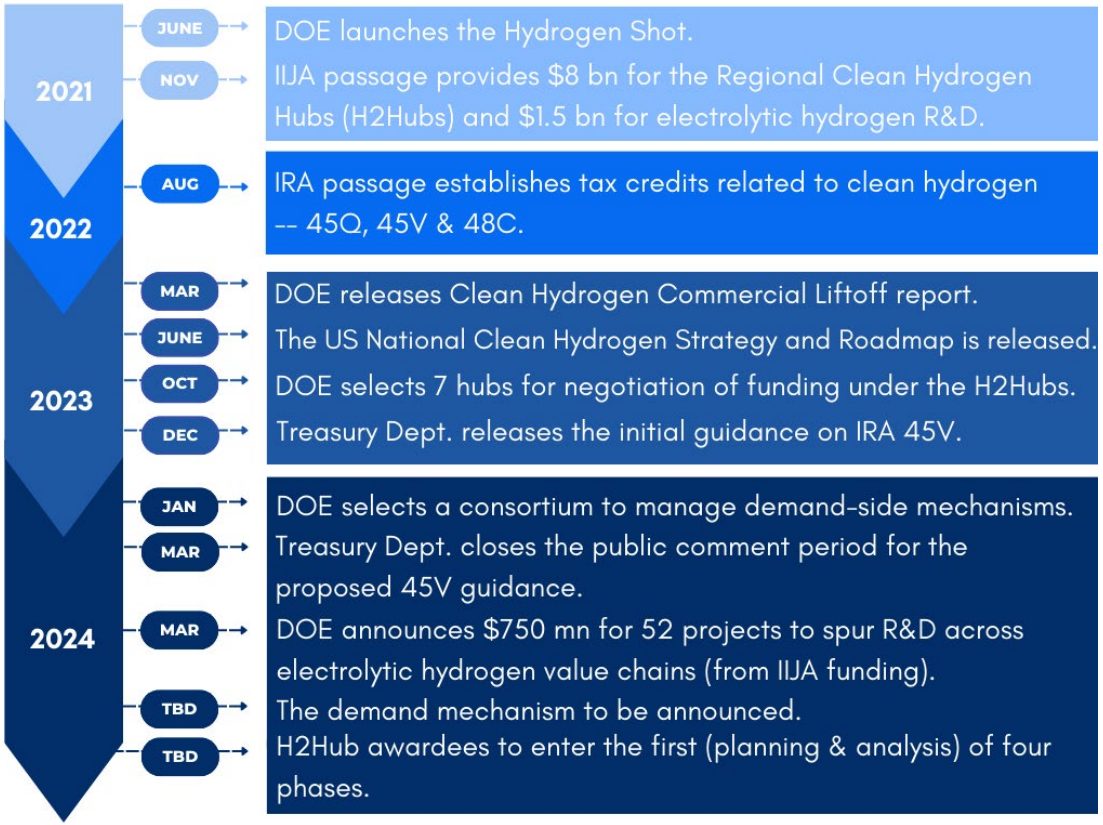
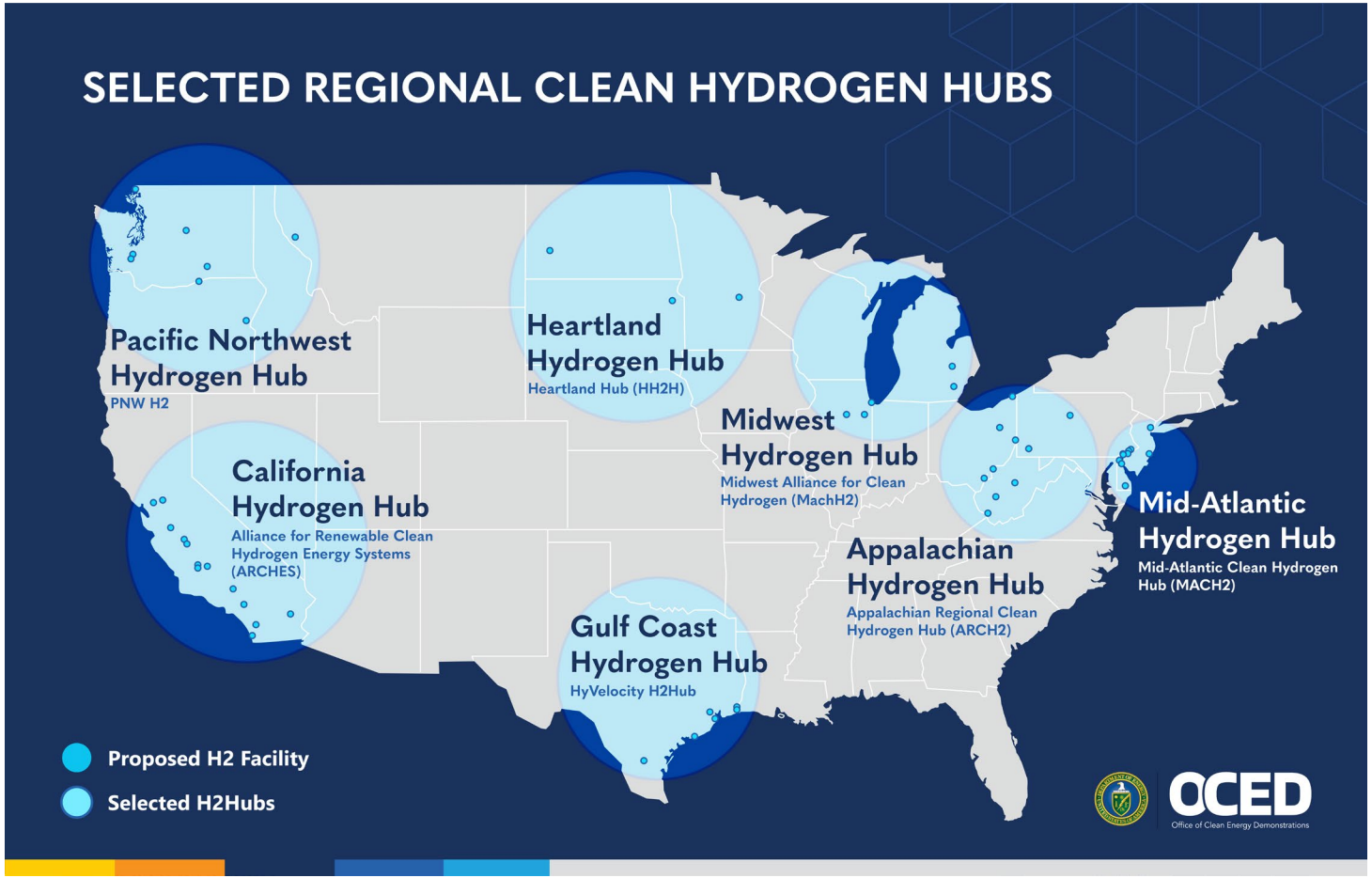
April 2024

Evaluating the U.S. Role in Clean Hydrogen Adoption in Indo-Pacific

CSIS | CENTER FOR STRATEGIC & INTERNATIONAL STUDIES

Key U.S. Policy and Program Developments & Export Consideration




SELECTED REGIONAL CLEAN HYDROGEN HUBS
Pacific Northwest Hydrogen Hub
PNW H2
Heartland Hydrogen Hub
Heartland Hub (HH2H)
Midwest Hydrogen Hub
Midwest Alliance for Clean Hydrogen (MachH2)
Mid-Atlantic Hydrogen Hub
Mid-Atlantic Clean Hydrogen Hub (MACH2)
California Hydrogen Hub
Alliance for Renewable Clean Hydrogen Energy Systems (ARCHES)
Appalachian Hydrogen Hub
Appalachian Regional Clean Hydrogen Hub (ARCH2)
Gulf Coast Hydrogen Hub
HyVelocity H2Hub
Proposed H2 Facility
Selected H2Hubs
OCED
Office of Clean Energy Demonstrations

Hydrogen Plans by Key Indo-Pacific Economies

	Nat'l strategy/plan	H2 consumption target (vol, %, years)	Electrolyser install capacity: current vs. target (year)	"Clean hydrogen" definition	Global H2 use by vol. and % (2020)
China	Medium-and long-term Plan for the Development of the Hydrogen Industry, 2021-2035 (Mar 2022)	Produce ~200,000 tons/yr of RE hydrogen by 2025.	200 MW~ in 2022; 120 GW by 2030	N/A	23.9 mmt/y; 20%
India	National Green Hydrogen Mission (Jan 2023)	Produce 5 mmt/yr of RE hydrogen by 2030	N/A today; est. ~12 GW by 2030	N/A	7.2 mmt/y; 6%
Indonesia	National Hydrogen Strategy (Dec 2023)	Use RE hydrogen in the transportation sector from 2031, and in the industrial sector from 2041.	N/A today; N/A target	N/A	1.5 mmt/y; 1.25%
Japan	Basic Hydrogen Strategy (rev. June 2023)	Produce 3 mmt/yr by 2030, 12 mmt/yr by 2040, and 20 mmt/yr by 2050.	N/A today; 15GW in 2030	3.4kgCO2e/kgH2	1.7 mmt/y; 1.42%
Korea	Hydrogen Economy Roadmap 2040 (2019)	Provide 3.9 mmt/yr in 2030 (incl. 750,000 t/yr from CO2 abated NG, 250,000 t/yr from RE, 1.96 mmt/yr of RE hydrogen import). Provide 27.9 mmt/yr by 2050 (3 mmt/yr from RE, 2 mmt/yr from CO2 abated NG, 22.9 mmt/yr of RE hydrogen import).	N/A today; N/A target.	4.0kgCO2e/kgH2	1.3mmt/y; 1.08%
Philippines	A policy framework for the integration of "green hydrogen" in the national energy mix is forthcoming.	N/A	N/A today; N/A target.	N/A	N/A
Singapore	National Hydrogen Strategy (Oct 2022)	Supply ~50% of electricity demand by 2050.	N/A today; N/A target	N/A	N/A
Thailand	National Power Development Plan (2023-2037) includes hydrogen fuel.	RE hydrogen is projected to become available for commercial use by 2030.	N/A today; N/A target	N/A	N/A
Viet Nam	National Green Growth Strategy for 2021-2030 includes a strategy to encourage hydrogen development (Oct 2021). A hydrogen strategy is reportedly under development.	Produce 100,000-500,000 tons/yr by 2030, and 10–20 mmt/yr by 2050.	N/A today; N/A target	N/A	500,000 tons/y; 0.33%

Potential U.S. Roles...

- Exporter of hydrogen molecules?
- Supplier of electrolyzer components?
- Shaper of hydrogen contractual features (e.g., price indexation)?
- Intermediaries and aggregators over in a far future?

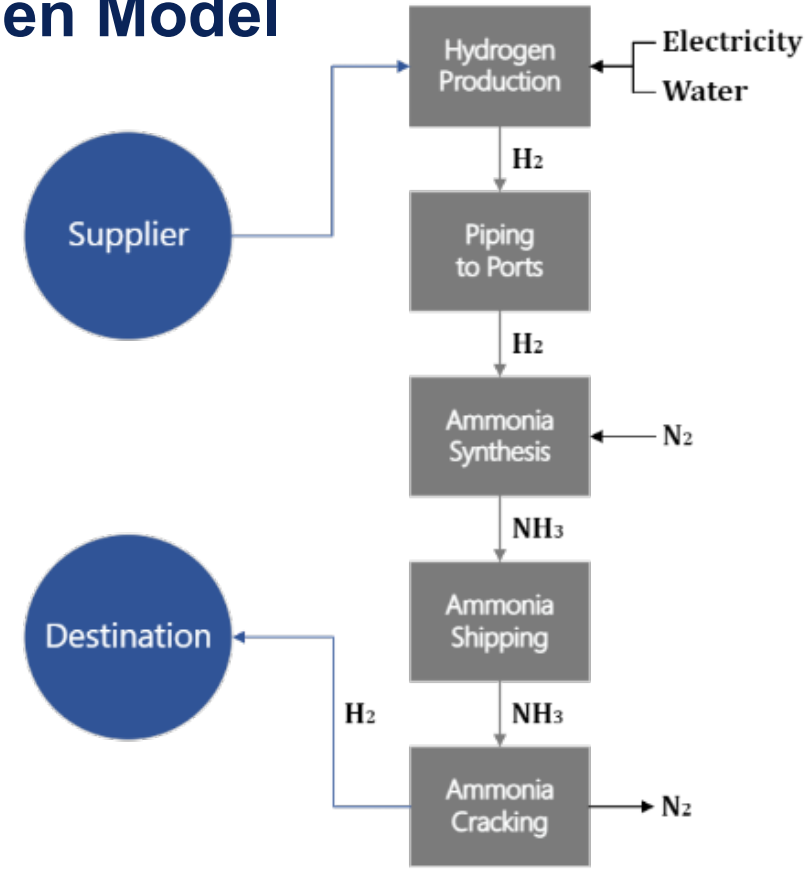
CSIS Hydrogen Model

Model Development

- Evaluate options for global hydrogen trade.
- Compute renewable hydrogen production costs.
- Add cost of hydrogen delivery.

Publication Status

- Production Model Paper (Submitted)
- CSIS Report (May/June Release)
- Transport Model Paper (In Development)



Total Cost of Renewable Hydrogen Delivery

Values in US$ per kilogram of hydrogen ($/kg H2)		Destinations			
		Japan	Korea	Singapore	Thailand
Suppliers	Australia	$4.41~$7.11	$4.42~$7.13	$4.40~$7.09	$4.43~$7.14
	Chile	$4.35~$7.65	$4.37~$7.68	$4.38~$7.69	$4.43~$7.84
	U.S. Gulf Coast (S)	$4.81~$7.85	$4.82~$7.88	$4.92~$8.02	$4.93~$8.05
	U.S. Gulf Coast (P)	$4.99~$8.22	$4.97~$8.19	$4.89~$8.00	$4.95~$8.70
	U.S. West Coast	$4.53~$8.34	$4.54~$8.37	$4.68~$8.69	$4.69~$8.70

*Accounts for costs of hydrogen production, hydrogen piping to ports, ammonia synthesis, ammonia shipping, and reconversion into hydrogen at destination. .

Appendix: Total Delivery Cost Input Parameters

- [illegible] - $0.60/kg H2 for piping of hydrogen to ports; electricity cost of $120/MWh; $800 per ton of MGO; project discount rate of 8%; 25-year project lifetime. Shipping distance differs by supplier/destination combination.
- [illegible] - MGO shipping fuel scenario; 500,000 tons of H2 delivered; supplier-specific low-cost of hydrogen production; ammonia boil-off rate of 0.025%.
- [illegible] - LNH3 shipping fuel scenario; 100,000 tons of H2 delivered; supplier-specific high-cost of hydrogen production; no ammonia boil-off (consumed as fuel instead).