Accelerating the Development of a Texas and Gulf Coast Clean Hydrogen Ecosystem

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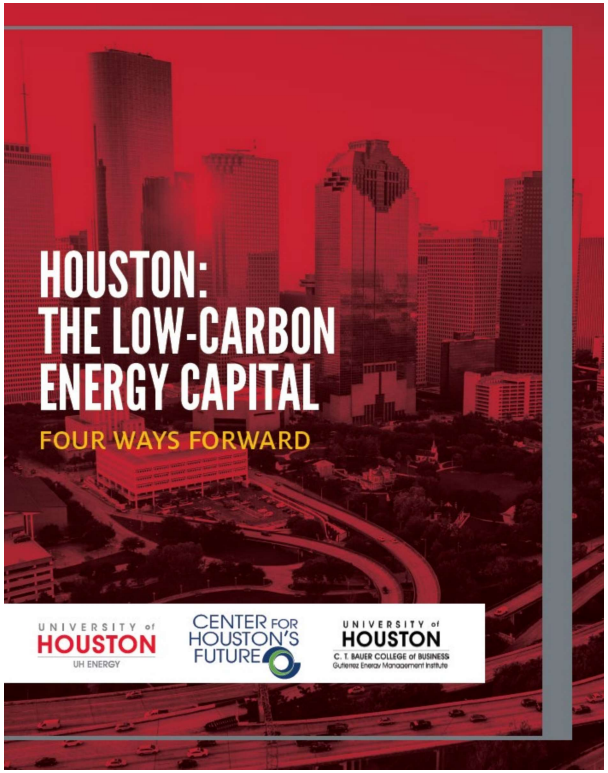
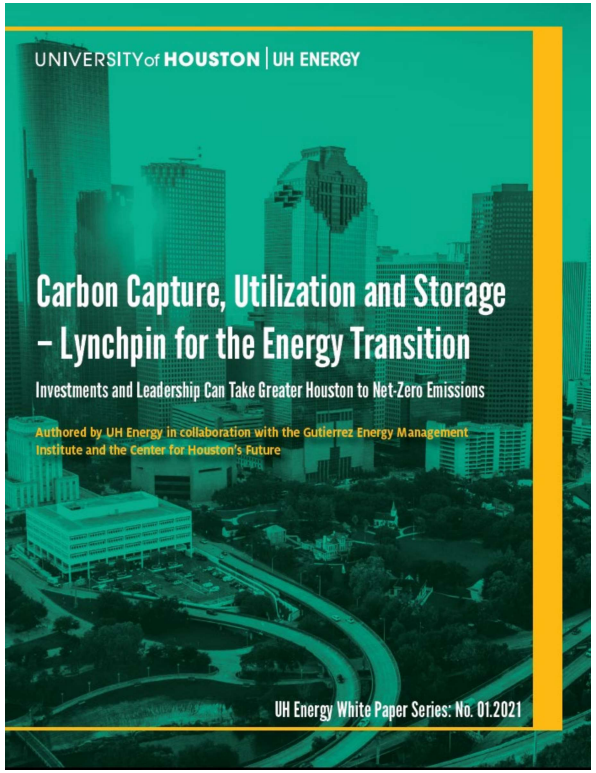
Center for Houston's Future

CHF and UH Collaboration on Low Carbon Energy





CENTER FOR HOUSTON'S FUTURE

Houston Region: Becoming a Global Hydrogen Hub

Hydrogen industry growth can drive diversification needed to sustain Houston's economic advantage.

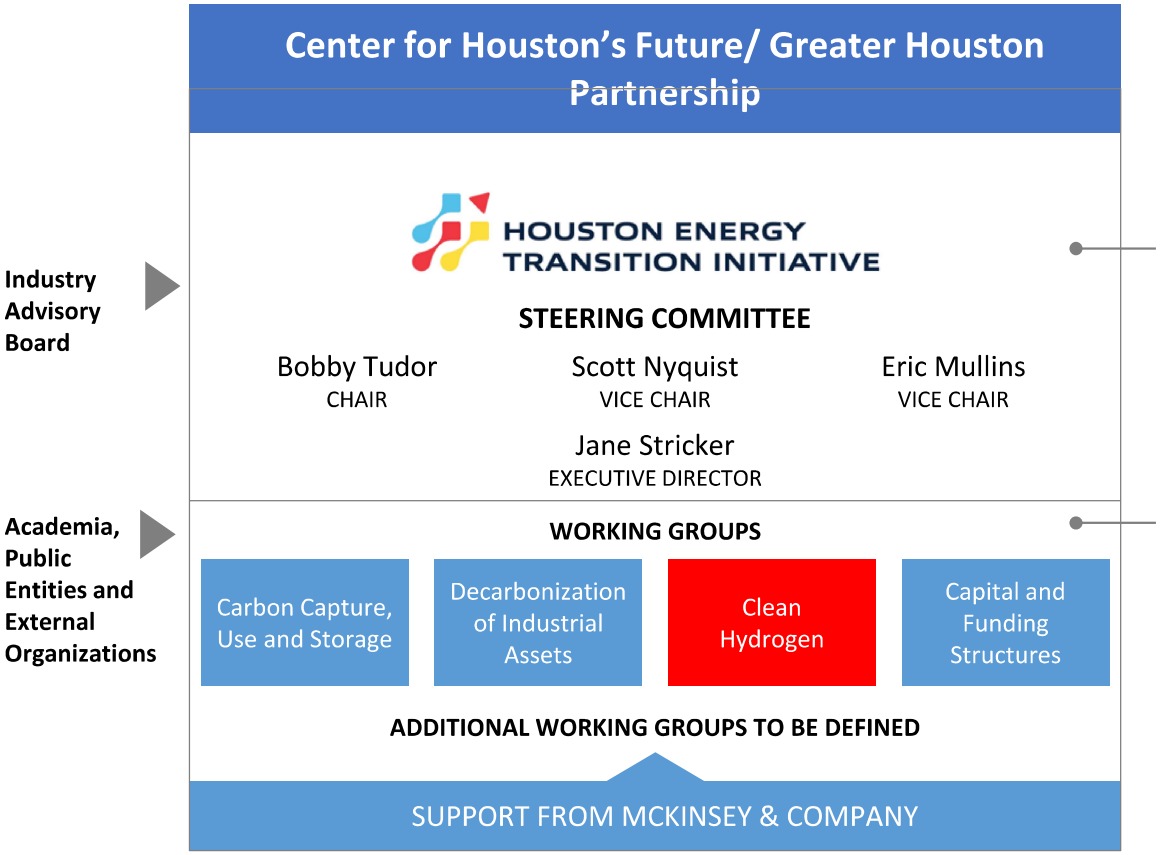
In 2019, the Center for Houston's Future (CHF) released an economic viability study that assessed Houston's long-term economic outlook given the close ties between the oil and gas (O&G) sector and the region's economic success.

The study found that Houston had outperformed economically versus peer cities, and that this growth was driven primarily by the O&G sector. Looking at the impact of the 2014 oil price crash, the study found that 80,000 O&G related jobs lost in the fallout of the 2014 oil price decline were:

- high-multiplier jobs, or jobs that spur additional economic activity in the region, resulting in higher economic impact than other jobs.
- not replaced with commensurate jobs once the region's job growth rebounded. (see Figures 1 and 2 below).

As a result, the study found that Houston's growth story had shifted: Houston's economy has since been growing slowing than peer cities as new jobs added after the oil price rebound had lower multipliers, whereby resulting in slower GDP growth. . Examples included temporary roles and construction jobs driven by Hurricane Harvey recovery, and hotel, restaurant and retail industry expansion resulting from the earlier high economic-growth period. As shown in Figures 1 and 2, the jobs lost during this time period had a 2.9x multiplier (meaning that they created 2.9x additional jobs) and the jobs gained had only a 1.66x multiplier.

Houston Energy Transition Initiative

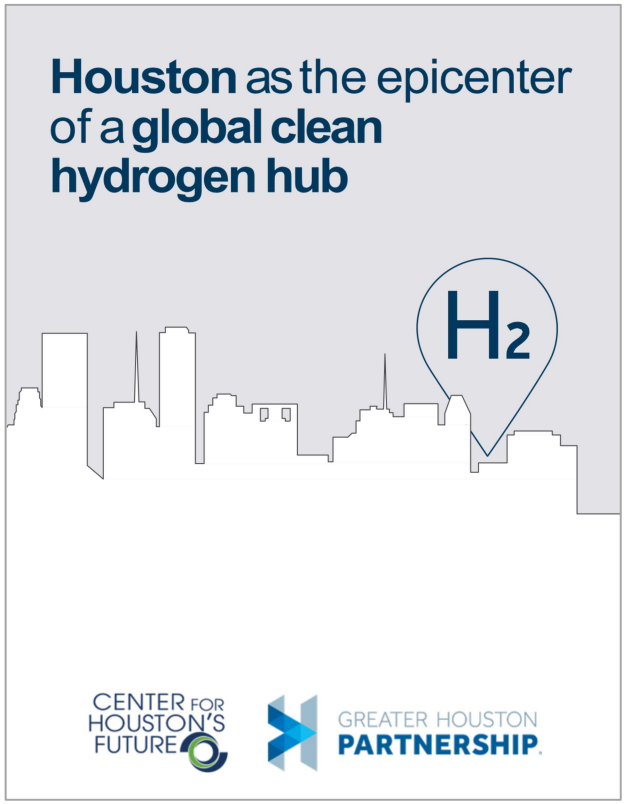


HETI STEERING COMMITTEE FOUNDING MEMBERS

- Baker Hughes
- Bechtel Energy
- BP
- Calpine
- CenterPoint Energy
- Chevron
- ConocoPhillips
- Dow
- ExxonMobil
- Hess
- LyondellBassell
- NRG Energy
- Oxy
- Plains All American Pipeline
- Schlumberger
- Shell
- Sunnova
- TC Energy
- Wood Group

2023 Hydrogen Steering Committee

Vision For Texas As A Hydrogen Hub – 2050 Snapshot



No.1 Global leader in hydrogen production, use, innovation, and talent development

21MT of clean hydrogen production in Texas, including 12MT local demand, 9MT export; 4% of global hydrogen production in 2050 (540MT)

170k potential direct, indirect, and induced jobs to be created in the hydrogen economy

$100b potential addition to Texas' GDP, i.e., 6% of Texas' 2019 GDP

220MT CO2 abatement potential from 21MT of hydrogen, i.e., 4x Houston's 2019 emissions

Sources: U.S. Bureau of Economic Analysis

Texas Enjoys Many Competitive Advantages for Clean Hydrogen Production

General

- Proximity to demand favorable to driving early adoption
- Welcoming environment for infrastructure development
- Existing hydrogen capacity and expertise
- Scale manufacturing
- Concentration of academic and industry-driven innovation
- Highly skilled workforce

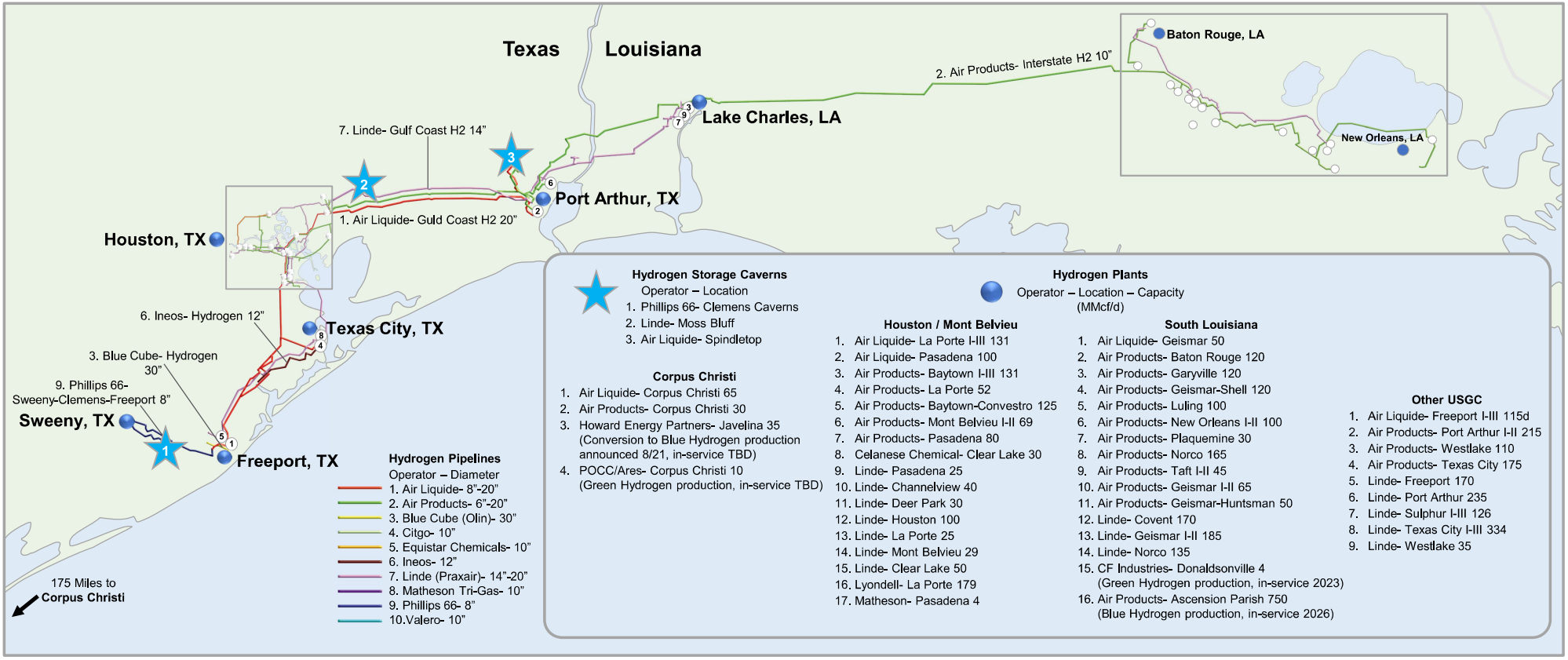
Production capacity & cost

- Access to low-cost renewable energy capacity
- Access to CO_2 storage locations
- Access to low-cost natural gas

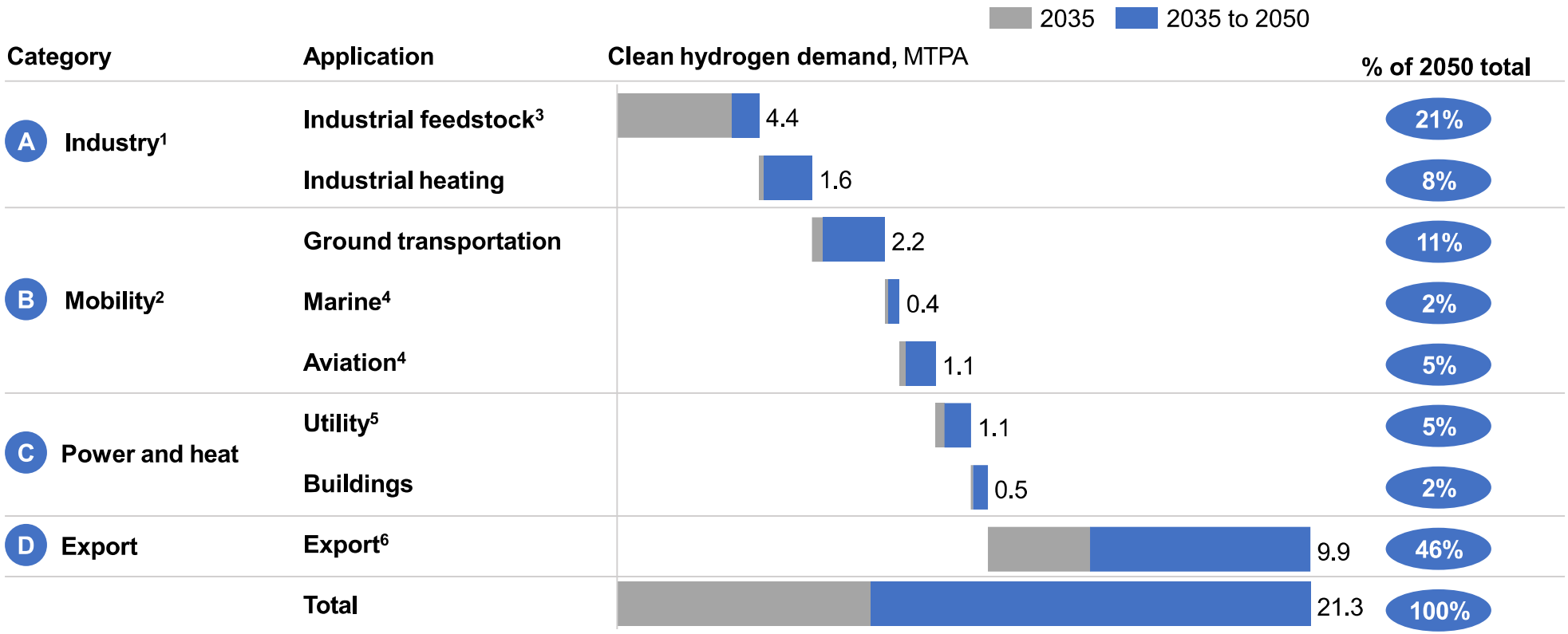
Transportation & storage

- Largest network of hydrogen pipelines in the US
- Access to geologic formations for seasonal storage

U.S. Gulf Coast Hydrogen Infrastructure
(>1000 P/L miles, >45 scale H2 plants, 3 H2 salt caverns)



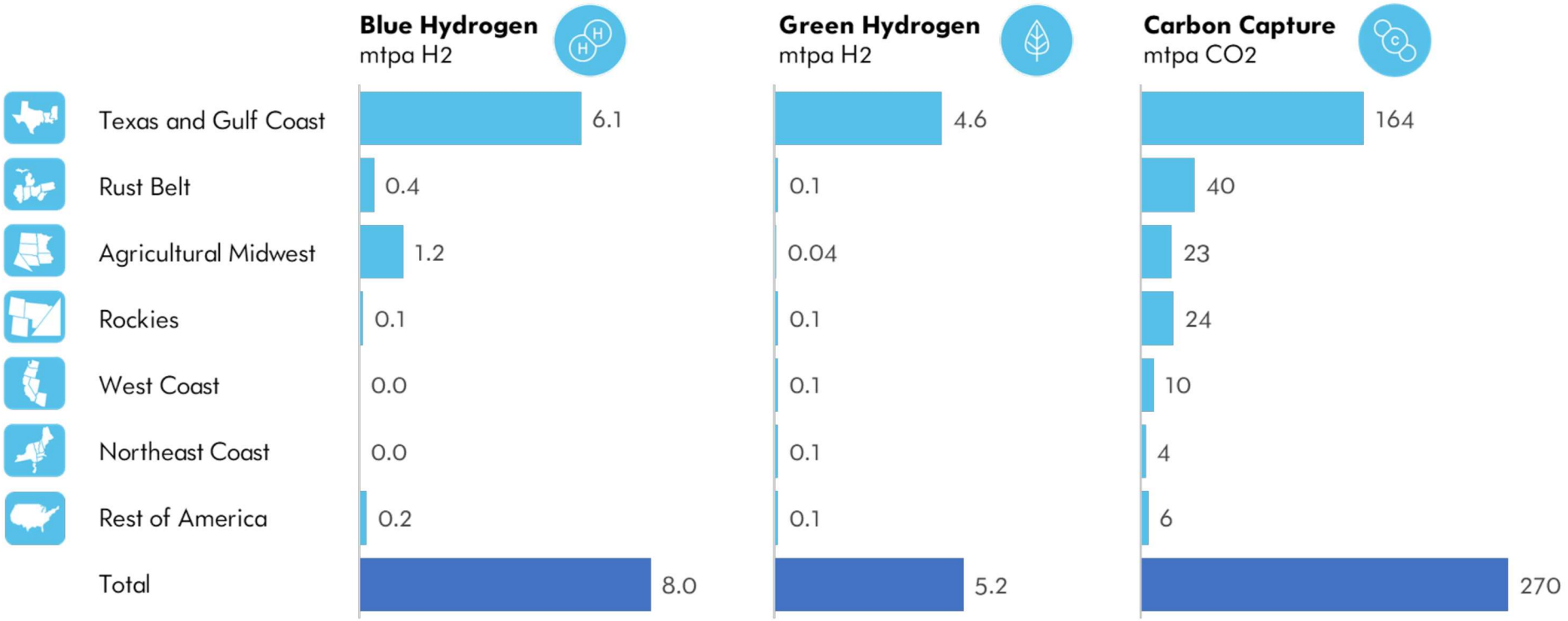
Industry and export could drive most of the demand that come online by 2035, with mobility and industrial heating to follow



1. Sizing includes Gulf Coast (Texas and Louisiana); 2. Sizing includes Texas; marine only includes Port of Houston; 3. Includes refining, petrochemicals, ammonia, iron, steel, and cement; 4. Includes synthetic fuels and hydrogen propulsion for Texas; 5. Includes natural gas power generation and energy storage; 6. Represents hydrogen and hydrogen-based fuels (e.g., for aviation and marine) produced in Texas and consumed elsewhere

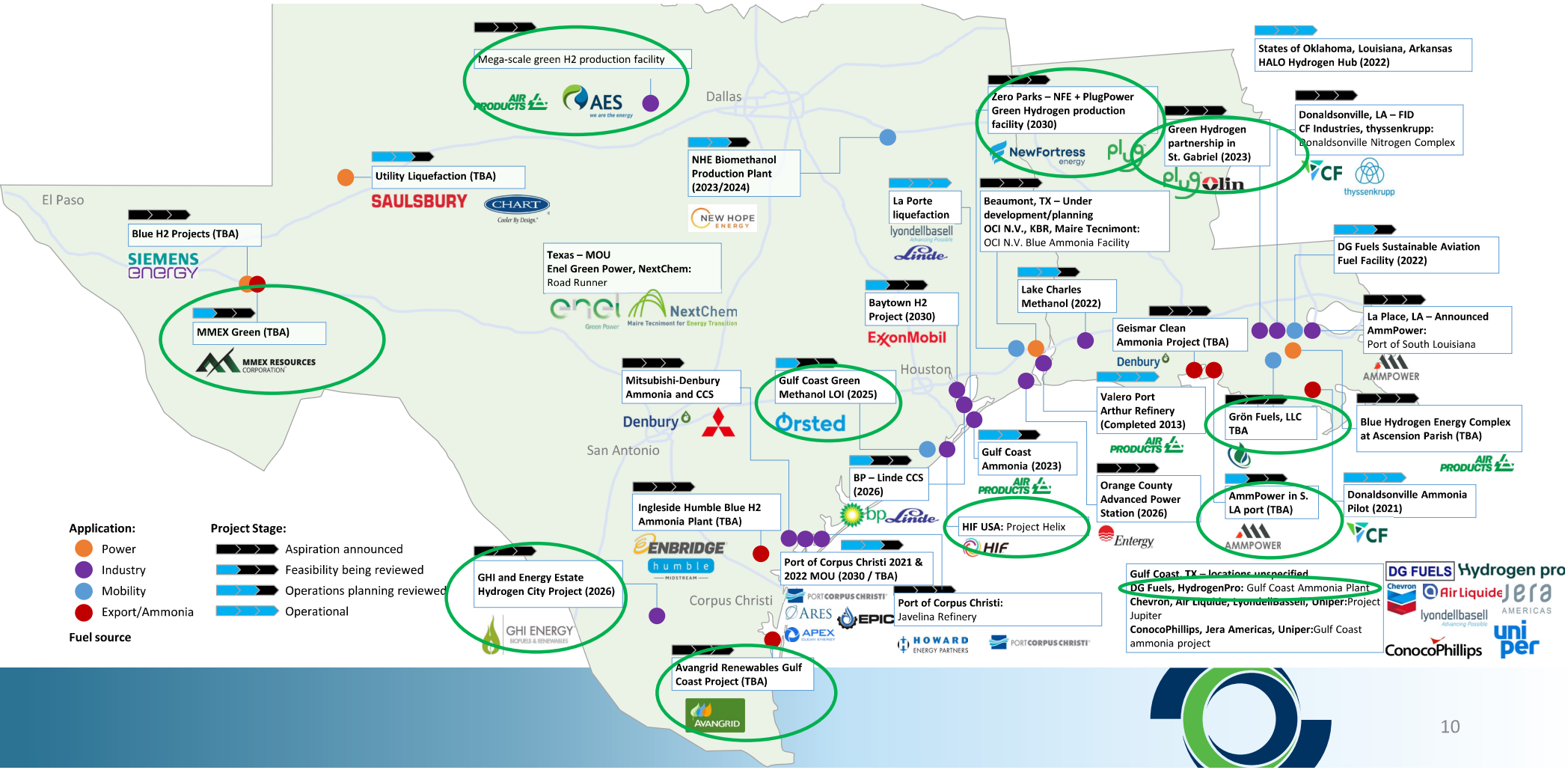
Texas and The Gulf Coast Are Expecting Substantial Investment Across Hydrogen and Carbon Capture

Announced project capacities by region[1]

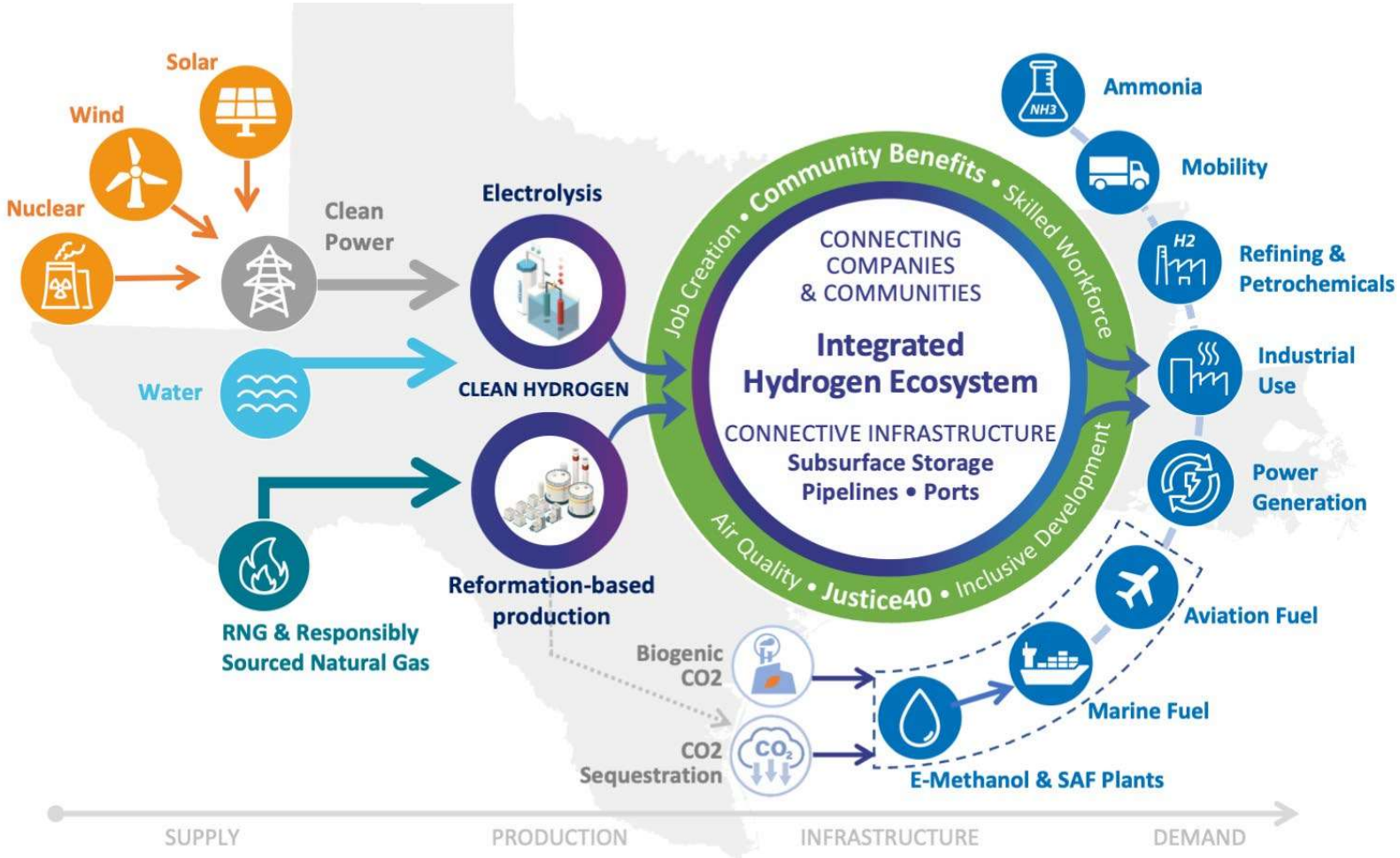


1. As of 01/2024. Source: McKinsey hydrogen project tracker, Clean Air Task Force

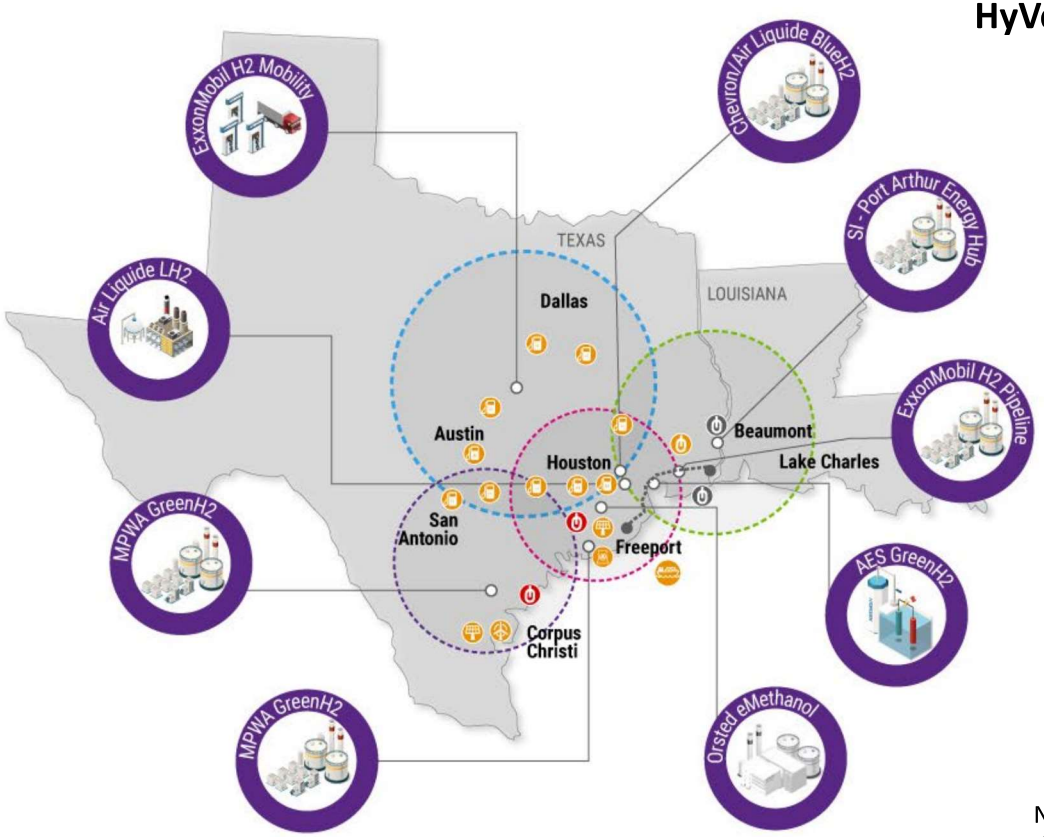
Announced Clean Hydrogen Projects in Texas and Louisiana



An Integrated Regional Clean Hydrogen Ecosystem



HyVelocity Envisioned Projects



HyVelocity Clean H2 Production Capacity: >5,000 mtpd

Corpus Christi Demand Cluster
Houston Demand Cluster
BPA-Lake Charles Demand Cluster
TX Triangle Demand Cluster

HYVELOCITY HUB > INTEGRATED INFRASTRUCTURE

- Solar Farms
- Wind Farms
- CO2 Storage Cavern
- Maritime
- H2 Fueling Stations
- Nuclear
- H2 Storage Cavern
- Future H2 Pipelines
- Future H2 Storage Cavern
- HyVelocity Infrastructure Elements

Note: Map shows general preliminary project locations and are subject to change during future negotiations and site planning

Hydrogen Ecosystem Development Projects

Hydrogen Sector Development: Focus on transportation as the next opportunity in sector development (statewide hydrogen fuel cell vehicle transportation infrastructure plan and opportunities for hydrogen deployment at ports and airports).

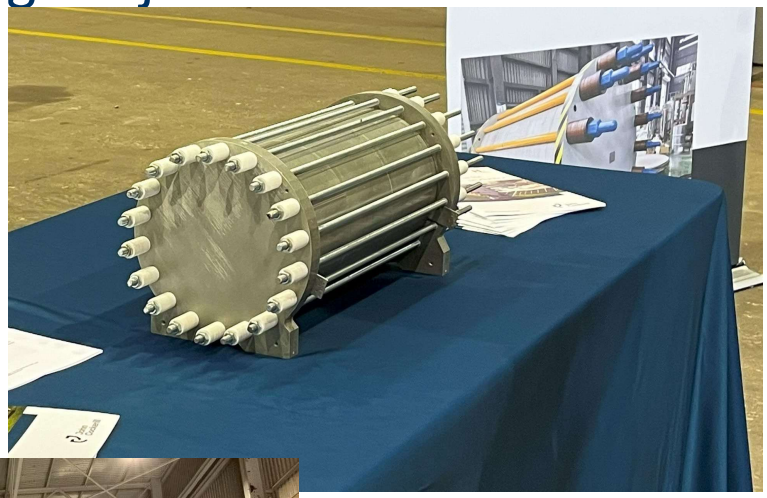
Manufacturing Cluster Development: Work with local energy manufacturing companies and new market entrants to make Houston an electrolyzer manufacturing cluster.

International Trade: Create bi-lateral relationships with European and Japanese counterparts to further development of international trade in hydrogen

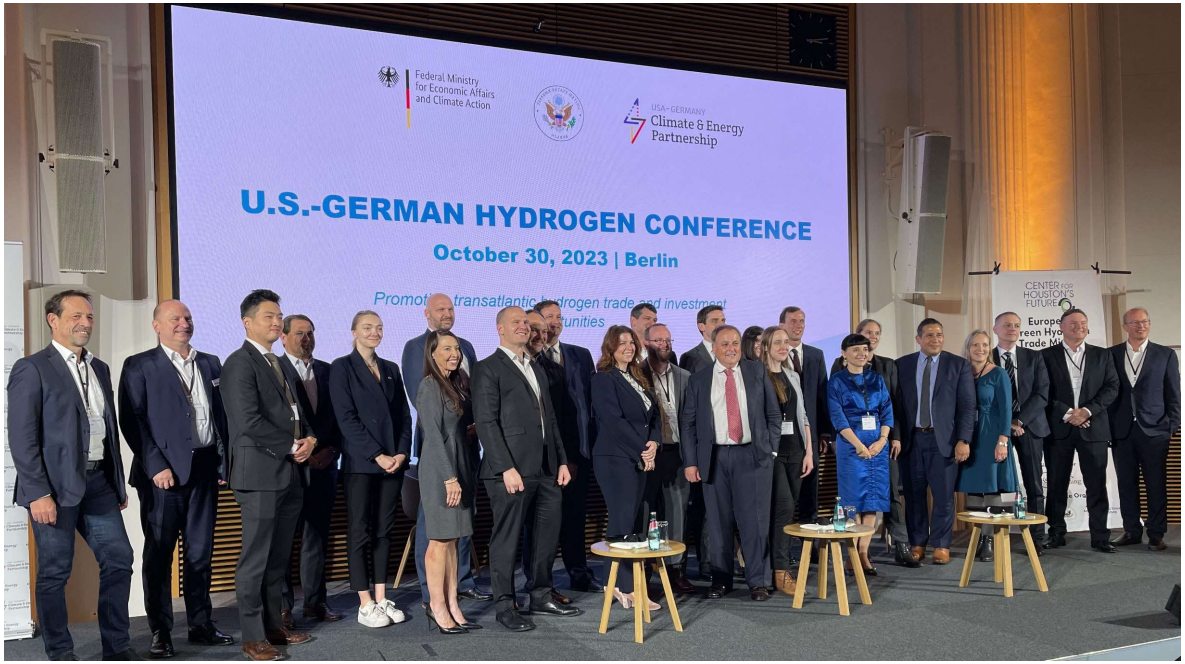
Marketplace Development: Partner with leading organizations to develop open-source carbon intensity measurements and to facilitate transparent, liquid markets in clean hydrogen

Demand Creation: Explore opportunities to create consortia to clarify and aggregate demand

Building the regional clean hydrogen ecosystem: Belgium MOU Signing and Ribbon Cutting for Clean Hydrogen Manufacturing Project



US-German Hydrogen Conference: Promoting trade and investment opportunities in hydrogen and related technologies



Participating Companies

- Baker Hughes
- Bloom Energy
- bp
- ExxonMobil
- First Ammonia
- HIF Global
- NextEra Energy
- Pattern Energy
- Sempra Infrastructure
- Técnicas Reunidas
- TES America
- Uniper
- Woodside Energy