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.

Special Act 22-8

Task Force to Study Hydrogen Power

October 11, 2022

Online and In-Person Meeting

FuelCell Energy

Agenda

- **Welcome and Introduction by FuelCell Energy** – 5 min
- **Approval of Meeting Minutes of September 13, 2022** – 5 min
- **Task Force – New Member Introductions** – 5 min
- **Hydrogen Safety Presented by Sandia National Lab** – 30 min
- **Environmental Justice and Equity – A Discussion with Bridgeport** – 30 min
- **Working Group Updates** – 30 min
- **Public Comments** – 15 min
- **FuelCell Energy Tour** – following meeting

Welcome and Introduction by FuelCell Energy

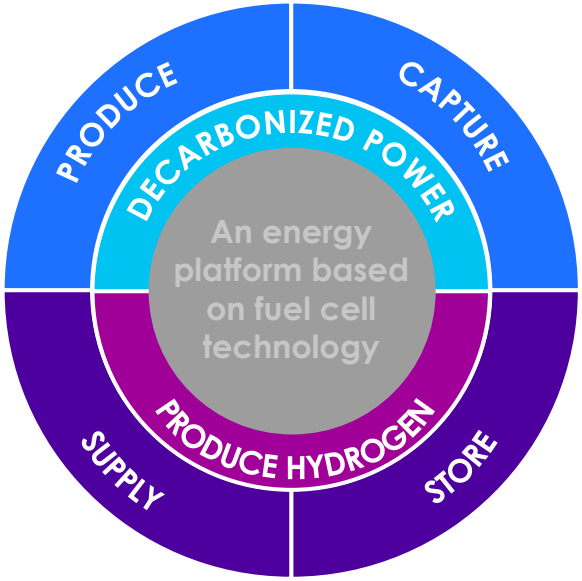
FuelCell Energy

FuelCell Energy Overview

October 2022

Our Purpose:
Enable a World Empowered by Clean Energy

ENABLING A SAFE, SECURE AND PRACTICAL JOURNEY TO CARBON ZERO



Our platform empowers a safe, secure and practical journey to carbon zero

DECARBONIZING POWER

- Produce decarbonized power
- Capture carbon and greenhouse gases at low cost with the ability to generate power and hydrogen at the same time
- Negligible nitrogen oxide (NOx) and sulfur oxide (SOx) emissions

PRODUCING HYDROGEN

- Supply green hydrogen power (using electrolysis of water) or blue hydrogen power (using natural gas) with high efficiency
- Working to commercialize a solution that scales renewables by converting excess power to hydrogen – then converting hydrogen back to power when needed
- Ensuring people continue to have access to reliable and affordable energy as the industrialized world continues to move forward

FuelCell Energy

FuelCell Energy: A Global Leader in Fuel Cell Technology – Operating Since 1969

COMPANY OVERVIEW

A global leader in **decarbonizing power** and **producing hydrogen** through our proprietary fuel cell technology

FuelCell Energy is working to:

- **Produce** low- to zero-carbon power
- **Capture** carbon and greenhouse gasses while simultaneously generating power; Negligible NOx or SOx emissions
- **Supply** green or blue hydrogen power
- **Store** energy from intermittent renewables by converting excess power to hydrogen – then converting hydrogen back into power when it's needed or delivering to other applications

COMPANY HIGHLIGHTS[1]

HQ Danbury, Connecticut	**~400** Employees	**95** Platforms in Commercial Operation	**3** Continents
FCEL Listing: NASDAQ	**>225 MW** Capacity in Field	**>13** Million MWh's generated with SureSource Patented Technology	

GLOBAL CUSTOMERS

LIPA, ExxonMobil, Toyota, Pfizer, CMEEC, Radisson, American Electric Power, KOSPO, Southern California Edison, Riverside, Federal Ministry of Education and Research, Friatec, Pepperidge Farm, Avangrid, Hartford Hospital, Clearway Energy, E.ON

Demand for Clean, Reliable Electricity Driving Adoption of Fuel Cell Technology

[1] As of the year ended October 31, 2021 [2] Percentages of FY21 revenue

FuelCell Energy

FCE Facilities

Headquarters
Danbury, CT
- Corporate Headquarters
- Research labs
- Engineering design
- Global Service center

Manufacturing
Torrington, CT
- Module Assembly & Stacking
- 167,000 sq. ft.

OTHER FACILITIES:

Taufkirchen, Germany
- Final Assembly for SubMW carbonate stack modules
- Carbonate SubMW power plant sales and service
- Sales and service for carbonate MW scale platforms made in US

Calgary, Canada
- Solid Oxide R&D for power generation, electrolysis, and energy storage
- Solid Oxide cell and stack manufacturing

~400 Employees

95 Platforms in Commercial Operation

3 Continents

>225 MW Capacity in Field

>12 Million MWh's generated with SureSource Patented Technology

FuelCell Energy

Two Leading Technologies to Provide More Energy Solutions

APPLICATION	CARBONATE	SOLID OXIDE
Power gen/CHP from natural gas, biogas, or H_2 blends	✓	✓
Power generation/CHP from hydrogen fuel		✓
CO_2 capture from platform	✓	✓
CO_2 capture from external source while making power	✓	
H_2/Power/Water production from natural gas or biogas	✓	✓
High efficiency electrolysis H_2 production		✓
Electrolysis/Reforming/Purification	✓	

TWO ADVANCED HIGH TEMPERATURE ELECTROCHEMICAL PLATFORMS ADDRESSING MULTIPLE APPLICATIONS

FuelCell Energy

Carbonate Power Generation Platforms

Individual fuel cell & 400-cell fuel cell stack

Single-stack Module 250 – 400kW

Four-Stack Module 1.4MW

250 - 400kW
SureSource250™
SureSource400™
47% Electrical Eff,
up to 90% Total Eff.

1.4 MW
SureSource1500™
47% Electrical Eff,
up to 90% Total Eff.

2.8 MW
SureSource3000™
47% Electrical Eff,
up to 90% Total Eff.

2.35 MW
SureSource Hydrogen™
2.35 MW Power plus
1270 kg/day Hydrogen

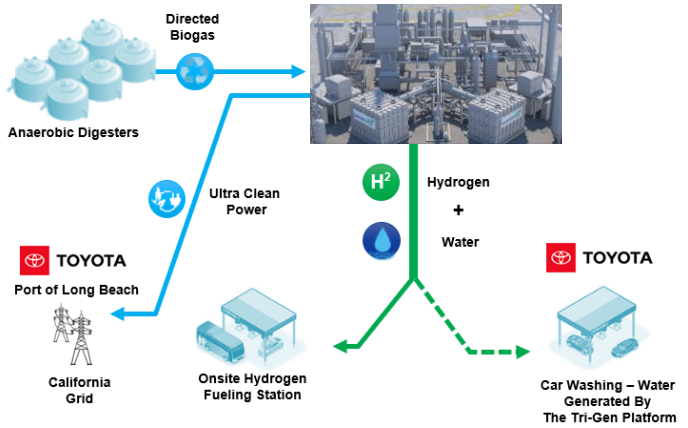
3.7 MW
SureSource4000™
60% Electrical Eff.
Up to 80% total Eff

Larger Scale Fuel Cell Parks

FuelCell Energy

Toyota Tri-generation Project

- Project supports Toyota vehicle fueling activities at the Port of Long Beach, where Toyota is importing fuel cell passenger vehicles and operating fuel cell trucks
- Fueled with directed biogas, project will produce renewable power and renewable hydrogen, plus clean water for car washing operations
- The system will generate 2.3MW of electricity, 1200kg of hydrogen, and 1400 gallons of water per day
- Enough to power ~ 2,250 average-sized homes and meet the daily driving needs of nearly 1,500 vehicles



FuelCell Energy

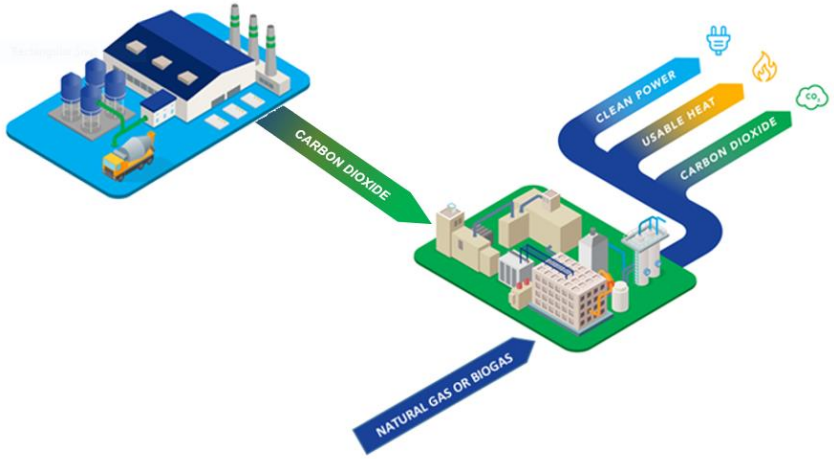
Carbonate CO_2 Capture and Separation Applications

CARBON SEPARATION
Purification and capture of CO_2 from fuel cell power generation

Capturing fuel cell CO_2 for supply to on site use or distribution to local off-takers for food and beverage or industrial applications

Commercially available today

CARBON CAPTURE
Purification and capture of CO_2 from External Sources



Under development with ExxonMobil

FuelCell Energy

Solid Oxide Applications

SOFC Stack

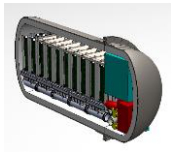
7 kW DC Power Generation
36 kW DC / 25 kg H_2/day electrolysis
350 cells, 17” height

Power Generation Stack Module – Only runs in power generation mode on a wide range of fuels, including natural gas, biofuels, propane, and hydrogen

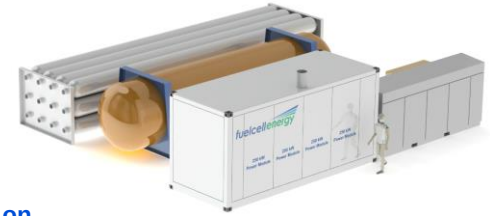
200kW Power Generation System

Electrolysis Stack Module – Produces hydrogen from steam with power input

Electrolysis
550 kg/day H_2 from 1 MW



Energy Storage Stack Module – Alternates between power generation on hydrogen fuel and electrolysis producing hydrogen from water



Energy Storage System
1MW 8 MWh

FuelCell Energy

Thank You

FuelCell Energy

Approval of Meeting Minutes of September 13, 2022

Task Force Logistics

Task Force

Still Waiting on Two Political Appointee Members

Appointer	Organization	Name	Area of Expertise
President Pro Tempore	▪ Avangrid ▪ HyAxiom ▪ Conservation Law Foundation	▪ Enrique Bosch ▪ Sridhar Kanuri ▪ Shannon Laun	▪ EDC (Electric – 17-) ▪ CT H2 Manufacturer ▪ ENGO (RE Advocate)
Majority Leader Senate	▪ AFL-CIO	▪ Keith Brothers	▪ Building Trades
Minority Leader Senate	▪ Avangrid ▪ Avangrid	▪ Adolfo Rivera ▪ Frank Reynolds	▪ EDC (Electric – 17-) ▪ EDC (Gas – 17-) ▪ ENGO (RE Advocate) ▪ CHFCC
Speaker of House	▪ Eversource ▪ Nel Hydrogen	▪ Digaunto Chatterjee ▪ Katherine Ayers	▪ EDC (Electric – 18+) ▪ CT H2 Manufacturer
Majority Leader House	▪ Eversource ▪ Sierra Club CT ▪ Fuel Cell Energy	▪ Nikki Bruno ▪ Samantha Dynowski ▪ Anthony Leo	▪ EDC (Gas – 18+) ▪ ENGO (RE Advocate) ▪ CHFCC
Minority Leader House	▪ Eversource ▪ Dominion Energy ▪ Infinity	▪ Jennifer Schilling ▪ Mary Nuara ▪ William Smith	▪ EDC (Electric – 18+) ▪ Nuclear Power ▪ CT H2 Manufacturer

Task Force

Ex Officio Members

Appointer	Organization	Name	Title
Ex Officio	DEEP	Katie Dykes	Commissioner
Ex Officio	PURA	Marissa Gillett	Chair
Ex Officio	UCONN	Ugur Pasaogullari	Professor (Designee)
Ex Officio	CCAT	Joel Rinebold	Director
Ex Officio (Chair)	CT Green Bank	Bryan Garcia	President and CEO
Ex Officio (Co-Chair)	CT Green Bank	Sara Harari	Associate Director

Upcoming Task Force Meetings

November 8

- Update on Working Group Findings and Recommendations
- H_2 Primer Sessions #4 – Hydrogen 301
- Tour of Facility – Dominion Millstone

December 13

- Discussion of Draft Final Working Group Findings and Recommendations
- Environmental and Climate Justice Fireside Chat
- Tour of Facility – HyAxiom

January 10

- Task Force Planning for Report Submission
- Tour of Facility – TBD

Hydrogen Safety Presented by Sandia National Laboratory

Energy & Homeland Security

The Scientific Basis for Hydrogen Technologies

Kristin Hertz, Hydrogen Program Manager

Connecticut Hydrogen Task Force Briefing, October 11, 2022

SAND2022-13676 PE

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia LLC, a wholly owned subsidiary of Honeywell International Inc. for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

U.S. DEPARTMENT OF ENERGY

NNSA

OUTLINE

Sandia's Hydrogen Program

Hydrogen Safety Codes & Standards Research

- Materials Compatibility
- Safety and Risk
- Regulatory Map

End Uses

- Rail
- Light Duty Vehicles – Tunnels and Refueling
- Maritime – vessels and ports

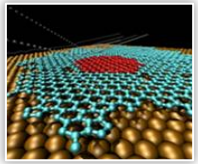
Questions

Sandia provides deep, quantitative understanding and a scientific basis for….

Materials **–** for hydrogen production, storage, delivery and utilization

Safety – risk analysis and the creation of risk-informed standards

Hydrogen Production



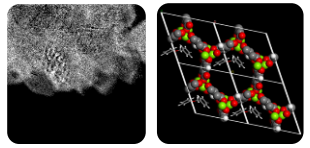
Discovery of advanced water-splitting materials for large-scale H_2 production

HydroGEN
Advanced Water Splitting Materials

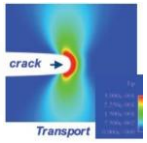
Hydrogen Storage

Discovering the behavior and performance of solid storage materials

HyMARC
Hydrogen Materials Advanced Research Consortium



Hydrogen Delivery

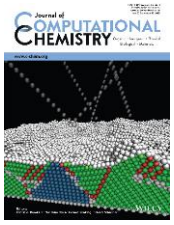


HyBlend
U.S. DEPARTMENT OF ENERGY

Fuel Cells

Develop new membrane systems for enhanced electrochemical performance

Materials Compatibility



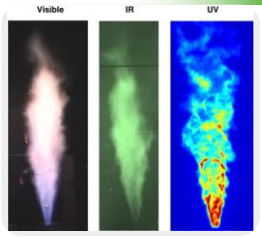
Elucidation of hydrogen embrittlement phenomena at the atomistic scale

H-Mat
Hydrogen Materials Compatibility Consortium

Systems Engineering

Hydrogen for marine, rail, and avia

Safety, Codes & Standards

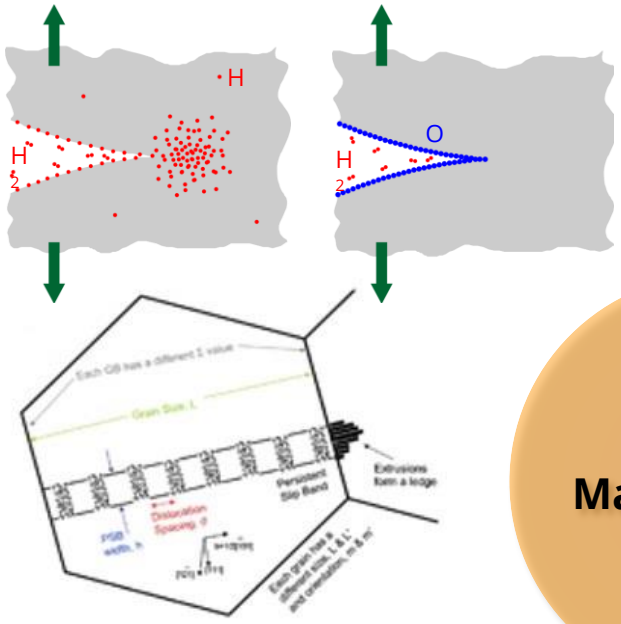


State-of-the-art characterization of thermophysical & thermochemical behavior of H_2 in

yesian theory

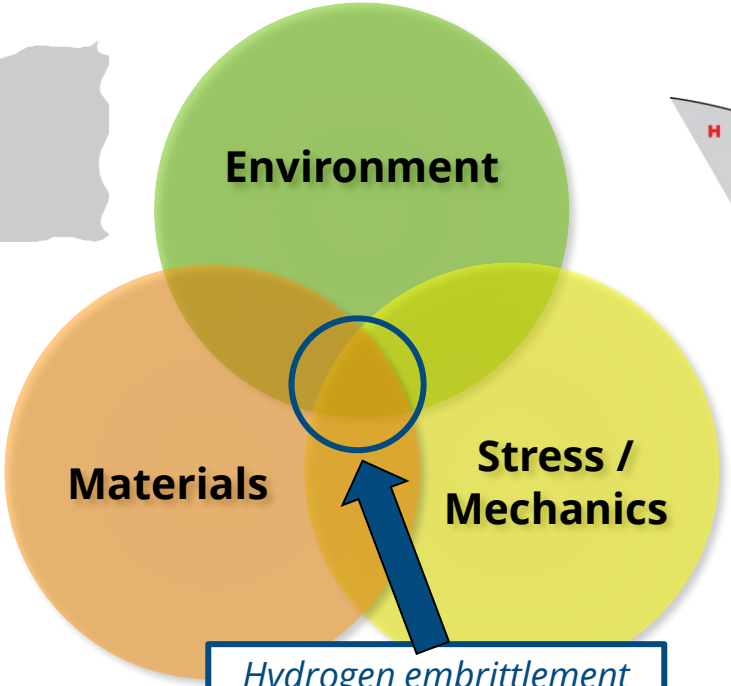
HyRAM+
Hydrogen Plus Other Alternative Fuels Risk Assessment Models

DECONSTRUCTING PHYSICS OF HYDROGEN EFFECTS ON MATERIALS



Materials

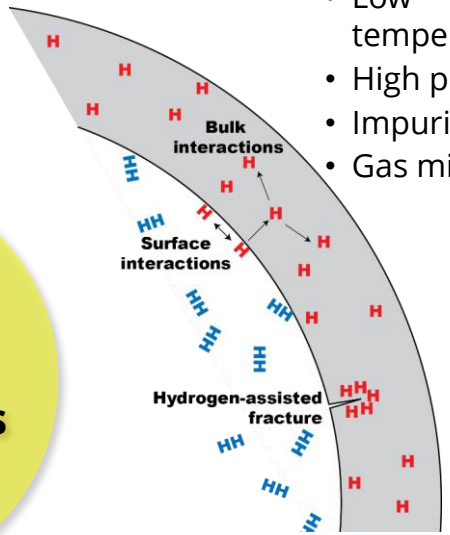
- High-strength
- Hydrogen-enhanced plasticity
- Boundary cracking
- Surface passivation



*Hydrogen embrittlement occurs in **materials** under the influence of **stress** in hydrogen **environments***

Environment

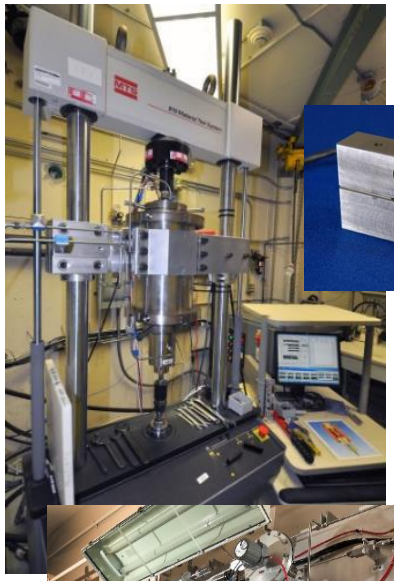
- Low temperature
- High pressure
- Impurities
- Gas mixtures

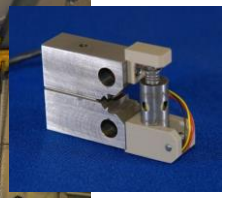


Mechanics

- Autofrettage
- Short crack behavior
- Fatigue crack initiation
- Fracture resistance

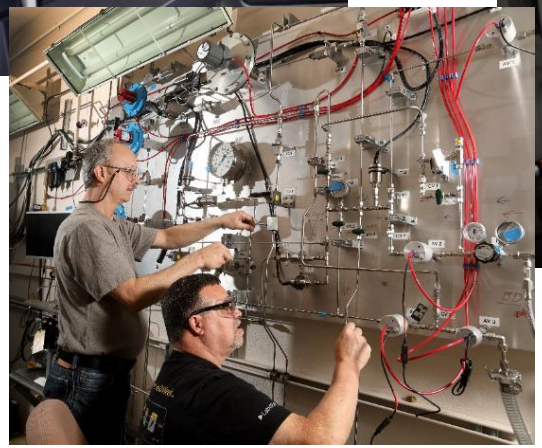
HYDROGEN ENVIRONMENT AND MATERIAL CHARACTERIZATION





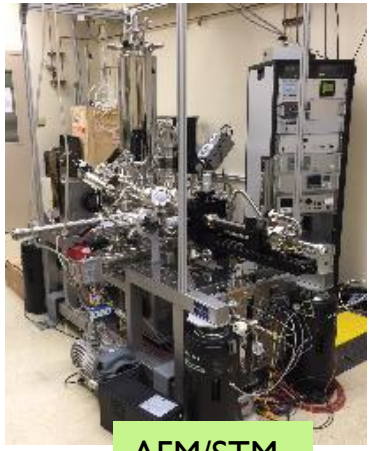
Thermal H-precharging
Long term H-exposure

High pressure dynamic loading

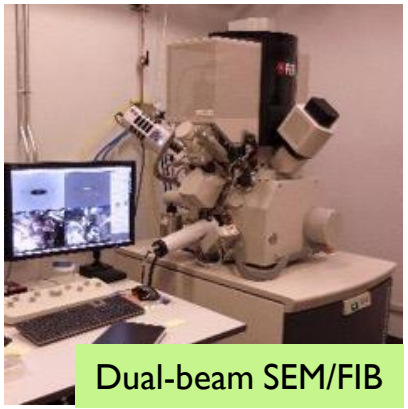


Low temperature Dynamic loading

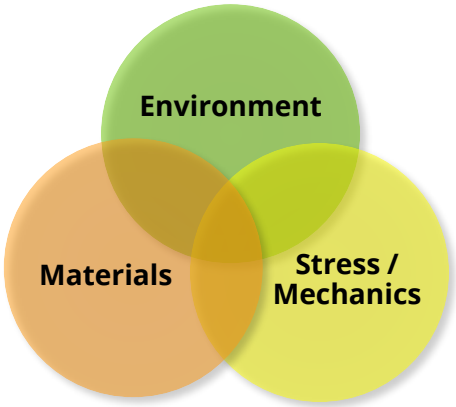
Polymer pressure cycling

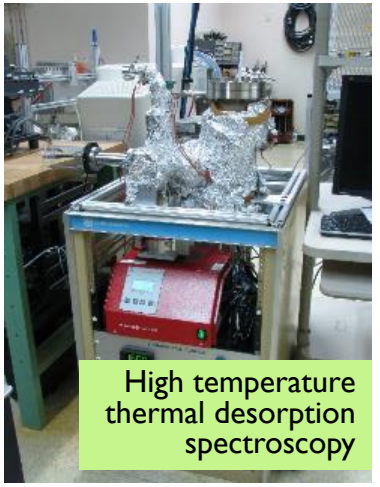


AFM/STM



Dual-beam SEM/FIB





High temperature thermal desorption spectroscopy

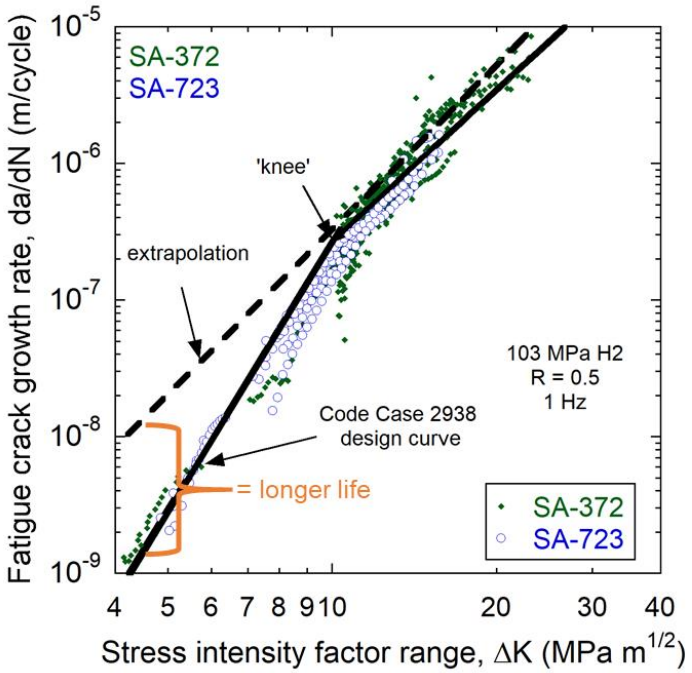
SAFETY CODES AND STANDARDS

ASME Boiler and Pressure Vessel Code

- CC 2938 (VIII.3): fatigue design curves

Fatigue crack growth rate curves for pressure vessel steels, commonly installed at hydrogen refueling stations, tested in high-pressure hydrogen gas.

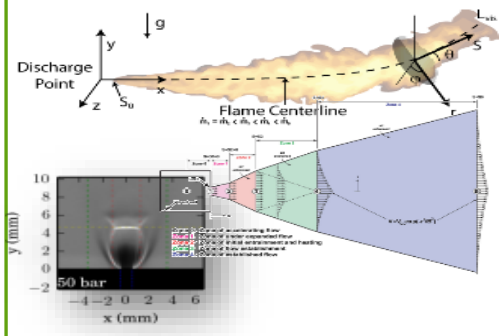
The use of these design curves ***enables approximately three times longer design life*** of typical hydrogen storage vessels compared to previous design basis.



CONSISTENT, ACCEPTED, AND RIGOROUS SAFETY ANALYSIS

HyRAM+
Hydrogen Plus Other Alternative Fuels Risk Assessment Models

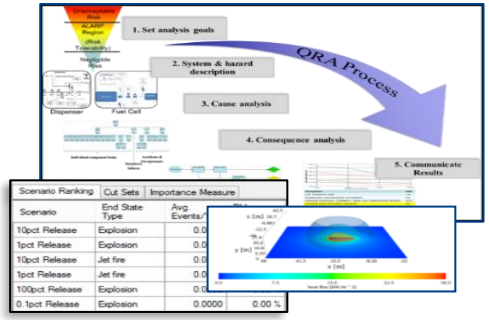
Behavior R&D



Develop and validate scientific models

to accurately predict hazards and harm from liquid releases, flames, etc.

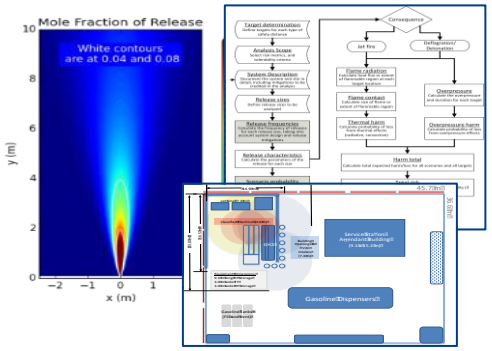
Risk R&D



Develop integrated methods and algorithms

for enabling consistent, traceable and rigorous quantitative risk assessment (QRA)

Application in Safety, Codes, and Standards



Apply QRA & behavior models to real problems

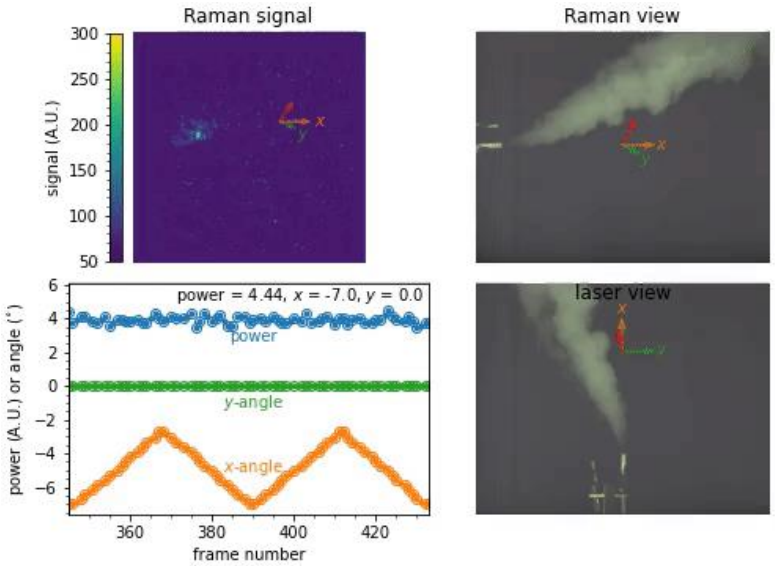
in hydrogen infrastructure and emerging technology

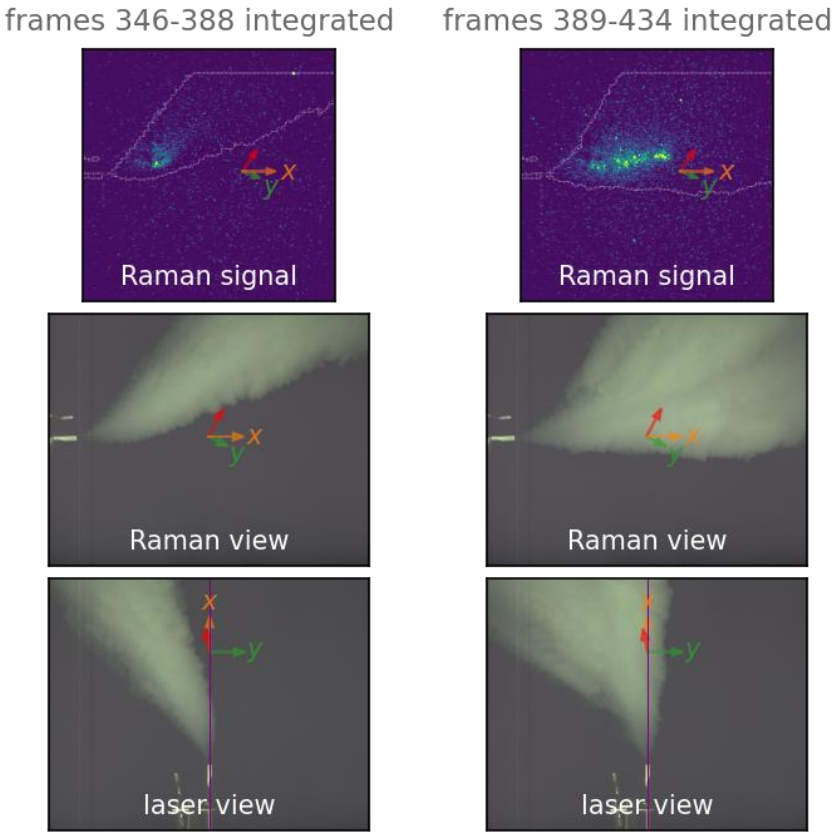
Developing methods, data, tools for H_2 safety, codes and standards

Tool available online: HyRAM

HYDROGEN BEHAVIOR - EXPERIMENTS TO VALIDATE MODELS

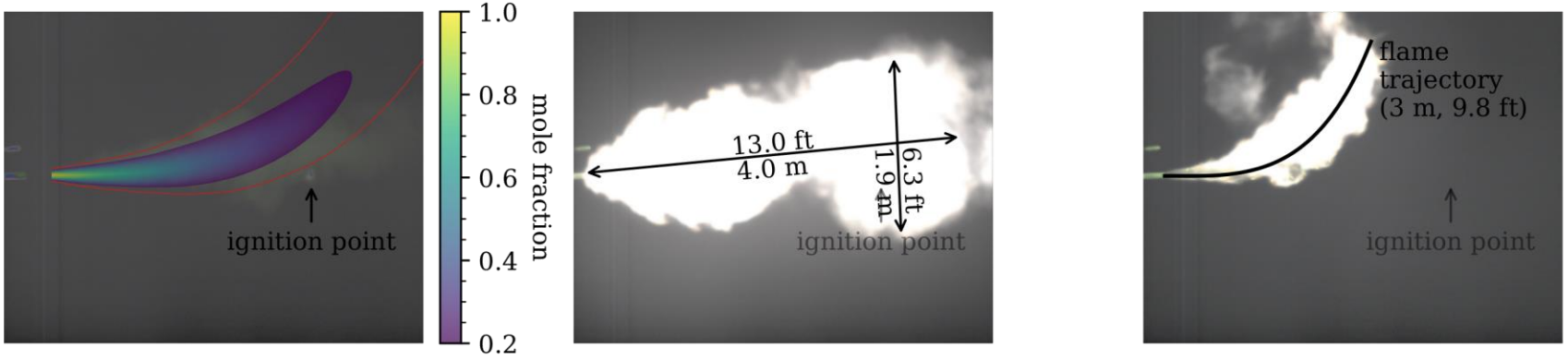
Vent-stack experiments demonstrated that hydrogen is concurrent with the visible plume





- As wind blows the visible plume off, then back onto the laser-line, the Raman signal disappears, then increases

HIGH LASER POWER RESULTED IN IGNITION, PROVIDING DATA TO UNDERSTAND LIGHT-UP AND JET FLAME PROCESSES



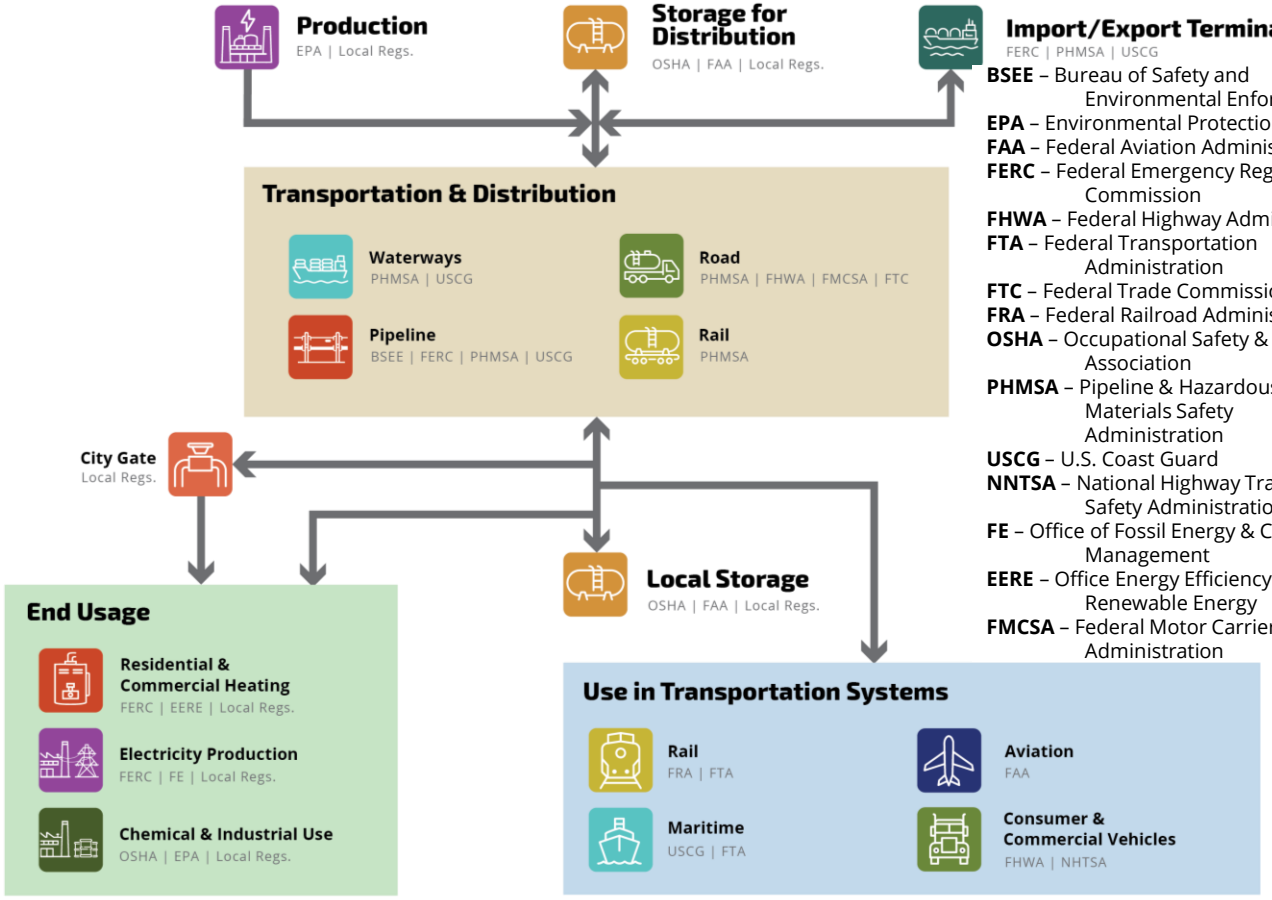
- Ignition point is near the HyRAM predicted 8% mole fraction boundary
- Initial fireball is significantly larger than steady jet flame
- Continued validation of flame trajectory with the HyRAM flame model

REGULATORY MAP – COLLABORATION IS NECESSARY

Regulation – Law. Federal regulations are in the Code of Federal Regulations (CFR). State laws for hydrogen are in the Building Code and other codes or standards adopted as law in the individual state.

Code – Document containing requirements. For hydrogen, some codes include American Society of Mechanical Engineers (ASME) documents and National Fire Protection Association (NFPA) documents like the National Electric Code (NEC, NFPA 70) and the Hydrogen Technologies Code (NFPA 2)

Standard – Document approved by a recognized agency that provides guidelines and instructions for designers and manufacturers ASTM, ISO



BSEE – Bureau of Safety and Environmental Enforcement
EPA – Environmental Protection Agency
FAA – Federal Aviation Administration
FERC – Federal Emergency Regulatory Commission
FHWA – Federal Highway Administration
FTA – Federal Transportation Administration
FTC – Federal Trade Commission
FRA – Federal Railroad Administration
OSHA – Occupational Safety & Health Association
PHMSA – Pipeline & Hazardous Materials Safety Administration
USCG – U.S. Coast Guard
NNTSA – National Highway Traffic Safety Administration
FE – Office of Fossil Energy & Carbon Management
EERE – Office Energy Efficiency and Renewable Energy
FMCSA – Federal Motor Carrier Safety Administration

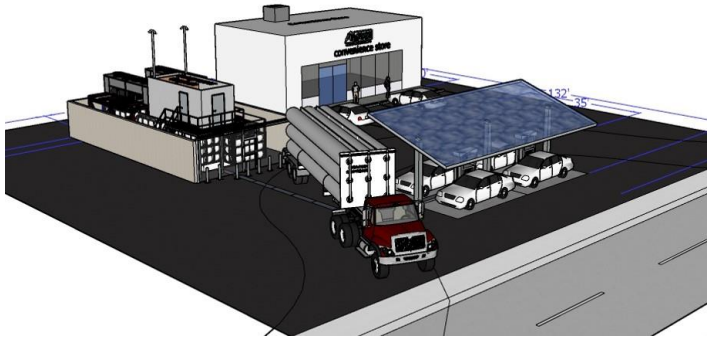
SEPARATION DISTANCES FOR LIQUID H2 REFUELING STATIONS

Current (2020) separation distances for liquid hydrogen (LH2) systems

- based on consensus without a documented scientific analysis

Compressed H_2 storage

Previous work by Sandia led to science-based gaseous H_2 separation distances



Liquid H_2 storage

Even with credits for insulation and fire-rated barrier wall, 75 ft. offset to building intakes and parking make footprint large

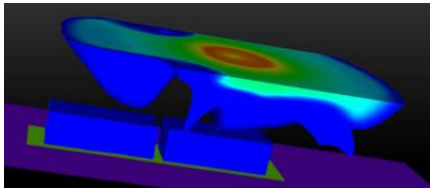
LH2 Proposed (10,800 ft^2) 2023 Edition NFPA 2

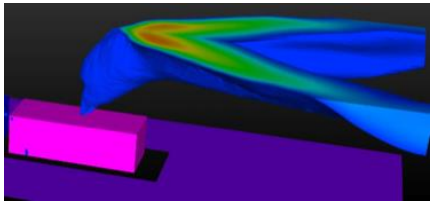
Footprint Reduction of ~40% (2016 Baseline)

- Key distances (1.5” diameter piping, >120 psi OP):
  - Group 1 (lot lines, air intakes): 24’ 6” (50% reduction of 49’ through use of a wall)
  - Group 2 (exposed persons not servicing system, parked cars): 19’ (50% reduction of 38’ through use of a wall)
  - (Group 3 reduced to 0 through use of a wall)

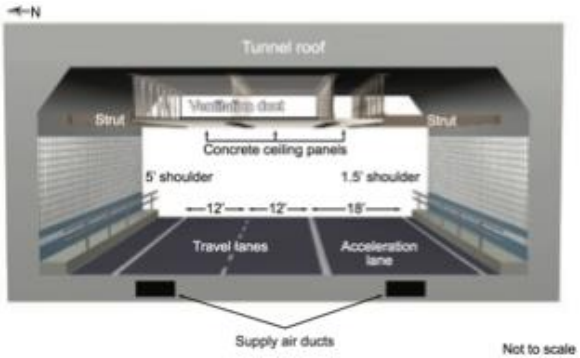
STATE REGULATION: MASSACHUSETTS TUNNEL ACCESS

Risk assessment and scenario analysis





Detailed modeling to scenarios of concern



Massachusetts Regulations modified to allow H2 Fuel Cell Vehicles in specific tunnels

RAIL REFUELING FEASIBILITY STUDY

Multiple unit train refueling facility direct-fill cryopump design

- refuel 10 multiple train units per day
- each train has 260 kg of gaseous H_2 at 350 bar on-board

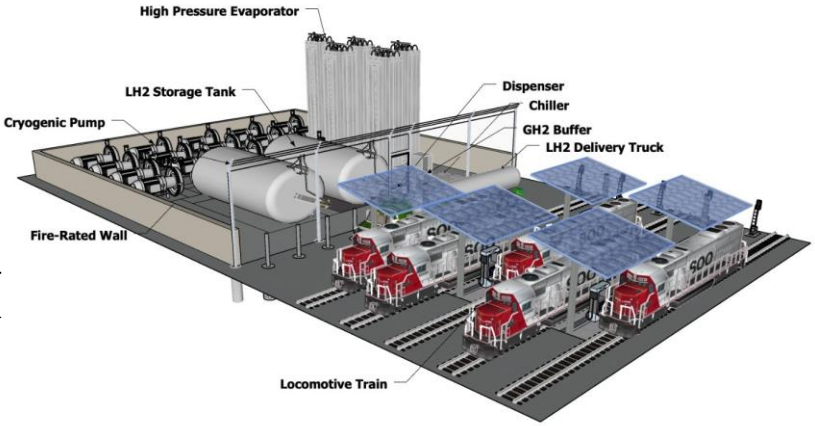
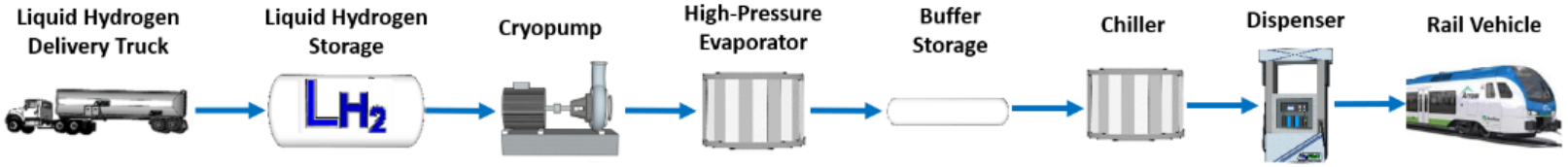


Table 2-3 Multiple Unit Train Refueling Facility Direct-Fill Cryopump 15-Minute Fill Time Design Component and Cost Summary

Component	Number of Components	Cost Per Component ($)	Total Cost ($)
LH_2 Tank	2	180,000	360,000
Cryopump	6	100,000	600,000
HP Evaporator	2	100,000	200,000
Buffer Storage Tank	1	35,000	35,000
Chiller	2	150,000	300,000
Dispenser	1	250,000	250,000
Total			**1,745,000**



"Refueling Infrastructure Scoping and Feasibility Assessment for Hydrogen Rail Applications", SAND2021-12851

HYDROGEN STATION EQUIPMENT PERFORMANCE (HYSTEP) DEVICE

Collaboration with Sandia National Labs, National Renewable Energy Lab, and Powertech Labs

Used by certification agencies

- Measure the performance of hydrogen dispensers with respect to the required fueling protocol standard
  - CSA HGV 4.3 – test methods
  - SAE J2601-2014 – fueling protocols standard

Still used in CA

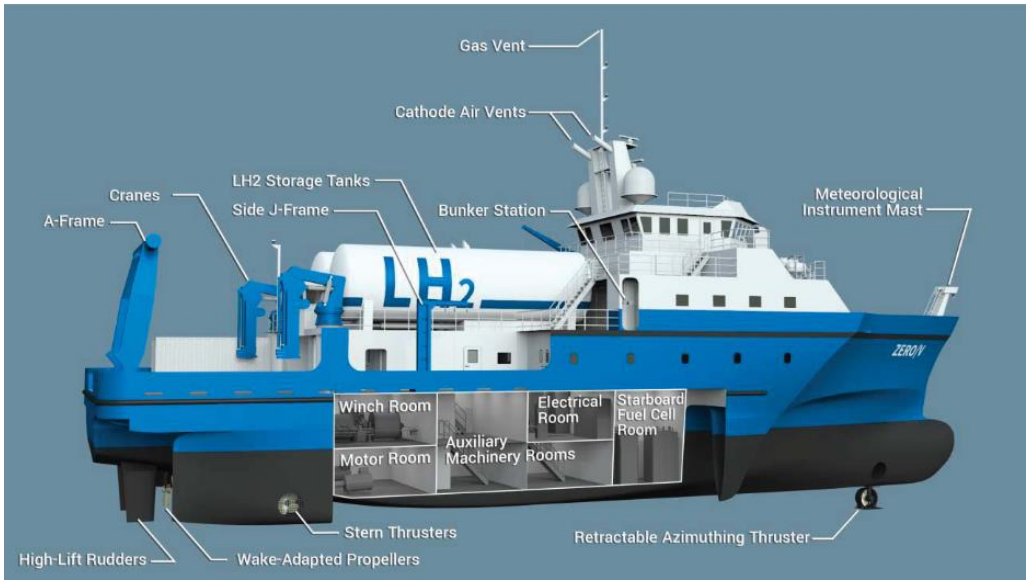
Previously each OEM had to test and evaluate the stations

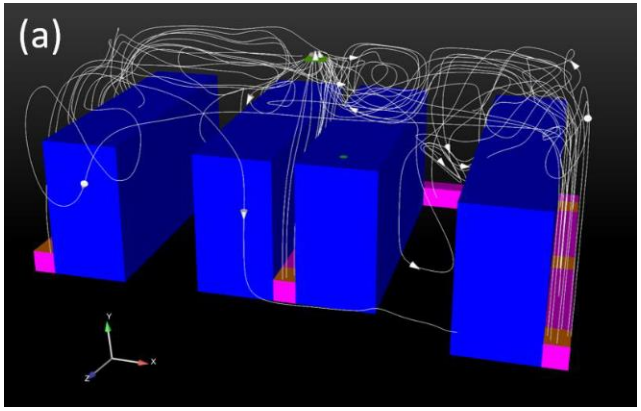
https://h2tools.org/hystep-hydrogen-station-equipment-performance-device

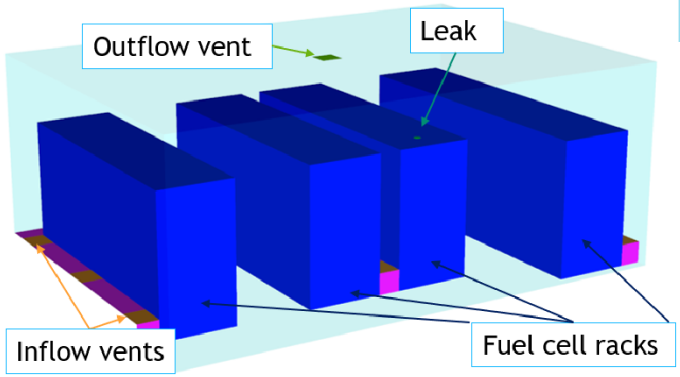
MARITIME – SCRIPPS INSTITUTION OF OCEANOGRAPHY

Hydrogen Hybrid (fuel cell/diesel electric)

- Diesel engines supplemented with H_2/Fuel Cells
- LH_2 storage: 733 kg
- Diesel engines:~1200 kW; Fuel Cells: ~800 kW
- 27% annual reduction in GH emissions
- 75% of the Sproul Missions can be performed on H_2 alone







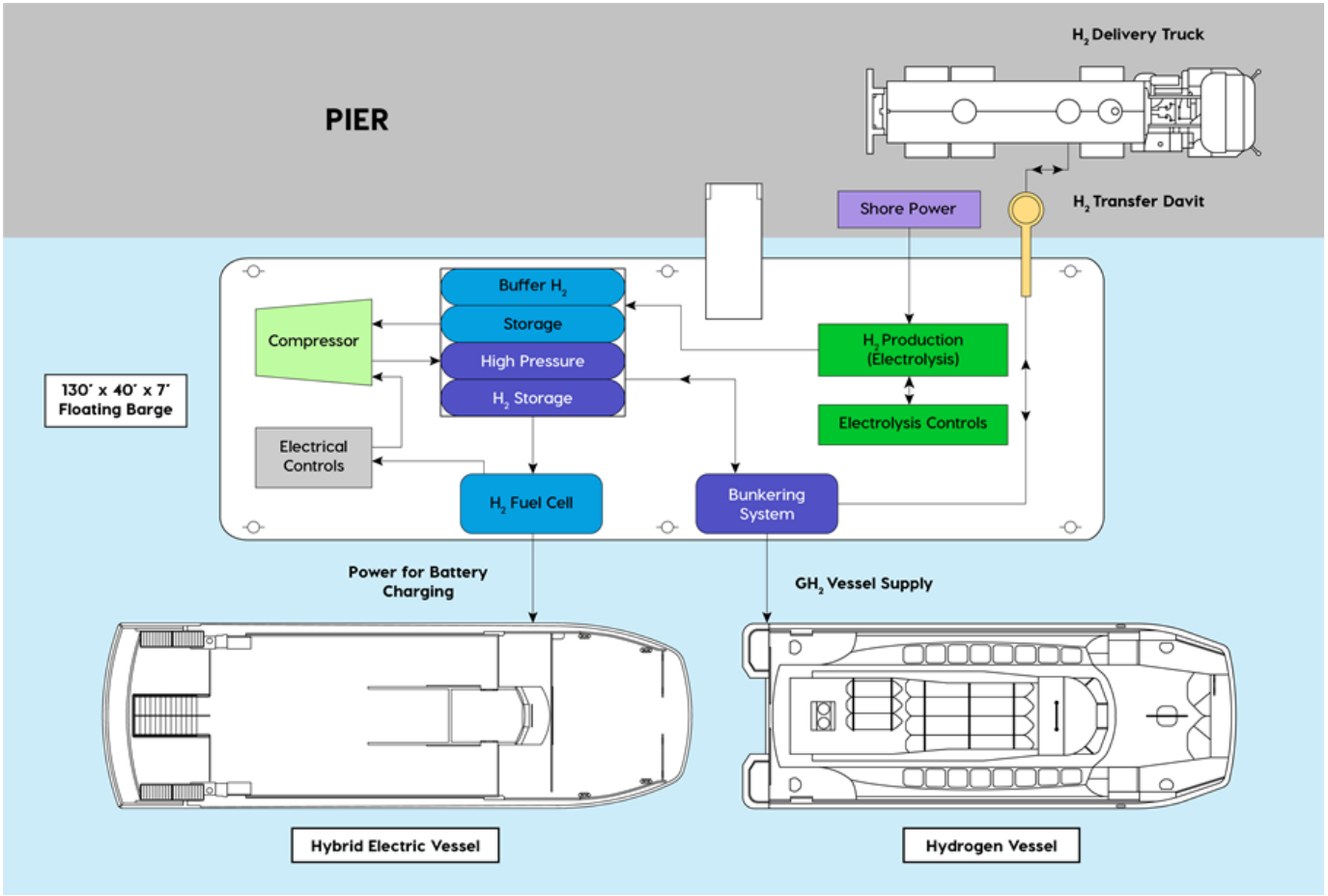
Fuel Cell Room

SF WATERFRONT MARITIME HYDROGEN DEMONSTRATION PROJECT

I. Demonstrate the feasibility and viability of hydrogen production, storage, and fueling in a maritime context.

II. Stimulate and develop a sustainable green hydrogen ecosystem in the San Francisco Bay Area

- ✓ Total 500 kg/day renewable hydrogen at 450 bar.
- ✓ 200 kg/day dedicated to hydrogen maritime vessels.
- ✓ 300 kg/day for ecosystem development to support land-based fuel-cell applications (motive and stationary).



THANK YOU!

Questions?

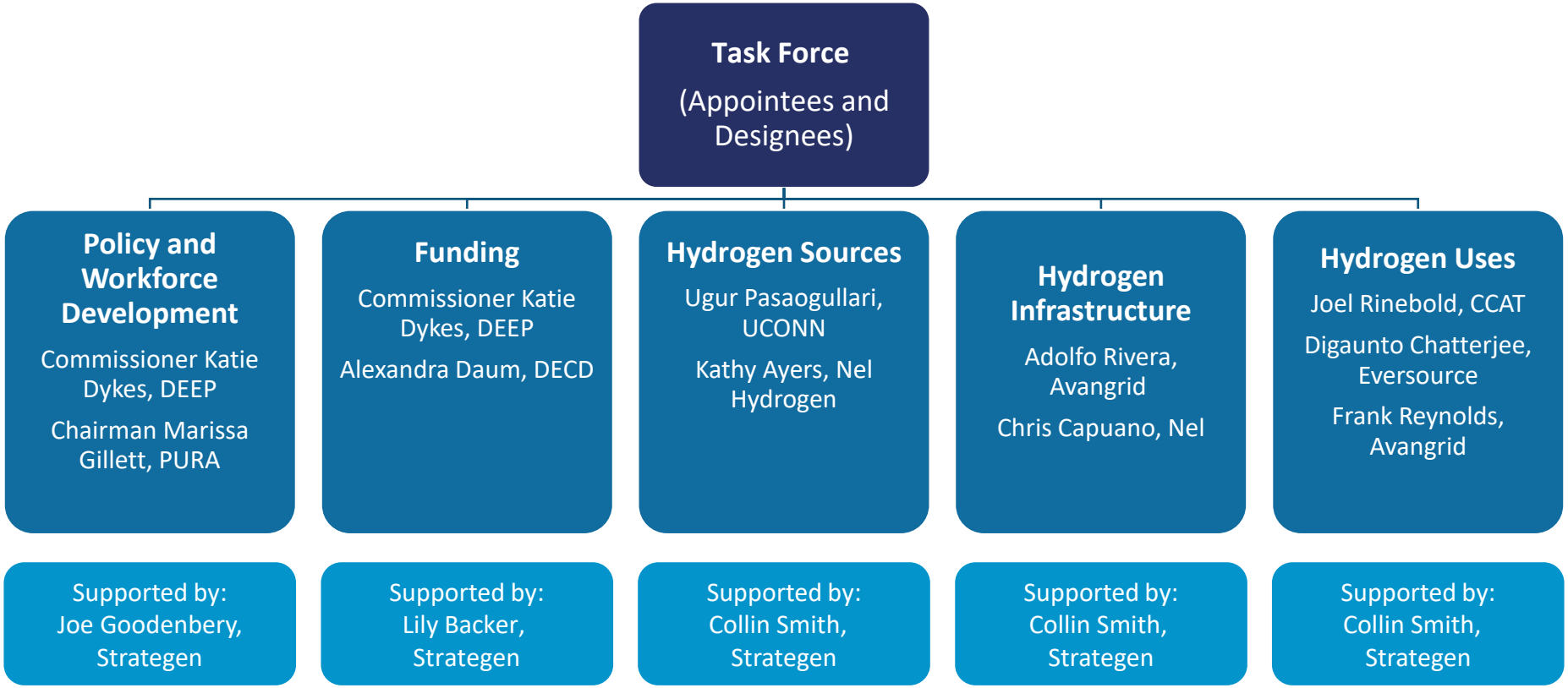
Kristin Hertz, PhD
Manager, Hydrogen and Material Sciences Department
Sandia National Laboratories
Office: (925) 294-4535
Mobile: (925) 667-6186
klhertz@sandia.gov
Pronouns: she/ her

https://energy.sandia.gov/programs/sustainable-transportation/hydrogen/

Environmental Justice and Equity – A Discussion with Bridgeport

Working Group Updates

Working Groups are coordinated and supported by Strategen



Public Working Group meetings kicked off in September and will be held monthly

	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	

We are starting to visualize how Working Group efforts will inform a final report

The Report is expected to include the following sections:

1. Executive Summary
2. Background and Motivation
3. Process
4. Findings
5. Recommendations

Findings are expected to cover:

- Research and analytical findings surfaced in working group meetings
- Stakeholder feedback
- Areas of consensus and majority-minority views

Recommendations are expected to cover actions on:

- Policy
- Workforce development
- Incentives
- Infrastructure priorities
- Updates to Brownfield Loan Program
- Facilitating high priority offtake
- Safety
- Incorporating hydrogen into planning processes
- Improving EJ and equity outcomes
- Community engagement
- Just transition
- Additional consensus building activities

Objective and Intent of Policy Guiding Principles

+ The objective of this Task Force is to develop recommendations for the legislature, including potential policy actions that can be taken at the legislative or regulator levels

+ To be most effective, recommendations should align with the intent of existing state policy as well as the trajectory of under-development hydrogen policy

+ The objective of Policy Guiding Principles is to clarify for all WG Chairs, Task Force Members, and participants how to focus recommendations to best align with the above by indicating:

- Areas of state policy or law that should be incorporated into planning processes

- Areas of state policy or law that are known to need update or additional assessment to appropriately incorporate and address hydrogen-related opportunities

- Areas where additional stakeholder engagement, record building, and consensus may be necessary

+ It should be noted that this Task Force and associated working groups are not intended to replace the stakeholder engagement process used to develop and vet updates to state policy; rather, the Task Force will surface ideas for consideration on how to incorporate hydrogen into a clean energy economy in CT

+ It is the intent of this Task Force to create appropriate transparency for stakeholders and to ensure that appropriate transparency is created during any subsequent related policymaking activities

Proposed Policy Guiding Principles

+ *All final recommendations from working groups should:*

1. Be in compliance with relevant state statutes and regulations, or identify changes that would enable compliance
2. Align with state policy and active regulatory proceedings
3. Identify any fundamental underlying policy or regulatory challenges or potential enablers
4. Identify expected impacts to active policy proceedings
5. Identify or recommend relevant regulatory stakeholder proceedings that could be used to allow for additional review and vetting, or identify the need for new procedural avenues

Policy and Workforce Development Working Group

Connecticut policy provides general ecosystem support for the development of clean hydrogen

- **Public Act 22-5 (2022)** requires 100% zero emission electricity supplied to electricity customers in the state by 2040.
- **Conn. Gen. Stat. 22a-200a. (2019)** requires greenhouse gas emission reduction of 45% by 2030, 80% by 2050 below 2001 levels.
- **Renewable Portfolio Standard.** Sets renewable targets for resources including fuel cells, which are included in the definition of Class I Renewable Resource in Conn. Gen. Stat. 16-1.
- **Conn. Gen. Stat. 22a-174-22e (2016) & Conn. Gen. Stat. 22a-174-22f (2016)** set limits for NOx of emissions from fuel-burning equipment at major stationary sources of NOx (e.g. combustion turbines).
- **Multi-State Medium and Heavy Duty Zero Emission Vehicle MOU.** Sets goals to achieve 30% ZEVs by 2030 and 100% by 2050.

Workgroup Discussion Questions were intended to identify any gaps in proposed Policy Guiding Principles

+ Do the proposed policy guiding principles achieve the objectives and intent as laid out previously? If not, what changes could support achievement of those objectives?
+ Are there any policy guiding principles that would be particularly applicable for specific other Working Groups (Uses, Sources, Infrastructure, Funding)?
+ What are the relevant state statutes and regulations that should guide the proposed guiding principles?

The Uses Working Group is evaluating twelve hydrogen end use applications to identify priority end uses

Hydrogen End Uses	
Power Generation (i.e. combustion turbines)	Industrial Heat (100% hydrogen blends)
Light-Duty Vehicles	Heavy-Duty Vehicles
Maritime Shipping	Aviation
Material Handling Equipment (e.g. forklifts)	Rail
Critical Facilities (e.g. hospitals, telecom towers)	Buses
Low-level Pipeline Blending	Residential/Commercial Heat (100% carbon-hydrogen blends)

Some end uses may not use hydrogen directly but instead use hydrogen-derived fuels.

End uses applications will be prioritized based on their performance against eight evaluation criteria

Criteria	Definition
Cost-Effectiveness Compared to Alternatives	Lifecycle cost of a hydrogen-based technology compared to the most likely alternative decarbonization solution
GHG Reduction Potential	Magnitude of the opportunity to reduce in-state GHG emissions by switching to green hydrogen
Technological Maturity / Commercial Readiness	Speed at which a hydrogen-based technology can be commercially deployed
Infrastructure Requirements	Extent to which ancillary infrastructure is needed to enable hydrogen use
Environmental Justice	Pollution impact on disadvantaged and frontline communities from switching to hydrogen
Workforce Development	Impact on local employment opportunities
Resilience Benefits	Value of fuel diversity in improving resilience to inclement events (e.g. storms, fuel shortages, supply chain risk)
Safety Regulation	Extent to which deployment of hydrogen for a particular end use would require additional safety protocols

All end uses will be ranked numerically on a three-part scale (e.g. 1/2/3 or 0/5/10)

Cost-effectiveness will be incorporated as a “gating criteria” in evaluation process

Assessed via literature review of:

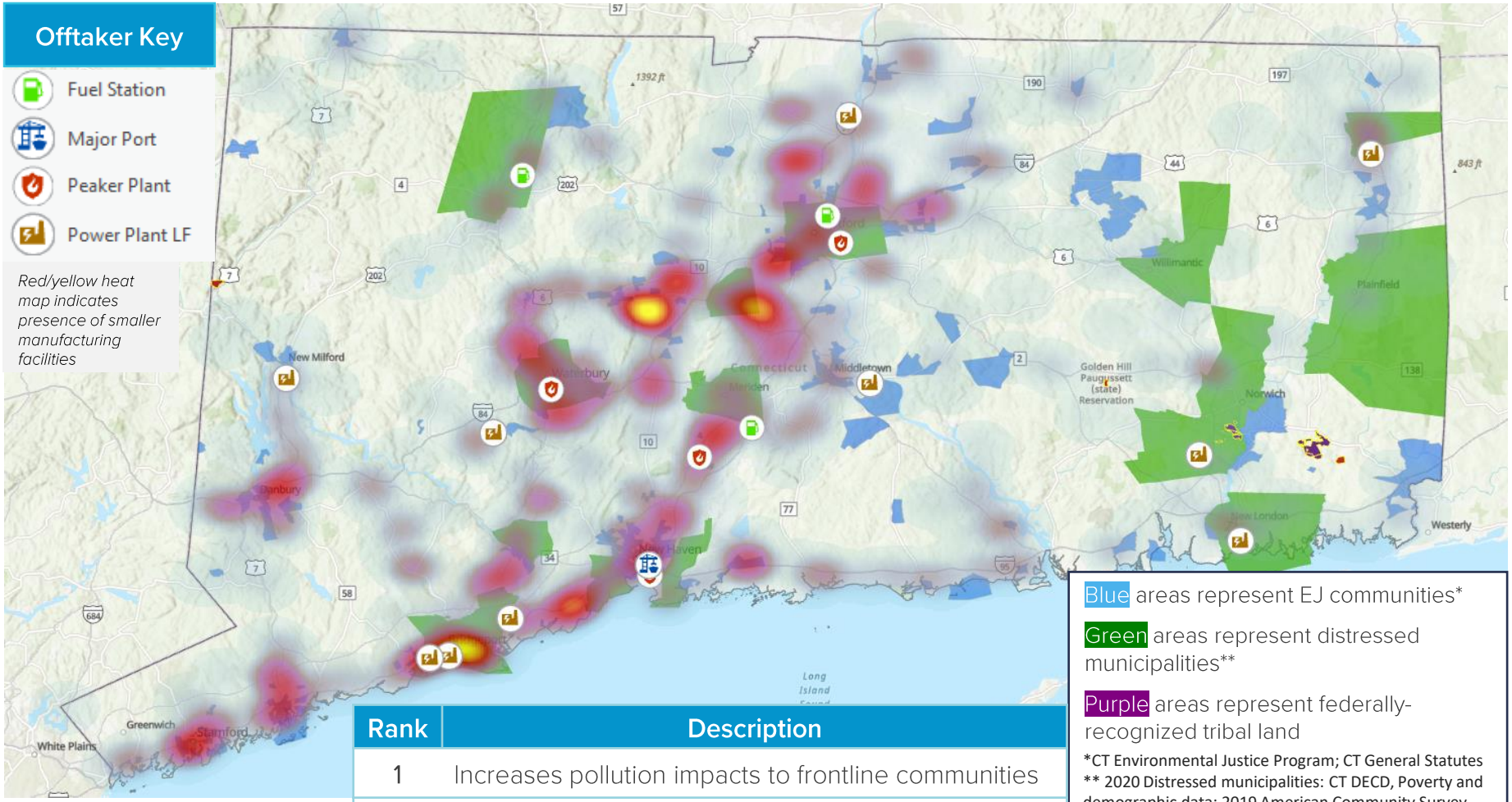
+ **Techno-economic analysis comparing hydrogen technologies to most likely decarbonization alternative (e.g. electrification)**
+ **System-level modeling of most cost-effective uses for hydrogen in advancing national decarbonization**

Rank	Description
1	Alternative is more cost-effective / preferred
2	Uncertainty / Ongoing competition
3	No alternative / Alternative is not feasible

Given the importance of cost-effectiveness for scaled adoption and efficient infrastructure deployment, this is proposed as a **“gating criteria”**:

Any end use that does not score above a “1” will be excluded from future analysis

Environmental Justice criteria will consider impacts to frontline communities associated with hydrogen usage



Rank	Description
1	Increases pollution impacts to frontline communities
2	Does not change level of localized pollution
3	Reduces pollution impacts to frontline communities

Public Comment

CATALYST H_2 November 14-16 | Hotel Maya in Long Beach, CA

Invitation: Accelerating North America's Green Hydrogen Economy

Sessions Include:

- Greening Ports and Maritime Shipping with Green Hydrogen
- Seasonal Renewable Energy Storage with Green Hydrogen: Update on ACES Project in Delta, Utah
- Innovations in GH2 Transport and Storage
- Goodbye Fossil-Fueled Backup Generators

Tour Fenix Marine Services, the second largest container terminal at the Port of Los Angeles, to see the potential of green hydrogen to decarbonize ports operations (11/14).

Cost should not be a barrier to participation! If you represent an environmental justice, tribal, labor, or environmental organization and would like to request a complimentary ticket, please reach out (lbacker@ghcoalition.org)

https://catalysth2-hydrogen.com/

Engage

Organizing Tours of Various Facilities

FuelCell Energy

C2E2 Center for Clean Energy Engineering

PROTON PART OF nel ON SITE

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Next Meeting – November 8, 2022

Dial-In
(949) – 346 – 4134
ID: 781 548 359#

Webinar
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Meeting ID: 276 913 467 857
Passcode: QgeLuG

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314 Rope Ferry Rd.
Waterford, CT 06385

Dominion Energy®

For access to Task Force materials, visit:

www.ctgreenbank.com/hydrogentaskforce

Thank You

Connecticut Green Bank
75 Charter Oak Avenue, Hartford
(860) 563-0015
www.ctgreenbank.com
www.greenlibertybonds.com

Appendix: Bridgeport Regional Energy Partnership Hydrogen Hub Recommendations

In Response to CT DEEP Request for Comment on Hydrogen Opportunities

BRIDGEPORT:
Aspiring Spoke in North East H2Hub

Presentation for Bridgeport Regional Energy Partnership:

Adrienne Farrar Houël: President & CEO Greater Bridgeport Community Enterprises, Inc.
Hon. Joseph Gresko: CT House of Representatives, 121st District &
Co-Chair Environment Committee
Jeffrey Leichtman: Representing Bridgeport Regional Business Council

April 6, 2022

Summary of Recommendations

- That the proposed New England H2Hub include Bridgeport as an experienced and responsive home for clean energy production and job training programs.
- That H2Hub partners integrate the principles of Justice 40 and EEEJ principles into their programs and delivery systems in the Bridgeport region and throughout participating communities and states
- That H2Hub partners ensure that the benefits of the new Hydrogen Economy accrue to the communities hosting new energy technologies and document the outcomes for the people most impacted.

Bridgeport: A Leader in Sustainability, Clean Energy and Resiliency

- **2008**: Mayor's Executive Order & all-of-community **BGreen 2020** Planning & Implementation effort, in collaboration with the Bridgeport Regional Business Council
- **2010**: Recipient of the Governor's Climate Change Award
- **2013**: One of 13 U.S. communities selected by HUD for 'Rebuild by Design' resilience planning
- **2023**: we will have more than 35 MW of renewable energy in our community with more on the horizon
- City has full time sustainability staff, are no strangers to energy innovation, and are preparing to enter the Hydrogen Economy!

Bridgeport : Clean Energy Pioneer

We have produced many clean energy projects over the last 12 years:

Home to…….

- 1st large-scale 15 MW grid connected fuel cell project in the U.S.
- 9000 unit solar panel & fuel cell farm on our closed municipal landfill; 5 MW
- District Heating & Cooling Loop: using waste heat from a 10 MW fuel cell, begins construction in 2022, providing clean energy to the grid, UB campus & City center
- PosiGen: solar development for low-income residential properties, over 1300 installations in the region
- Park City Wind: nation's first wind energy project off MA coast facilitating creation of our hydrogen economy
- Energy efficient school facilities: schools built since 2010 are LEEDs Silver or higher
- University, commercial properties powered by onsite, clean renewable generation
- Largest user of Green Bank and C-Pace funding in the State: more than $20 M in direct public investments leveraged to $320 M in private sector development
- Bridgeport Harbor coal fired power plant was closed in 2021

H2Hub: Deployment Focal Points in Local Distressed Communities:

an objective of the USDOE & Northeast H2Hub Proposal

- Bridgeport is a Distressed Community and an Environmental Justice Community designated by the State of CT
- It is a poverty-stricken community with a poverty rate as high as 21% while the poverty rate for the state of CT is 10%. Unemployment for Bridgeport was at 7.6% for February 2022 while the state's rate was 5%
- Bridgeport is Energy Burdened at the overall rate of 6.2% with some residents paying as much as 10-15% of household income for energy costs (2019 ACS)
- There are 8 Affecting Facilities in this geographically small city of 17 sq. miles. All are located in the southern, shoreline districts of the city, along I-95, the biggest polluter of all.

Bridgeport Regional Energy Partnership

The Bridgeport Regional Energy Partnership (BREP) is an **all of community** effort to develop a Clean Energy Strategy & Implementation Plan to address the 21st Century energy infrastructure needs of the Bridgeport region in an environmentally and socially responsible manner under the umbrella of Justice 40 Presidential Executive Orders.

BREP's Mission:

- lessen the energy burden of Bridgeport families and increase the opportunities to create local jobs in the new energy-efficient-focused economy.
- promote government and private investment in safe and environmentally responsible projects that reduce our carbon footprint & energy consumption
- create a clean energy economy that maximizes renewable energy generation and lowers the health risks and environmental impacts on our residents.

BREP members include city & state officials, business leaders, not for profit agencies, university and workforce development organizations, neighborhood leaders, energy industry stakeholders, and technical experts. Members are working in 3 subcommittees:

- Energy Efficiency / Energy Burden
- Clean Energy Planning, Development and Resilience
- Enhanced Manufacturing & Workforce Development

Bridgeport Aligned with USDOE Hydrogen Shot and EEEJ Goals

- Equity Environmental and Energy Justice has produced 8 policies that it invites us to put in our own order:
  - Increase energy democracy, including community ownership
  - Decrease environmental exposure and burdens
  - Increase parity in clean energy technology access and adoption
  - Increase access to low-cost capital
  - Decrease energy burden
  - Increase energy resilience
  - Increase clean energy job pipeline and job training for individuals
  - Increase clean energy enterprise creation

Re-Ordering Should Reflect Our Community Needs – Debate to Have

1. Combine increase in energy democracy along with parity in clean energy technology access and adoption. This is why our inclusion in the Hydrogen Hub is crucial.

2. Next would be decrease environmental exposure and burdens combined with increase in energy resilience.

3. Increase clean energy job pipeline and Job training

4. Lastly, we would combine increase in access to low-cost capital with increase in clean energy enterprise creation (which would increase the energy job pipeline!)

Equity, Environmental, & Energy Justice Priorities

What strategies, policies, and practices can H2Hubs deploy to support EEEJ goals?

As the planning and implementation of the H2Hubs rolls out, the

- Create a **workplan** to include presentations and explanations of process and benefits to the community as outlined.
- The **Justice 40** principals are relevant to the implementation of the hubs/spokes and the steps of meetings, events and surveys should be integrated into a comprehensive program
- **Track** the success of outreach programs which can be measured by attendance and community support for various components in the process of growing the hubs.

Equity, Environmental, & Energy Justice Questions

How can H2Hubs ensure community-based stakeholders / organizations are engaged and included in the planning, decision-making and implementation processes?

Using BREP experience as an example: we intend to acquire technical assistance to produce a community-led energy conservation and clean energy plan followed by implementation. The paths that we choose to follow include:

- ❑ Clean Energy Planning and Development
- ❑ Energy Efficient Buildings & Beneficial Electrification Planning & Development
- ❑ Clean Transportation Planning & Investment
- ❑ New or Enhanced Manufacturing

These pathways are covered in the BREP sub-committees

Equity, Environmental, & Energy Justice Questions

How can DOE support meaningful and sustained agreement with H2Hub relevant disadvantaged communities?

BREP is the principal organization through which H2Hub leaders can reach out to our broad-based community. Indeed, community leaders are members of BREP, as are many clean energy generators right now. The dialogue and information spread should take place organically. BREP can be a model for other communities.

The benefits of the hydrogen technology will be the subject of a series of community meetings to which others not currently sitting on BREP may attend. These meetings will be led by Dr. Joel Rinebold, and will be accessible by virtual platform and in person.

Ongoing engagement with neighborhood leaders through peer-to-peer networks such as Sustainable Communities, already operating in Bridgeport, and our well-established Neighborhood Revitalization Zones are also valuable outreach vehicles.

THANK YOU

- Adrienne: houel@greenteambpt.com
- Joe: joseph.gresko@bridgeportct.gov
- Jeff: jeff@globalisllc.com

Appendix: Uses Working Group End Use Evaluation Framework

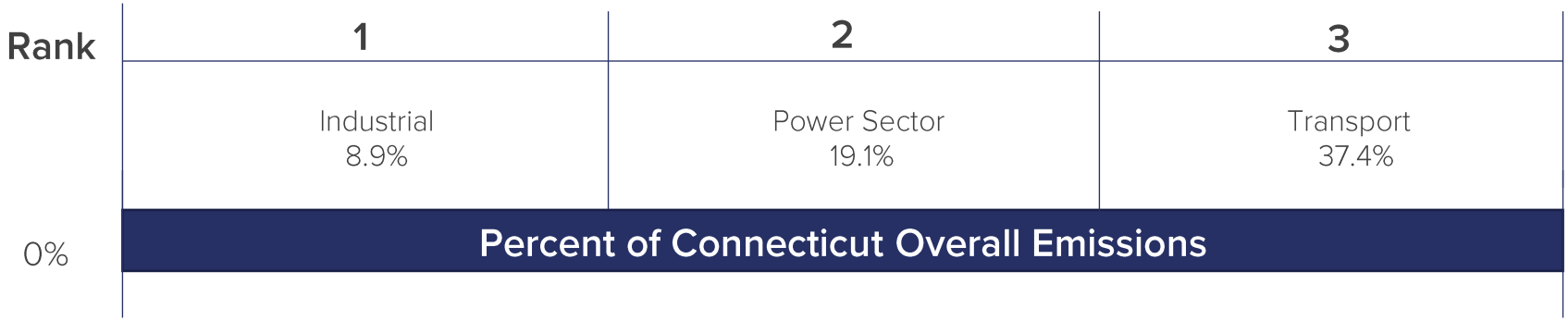
Custom rankings systems have been developed for each criteria

Criteria	1 / Lowest Rank	2 / Median Rank	3 / Highest Rank
Cost-Competitiveness Compared to Alternatives	Alternative is cost-effective / preferred	Uncertain / ongoing competition with alternative	No alternative / alternative not economically feasible
GHG Reduction Potential	Lowest third of CT's GHG emission sources	Middle third of CT's GHG emission sources	Highest third of CT's GHG emission sources
Technological Maturity / Commercial Readiness	Deployment Timeline: Now-2030	Deployment Timeline: 2030-2040	Deployment Timeline: 2040-2050
Infrastructure Requirements	No new infrastructure needed	Infrastructure needed at a limited number of sites	Statewide infrastructure development required
Environmental Justice	Increases pollution impact to frontline communities	Does not change level of localized pollution	Reduces pollution impact to frontline communities
Workforce Development	Reduces workforce need	Keeps workforce need the same	Increases workforce need
Resilience Benefits	Resilience is not a major consideration	Resilience is valuable but not critical	Resilience is a critical need
Safety Regulation	No new safety regulations needed	New safety regulations needed, but same as would be required for the most likely alternative	More safety regulations are needed than for the most likely alternative

GHG Reduction Potential

- **Evaluated as a function of a sector's contribution to CT's overall emissions**
  - Fuel-switching in end uses with a higher share of statewide emissions would be scored higher
  - Ranking determined by aligning use cases according to their emissions contribution, 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

- Faster deployment is preferred to accelerate market deployment
- Factors in both technological maturity and commercial readiness of a particular technology
- Can be determined through literature review and sub-divided based on period of expected deployment

Ranking	Description
3	Now-2030
2	2030-2040
1	2040-2050

Infrastructure Requirements

- 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)

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

Workforce Development

- Similar to Environmental Justice criterion, 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

Ranking	Description
1	Reduces local workforce need
2	Keeps local workforce need the same
3	Increases local workforce need

Resilience Benefits

- 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

Ranking	Description
1	Resilience is not a major consideration
2	Resilience is valuable but not critical
3	Resilience is a critical need

Safety Regulation

- Hydrogen has been commercially produced and used in the U.S. for several decades, but applying it to new applications will likely require new protocols to ensure it is used safely
- Hydrogen use can be prioritized in areas where fewer additional regulations are required, or where a relatively safer alternative is not available

Ranking	Description
3	No new safety regulations needed
2	New safety regulations needed, but same as would be required for the most likely alternative
1	More safety regulations are needed than for alternative