
**ASSOCIATION OF AIR POLLUTION
CONTROL AGENCIES
2023 SPRING MEETING
OKLAHOMA CITY
ENERGY SECTOR UPDATES**

HYDROGEN FUNDAMENTALS

- Hydrogen is colorless, odorless and has the highest energy content by **weight** of any fuel – 3X higher than gasoline
- Hydrogen is the most abundant element in the universe; however, it is rarely found in its elemental form
- Hydrogen is produced from a hydrogen-containing feedstock
 - Steam Methane Reforming (SMR) from natural gas
 - Gasification and pyrolysis fossil fuels and plastics
 - Electrolysis using water
- 99% of the US hydrogen production is derived from fossil fuels and 1% from electrolysis.
 - 95% of fossil fuel derived hydrogen produced today is from steam methane reforming
 - 4% is produced via gasification
- Hydrogen is used within oil refineries, to produce ammonia (NH_3 for fertilizer) and methanol production

BACKGROUND & OVERVIEW



The U.S. Department of Energy (DOE) opened a competitive application (FOA) for the \$7 billion Regional Clean Energy Hydrogen Hubs program.



DOE is aiming to select six to ten hydrogen hubs across the country, with individual hubs receiving up to \$1.25 billion in federal funding.



This effort will catalyze investment in the development of hydrogen hubs that demonstrate the production, processing, delivery, storage, and end-use of clean hydrogen, in support of the Biden Administration's goal to achieve a carbon-free electric grid by 2035 and a net zero emissions economy by 2050.



Governors Asa Hutchinson of **Arkansas**, John Bel Edwards of **Louisiana**, and Kevin Stitt of **Oklahoma** created a bipartisan three-state partnership, known as the **HALO Hydrogen Hub**, to compete for this funding opportunity.

DOE H₂HUB APPLICATION PROCESS

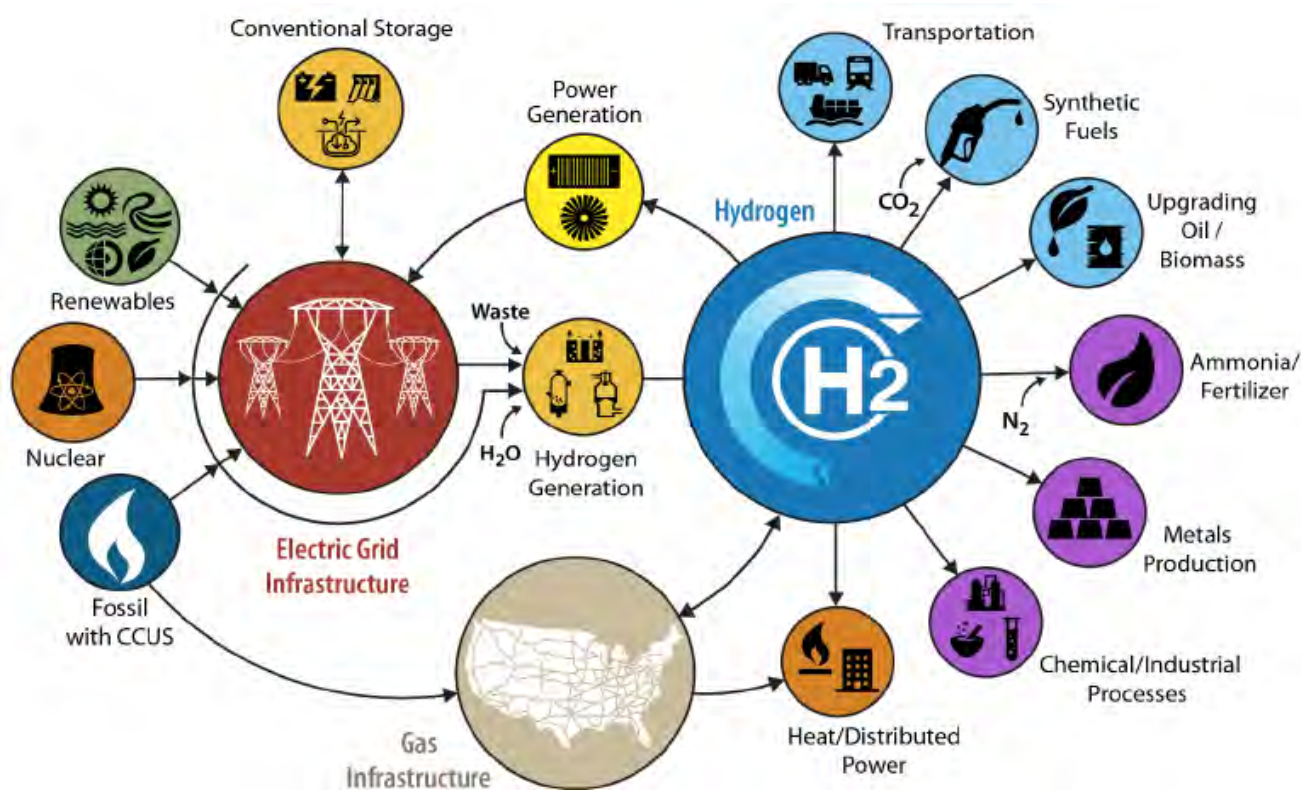
HALO Hub's Concept Paper was formally submitted to DOE on November 4, 2022

After conducting an independent assessment of submissions, DOE encouraged the HALO Hub to submit a Full Application

The Full Application is due to DOE on April 7, 2023

DOE expects to provide selection notifications to awardees in the Fall of 2023

HYDROGEN FUNDAMENTALS



DOE H2Hub
\$7 Billion,
6-10 Hydrogen
hubs

DOE H2HUB COMPETITIVE LANDSCAPE

**79 Concept
Paper
Submissions**



**33 Encouraged to
Submit Full
Applications**

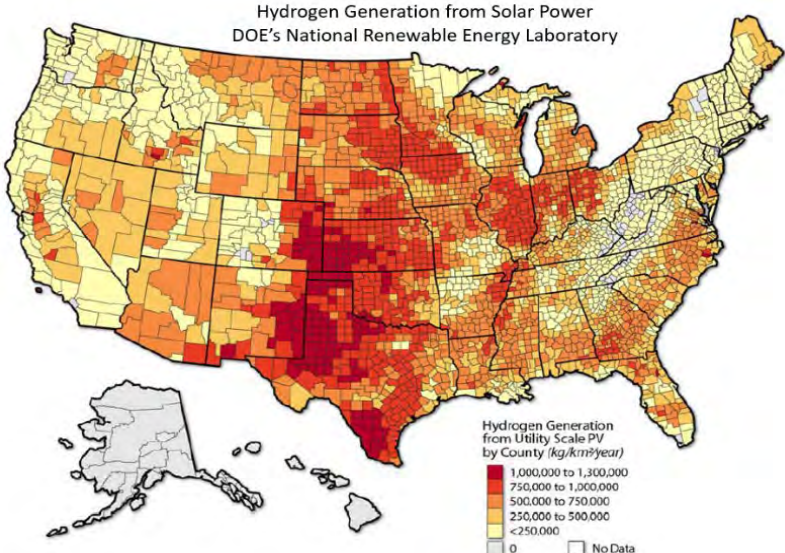
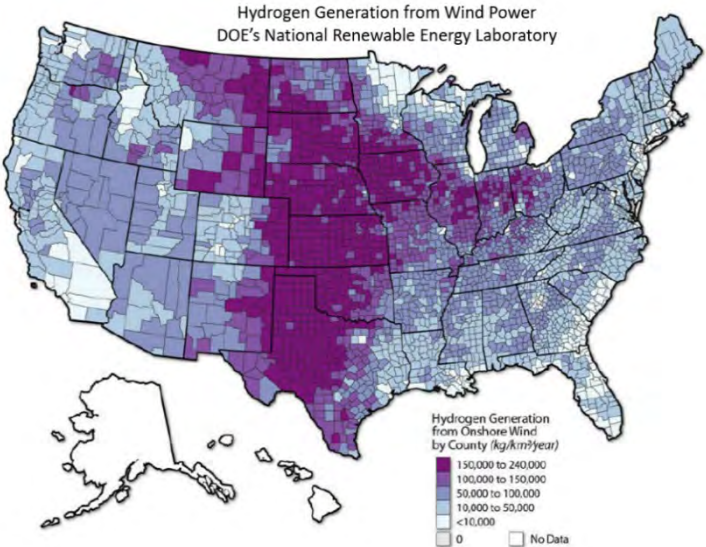
PUBLICIZED HUBS SUBMITTING FULL APPLICATIONS



■ Concept encouraged by DOE
 ■ Concept discouraged by DOE
 ■ Not encouraged/discouraged; Status unknown
↖ State or multi-state hub
 ○ State or within-state hub
 🚚 Pipeline/transportation

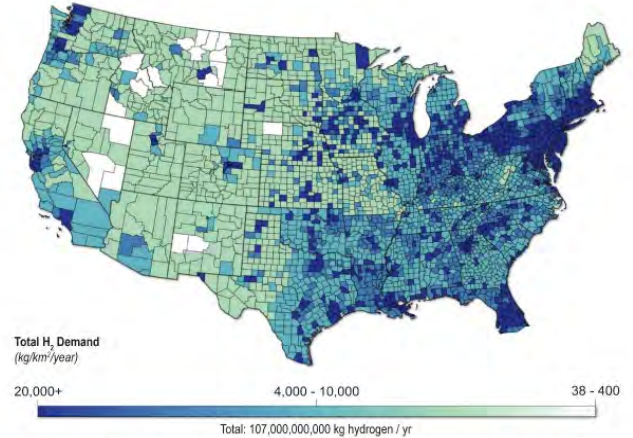
- ① Pacific Northwest Hydrogen Hub
- ② Obsidian Pacific Northwest Hydrogen Hub
- ③ Alliance for Renewable Clean Energy Systems (ARCHES)
- ④ Southwest Clean Hydrogen Innovation Network (SHINE)
- ⑤ Western Interstate Hydrogen Hub (WIH2)
- ⑥ Heartland Hydrogen Hub
- ⑦ Hawai'i Pacific Hydrogen Hub
- ⑧ Trans Permian Hydrogen Hub
- ⑨ Horizons Clean Hydrogen Hub
- ⑩ HyVelocity Hydrogen Hub
- ⑪ HALO Hydrogen Hub
- ⑫ HARVEST Hydrogen Hubs Coalition
- ⑬ Mid-Continent Hydrogen Hub
- ⑭ Midwest Alliance for Clean Hydrogen (MachH2)
- ⑮ Northwest Indiana Hydrogen Hub
- ⑯ Southeast Hydrogen Hub
- ⑰ Great Lakes Clean Hydrogen Hub
- ⑱ Appalachian Regional Clean Hydrogen Hub (ARCH2)
- ⑲ Decarbonization Network of Appalachia
- ⑳ Mid-Atlantic Hydrogen Hub (MAAH)
- ㉑ Mid-Atlantic Clean Hydrogen Hub
- ㉒ Northeast Hydrogen Hub

HALO HYDROGEN FUTURE



HYDROGEN FUTURE

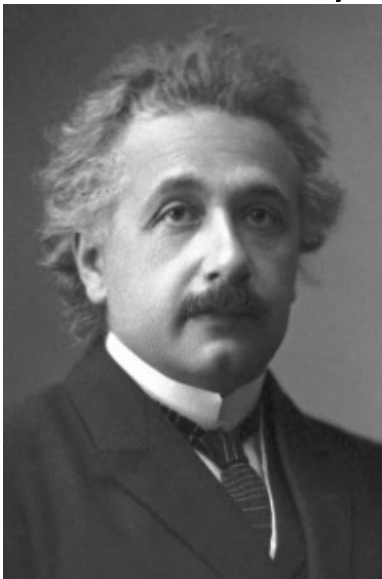
- The majority of hydrogen used in refineries, ammonia and methanol production
- Blending into natural gas pipeline infrastructure
- Electricity grid balancing
 - Energy storage and power generation
- Transportation fuel
 - Light, medium and heavy-duty vehicles
 - Airplanes and drones
- Airport ground equipment, Ports, Forklifts
- Steel and concrete production
- Biofuels and synthetic fuels



DOE's National Renewable Energy Laboratory
Consumption Potential Industrial and Transportation

DOE HYDROGEN HUB ROADMAP

A brief history and pathway forward



- 1921 Einstein Wins Nobel Prize for “Photoelectric Effect”
- 1954 Solar Photovoltaic Cell Invented
- 1960’s and 1970’s Solar PV for satellites \$100,000/kw
- 1970’s Exxon reduces Solar PV costs to \$20,000/kw
- DOE’s National Renewable Energy Lab research 1977
- 2023 approx \$2,000/kw

Hydrogen Production Cost
1 kg = 1 gal of gasoline

- Steam Methane Reforming: \$1-\$2+/kg
- SMR with Carbon Capture: \$3-\$4+/kg
- Electrolysis: \$6-\$8/kg
- Methane Pyrolysis: \$10+/kg



) Hydrogen

H2ALO.ORG

QUESTIONS AND ANSWERS
