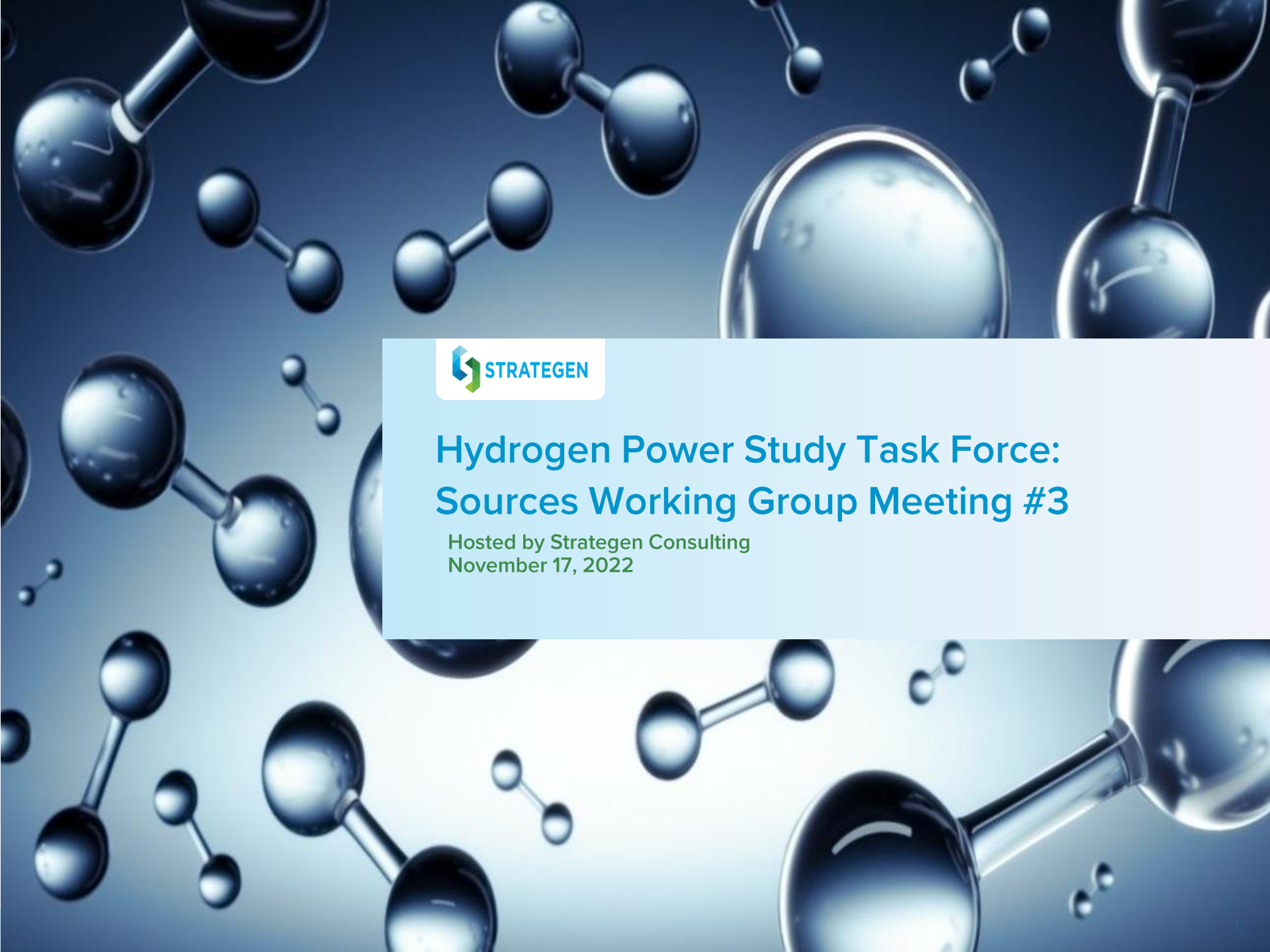


Hydrogen Power Study Task Force: Sources Working Group Meeting #3

Hosted by Strategen Consulting
November 17, 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
- Defining Clean Hydrogen: Update and Discussion – 20 minutes
- Preliminary Hydrogen Supply Assessment: Cost, Volumes, and Emissions – 15 minutes
- Discussion and Next Steps – 15 minutes

Reminder: Strategen's Role

- The Strategen team will handle meeting logistics including scheduling and recording meeting minutes.
- The Strategen team will coordinate with Working Group Co-Chairs to develop meeting agendas which will be provided to participants in advance of Working Group meetings.
- The Strategen team will provide technical assistance (including research), where appropriate, for the Working Group.
- It is expected that this working group will meet on a monthly cadence. Meeting recordings and meeting minutes will be publicly available.

Introductions

Please share your name, title, and organization

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	

Clean Hydrogen Definition

Summary of Policy & Workforce Development Working Group discussions

Clean Hydrogen Definition

A carbon intensity-based definition removes the ambiguity with the “colors of hydrogen”

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).

Survey of national and international definitions of clean, renewable, or green hydrogen shows a diversity of approaches

	Hydrogen Type (e.g. clean, renewable, green)	Based on a carbon intensity calculation	Technology agnostic (e.g. includes biomass, biogas, electrolysis, nuclear)	Electrolysis with renewables only	Excludes use of fossil fuels
US DOE	Clean	X	X		
Montana	Green		X		X
Washington State	Renewable		X		
Oregon	Renewable		X		X
Australia	Clean		X		
Canada	Green			X	X
Canada	Low Carbon Intensity	X	X		
Chile	Green			X	X
France	Renewable	X		X	X
France	Low Carbon	X	X		
Germany	Green			X	X
Sweden	Renewable/Clean		X		
CertifHy	Green	X	X		X
CertifHy	Low Carbon	X	X		

Federal definition focuses on emissions intensity, while state-specific definitions consider a wider variety of factors

+ Alignment of a state's definition with Federal guidance from the IIJA and Proposed Clean Hydrogen Standard is important for access to Federal funding opportunities.
  - Based on Federal guidance, clean hydrogen is defined as hydrogen that is produced through a process that results in a lifecycle greenhouse gas emissions rate of not greater than 4 kilograms of CO_2e per kilogram of hydrogen and with less than 2 kilograms of CO_2e per kilogram of hydrogen at the point of production.
+ To date, three US states – Oregon, Washington, Montana – have defined clean hydrogen in statute.
  - Varying approaches have been taken for defining hydrogen based on a region's climate goals, technology development activities, and geographic considerations.

A tiered definition could provide flexibility while catering to CT's specific climate goals

+ A definition of "clean hydrogen" that aligns with federal standards will maximize Connecticut's opportunity to access federal funding and participate in a regional or national hydrogen ecosystem
  - Will be necessary to receive full tax credits provided by the IRA
  - May facilitate hydrogen imports from states in regional hydrogen hub
  - Will allow for broad participation across different technologies and production mechanisms
+ Given state climate goals, limited access to zero-carbon resources, and stakeholder feedback, Connecticut could also establish a state-specific definition for green, renewable, or zero-carbon hydrogen
  - Would acknowledge the reduced carbon footprint of specific production sources and encourage development of hydrogen that's able to maximize hydrogen's PTC benefits
  - Connecticut's target of 100% carbon free power by 2040 may require hydrogen production that does not create any carbon emissions
  - Establishing a more stringent carbon intensity standard could support additional financial incentives for the production of hydrogen with lower carbon intensity

Hydrogen Supply Analysis

Presentation of preliminary results

Low, medium, and high supply scenarios were developed based on technical energy production potential

Low Case

- Most limited siting restrictions for solar and onshore wind
- Only fixed-bottom offshore wind
- Low supply potential for biogas
- 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
- 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
- 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*

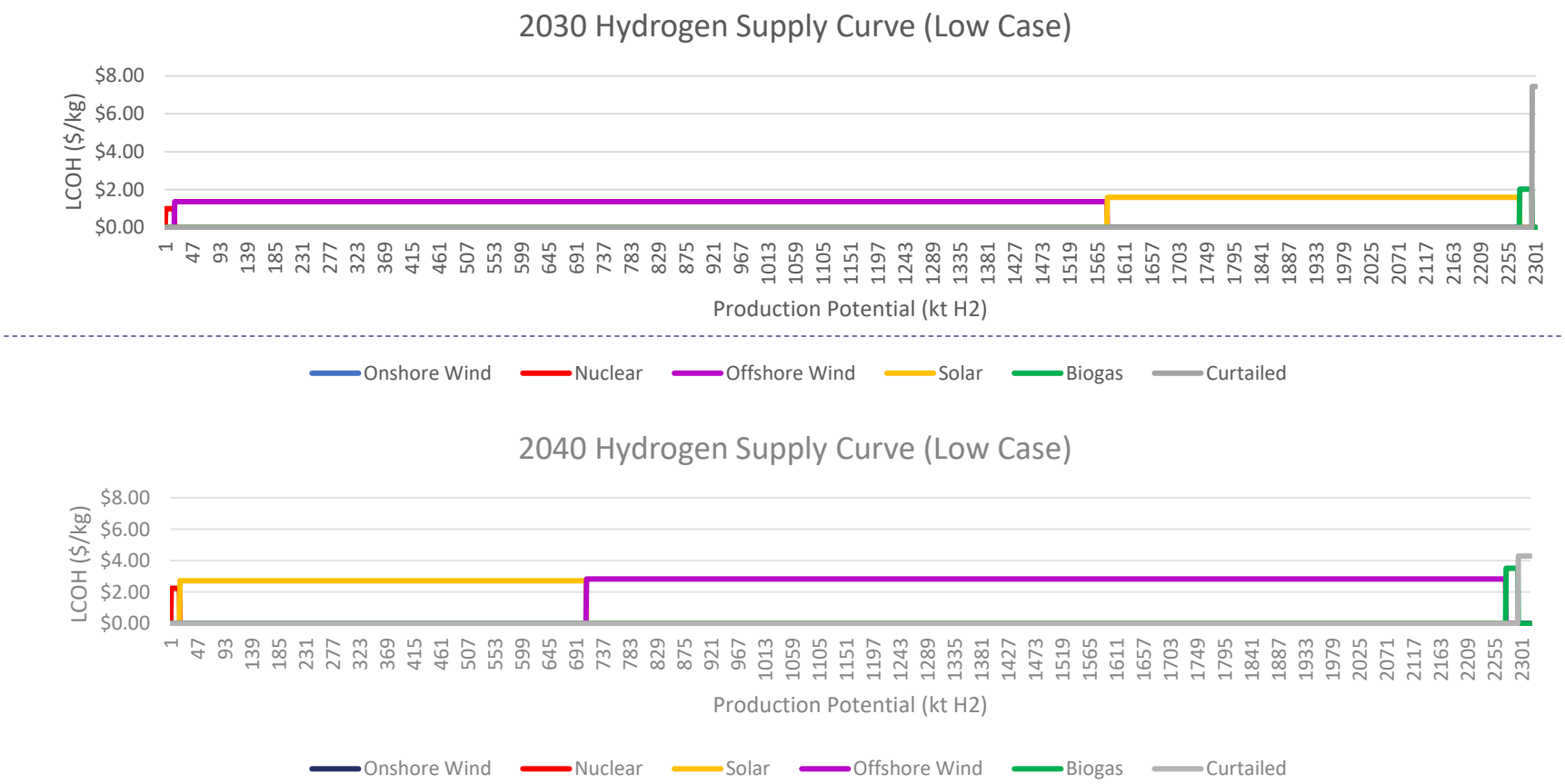
*Based on DEEP Decarbonization Pathway IRP, Electrification Millstone Extension Scenario (as used in ISO-NE Pathways Study)

Preliminary

Hydrogen Supply Analysis

Low Case supply projections indicate over 2 Mt of hydrogen production potential, primarily from solar and offshore wind

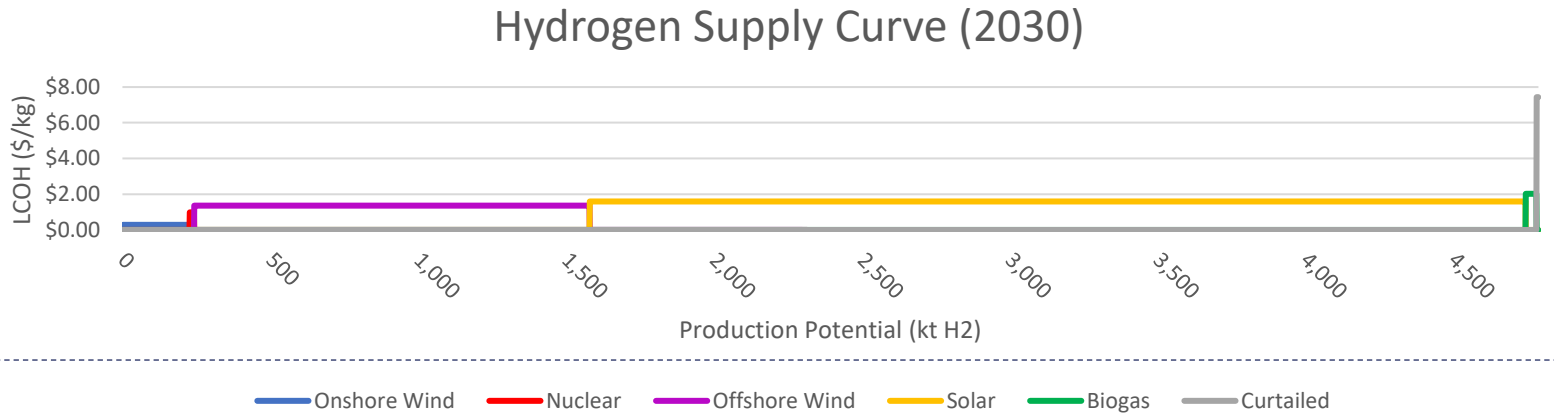
Prices for bulk production fall under $2/kg in 2030 and settle around $3/kg in 2040

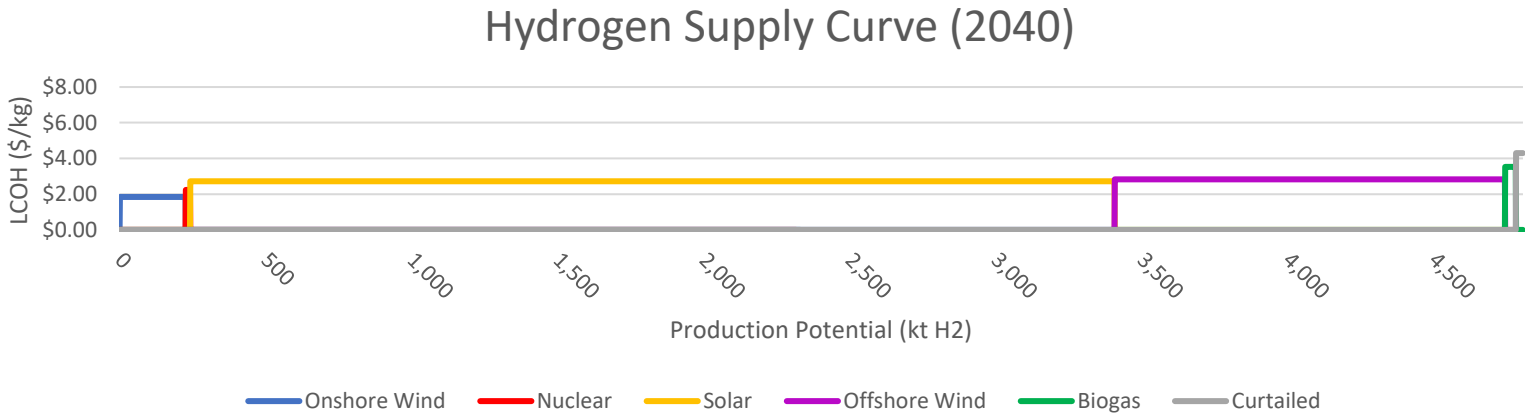


Note: LCOH represents price at point of production and does not include cost of hydrogen infrastructure (e.g. pipelines, compressors, storage)

Mid Case supply projections show some possibility of producing ultra-low-cost hydrogen from onshore wind

Overall technical production potential exceeds 4.5 million metric tons, led by higher potential solar resources

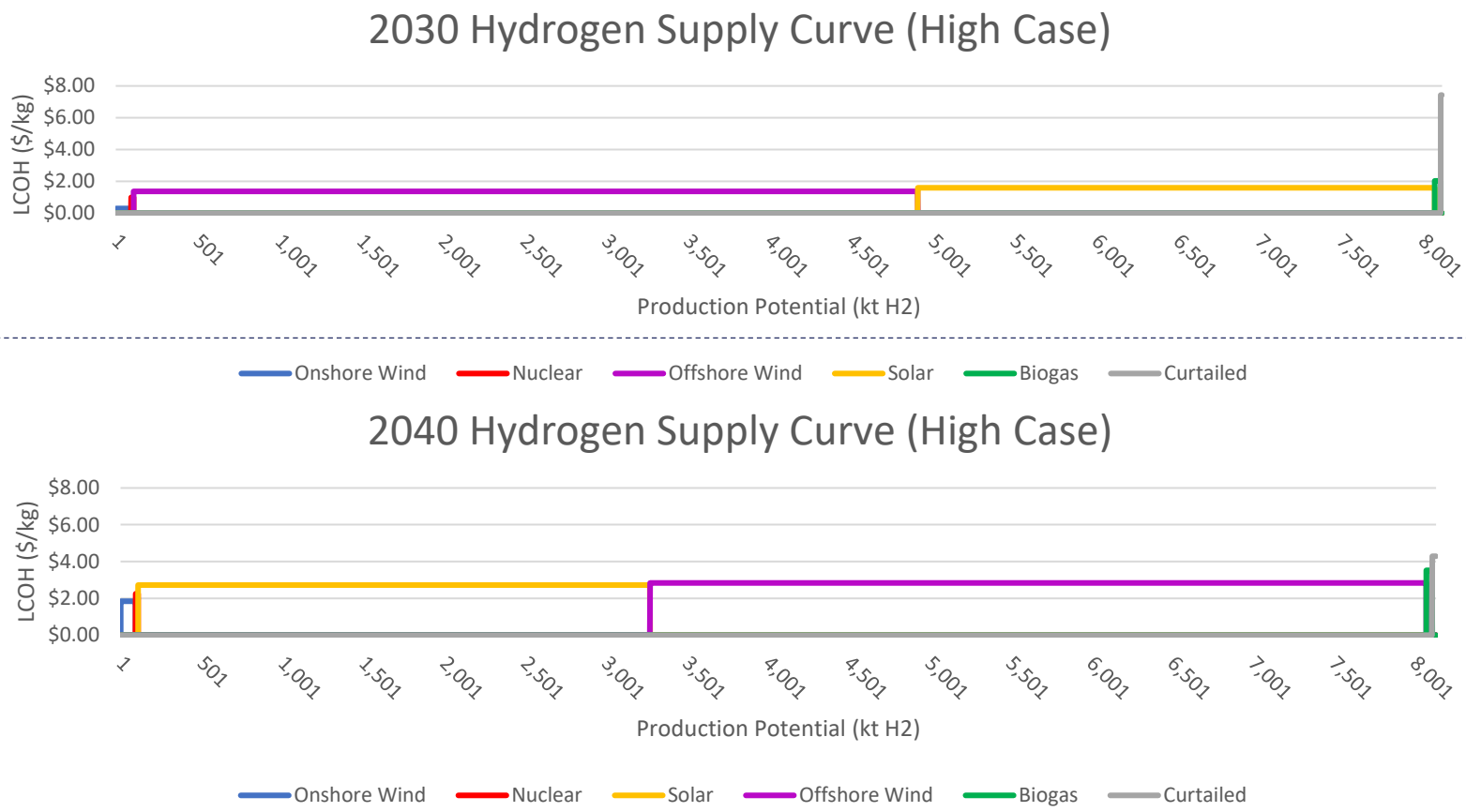




Note: LCOH represents price at point of production and does not include cost of hydrogen infrastructure (e.g. pipelines, compressors, storage)

High-case supply projections show offshore wind has largest potential for bulk hydrogen production

Total technical production potential comes in around 8 million metric tons



Note: LCOH represents price at point of production and does not include cost of hydrogen infrastructure (e.g. pipelines, compressors, storage)

Assessment will continue to be developed, with final results presented at the December Sources & Uses Working Group meeting

Next Steps

- Further refine and confirm clean hydrogen definition in coordination with Policy and Workforce Development Working Group
- Refine supply and price analysis based on stakeholder interviews (particularly nuclear supply)
- Update LCOH to include cost impact of connecting infrastructure
- Integrate supply curves with demand curves (presented at Nov. Uses Working Group meeting on 11/22)

Discussion Questions

- Clean Hydrogen Definition
  - Are there any concerns about the proposed tiered approach?
  - What should a more stringent criteria for clean hydrogen consider?
- Hydrogen Supply Assessment
  - Is “technical potential” an appropriate framing for this analysis?
  - Should the assumed potential be downgraded, and by how much?
  - Are there any additional scenarios or factors that should be considered?