Uses Working Group #1

Hosted by Strategen Workstream Support:

- Collin Smith

Meeting Announcements

+ 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.
+ Recording Meeting – we will record and post the board meetings (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

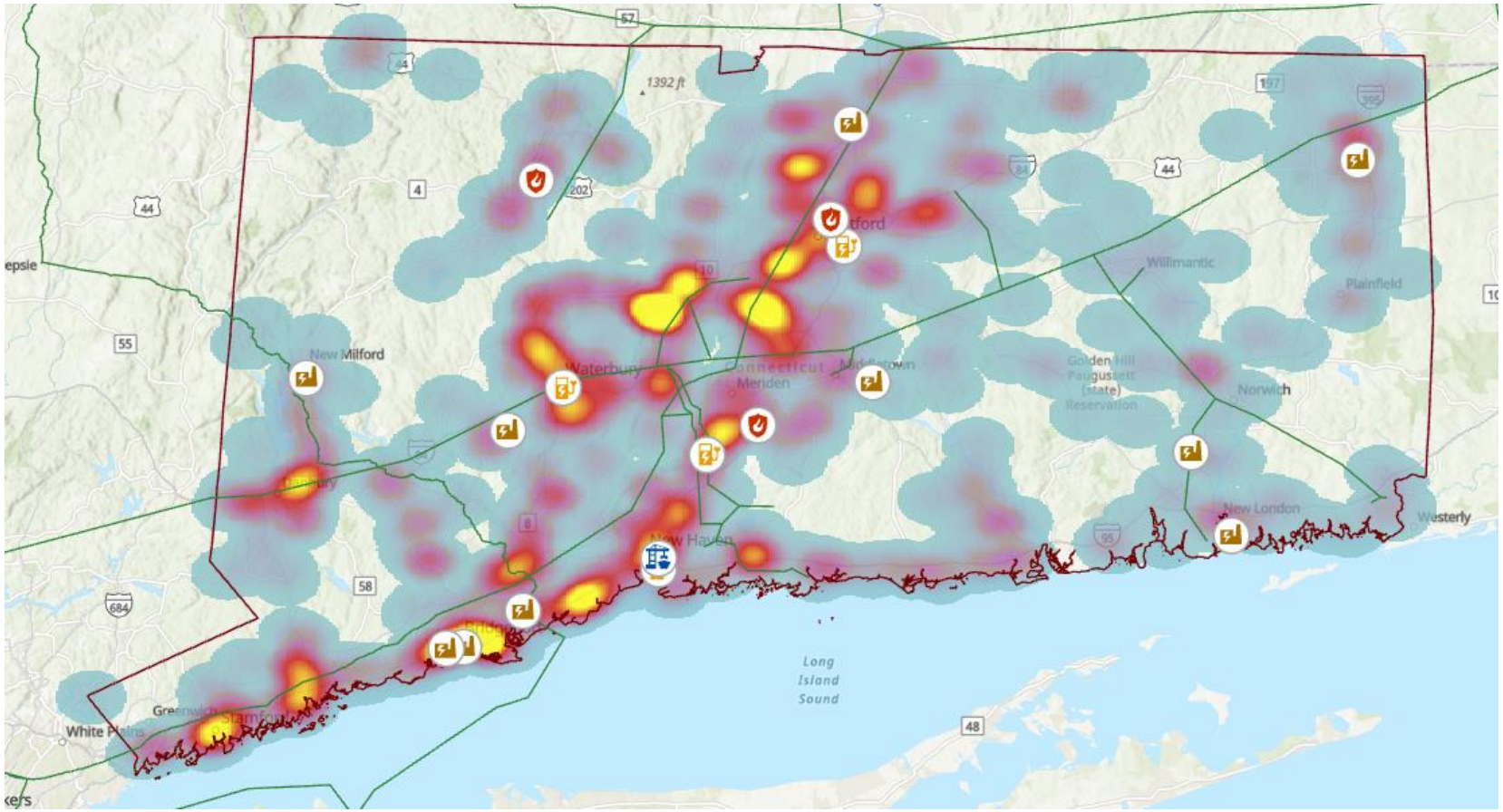
Overview and introductions	5 min
Review of Working Group Charter and schedule	10 min
Review and Discussion of End Use Evaluation Framework	45 min

Uses Working Group Charter Overview

+ **Co-Chairs –** Joel Rinebold (CCAT), Digaunto Chatterjee (Eversource), Frank Reynolds (Avangrid)
+ **Strategen Support –** Collin Smith
+ **Proposed Deliverables**

1. Structured framework to prioritize hydrogen end use applications relevant for Connecticut.
2. Total demand size of priority hydrogen end uses identified through the framework, developed across at least 3 scenarios (e.g. High, Medium, Low).
3. Scenario-based demand curves for each hydrogen end use, identifying:
    a. Price points at which hydrogen would become competitive for different end uses.
    b. Expected demand at those price points.
4. 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 in a regional proposal.

Major U.S. Offtaker Types and Locations in Connecticut



Several types of offtakers involved in H2 hubs elsewhere (e.g. ammonia, steel, cement) are not located in CT

Green lines indicate gas transmission pipelines. Red/yellow heat map indicates presence of smaller manufacturing facilities

Potential Evaluation Criteria and End Uses

Criteria

+ Cost-Effectiveness Compared to Alternatives
+ GHG Reduction Potential
+ Technology Maturity/Commercial Readiness
+ Infrastructure Requirements
+ Environmental Justice
+ Workforce Development
+ Resilience Benefits

Potential End Uses

Power Generation	Industrial Heat
Light-Duty Vehicles	Heavy-Duty Vehicles
Maritime	Aviation
Warehouse Forklifts	Port Equipment
Critical Facilities	Buses
Hydrogen Pipeline Blending	Residential/Commercial Heat

End uses can be ranked numerically on each criteria (e.g. 1/2/3)

Cost-effectiveness Compared to Alternatives

The lifecycle cost of a hydrogen-based technology compared to the most likely alternative decarbonization solution for that end use

Assessed via literature review and ranked based on comparison to alternative decarbonization route

- 1 = Alternative is better/cheaper
- 2 = Uncertainty/Ongoing competition
- 3 = No alternative/Alternative not feasible

Given its importance, this is proposed as a "gating criteria" – i.e. any end use that does not score above a "1" is excluded from further analysis

Potential Alternative	End Use
Electrification	Light-duty vehicles and Buses Heavy-duty vehicles & Rail Maritime & Aviation Warehouse & Port equipment Residential & Commercial heat
Carbon capture and storage	Heavy industries (steel, oil)
Storage and renewables	Peak power generation Back-up power
Renewable natural gas	Industrial heat

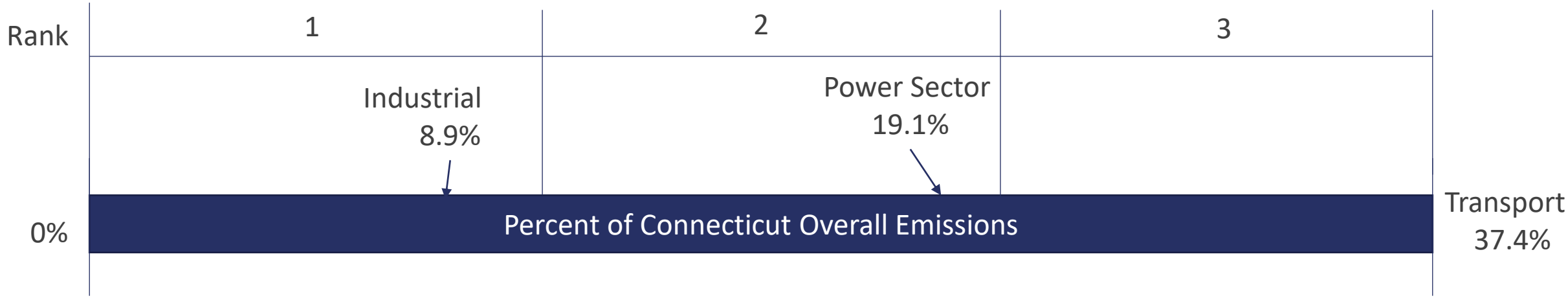
GHG Reduction Potential

The magnitude of the opportunity to reduce *in-state* GHG emissions by fuel-switching to green hydrogen

+ Evaluated as a function of a sector's contribution to CT's overall emissions

- Displacing end uses with a higher share of statewide emissions would be scored higher
- Ranking can be determined by aligning all use cases from lowest/highest emission intensity, then subdividing evenly

Example



Note: In actual evaluation, end uses would be divided into relevant sub-categories (e.g. "transport" divided into "light-duty vehicles" and "heavy-duty vehicles")

Technological Maturity/Commercial Readiness

The speed at which a hydrogen-based technology can be commercially deployed with appropriate safeguards

+ Faster deployment is preferred to accelerate market deployment
+ Factors in both technological maturity and commercial readiness of a particular technology, as well as the ability for a technology to be safely operated
+ Can be determined through literature review and sub-divided based on period of expected deployment

Deployment Timeline	Ranking
Now-2030	3
2030-2040	2
2040-2050	1

Infrastructure Requirements

Extent to which ancillary infrastructure is needed to enable hydrogen use in a particular end use

+ For hydrogen, cost of deploying a new technology is affected by both the cost of the technology and its supporting infrastructure
+ Easiest comparison occurs within sectors (e.g. fueling station infrastructure need for light-duty vs. heavy-duty fuel cell vehicles)
+ Comparison with alternative technology may also be relevant (e.g. cost of hydrogen fueling stations vs. EV charging stations)

Infrastructure Requirement	Ranking
No new infrastructure needed	3
Isolated infrastructure needed at a limited number of sites	2
Statewide infrastructure development required	1

Environmental Justice and Workforce Development

Two separate criteria evaluating hydrogen's impact on frontline communities and local employment

+ Both can be evaluated on a "do no harm" principle (i.e. median score implies no change from the status quo)

+ Can also be evaluated against most likely alternative decarbonization solution

Environmental Justice

- 1 = Increases local pollution
- 2 = Keeps local pollution neutral
- 3 = Reduces local pollution

Workforce Development

- 1 = Reduces workforce need
- 2 = Keeps workforce need the same
- 3 = Increases workforce need

Resilience Benefits

Ability for system to respond to inclement events (e.g. extreme weather, supply chain disruptions, fuel constraints)

+ Hydrogen can provide fuel diversity that improves resilience by reducing reliance on a single network (e.g. the electrical grid)

+ End uses where resilience is particularly important should be priorities for hydrogen development

Value of Resilience	Ranking
Resilience is not of major importance	1
Resilience is valuable but not critical	2
Resilience is a critical need	3

Questions

+ What aspects of this evaluation criteria are valuable? What should be changed?
+ Which criteria evaluation methodology should be adjusted?
+ What additional criteria should be evaluated?
+ Does it make sense to apply “Cost-Effectiveness Compared to Alternatives” as “gating criteria” for continued analysis?
+ What additional factors are important to consider in the “Environmental Justice” criteria?
+ Are there any other end uses that should be considered?