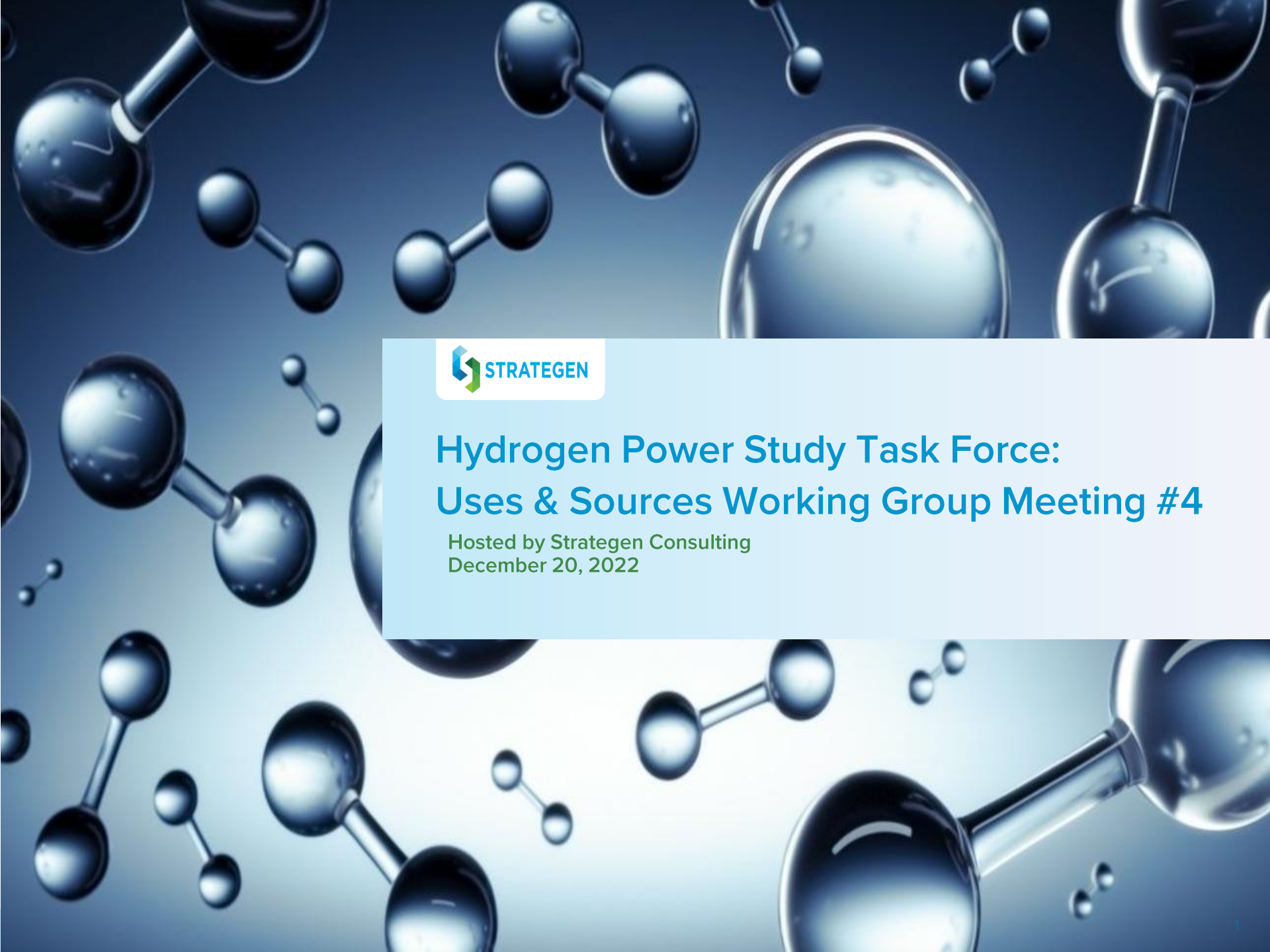


Hydrogen Power Study Task Force: Uses & Sources Working Group Meeting #4

Hosted by Strategen Consulting
December 20, 2022

Meeting Logistics

- Mute Microphone – in order to prevent background noise that disturbs the meeting, if you aren't talking, please mute your microphone or phone.

- Chat Box – if you aren't being heard, please use the chat box or raise your hand to ask a question. Please try to limit comments in the chat as these may not be officially captured in the record.

- Recording Meeting – we will record and post the meetings at www.ctgreenbank.com/hydrogentaskforce and you can also access meeting dates and dial-in information through Secretary of State.

- State Your Name – for those talking, please state your name for the record.

Agenda

- Welcome and Introductions – 10 minutes
- Review of Working Group Deliverables – 5 minutes
- Review Key Findings – 20 minutes
- Discuss Draft Recommendations – 50 minutes
- Next Steps – 5 minutes

Introductions

Please share your name, title, and organization

Working Group Deliverables

Review of Initial Charters and Developments

Sources Working Group Deliverables Review

+ Proposed definition of clean hydrogen (in collaboration with the Policy and Workforce Development Working Group). Reviewed best practices, included in recommendations to DEEP.
+ Total production potential of clean hydrogen within Connecticut, developed across at least 3 scenarios (e.g. High, Medium, Low).
+ Impact on local manufacturing potential and industry in each of the hydrogen production scenarios identified above (in collaboration with the Policy and Workforce Development Working Group). Primarily addressed in P&WD WG
+ (If not addressed by other state agencies) Comparison of Connecticut's hydrogen production potential to other Northeast states in the Regional Clean Hydrogen Hub (e.g. NJ, NY, MA). To be addressed by DEEP.
+ Scenario-based production curves for clean hydrogen, identifying the amount of hydrogen that could be produced at different price points based on cost of underlying energy feedstocks.

Uses Working Group Deliverables Review

+ Structured framework to prioritize hydrogen end use applications relevant for Connecticut.
+ Total demand size of priority hydrogen end uses identified through the framework, developed across at least 3 scenarios (e.g. High, Medium, Low). Scenario condition achieved in sectoral breakdown of estimated hydrogen demand.
+ Scenario-based demand curves for each hydrogen end use, identifying price points at which hydrogen would become competitive for different end uses and expected demand at those price points.
+ As appropriate, coordination with DEEP's efforts to develop project concepts for clean hydrogen use in a Regional Clean Hydrogen Hub that would be accepted by stakeholders as a regional proposal. Not required at this time.

Key Findings

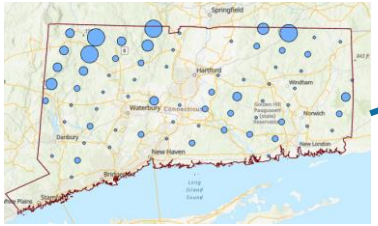
Review and Updated Results

Hydrogen Prioritization Framework

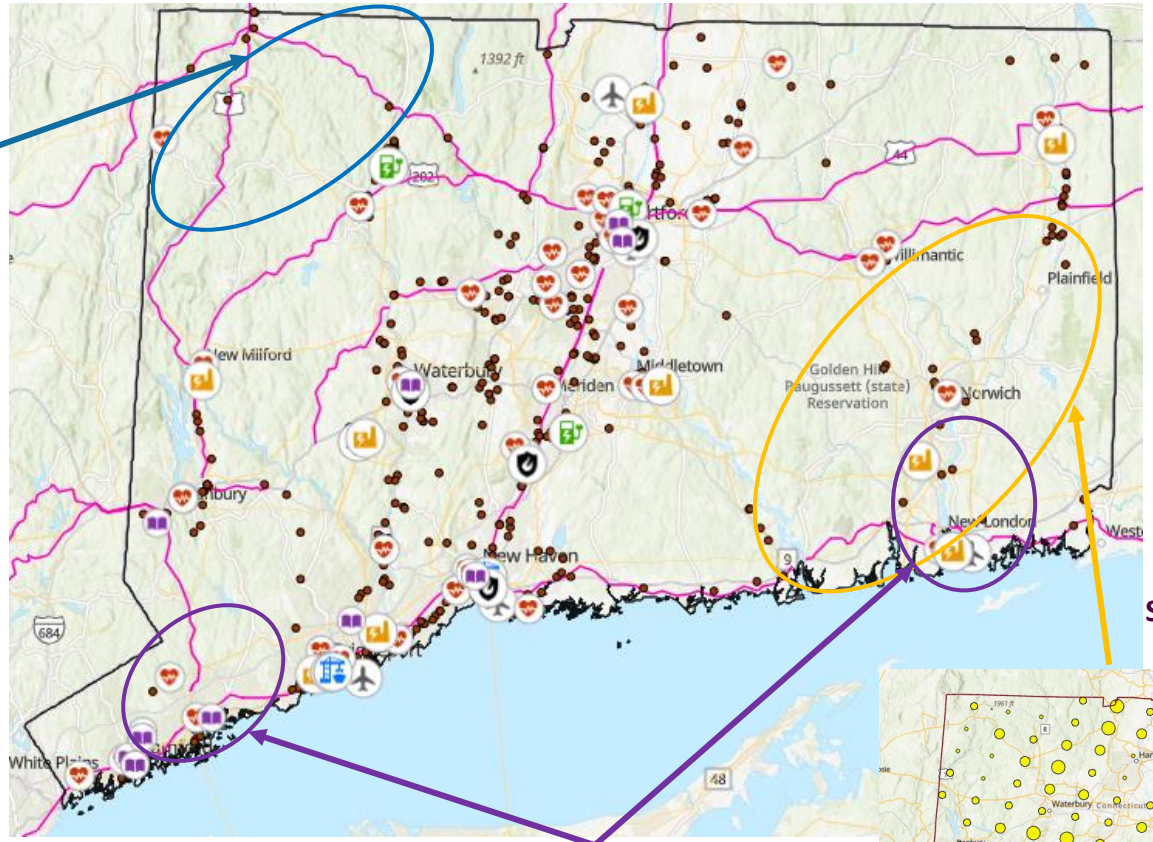
Highest Priority for Additional Investigation	High Priority for Additional Investigation	Other Potentially Valuable Applications
+ Critical facilities (24-hour backup need) + Aviation (long- and medium-haul) + Cargo ships + Material handling equipment with long uptimes and charging space constraints + Long-haul heavy duty trucks + Fuel cells for peak power generation + High heat industrial processes	+ Long-distance buses + Ferries + Freight rail + Fleet vehicles with long uptimes and specific refueling locations + Heavy duty vehicles with charging constraints (e.g. drayage trucks, some commuter buses) + Hydrogen blending for non-core customer (i.e. power generation and industrial heat)	+ Hydrogen blending for core customers (e.g. commercial and residential) + Buses and other heavy-duty vehicles with shorter driving ranges and no charging constraints + Privately-owned light-duty vehicles + Low heat industrial processes + Short-haul aviation
End uses that have high potential to drive demand over long term due to scale and/or underlying economics **Included in demand analysis**	Smaller-scale end uses that can provide first-mover projects and/or be integrated into larger hydrogen hubs **Not included in demand analysis**	End uses that can be kept "in view" as economics for at-scale hydrogen delivery change over time **Not included in demand analysis**

Locations of Hydrogen Production and Offtake Opportunities

Wind Production Potential



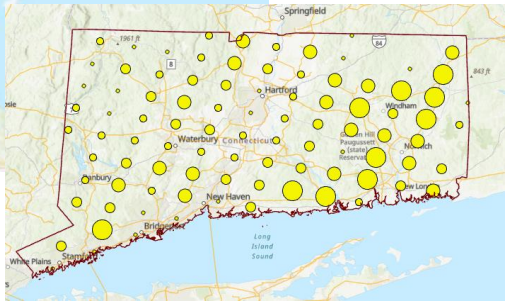
Potential Hydrogen Offtaker Locations



Offtaker Key

- Fuel Station
- Major Port
- Peaker Plant
- Power Plant LF
- Hospitals
- Major Highways
- Airports
- Electric Transmission
- High Heat Manufacturing

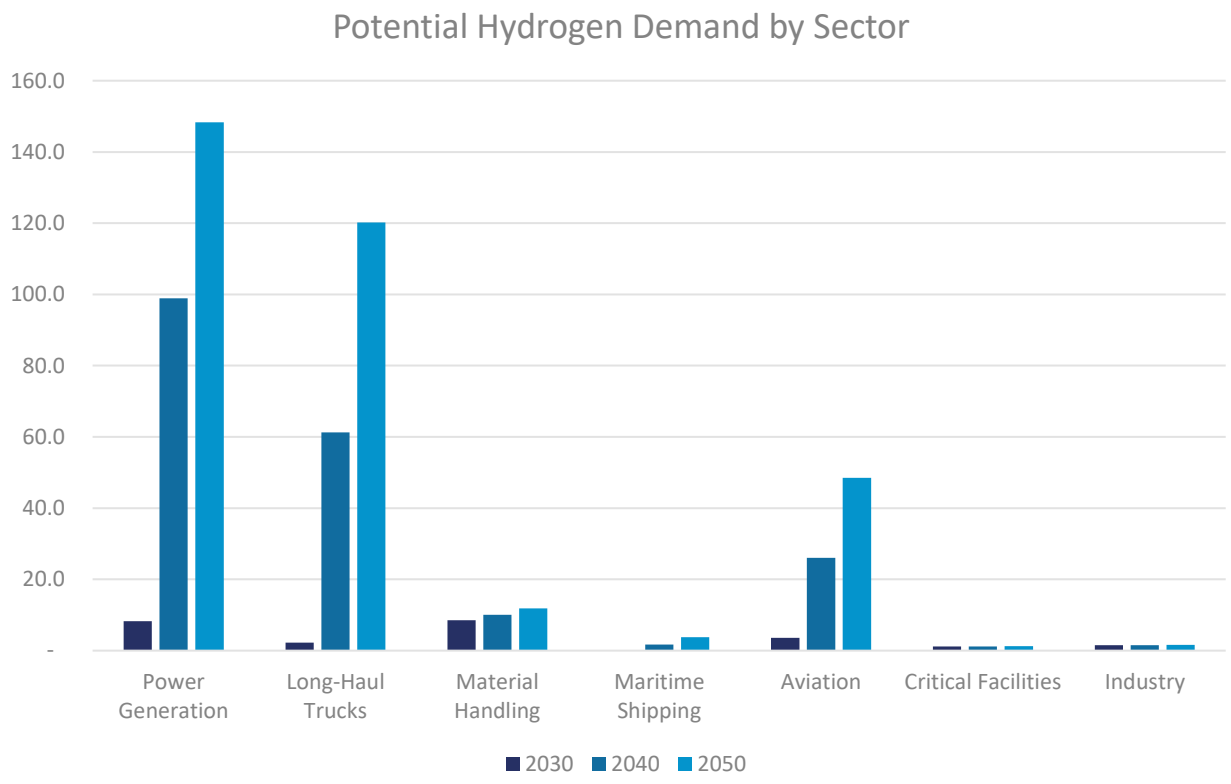
Solar Production Potential



Potential Offshore Wind Interconnection Points

Updated Demand Estimates for Connecticut

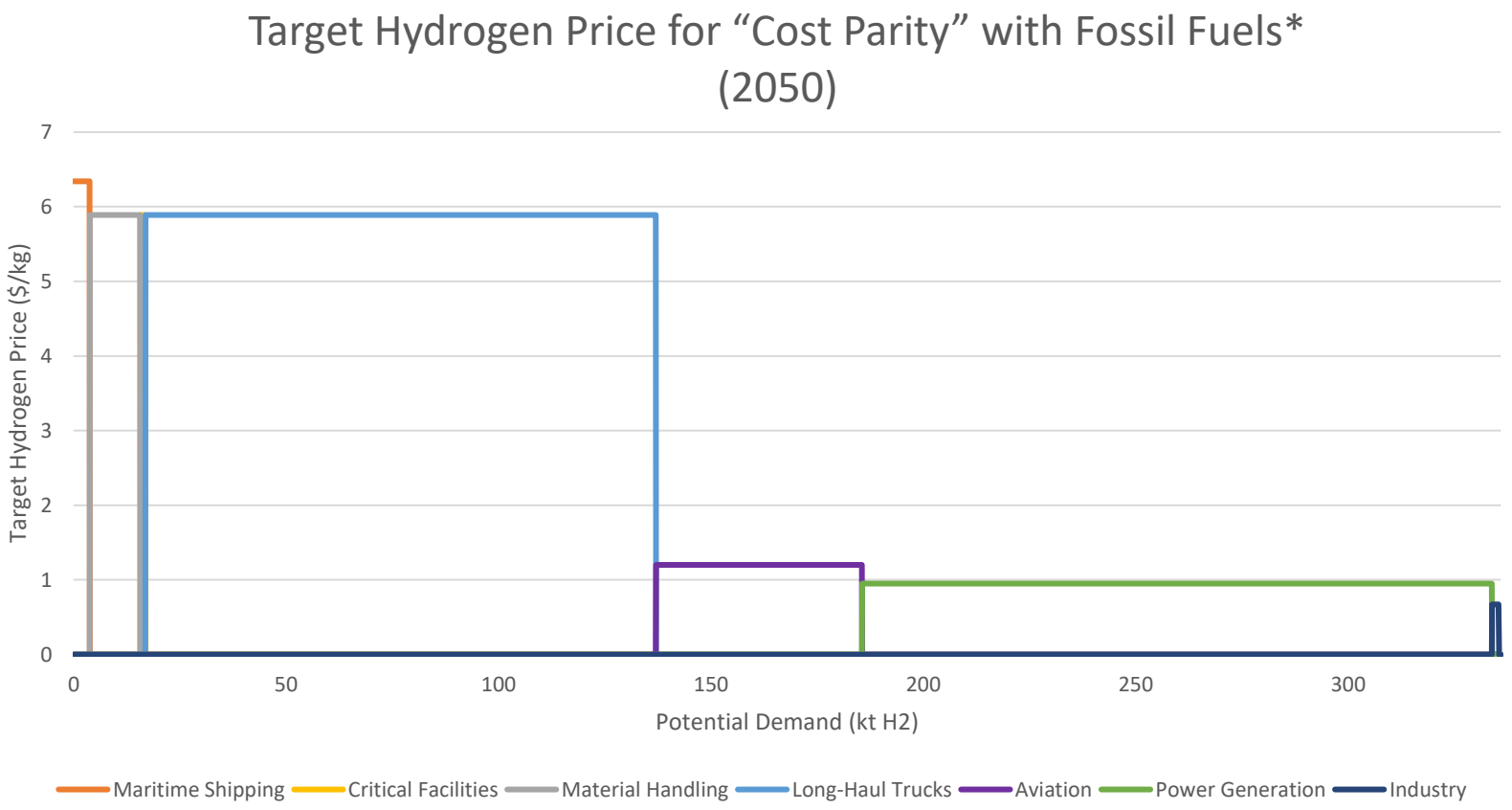
Full transition could add an additional 12.8 GW of fuel cell manufacturing need, primarily for use in power generation and long-haul trucking



Year	Total Demand (kt/year)
2030	25.2
2040	200.5
2050	335.5

Adjustments made to long-haul trucking, maritime shipping, and aviation demand estimates due to conversations with industry stakeholders and updates to data sources and scenarios

Hydrogen Demand Curve



*Based on cost of energy content and relative equipment efficiencies. Does not include capital costs of equipment.

Hydrogen Supply Scenarios

Low Case

- Most limited siting restrictions for solar and onshore wind
- Only fixed-bottom offshore wind
- Low supply potential for biogas
- Low nuclear energy availability for H2 production
- Curtailment forecasts in line with ISO-NE Pathways Study (Status Quo scenario)

Mid Case

- Medium-level siting restrictions for solar and onshore wind
- Only fixed-bottom offshore wind
- High supply potential for biogas
- Medium nuclear energy availability for H2 production
- Curtailment forecasts in line with ISO-NE Pathways Study (Status Quo scenario)

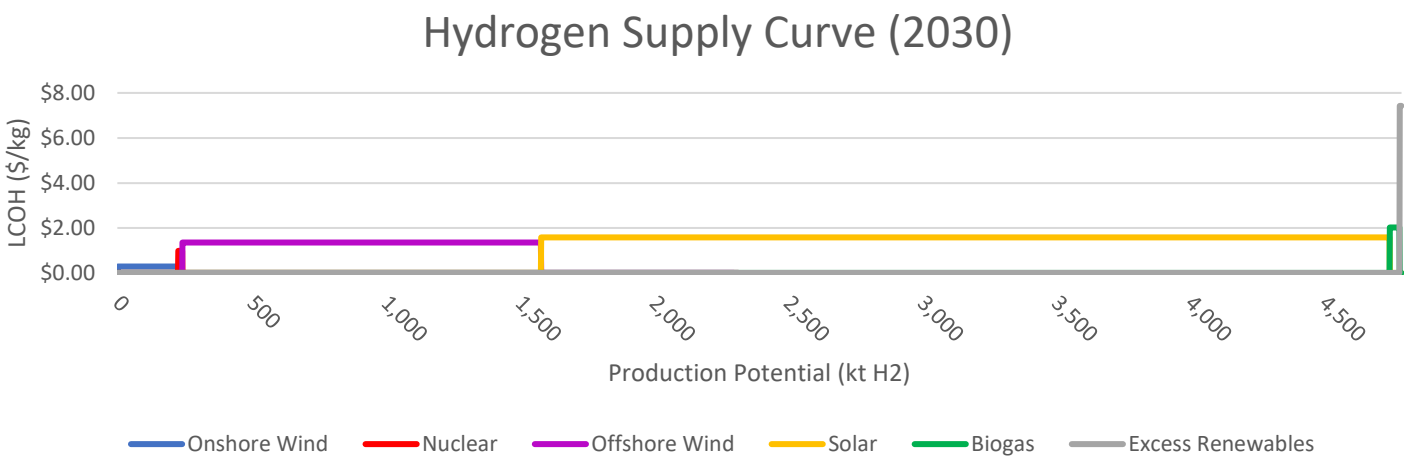
High Case

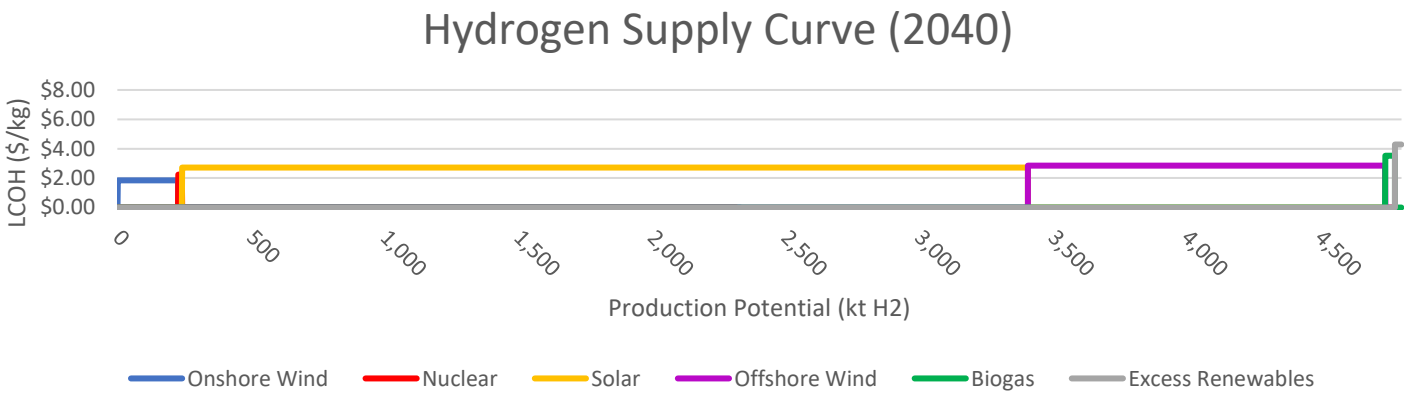
- Medium-level siting restrictions for solar and onshore wind
- Fixed-bottom and floating offshore wind
- High supply potential for biogas
- High nuclear energy availability for H2 production
- Curtailment forecasts in line with ISO-NE Pathways Study (Status Quo scenario)

All scenarios assumed enough renewable energy was first allocated to meet CT's general decarbonization targets*

*Based on DEEP Decarbonization Pathway IRP, Electrification Millstone Extension Scenario (as used in ISO-NE Pathways Study)

Hydrogen Supply Curve (Mid Production Case)



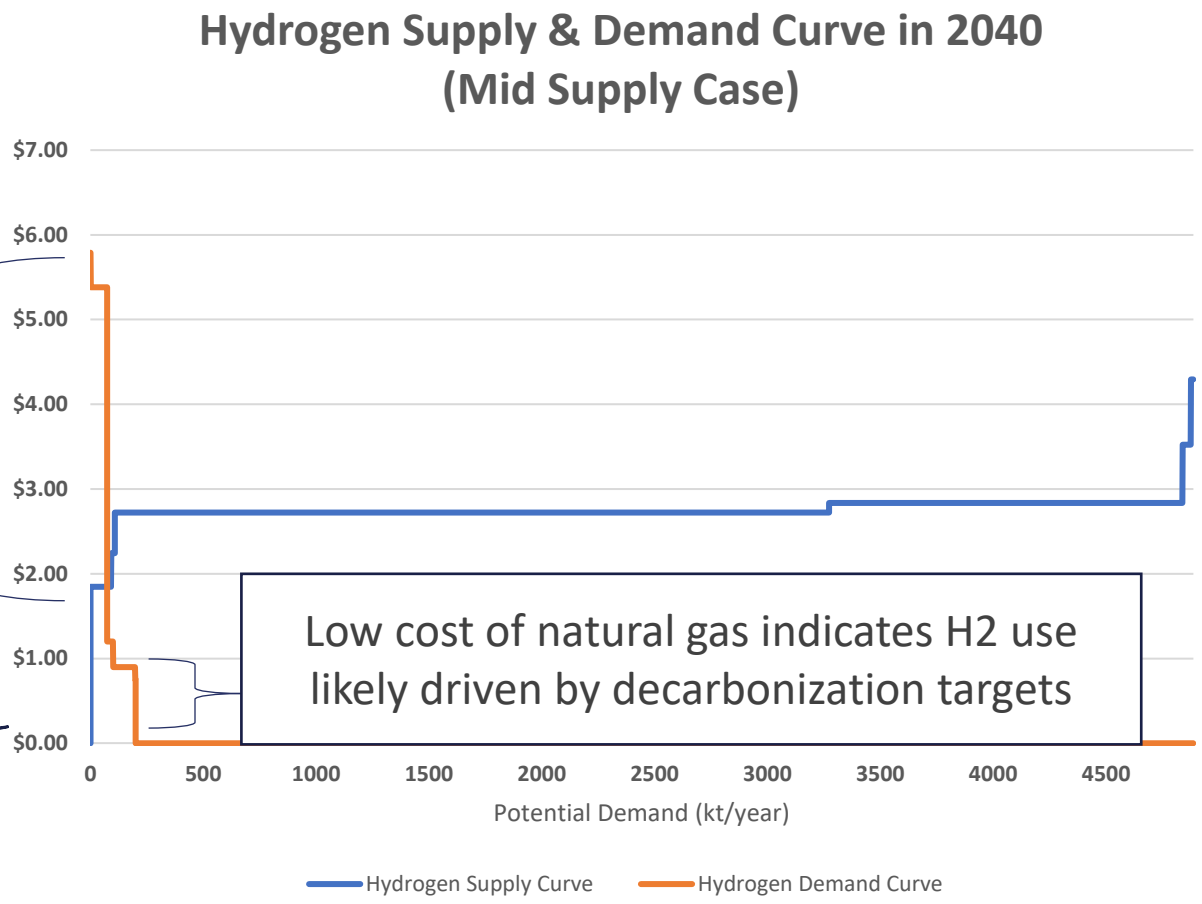


Lower costs in 2030 due to IRA tax credits

Note: LCOH represents price at point of production and does not include cost of hydrogen infrastructure (e.g. pipelines, compressors, storage). Estimates assume hydrogen producers meet labor requirements needed to receive full production tax credit under the IRA

Hydrogen Supply & Demand Comparison

Cost gap between H2 production cost and price parity point with diesel/bunker fuel



Low cost of natural gas indicates H2 use likely driven by decarbonization targets

Y-Axis
Blue line: LCOH at point of production
Orange line: H2 price parity point

Clean Hydrogen Definition Best Practices

From complexity
(hydrogen colors)

To one indicator based on CI
(e.g., kgCO2e/kgH2, gCO2e/MJ…)

- A carbon intensity framework is a technology-neutral approach to assessing the GHGs associated with hydrogen production. It opens the debate about competition between various hydrogen production routes that meet the required carbon intensity at the least cost.
- A carbon intensity framework can adopt a threshold and certification scheme to rigorously account for GHGs arising both at the site of production and upstream of production.

Key Considerations for a Carbon Intensity-Based Definition

- Is it based on a quantifiable methodology?
- What is the hydrogen production CO2e threshold?
- Does it consider the lifecycle impacts?
- Does it support technology-neutrality?
- How will it be certified?

Federal guidance from the proposed Clean Hydrogen Production Standard has established "clean hydrogen" as that with less than 4 kg of CO2e/kg H2 on a lifecycle basis (well-to-gate).

Draft Recommendations

Working Group Review

Hydrogen Sources Draft Recommendations (1 of 2)

Agency	Recommendations
DEEP	• Conduct further investigation to ultimately establish a definition of clean hydrogen that would be most appropriate for Connecticut. • Continue to evaluate the sufficiency of zero-emission electricity sources to meet both electric sector decarbonization goals and hydrogen production needs. • Consider accounting mechanisms that encourage hydrogen producers to certify the carbon intensity of produced hydrogen. • Consider investigating additional approaches to expanding clean hydrogen supply within the state, as appropriate based on the definition of clean hydrogen established.

Hydrogen Sources Draft Recommendations (2 of 2)

Agency	Recommendations
PURA	• Consider whether existing renewable energy, flexible and/or interruptible load tariffs could be applied to electrolytic hydrogen production and determine if a specific electrolytic tariff would be required.
DECD	• Evaluate the need for additional funding for Brownfield Loan and Grant programs to help meet the clean energy needs of the state and its subsequent land requirements. •
Inter-Agency	• DEEP and DECD should continue maintaining the Connecticut Brownfields Inventory as a resource for potential developers to identify prospective project sites, including those potentially eligible as "energy communities" under the Inflation Reduction Act. • DEEP and DECD should continue supporting development of clean energy projects on brownfields and projects that have community support and/or have completed community benefits agreements.

Hydrogen Uses Draft Recommendations (1 of 2)

Agency	Recommendations
DEEP	• Consider further investigation and the possibility of focused policy and market development support for clean hydrogen use in the highest priority end uses. • Consider further investigation into high priority hydrogen end uses and the possibility of coordinating support measures with other hydrogen efforts. • Explore market-based approaches to incent reductions in the carbon intensity of fuels for mobility end use applications. • Identify and potentially expand clean transportation incentives to include on-site port handling equipment, harbor crafts, and ocean-going vessels in collaboration with other state and federal agencies • Investigate the need for hydrogen fueling stations to support multi-sectoral mobility applications, and as appropriate, coordinate with CT DOT to develop more specific strategies for optimizing siting and funding.

Hydrogen Uses Draft Recommendations (2 of 2)

Agency	Recommendations
Legislature	• Consider tax exemptions for hydrogen vehicles and critical facilities that produce or use clean hydrogen. • Evaluate broader policies that would ensure the decarbonization of hard-to-electrify sectors, including long haul heavy-duty trucking, aviation, shipping, and industrial processes.
PURA	• Evaluate the role of hydrogen fuel cells for critical backup power and peak power generation and identify approaches to incorporate recommendations into appropriate planning venues.
Inter-Agency	• DEEP and PURA may wish to consider promoting the use of hydrogen end uses that are currently commercially viable through the existing clean energy programs. PURA's consideration should include how any changes would affect the programs' existing objectives and cost-effectiveness. • DECD and OPM should identify opportunities for tax incentives or programs to support CT's leading hydrogen fuel cell manufacturing industry.

Next Steps

Working Group Meeting Schedule

	September	October	November	December
Funding	9/27 4-5pm	10/26 10:30am-12 pm	11/18 10:30am-12 pm	12/15 10:30am-12:00 pm
Infrastructure	9/28 2-3pm	10/24 2-3pm	11/17 3-4pm	12/19 3-4pm
Policy & Workforce Development	9/26 3-4pm	10/20 12-1pm	11/29 12-1pm	12/15 12-1pm
Sources	9/27 1-2pm	10/25 2-3:30pm	11/17 11am-12pm	12/20 1-2:30pm
Uses	9/27 12-1pm		11/22 12-1pm	

Upcoming Task Force Milestones

Date	Description
Dec. 15 – 20, 2022	Final Working Group Meetings • **Funding:** Dec. 15 from 10:30 am to Noon • **Policy & Workforce Development:** Dec. 15 from Noon to 1 pm • **Infrastructure:** Dec 19 from 3 pm to 4 pm • **Sources & Uses:** Dec 20 from 1 to 2:30 pm
Dec. 16, 2022	Distribution of Draft Final Report for Task Force Review
Dec. 23, 2022	Task Force Feedback Due on Draft Final Report
Jan. 6, 2023	Final Report Text Distributed to the Task Force
Jan. 10, 2023	January Task Force Meeting (Vote out on final report)
Jan. 15, 2023	Report Due to the Legislature