U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

U.S. Department of Energy Hydrogen and Fuel Cell Perspectives

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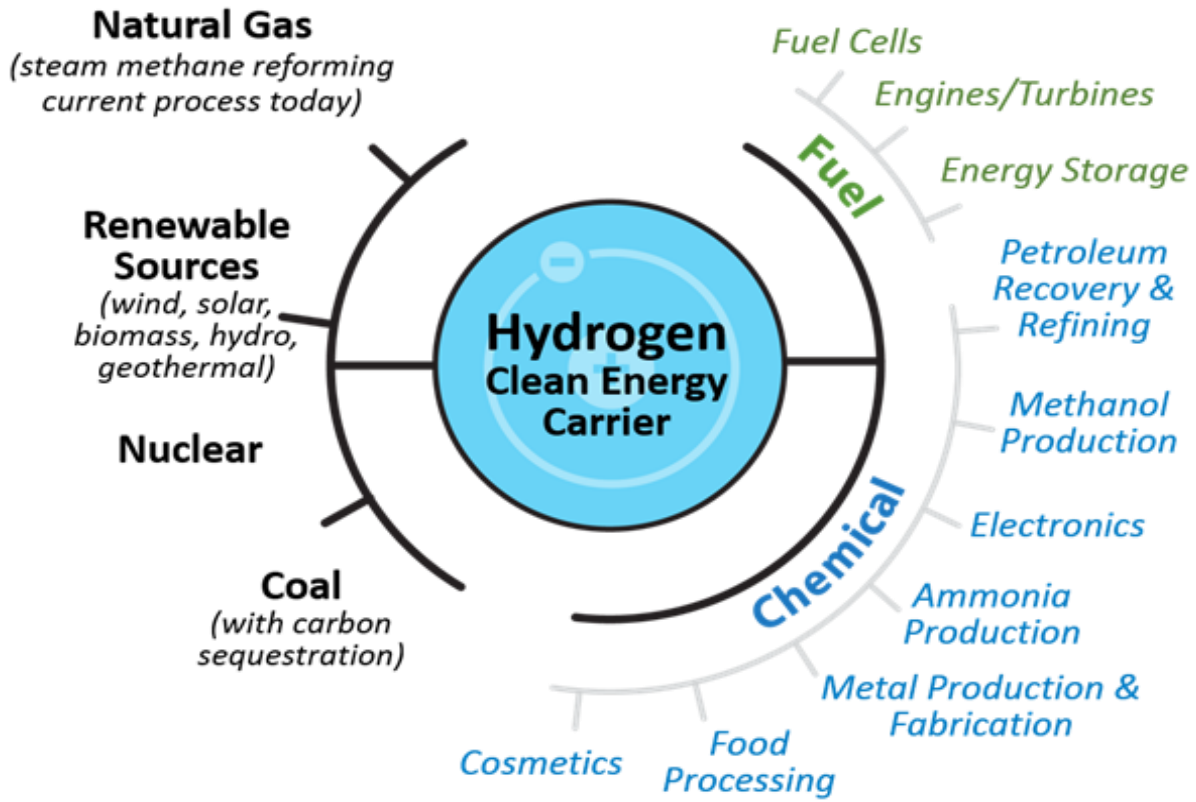
Power-to-Gas Webinar

May 26, 2020

Hydrogen – One Part of a Comprehensive Energy Strategy

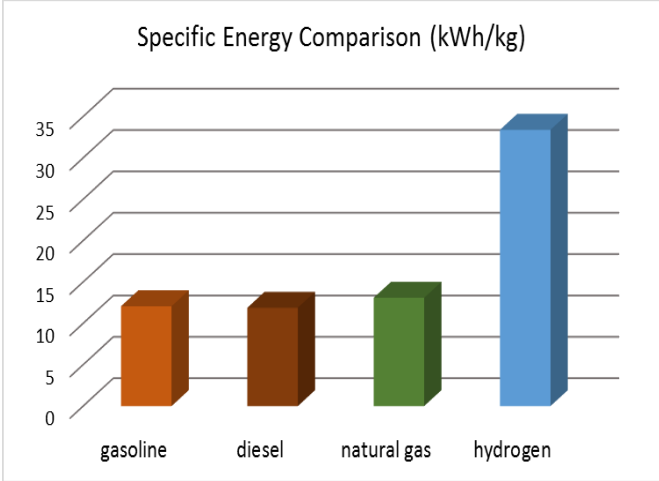
H_2 can be produced from diverse domestic sources

Many applications rely on or could benefit from H_2

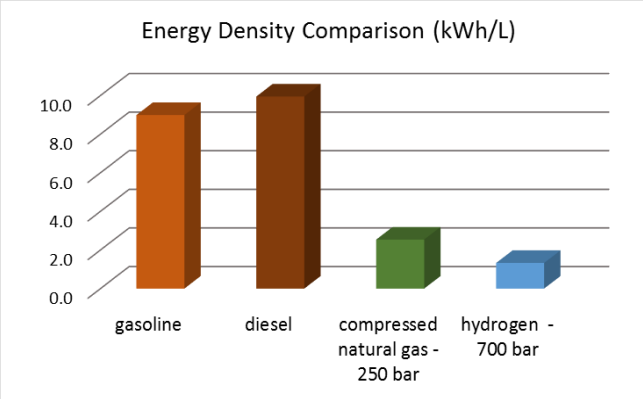


High energy content by mass

Nearly 3x more than conventional fuels



Low energy content by volume



Clean , sustainable, versatile, and efficient energy carrier

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

Examples of Applications

>500MW
Stationary Power

>33,000
Forklifts

>30
Fuel Cell Buses

>45
H_2 Retail Stations

>8,500
Fuel Cell Cars

Hydrogen Production Across the U.S.

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

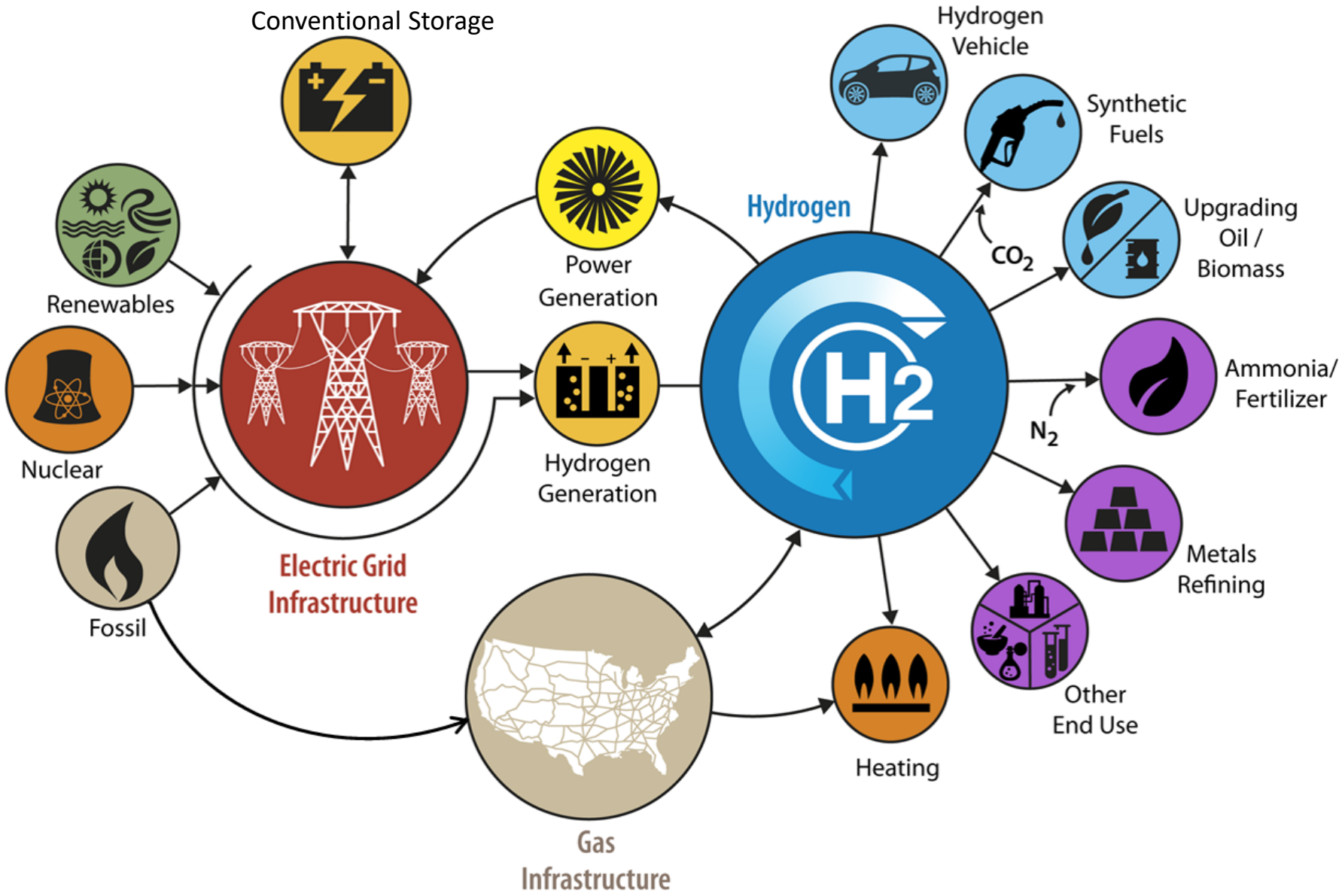
Hydrogen Stations: Examples of Plans Across States

California
200 stations planned - CAFCP goal

Northeast
12 – 20 stations planned

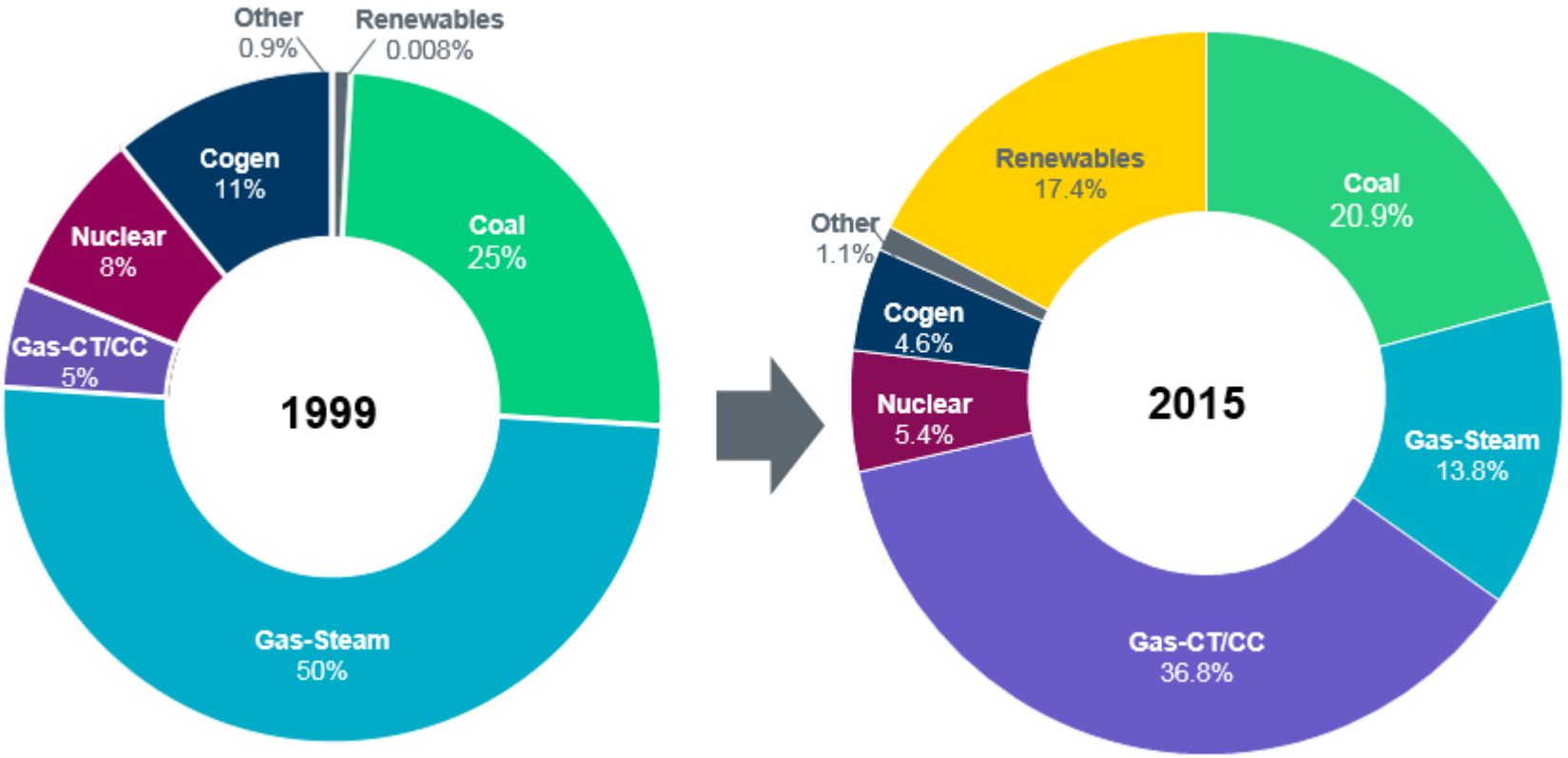
HI, OH, SC, NY, CT, MA, CO, UT, TX, MI, and others

H_2@Scale: Enabling affordable, reliable, clean, and secure energy across sectors



Electricity Mix Landscape is Changing

Example: Installed Capacity in Texas



The price of solar and wind has dropped dramatically

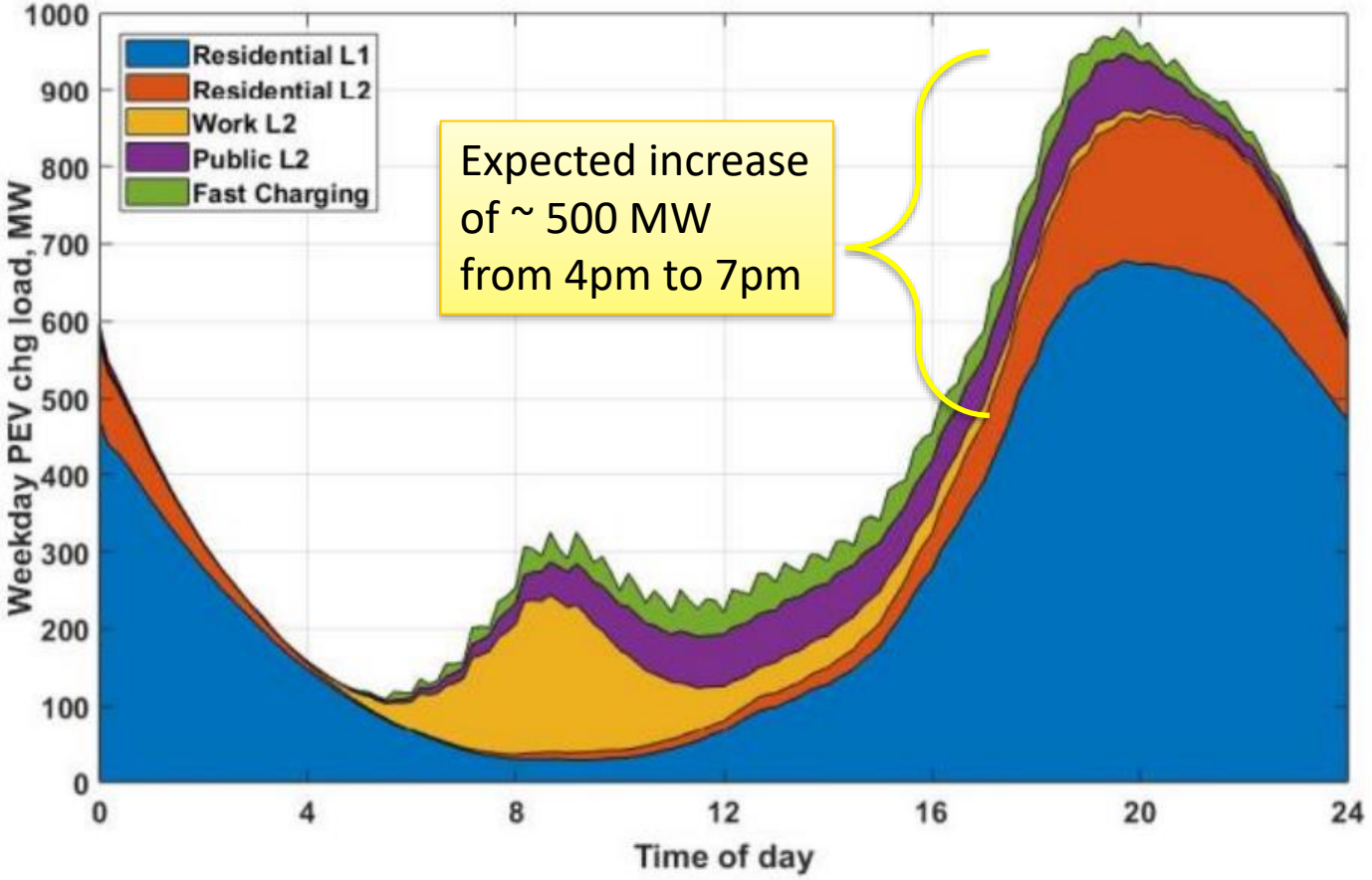
Hydrogen costs can be less than $5/kg

Source: ERCOT, DOE H2@Scale Workshop, TX

Additional Value of Hydrogen: Grid Services and Resiliency

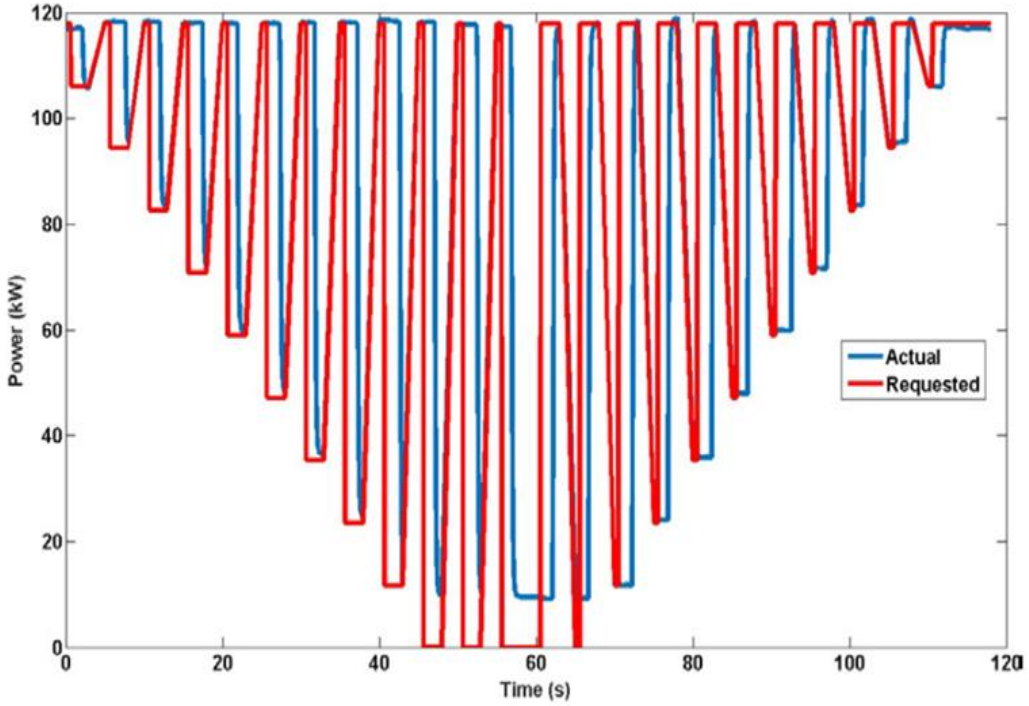
Flexibility will be needed to address grid challenges: high ramp rates and demand fluctuations

Predicted 2025 California EV Charging Load Profile (Weekday) shows impact of demand profiles on the grid



Source: CEC/NREL Report https://www.nrel.gov/docs/fy18osti/70893.pdf

DOE national lab tests show dynamic response potential of electrolyzers



Idaho National Lab & National Renewable Energy Lab results
Direct fast charger impact project underway 2020-2021

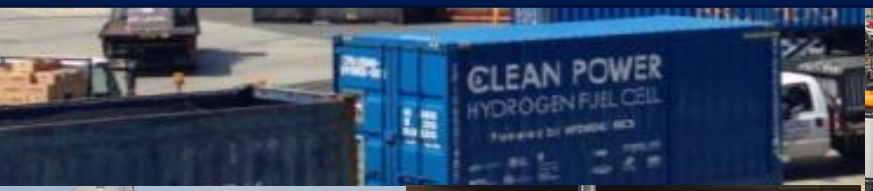
Commercial Hydrogen and Fuel Cell Technologies Now Available across Sectors





Over 1/3 Million Stationary Fuel Cells, More Than 15,000 Fuel Cell Vehicles, 400 Stations Worldwide

1 GW Fuel Cells Shipped in 2019





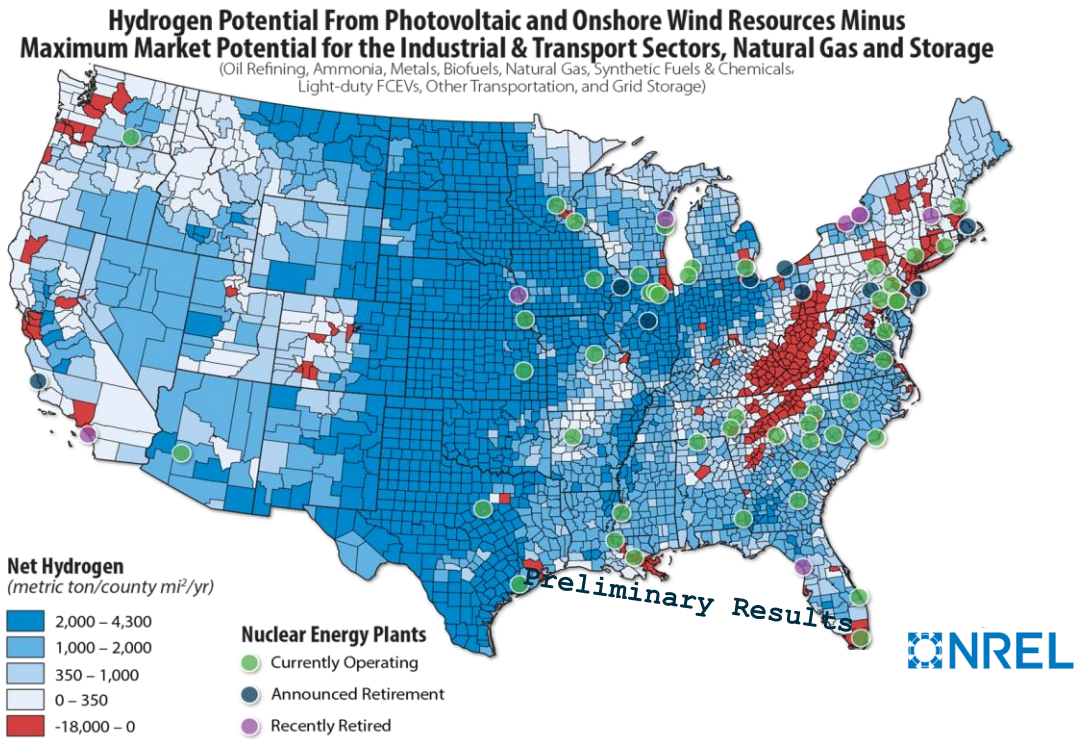
Examples of U.S. Activities to Enable H2@Scale

Assessing resource availability.
Most regions have sufficient resources.

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

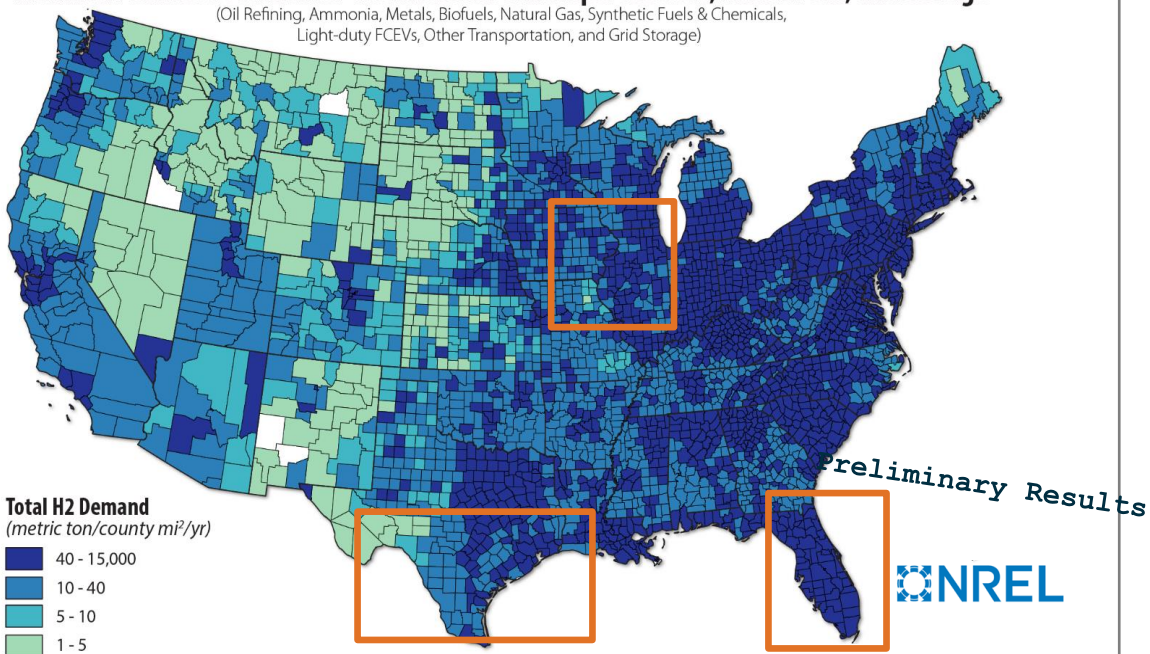
*Includes 1 project by Office of Nuclear Energy

Hydrogen Availability



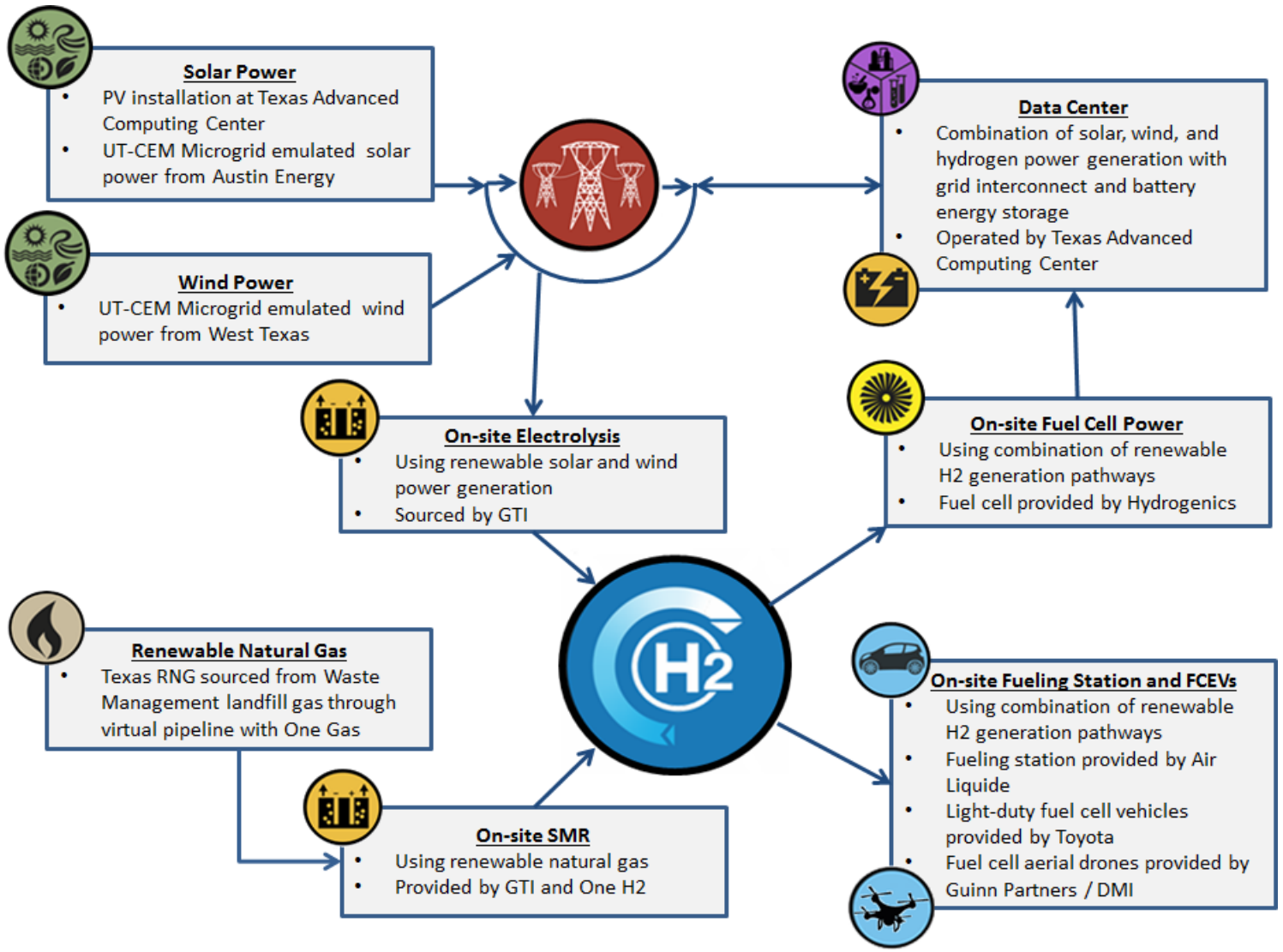
Red: Only regions where projected industrial & transportation demand exceeds supply.

Hydrogen Demand Potential



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

Integration Concepts Being Considered



Partners include:

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

Duration

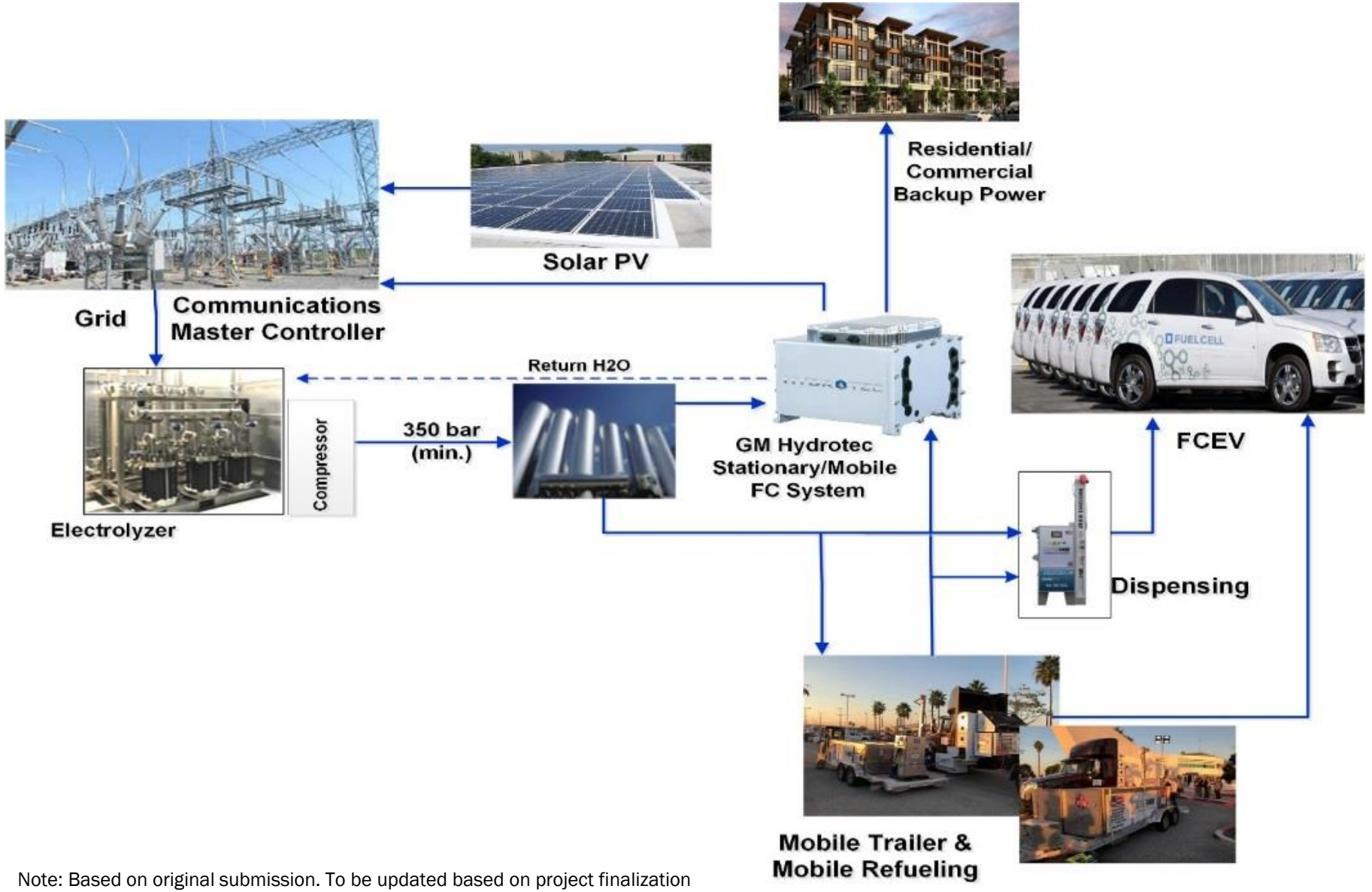
36 Months

Total budget

$12.7M

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

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

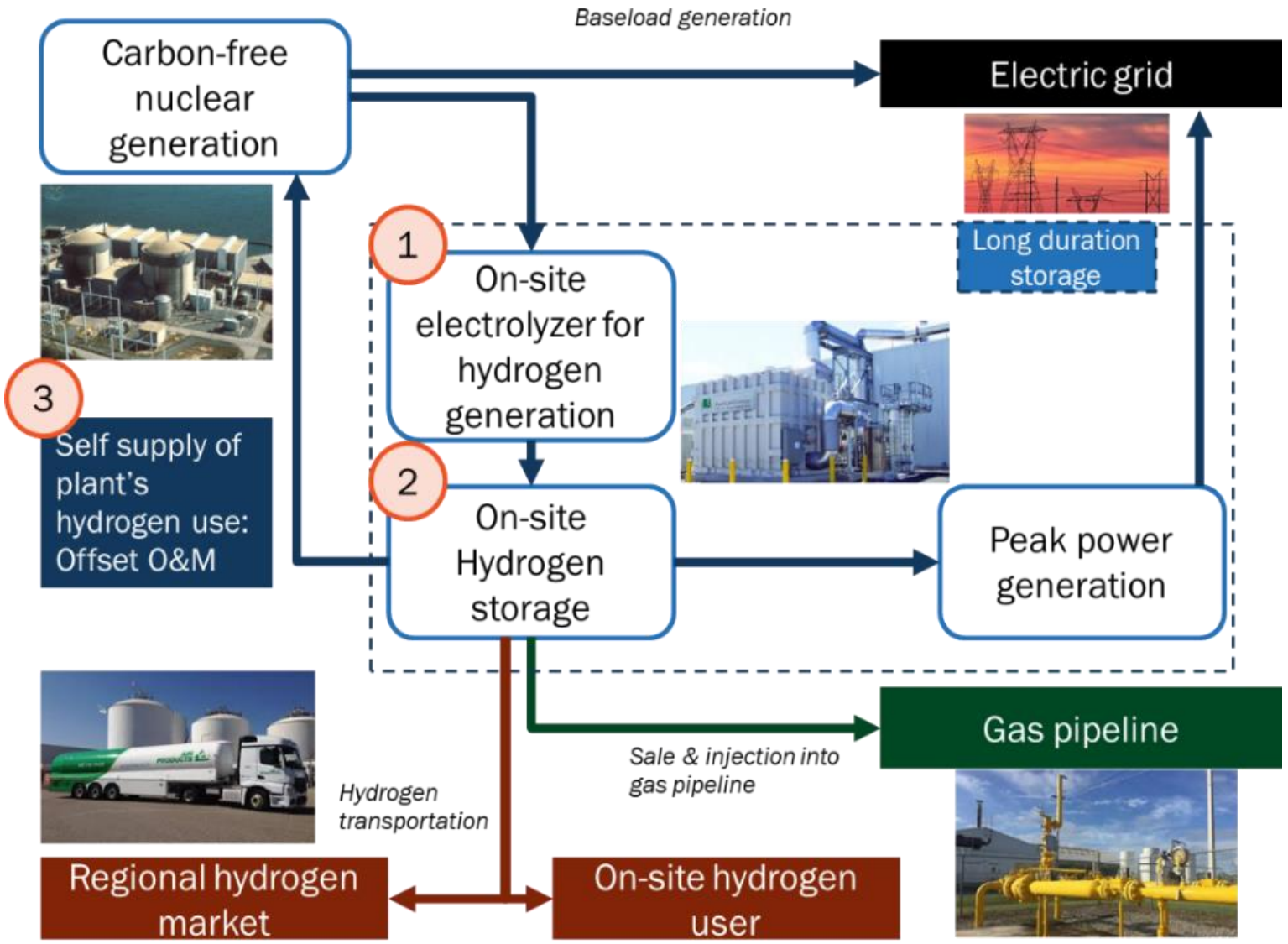
36 Months

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

First Ever 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**

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

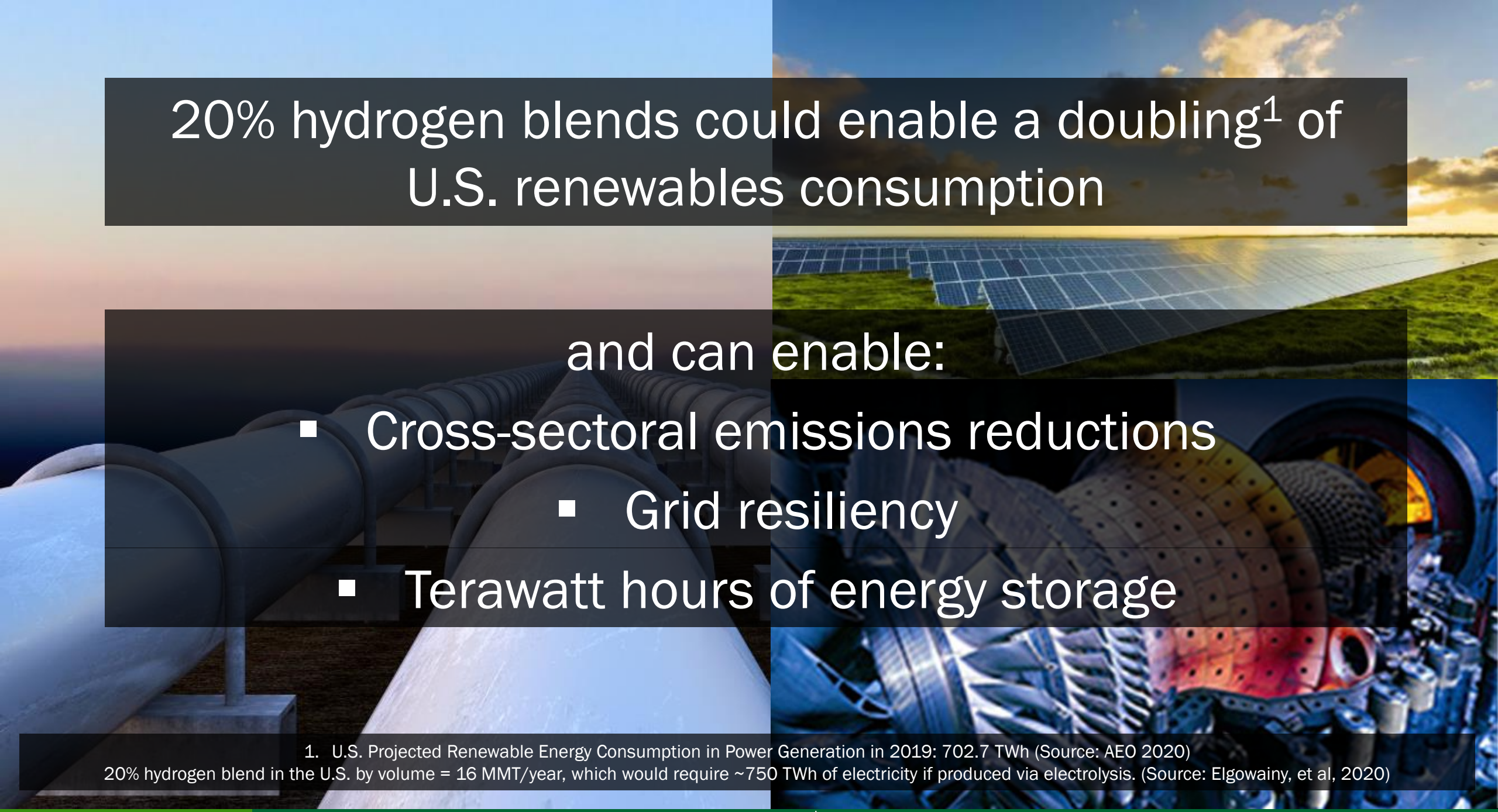
Biomethanation Process:

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

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

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

See: Kevin Harrison presentation later in the webinar



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

and can enable:

- Cross-sectoral emissions reductions
- Grid resiliency
- Terawatt hours of energy storage

1. U.S. Projected Renewable Energy Consumption in Power Generation in 2019: 702.7 TWh (Source: AEO 2020)
20% hydrogen blend in the U.S. by volume = 16 MMT/year, which would require ~750 TWh of electricity if produced via electrolysis. (Source: Elgowainy, et al, 2020)

Global Center for Hydrogen Safety Launched 2019

Promotes safe operation, handling and use of hydrogen across all applications.
Provides training and resources, includes industry, government, access to 110 countries

IPHE Hydrogen Council

AIChE

Pacific Northwest NATIONAL LABORATORY

Includes over 40 partners from industry, government and academia

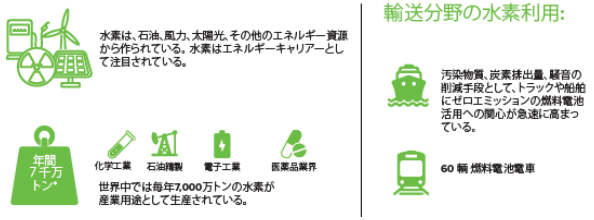
CENTER FOR Hydrogen SAFETY
Connecting a Global Community

HYDROGEN Safety Panel

HYDROGEN Emergency Response Training Resources

Access to >110 countries, 60,000 members

CENTER FOR 水素安全センター Hydrogen SAFETY
Connecting a Global Community



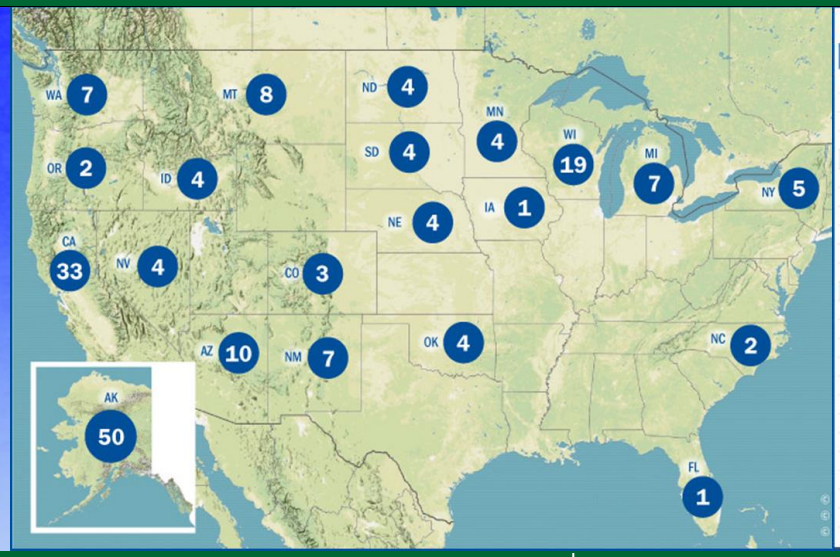
Language translations underway

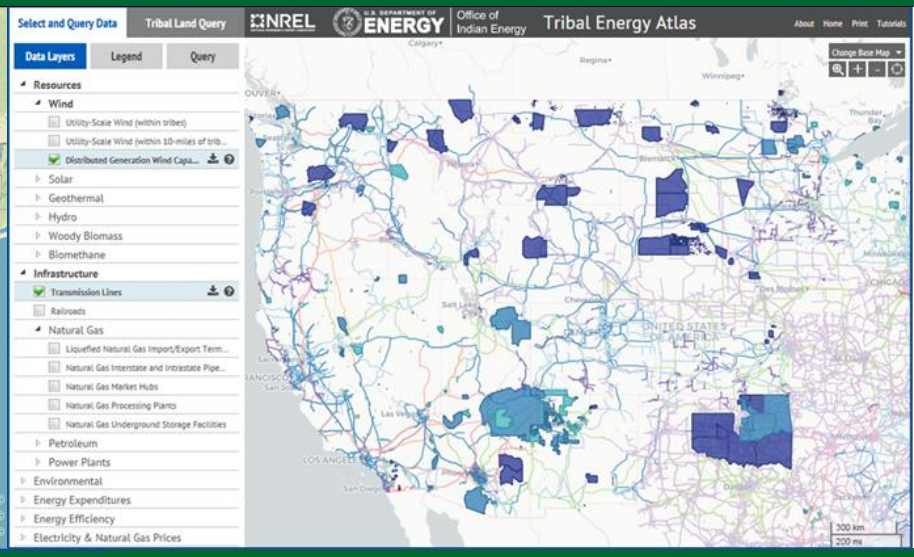
www.aiche.org/CHS

In addition to DOE Technology Offices: DOE Office of Indian Energy

- U.S. DOE Office of Indian Energy authorized under the Energy Policy Act of 2005, established January 2011
- IE offers ***competitive grants***, ***technical assistance***, and ***education and capacity building*** to assist Indian Tribes, including Alaska Native Villages to overcome regulatory and economic challenges to developing their vast energy resources
- IE invested nearly $85 million in more than 180 tribal energy projects valued at over $180 million (2010-2019)
- Tribal Energy Atlas – First-of-its-kind interactive geospatial application for tribes to conduct analyses of installed energy projects and resource potential on tribal lands

www.energy.gov/indianenergy/office-indian-energy-policy-and-programs





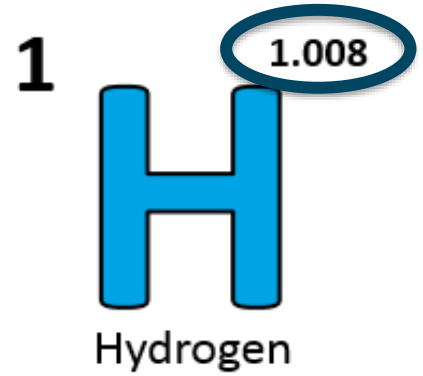
Resources and Announcements

Save the Date

June 8-10, 2021 Annual Merit Review and Peer Evaluation Meeting for the Hydrogen and Fuel Cells Program in Arlington, VA

Oct 8 - Hydrogen and Fuel Cells Day

(Held on its very own atomic weight-day)



Resources

INCREASE YOUR H2IQ

Download
H2IQ For Free

Join Monthly
H2IQ Hour Webinars

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

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

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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Looking for more info?

#H2IQ

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