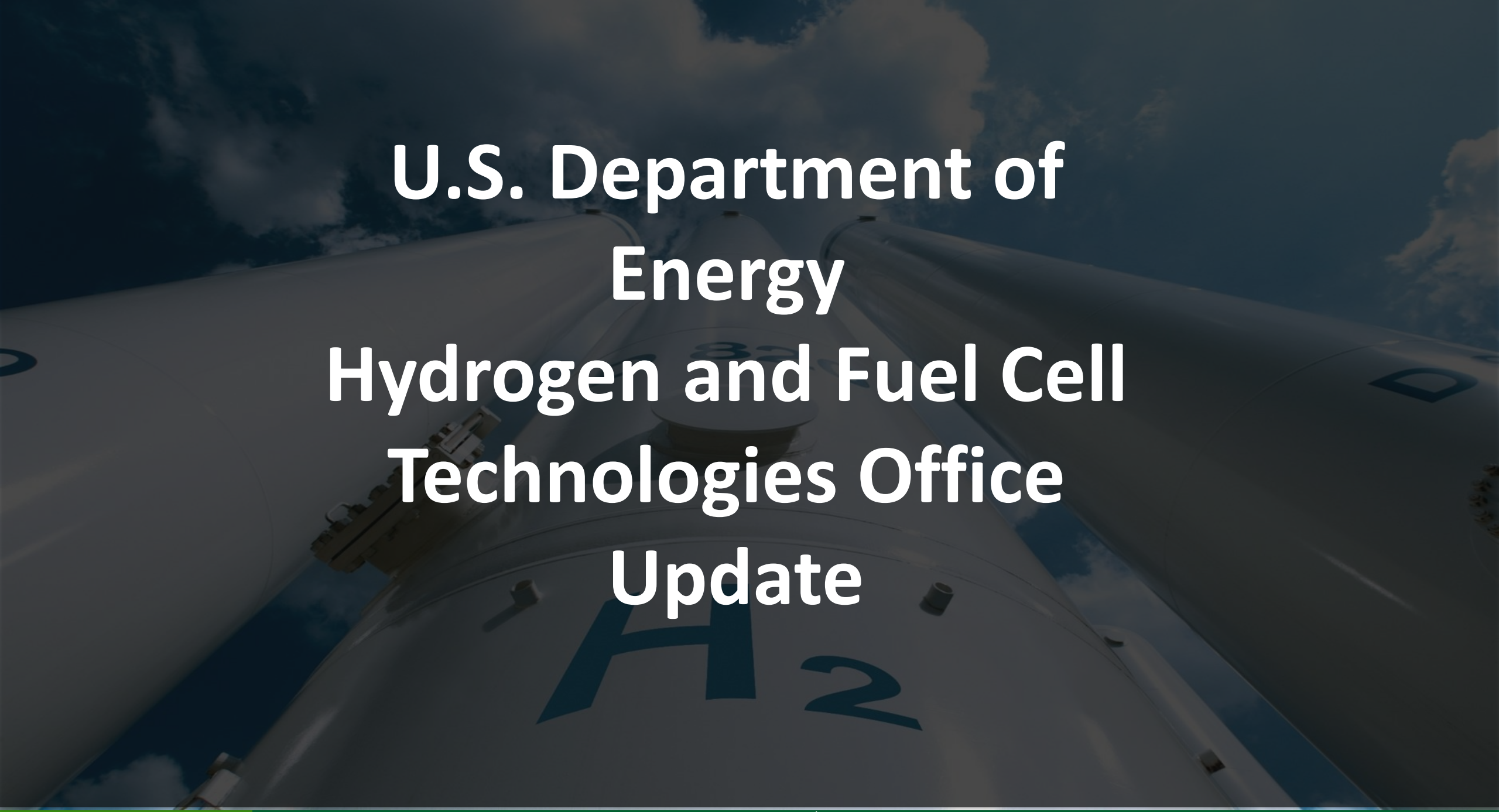
Roadmaps and Plans Developing Worldwide

H2 Ministerial Global Action Agenda Goals:
"10, 10, 10"
10M systems, 10K stations, 10 years

Hydrogen Council: Global industry partnership projects up to 10X increase in H_2 demand by 2050

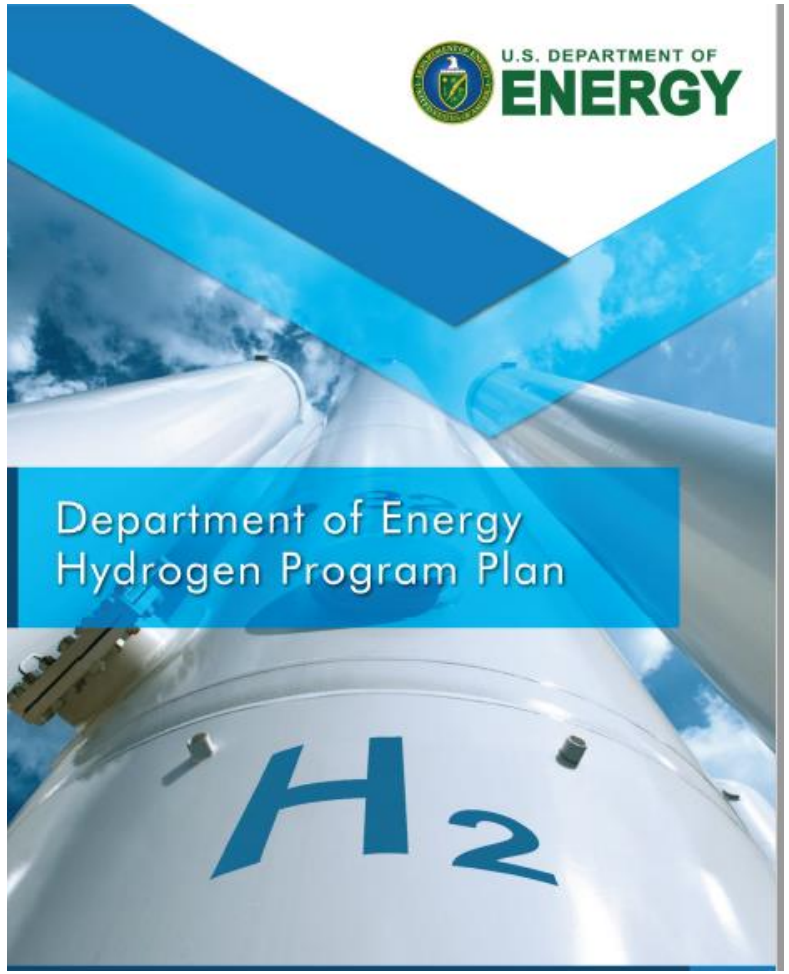


H2 Council Global Impact Potential by 2050



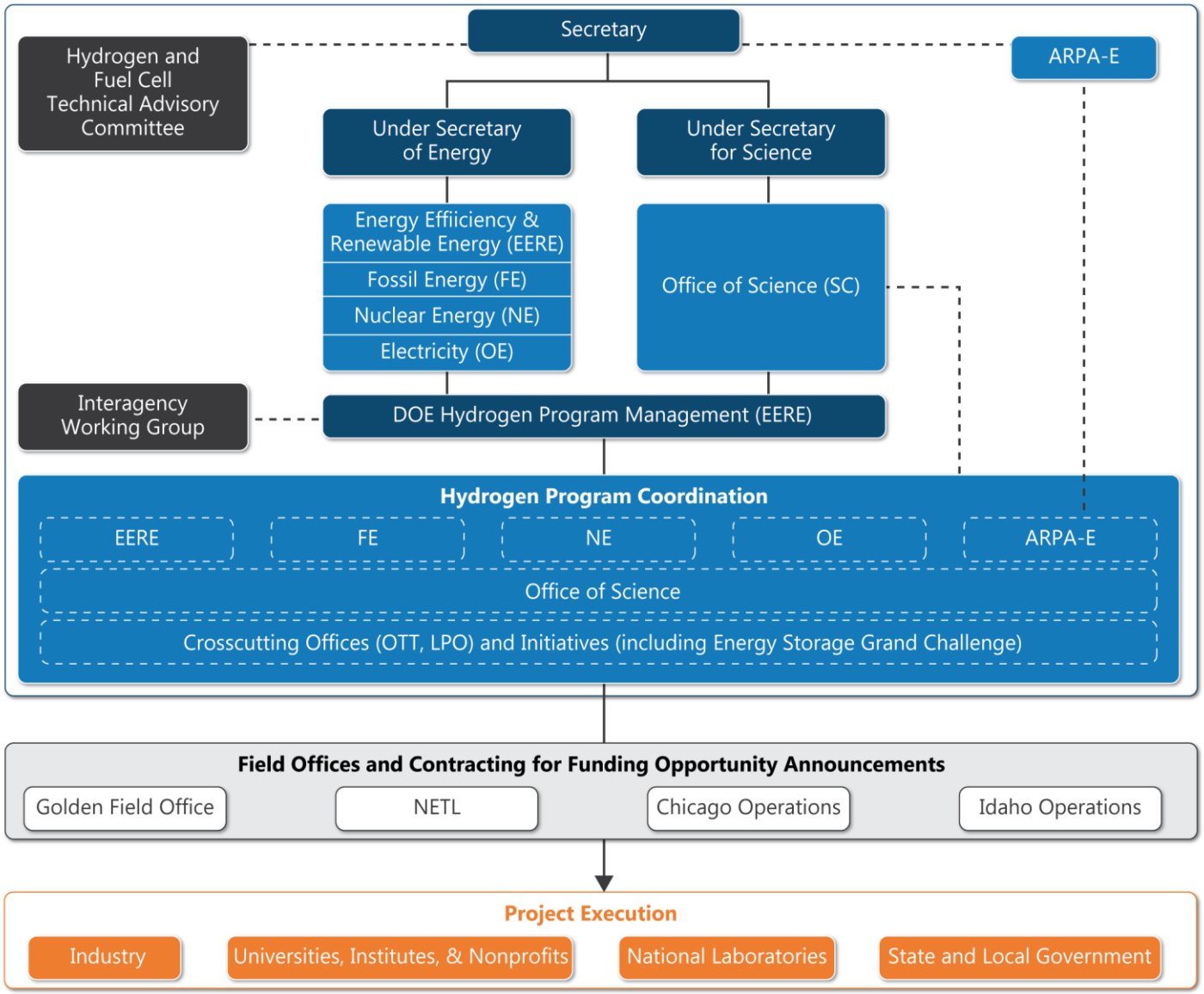
U.S. Department of Energy Hydrogen and Fuel Cell Technologies Office Update

US DOE Hydrogen Program Plan Released November 2020



www.hydrogen.energy.gov

Includes multiple offices across DOE



Hydrogen Program Vision and Objectives

Vision

The Program's vision is a prosperous future for the nation, in which clean hydrogen energy technologies are affordable, widely available and reliable, and are an integral part of multiple sectors of the economy across the country.

The Program works in partnership with stakeholders to:

- **Overcome technical barriers** through basic and applied research and development
- **Integrate, demonstrate, and validate** "first-of-a-kind" hydrogen and related technologies
- **Accelerate the transition of innovations** and technologies to the private sector
- **Address institutional issues** including safety concerns, education and workforce development, and the development of codes and standards
- **Identify, implement, and refine appropriate strategies** for federal programs to catalyze a sustainable market and concomitant benefits to the economy, the environment, and energy security

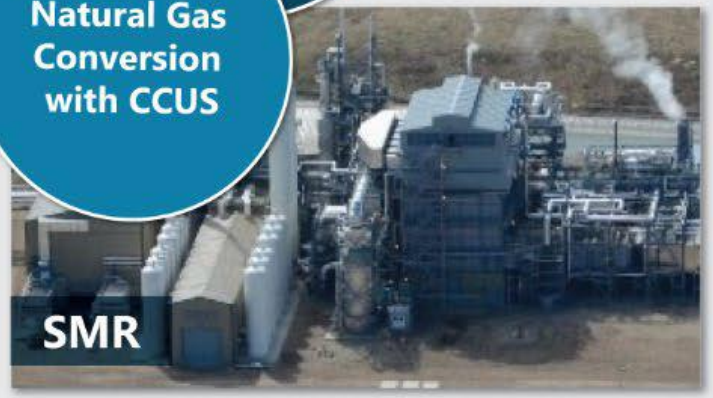
Portfolio Includes Hydrogen Production from Diverse Sources and Pathways

FOSSIL RESOURCES

- Low-cost, large-scale hydrogen production with CCUS
- New options include byproduct production, such as solid carbon

Coal Gasification with CCUS

Natural Gas Conversion with CCUS



BIOMASS/WASTE

- Options include biogas reforming and fermentation of waste streams
- Byproduct benefits include clean water, electricity, and chemicals

Biomass Conversion

Waste to Energy

H_2O SPLITTING

- Electrolyzers can be grid-tied, or directly coupled with renewables
- New direct water-splitting technologies offer longer-term options

Direct-Solar

High Temp. Electrolysis

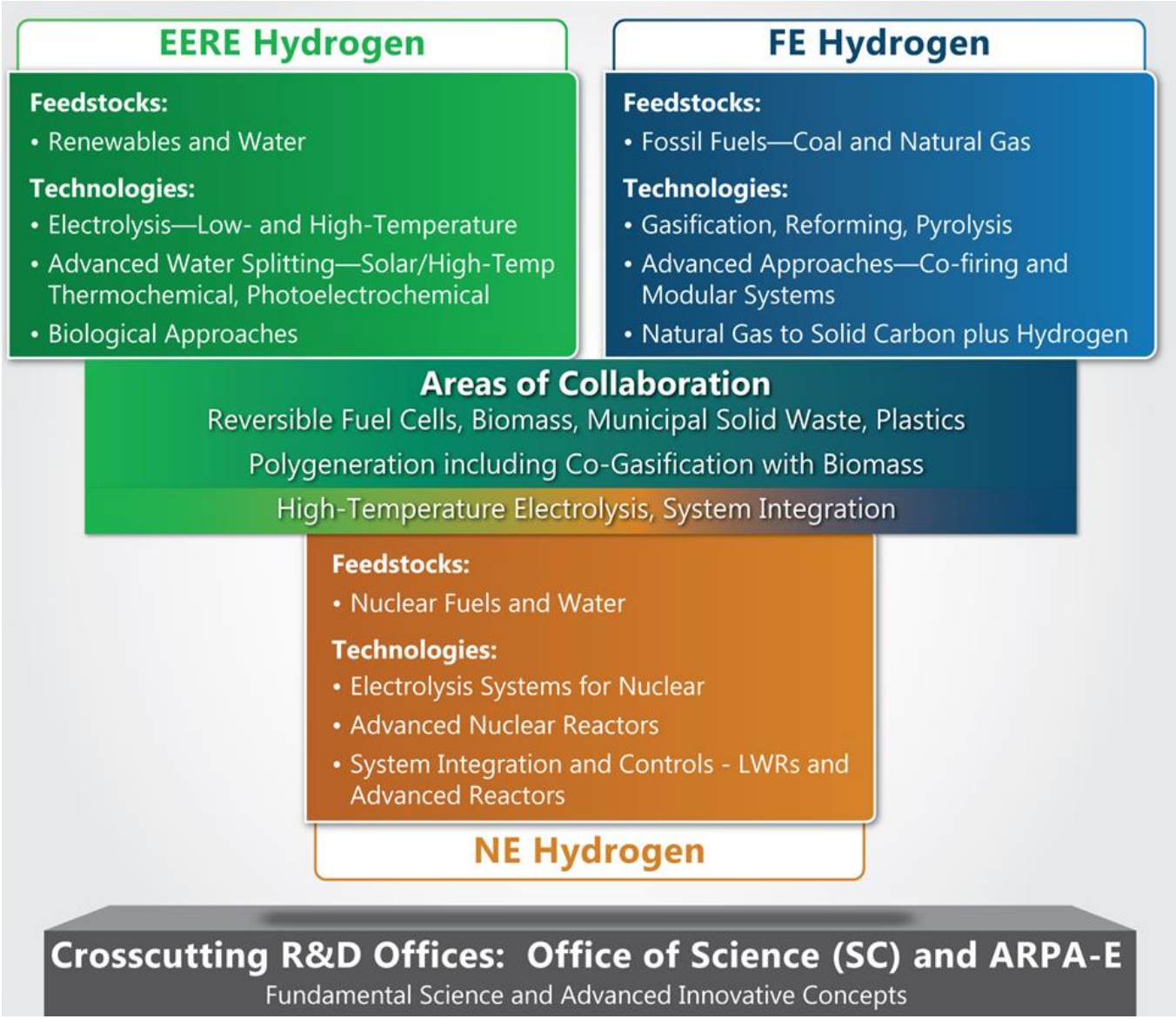
Low Temp. Electrolysis

Key Program Targets and Key R&D Office Activities

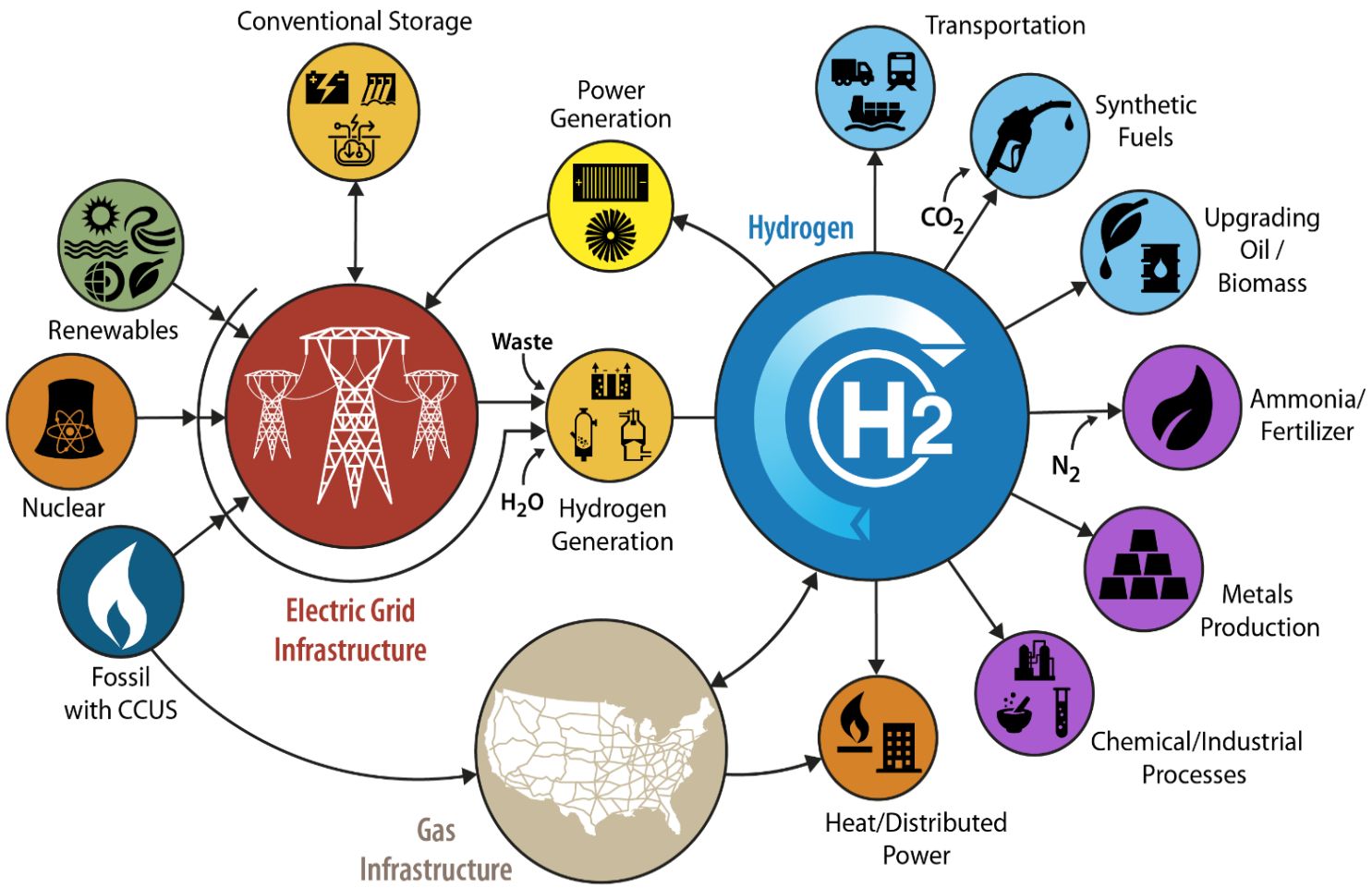
Examples of Key DOE Hydrogen Program Targets

DOE targets are application-specific and developed with stakeholder input to enable competitiveness with incumbent and emerging technologies. These targets guide the R&D community and inform the Program's portfolio of activities. Examples include:

- $2/kg for hydrogen production and $2/kg for delivery and dispensing for transportation applications
- $1/kg hydrogen for industrial and stationary power generation applications
- Fuel cell system cost of $80/kW with 25,000-hour durability for long-haul heavy-duty trucks
- On-board vehicular hydrogen storage at $8/kWh, 2.2 kWh/kg, and 1.7kWh/l
- Electrolyzer capital cost of $300/kW, 80,000 hour durability, and 65% system efficiency
- Fuel cell system cost of $900/kW and 40,000 hour durability for fuel-flexible stationary high-temperature fuel cells



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



- Hydrogen can address specific applications across sectors that are hard to decarbonize
- Today: 10MMT H_2 in the U.S.
- Economic Potential: 2 to 4x more

Strategies

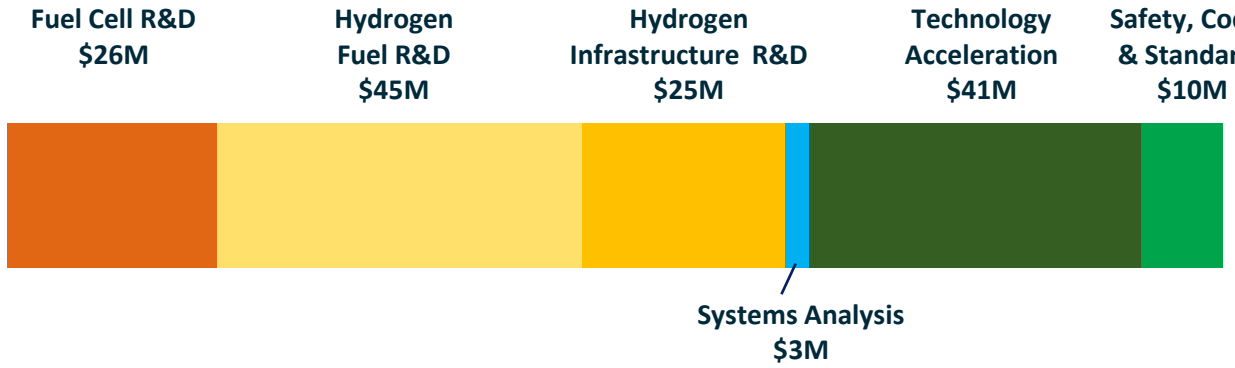
- Scale up technologies in key sectors
- Continue R&D to reduce cost and improve performance, reliability
- Address enablers: harmonization of codes, standards, safety, global supply chain, workforce development, sustainable markets

Source: U.S. DOE Hydrogen and Fuel Cell Technologies Office, https://www.energy.gov/eere/fuelcells/h2scale

Budget and Focus Areas in EERE H_2 and Fuel Cell Technologies Office

EERE HFTO Activities	FY 2020 ($K)
Fuel Cell R&D	**26,000**
Hydrogen Fuel R&D	**45,000**
Hydrogen Infrastructure R&D (included in Hydrogen Fuel in FY21)	25,000
Systems Development & Integration (Technology Acceleration)	**41,000**
Safety, Codes, and Standards (included in Systems Development & Integration in FY21)	10,000
Data, Modeling and Analysis	**3,000**
Total	**$150,000**

Hydrogen and Fuel Cells Breakdown FY 2020



- **Production:** Water splitting – electrolysis (high and low temperature), PEC, STCH, biomass/biological
- **Infrastructure:** Materials, delivery, components & systems
- **Storage**: materials-based, carriers, tanks, liquid
- **Fuel cells**: materials, components, systems, reversible FCs
- **Systems Development & Integration:** Tech Acceleration includes hybrid/grid integration, new markets, heavy duty, energy storage, manufacturing industrial applications (e.g. steel) safety, codes, standard, workforce development

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

Note: Office of Fossil Energy covers fossil fuels to H_2

DOE Hydrogen and Fuel Cell Technologies Office Focus Areas

Mission

Research, development, and innovation in hydrogen and fuel cell technologies leading to:

- **Energy security**
- **Energy resiliency**
- **Strong domestic economy**

Enabling

H2@Scale U.S. Department of Energy

Key R&D Budget Sub-Programs and Focus Areas

Fuel Cells

- Cost, durability, efficiency
- Components (catalysts, electrodes) & systems
- Focus on heavy duty applications (trucks, marine, data centers, rail, air, etc.)

Hydrogen

- Hydrogen production, infrastructure/delivery, storage (for transport and stationary storage)
- Cost, efficiency, reliability & availability.

Systems Development & Integration

- Hybrid, grid integrated systems, energy storage
- Safety, codes & standards
- Technology acceleration, workforce development

Data, Modeling, Analysis: Assess pathways, impacts; set targets, guide R&D

Key Goals

Reduce the cost of:

- Heavy duty fuel cells by 2X to $80/kW
- Electrolyzers by 3 to 5x to $300/kW
- Storage tanks by over 40% to $9/kWh
- H_2 delivery and dispensing by 4 to 5x to $2/kg
- H_2 production by 2 to 3x to $2/kg

Improve fuel cell durability 5x to 25,000 hours

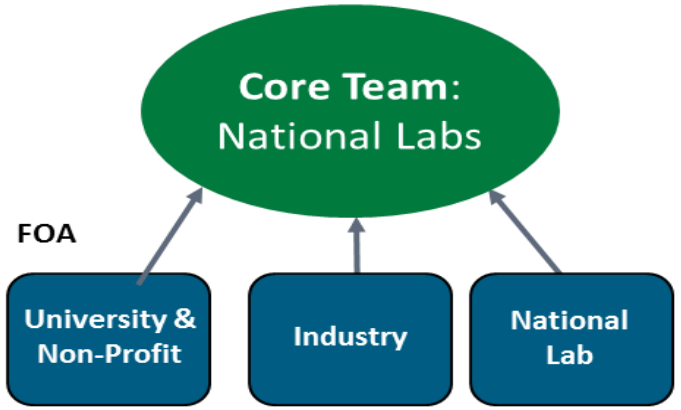
Double energy density for onboard storage to 1.7 kWh/L

Budget: $150M in FY2020

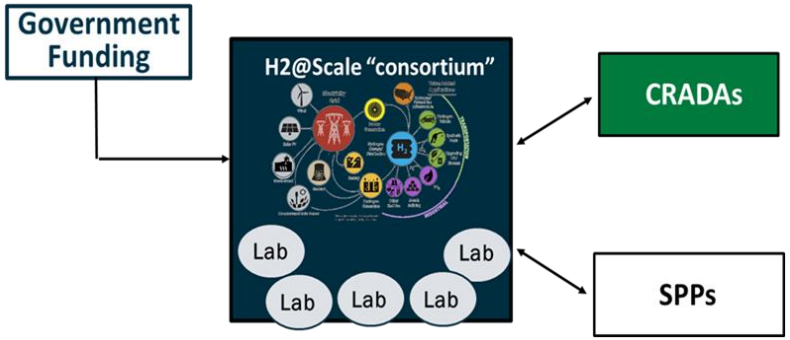
Key Programmatic Areas

<u>Includes early stage R&D</u>: Funding Opportunity Announcements (FOAs) for industry, universities and national labs, including consortia

<u>And includes later stage RD&D</u>: Leverages private sector for large-scale demonstrations and cost-shared RD&D. Demos in TX, FL, Midwest, CA and more



2 New Lab Consortia Just Announced: H2NEW and Million Mile Fuel Cell Truck Consortium



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

HydroGEN Advanced Water Splitting Materials

ElectroCat Electrocatalysis Consortium

HyMARC Hydrogen Materials Advanced Research Consortium

H-Mat™ Hydrogen Materials Compatibility Consortium

Over 25 CRADA projects with private sector

Just Announced: $64M for 18 projects including R&D and demonstrations at ports and datacenters, and a workforce development program . Includes collaboration with Advanced Manufacturing Office and Vehicles Office in EERE

Examples of DOE-Funded Innovation and Impact

Impact due to HFTO Funding

Innovation

1,110 patents
H_2 and fuel cell
enabled by HFTO funds

Approx. 35% of H_2 and fuel cell patents
come from National Labs

Market Impact

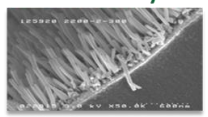
More Than 30 Technologies
Commercialized
by private industry

And Over 65 with potential
to be commercial in
the next 3 – 5 years

Can be traced back to HFTO R&D

Examples of Technologies Enabled

Fuel Cell Catalysts



Catalyst and Supports for PEM Fuel Cells
3M

Hydrogen Tube Trailers

Hydrogen Tube Trailers
Hexagon Lincoln

Forklifts

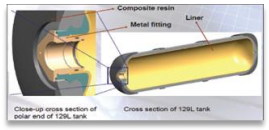
Class-1, -2, and -3 Forklifts
Plug Power (GenDrive FCs)

Electrolyzers

Electrolyzer System
Proton Series

PEM Electrolyzer System
Giner

Hydrogen Tanks



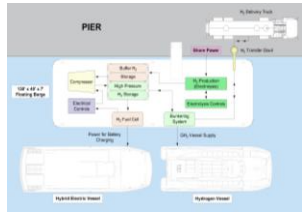
Optimized 129L Tank
Quantum Technologies

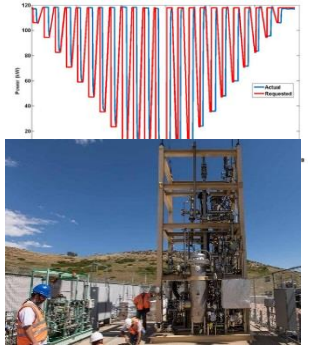
- Small scale H_2 fueler now available
- 5 to 20 kg unit, 700 bar fueling

$1M H-Prize H2Refuel Winner: SimpleFuel

First-of-a-Kind Demonstrations

- Marine application- ½ ton H_2 fueling for vessel
- Data center- 1.5 MW
- First ground support equipment
- Parcel delivery vans (2x range vs BEVs)
- Mobile H_2 fueler
- First nuclear to H_2 demos
- First tri-gen system
- Dynamic response of electrolyzers and systems integration
- First H_2+CO_2 to renewable methane demo
- H_2/NG blending





Example: American Recovery Act co-funded few hundred fuel cell forklifts and backup power units for cell phone towers

Today ~ 40,000 systems commercially deployed at major companies, millions of H_2 fuelings to date

Snapshot of Hydrogen and Fuel Cells in the U.S.

Examples of Applications

- **>500MW** — Backup Power
- **>35,000** — Forklifts
- **>14 MW** — PEM* Electrolyzers
- **>60** — Fuel Cell Buses
- **>45** — H_2 Retail Stations
- **~9,000** — Fuel Cell Cars

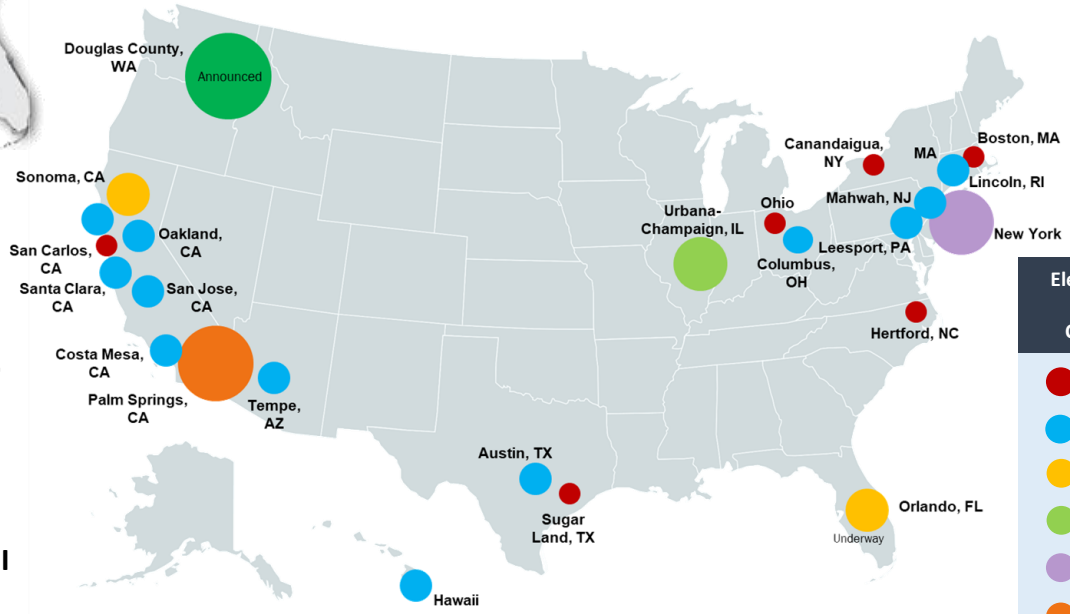
Hydrogen Production Across the U.S.

0 – 50
50 – 100
100 – 200
200 – 400
400 – 800

Hydrogen Production Units
Gaseous Metric Tons/Day

- 10 million metric tons produced annually
- More than 1,600 miles of H_2 pipeline
- World's largest H_2 storage cavern

PEM Electrolyzer Deployment Across the U.S.



* Polymer electrolyte membrane

Hydrogen Stations Plans Across States

California
200 Stations Planned
CAFCP Goal

Northeast
12 – 20
Stations Planned

HI, OH, SC, NY, CT, MA, CO, UT, TX, MI
And Others

Fuel Cell Stationary Power for Multiple Applications

Fuel cells provided backup power during Hurricane Sandy in the U.S. Northeast

Fuel cells included for power to new World Trade Center in NYC

Fuel cell power for maritime ports demonstrated in Honolulu, Hawaii

Over 500 MW of fuel cell stationary power installed across more than 40 US states

Fuel Cell Forklifts for Material Handling Applications

Heavy Duty Applications Emerging

Several companies developing long haul Class 8 fuel cell trucks

Fuel cell buses in CA surpass 20M passengers

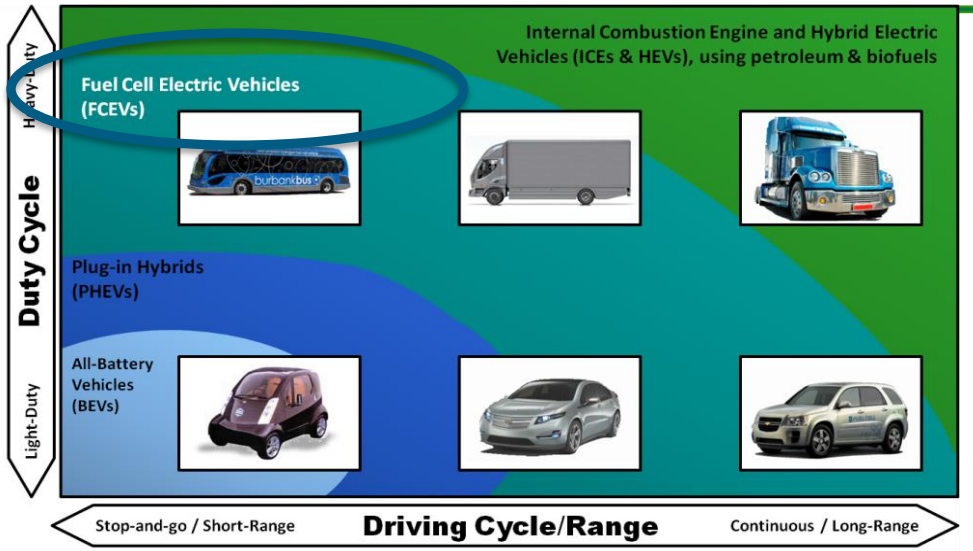
Fuel cell parcel truck demonstration projects by DOE + industry

Fuel cell delivery truck projects by DOE + industry

Opportunities for Hydrogen and Fuel Cells

Hydrogen and Fuel cell Attributes

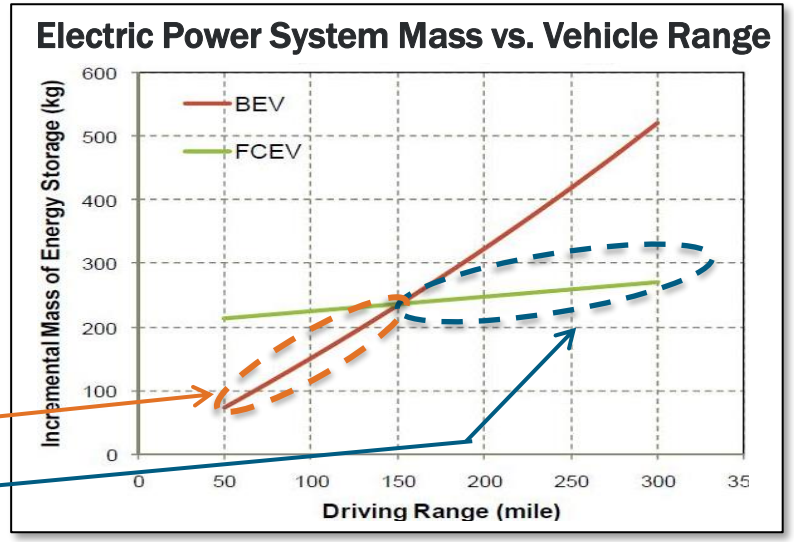
- Performance: Short fueling times, long range, high power
- Zero pollution from tailpipe, very low life cycle emissions
- Uses domestic sources for fuel
- Particularly suitable for hard to decarbonize applications- e.g. heavy duty trucks, marine, rail, and others



Refueling/Recharging Time:

Energy Source	Rate (miles/min)	Long-Trip % Charging Time
Gasoline	150	1-2%
Hydrogen	100	<2%
EV Supercharger	6	15%

Assumptions: Gasoline & Hydrogen Electric: 350 mile range, Battery Electric: 250 mile range. Source: General Motors, with permission April 2016

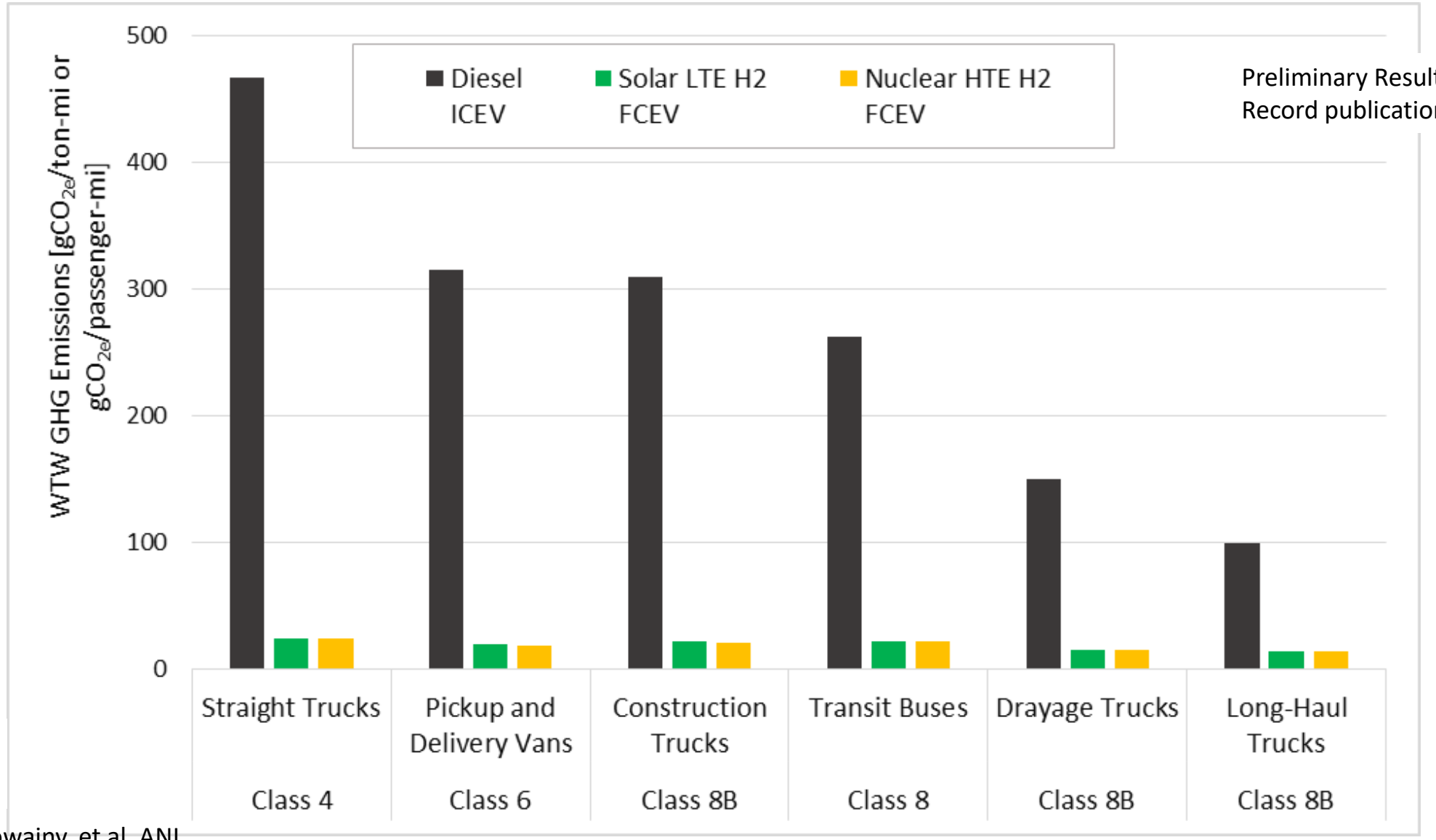


SOURCE: General Motors, Inc.

For shorter distances, batteries are more effective in terms of system mass

Fuel cells offer an advantage for longer driving range with less weight penalty

Benefits and Impacts Analyses Underway – Example



Preliminary Results
Record publication underway

Source: A. Elgowainy, et al, ANL

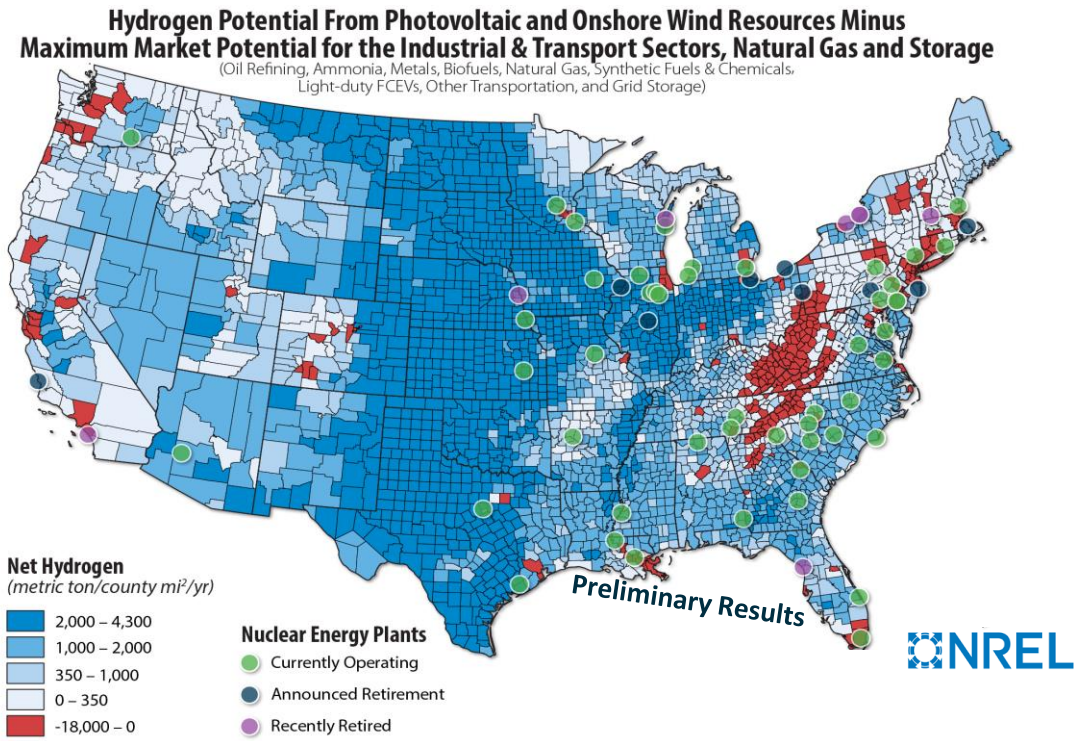
Examples of H2@Scale Analysis and Demonstration Projects

Assessing resource availability.
Most regions have sufficient resources.

New H2@Scale demonstration projects cover range of applications

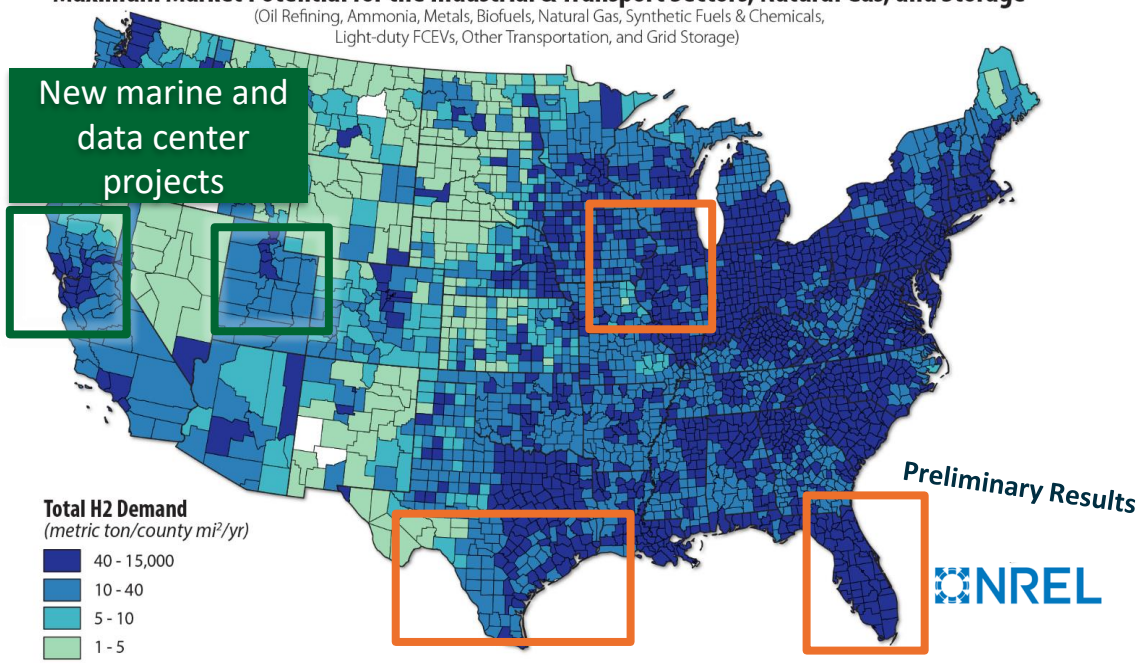
*Includes 1 project by Office of Nuclear Energy

Hydrogen Availability



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

Hydrogen Demand Potential



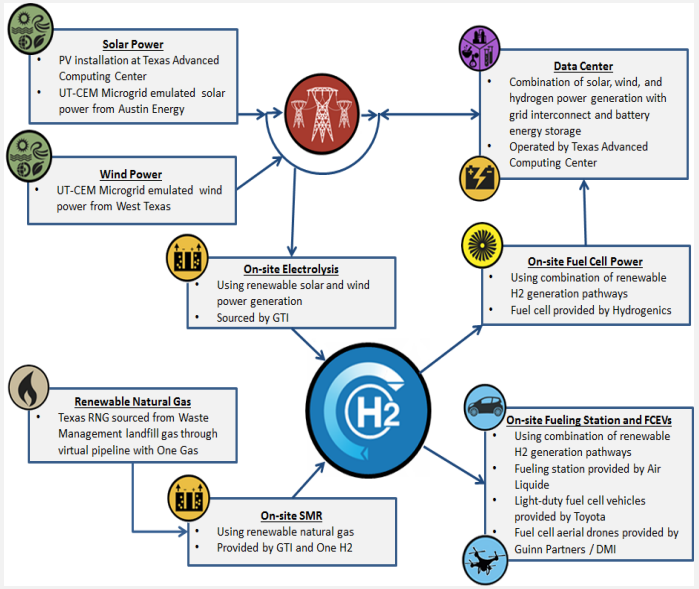
Example of H2@Scale Demonstration Projects

Demonstration of H2@Scale: Different regions, hydrogen sources and end uses

Texas

Total Budget
$10.8M

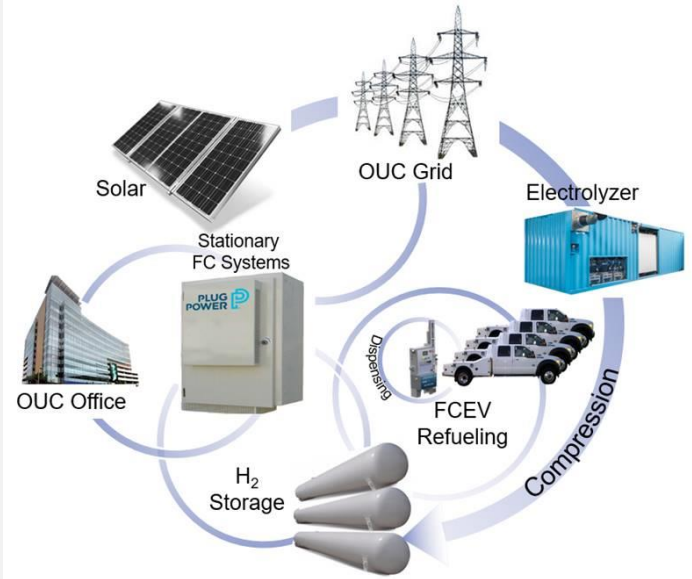
Wind, Solar, RNG/Waste



Florida

Total budget
$9.1M

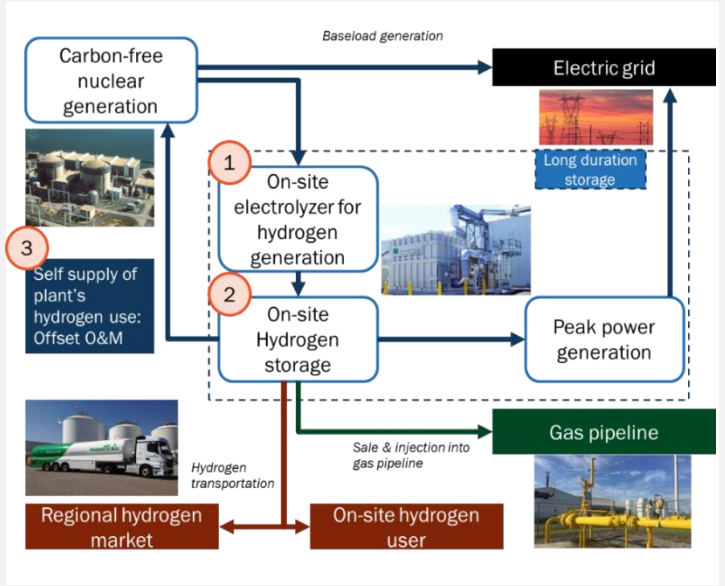
Solar-to-H_2 with End Uses



Site selection in process

Total Budget
$7.2M

Nuclear-to-H_2 for at-Plant Use



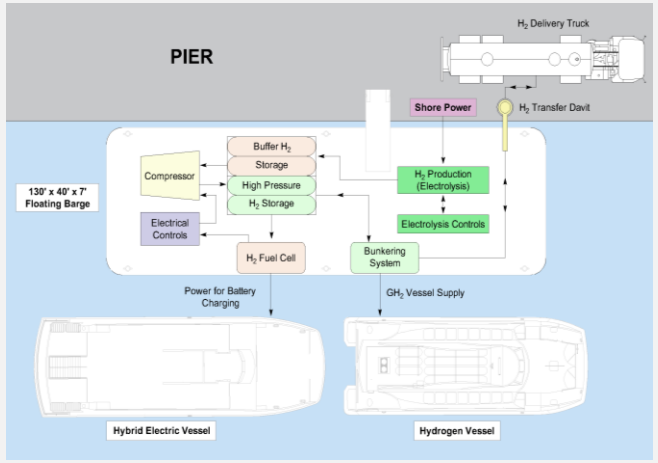
Examples of H2@Scale Demonstration Projects -2020

Demonstration of H2@Scale: Different regions, hydrogen sources and end uses

Marine Application

Total Budget $16M

Electrolyzer and fuel cell for marine application

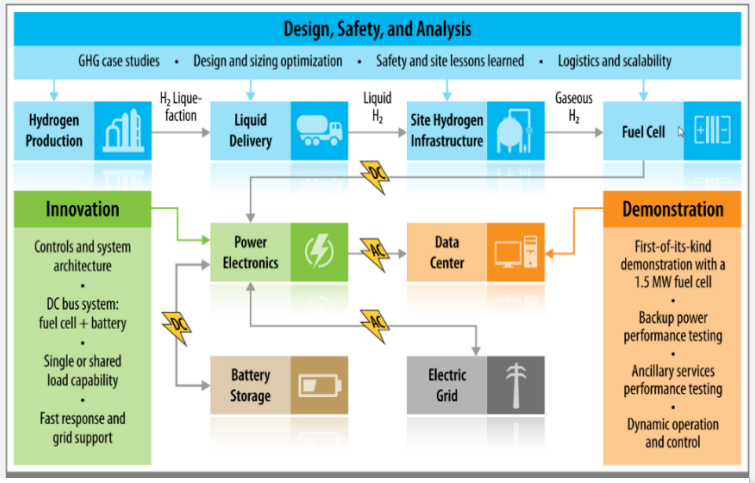


1st-of-its-kind maritime H_2 refueling on floating barge - up to 530 kg H_2 /day

H_2 for Data Center

Total Budget $13.7M

PEM fuel cell for data center power

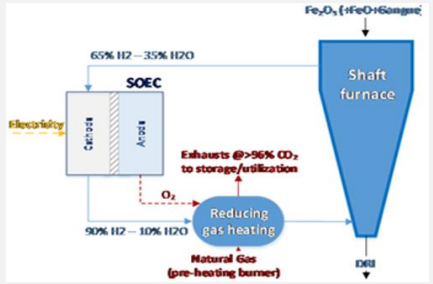


1.5MW fuel cell to meet data center requirements and future scale up

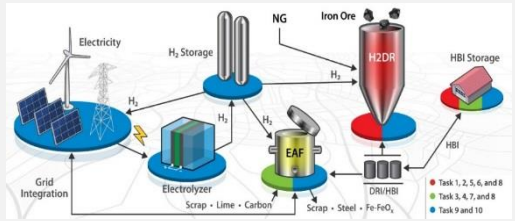
H_2 for Steel Production

Total Budgets $5.7M & $7.2M

DRI-process and grid-interactive steelmaking



Reduction of 30% in energy and 40% emissions vs conventional DRI processes



1 ton/wk iron prod.; scaled to 5,000 ton/day

First Carbon-Free, "Power-to-Gas" System in U.S.

Flagship Power-to-gas Project

Funded By DOE EERE In Partnership With Southern California Gas Company (SoCalGas)

- Approx. $2.5 million funded through EERE's Solar, Hydrogen and Fuel Cells, and Bioenergy Offices along with cost share by SoCalGas
- Process uses a low-temperature water electrolyzer to produce hydrogen from **renewable power**, then feeds the hydrogen and carbon dioxide into a bioreactor where methanogens produce methane and water
- With minor filtration, the product gas from the bioreactor will meet pipeline quality, allowing it to be injected into the **existing natural gas infrastructure**

Located at NREL, Golden, CO

- **Utilizes H_2+ CO_2 to generate pipeline quality natural gas** (> 97% CH_4)
- **Biocatalyst used in the process** - Methanothermobacter thermautotrophicus

Biomethanation Process:

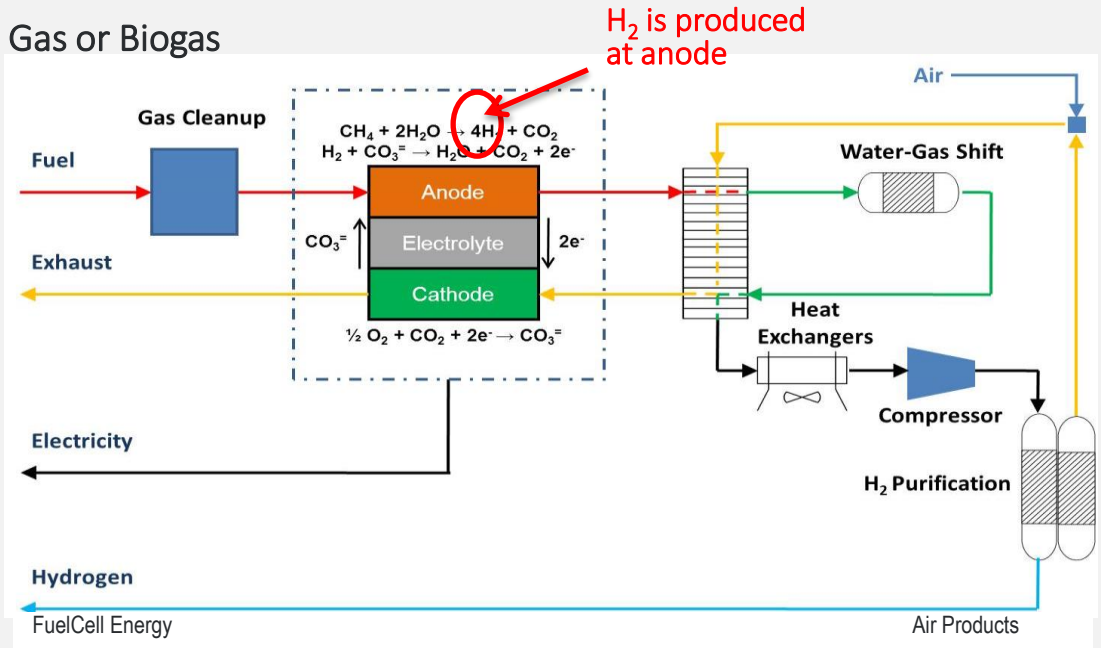
$$CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$$

- **Industry and lab partners:** Southern California Gas Company, NREL and Electrochaea

Press Release
https://www.nrel.gov/esif/partnerships-southern-california-gas.html

Example of Innovation: World's First Tri-Generation Station

- **Demonstrated co-production of electricity and hydrogen with 54% efficiency**
- **Uses biogas from wastewater treatment plant**



Co-funded by DOE/HFTO and multiple partners

Fountain Valley Demonstration Completed

- **~250 kW of electricity**
- **~100 kg/day hydrogen capacity (350 and 700 bar), enough to fuel 25 to 50 vehicles.**

Tri-Generation co-produces power, heat and hydrogen. World's First Fuel Cell and Hydrogen Energy Station demonstration completed in Orange County

Increased Activities on Integrated/Hybrid Systems and Energy Storage

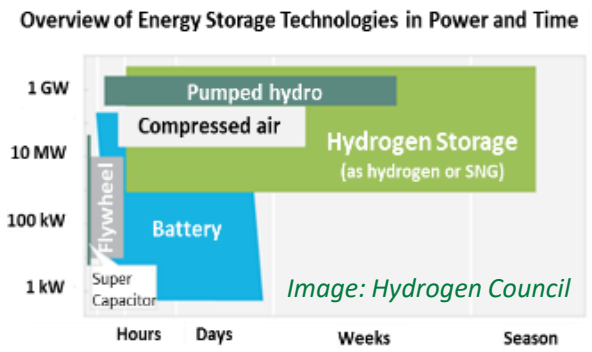
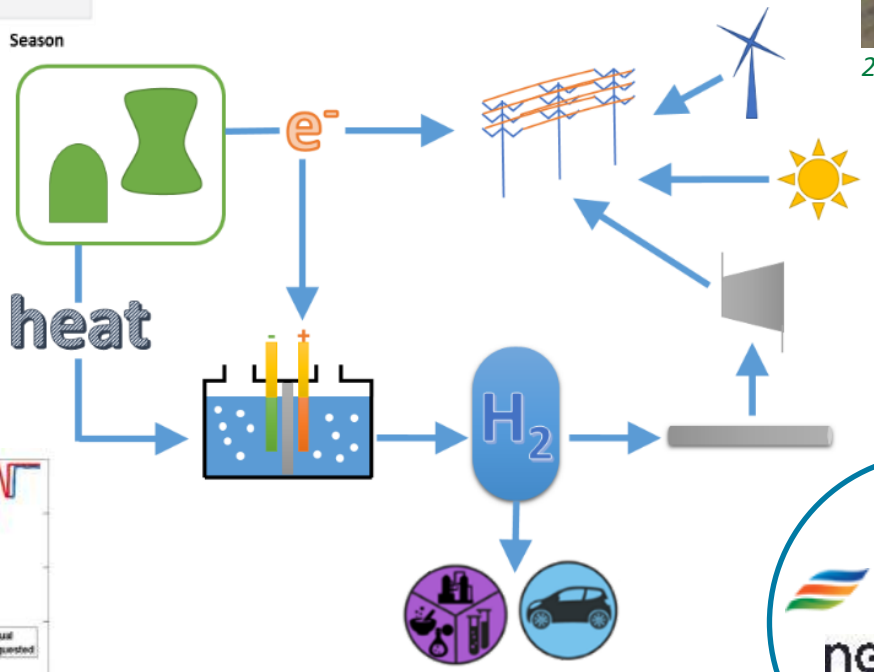


Image: Hydrogen Council

H_2 energy storage

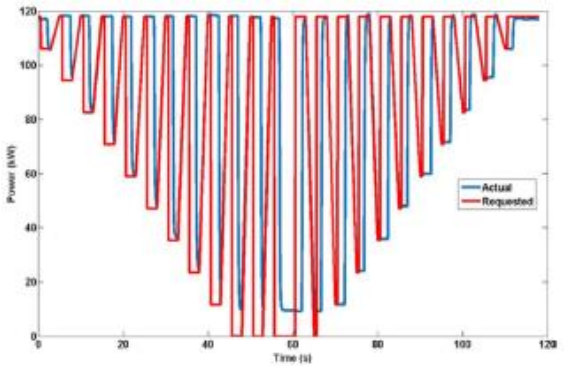
Increased opportunities for nuclear and hydrogen



25 kW high-temperature electrolysis @ INL Energy Systems Laboratory

Thermal Integration

Dynamic response



Dynamic electrolyzer response – INL & NREL

Multiple end use applications

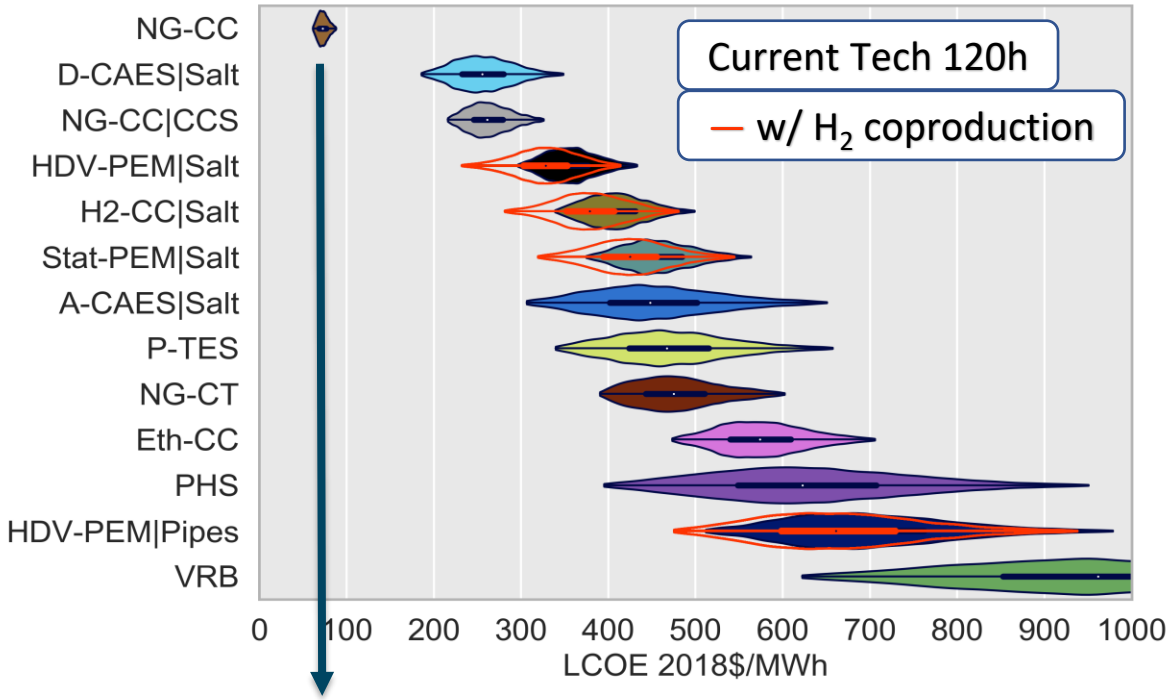
DOE Industry demos

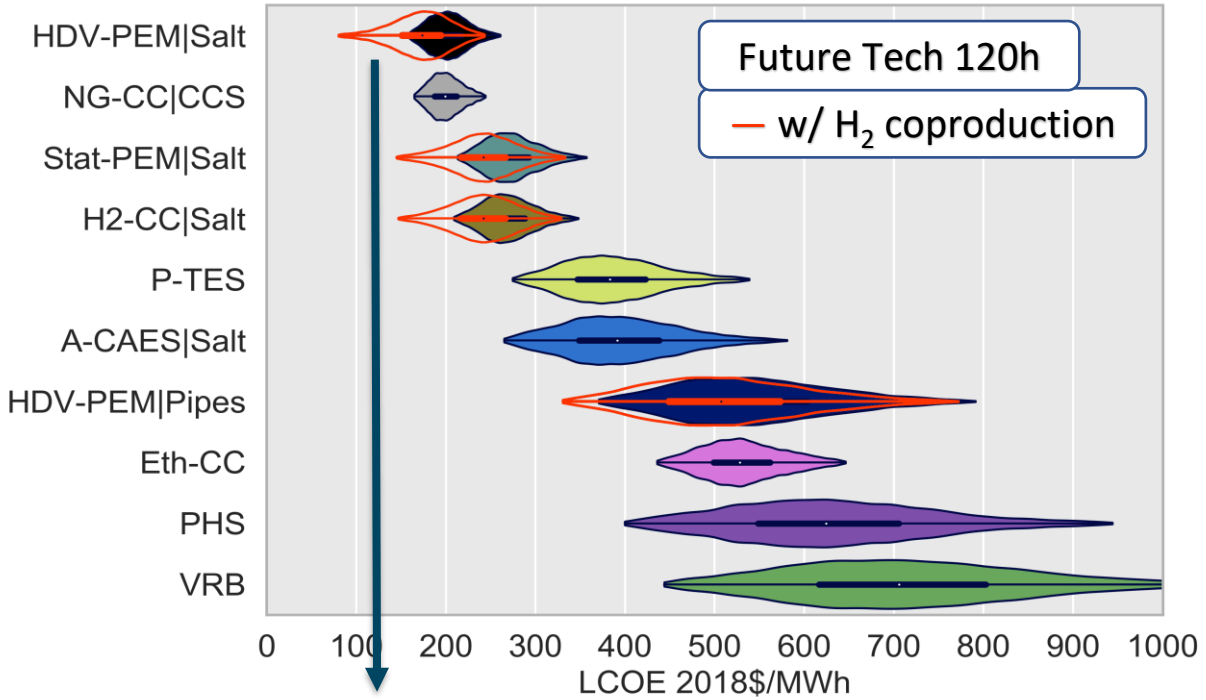
Exelon
nel
FirstEnergy Solutions
Xcel Energy
aps

Recently announced demonstrations

Long Duration Energy Storage and Flexible Power Generation Analysis

NREL's Techno-Economic Analysis of Long Duration Energy Storage- Preliminary Results across Technologies





Natural gas combined cycle (NG-CC) is the lowest cost option today
Wide Range of Costs for Various Technologies $200 to >$1,000/MWh

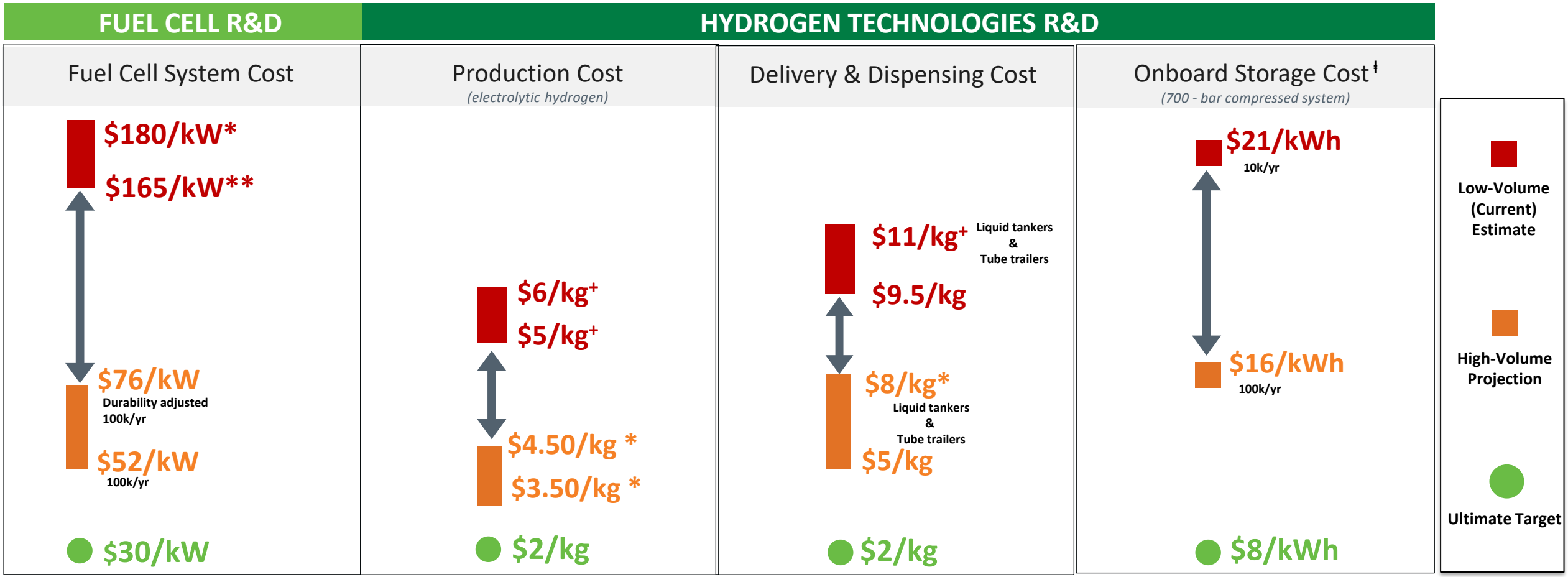
Future Scenario: Shows PEM fuel cells (for Heavy Duty Vehicle market), salt caverns + co-production of H_2 may be most economically competitive for 120 h storage

Source: Hunter, et. al., 2020, NREL- publication in process

Cost Reduction Efforts Underway

Technology targets guide HFTO R&D activities

Key Goals: Reduce the cost of fuel cells and hydrogen production, delivery, storage, and meet performance and durability requirements – guided by applications specific targets



*Based on state of the art technology

** Based on commercially available fuel cell cars at 3,000 systems/year

‡5 to 7 cents/kWh, 90% capacity factor at $1500/kW
*5 to 7 cents/kWh, 90% capacity factor at $460/kW

†For range: Delivery and dispensing at today's (2020) stations with capacity ~450 kg/day
*For range: Delivery and dispensing at today's (2020) stations with capacity 450-1,000 kg/day at high volume manufacturing

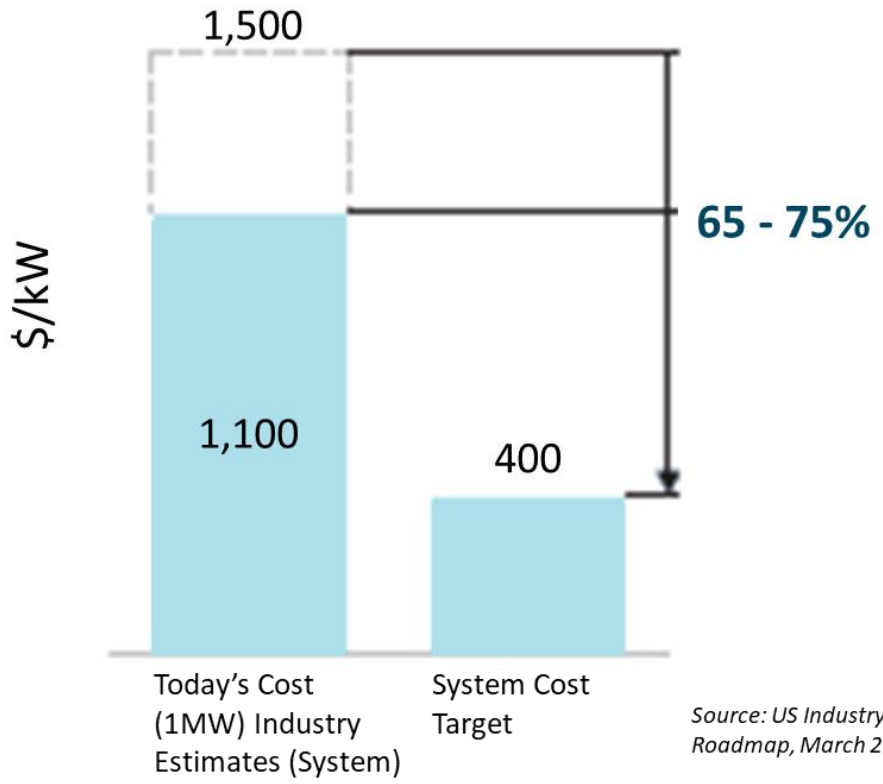
‡Storage costs based on 2019 storage cost record

All costs based on $2016

Note: Graph is not at scale. For illustrative purposes only

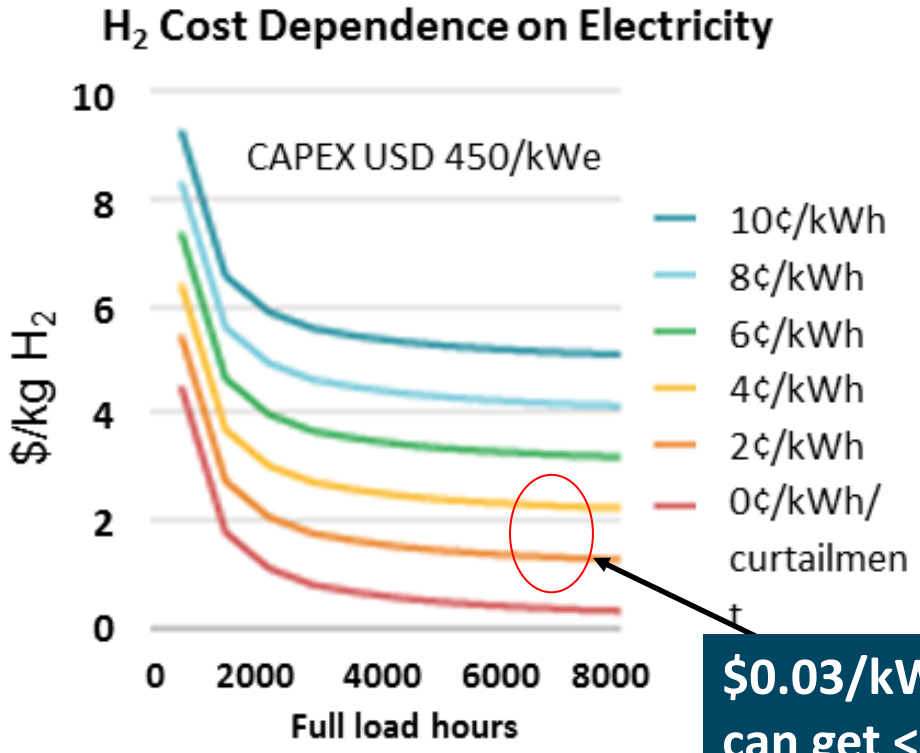
Electrolysis Cost – Recent Independent Analyses

Today's Polymer Electrolyte Membrane (PEM) electrolyzers require 65 75% cost reduction



Source: US Industry H2 Roadmap, March 2020

$2/kg H2 is achievable at about $0.03/kWh electricity cost and high utilization

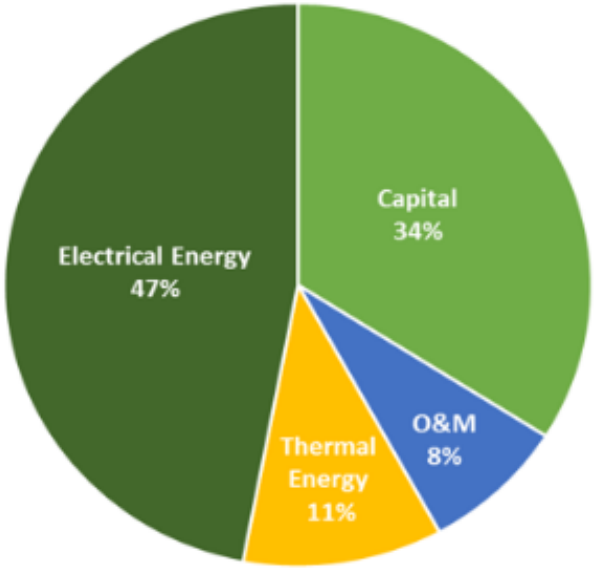


Source: IEA Hydrogen Future Report 2019

Today's hydrogen cost from PEM electrolyzers: ~ $5 to $6/kg at $0.05 to $0.07/kWh

Identifying Hydrogen Cost Drivers is Key

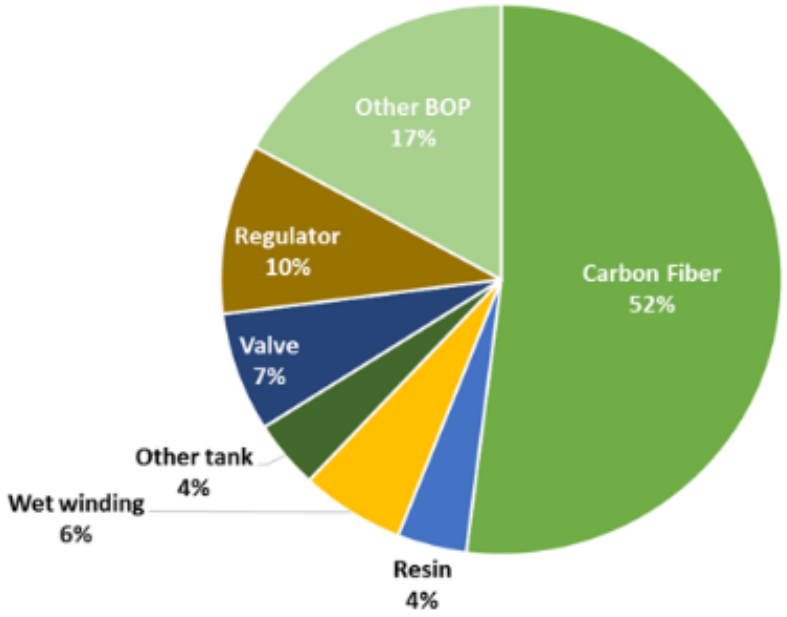
Hydrogen Production Cost
(High Temperature Electrolysis)



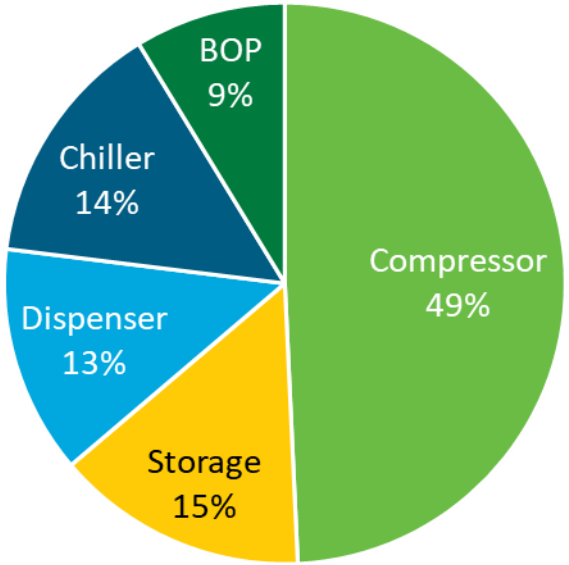
H_2 Production (Electrolysis) Cost Drivers: **Electrical energy and capital costs**

H_2 Onboard Storage Cost Drivers:
Carbon Fiber Precursors and Processing

Hydrogen Storage Cost
(Onboard 700 Bar Hydrogen Storage Vessel)

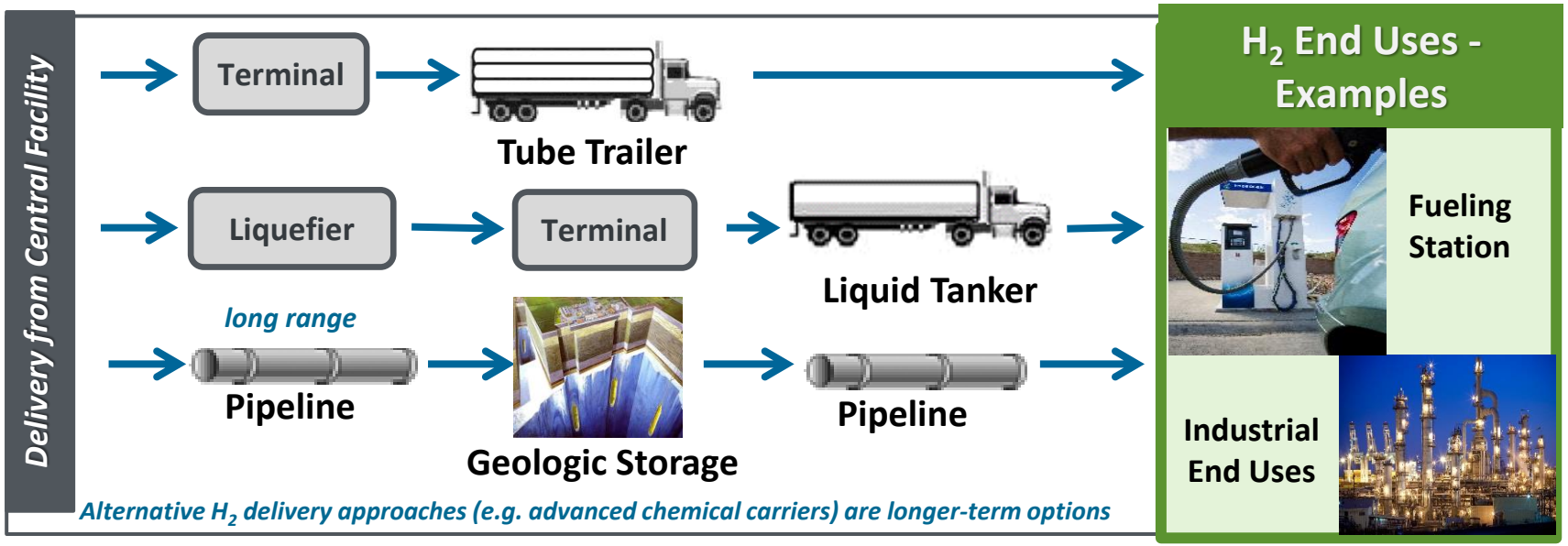


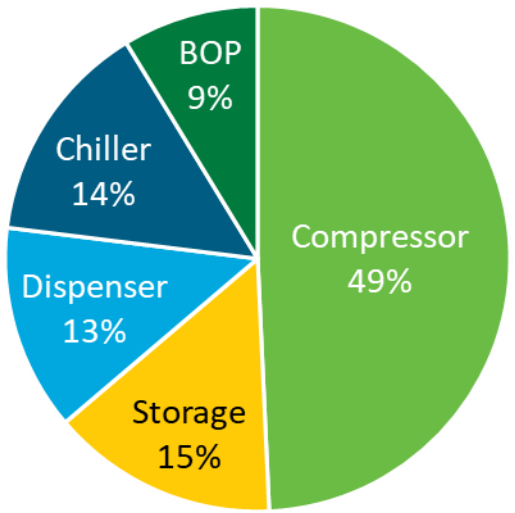
Hydrogen Fueling Station Cost[1]
(700 Bar, 800 kg/day Station)



H_2 Infrastructure Cost Drivers:
Compressors and Storage

Hydrogen Infrastructure R&D





R&D Challenges:

Cost, reliability, efficiency, and scalability of technologies for use in heavy-duty H_2 fueling stations and large-scale hydrogen distribution and materials compatibility issues

Strategy:

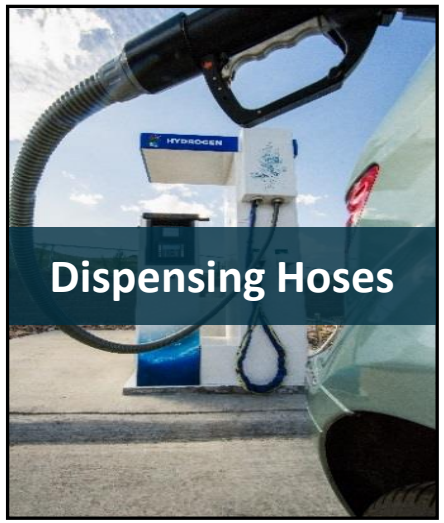
Near term: Affordable and reliable components and systems for **H_2 transport and dispensing** in heavy-duty applications

Long term: Materials and components for advanced **H_2 liquefaction and carrier distribution** concepts

Cross-cutting Materials Compatibility R&D

H-Mat℠ Hydrogen Materials Compatibility Consortium

H-Mat Consortium conducts R&D on hydrogen effects on polymers and metals



- Enabling the safe use of hydrogen across applications and the development of harmonized codes and standards
- Addressing hydrogen blending with natural gas, reducing expansion of seals, improving life of vessels through improved understanding of crack nucleation, enhancing fracture toughness of high-strength steels, and more
- Over 40 partners with industry, labs, universities

Sandia National Laboratories · Pacific Northwest National Laboratory · Oak Ridge National Laboratory · Savannah River National Laboratory (Operated by Savannah River Nuclear Solutions) · Argonne National Laboratory

For More Information

Website: h-mat.org

Email: h-matinfo@pnnl.gov

20% hydrogen blends could enable a doubling[1] of U.S. renewables consumption

% H_2/NG blends vary widely from <1% to 30%. Up to 15% may be feasible without significant modification to existing infrastructure

"HyBlend": R&D project to enable H_2 blending and address challenges

1. U.S. Projected Renewable Energy Consumption in Power Generation in 2019: ~703 TWh (Source: AEO 2020)
20% hydrogen blend in the U.S. by volume could enable >750 TWh of clean electricity to produce hydrogen via electrolysis.
(Source: Elgowainy, et al, ANL, 2020)


Collaboration

“No one can whistle a symphony. It takes a whole orchestra to play it.”

- H. Luccock

Examples of Global Collaboration

Coordinating across global partnerships: IPHE, Ministerials, Mission Innovation, IEA, etc.
Global Center for Hydrogen Safety established to share best practices, training resources and information

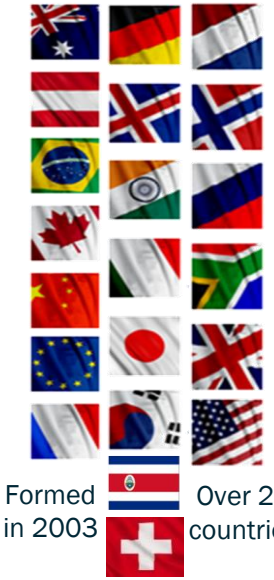
The International Partnership for Hydrogen and Fuel Cells in the Economy

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

Elected Chair and Vice-Chair, 2018

New Chair: Dec 2020: The Netherlands
Vice Chairs: U.S. Japan

www.iphe.net



Formed in 2003

Over 20 countries

Key Activities: Harmonization of codes & standards, Information sharing on safety, policies, regulations, analysis, education. Task force on developing H_2 production analysis methodology to facilitate international trade, global RD&D monitoring

Hydrogen and Clean Energy Ministerials	Mission Innovation Hydrogen Challenge	International Energy Agency

www.aiche.org/CHS

CENTER FOR 水素安全センター Hydrogen SAFETY

Connecting a Global Community

IPHE

Hydrogen Council

hySafe

AIChE

Pacific Northwest NATIONAL LABORATORY

Includes over 40 partners from industry, government and academia

Access to >110 countries, 60,000 members

CENTER FOR Hydrogen SAFETY

Connecting a Global Community

HYDROGEN Safety Panel

HYDROGEN Emergency Response Training Resources

Hydrogen Production Analysis Task Force (H2PA TF)

Addressing Priority from Industry and Governments

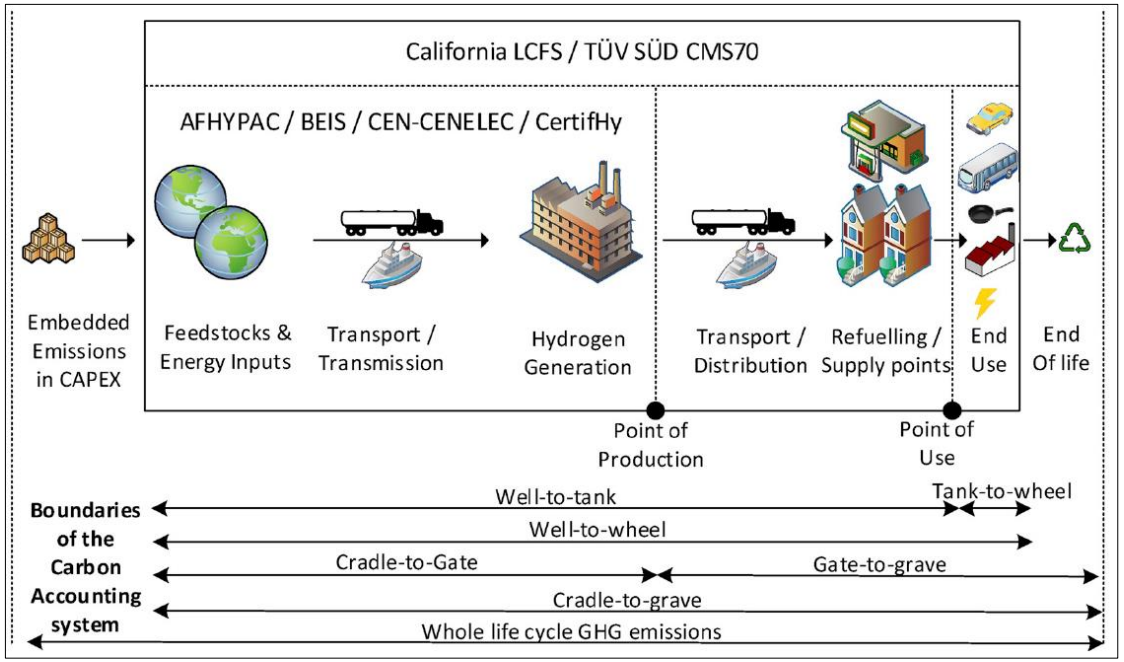
- Harmonize approach and develop framework to facilitate global trade of hydrogen

Scope

- Develop a mutually agreed upon analytical methodology for determining greenhouse gas (GHG) and other emissions associated with H2 production.

Next Steps and Engagement

- Continue to engage stakeholders, industry and experts to develop framework for methodology



(Source: Abad et al., Energy policy 138 (2020) 111300)

Application of methodology will help facilitate market valuation and global trade in 'clean' hydrogen by recommending a common approach with adoption not mandatory and subject to each member's discretion and circumstance.

IPHE E&O Working Group Early Career Network

- **Established by IPHE's Education & Outreach (E&O) Working Group** to promote international H_2 and fuel cell awareness and launch a platform for the next generation of H_2 and fuel cell leaders
- **Open to students, post-docs and early career** professionals

Stephanie Azubike
Chair

Learn more: iphe.net/early-career-chapter

Membership form: https://forms.gle/gUnWyV7gU4QqoHLm7

Priya Buddhavarapu
Co-Chair

#HydrogenNow

#FuelCellsNow

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@The_IPHE IPHE

iphe.net IPHE

Workforce Development, Training and STEM

Hydrogen Education for a Decarbonized Global Economy (H2EDGE)

Objectives:

- Enhance workforce readiness through training and education (T&E)
- Develop T&E materials and deliver professional training courses and university curriculum content
- Collaborate with industry and university partners to develop certifications, credentials, qualifications, and standards for training and education needs

Recipient: EPRI

Partners include: GTI, OSU, Purdue, UD, EA

June 2020: DOE EERE announces $20M investment at U of TN to advance workforce development in emerging energy fields, partnering with ORNL and Oak Ridge Institute (ORI)

- ORI will develop model workforce development program and partnerships with universities, agencies, and national labs
- Focuses on EERE related technologies including hydrogen and fuel cells

Summary of ways to engage with DOE HFTO

Lab-Based Consortia

HydroGEN
Advanced Water Splitting Materials

HyMARC
Hydrogen Materials Advanced Research Consortium

ElectroCat
Electrocatalysis Consortium

FCPAD
FUEL CELL PERFORMANCE AND DURABILITY

In Development

New Lab Consortia:

- H2NEW: Electrolyzer Consortium
- Million Mile Fuel Cell Truck Consortium

Lab - Industry Bridge

- H2@Scale Consortium
- CRADAs
- SPPs (WFOs)
- L'Innovator
- Technology Commercialization Fund

Private Sector

- FOA projects
- SBIRs
- Prizes
- State funding
- Demos & Deployments
- Partnerships
- US Industry Roadmap

H-Mat™ Hydrogen Materials Compatibility Consortium

H_2 materials R&D, enable codes & standards, reduce regulatory barriers

Safety – Lessons learned, best practices, enable safe infrastructure across sectors





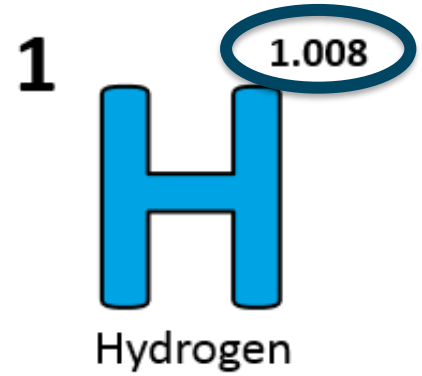

Resources and Events

Save the Date

Week of June 7, 2021
Annual Merit Review and Peer Evaluation Meeting (AMR) for the DOE Hydrogen and Fuel Cells Program

Oct 8 - Hydrogen and Fuel Cells Day

(Held on its very own atomic weight-day)



Resources

INCREASE YOUR H2IQ

Join Monthly
H2IQ Hour Webinars

Download
H2IQ For Free

energy.gov/eere/fuelcells/fuel-cell-technologies-office-webinars

energy.gov/eere/fuelcells/downloads/increase-your-h2iq-training-resource

Visit H2tools.Org For Hydrogen Safety And Lessons Learned
https://h2tools.org/

Learn more:

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 AND www.hydrogen.energy.gov

Thank You

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Director, DOE Hydrogen and Fuel Cells Program
Sunita.Satyapal@ee.doe.gov

Looking for more info?

#H2IQ

hydrogen.energy.gov