



PHMSA/DOT WORKSHOP Hydrogen & Emerging Fuels R & D

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Key Actions Needed for Decarbonization in the NG Industry

Methane Leak Detection and Emissions Mitigation

- Advances in Leak Detection
- Quantification & Validation of 3rd Party Measurements on Methane Emissions
- Understanding of LDC Emissions Factors

Energy Efficiency

- Appliances
- Power/heat pump systems
- Building Construction

Renewables and Low Carbon Fuels

- Solar, Wind, Geothermal
- Renewable Natural Gas
- Clean H₂

Potential Industry Timeline?

Goals are set; N.American projects planned; and several being implemented



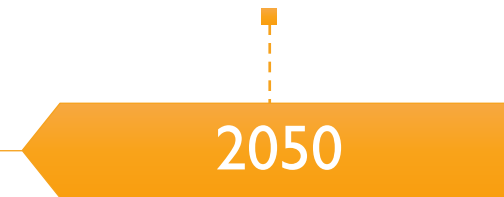
RNG, Grey H2

RNG, Blue H2



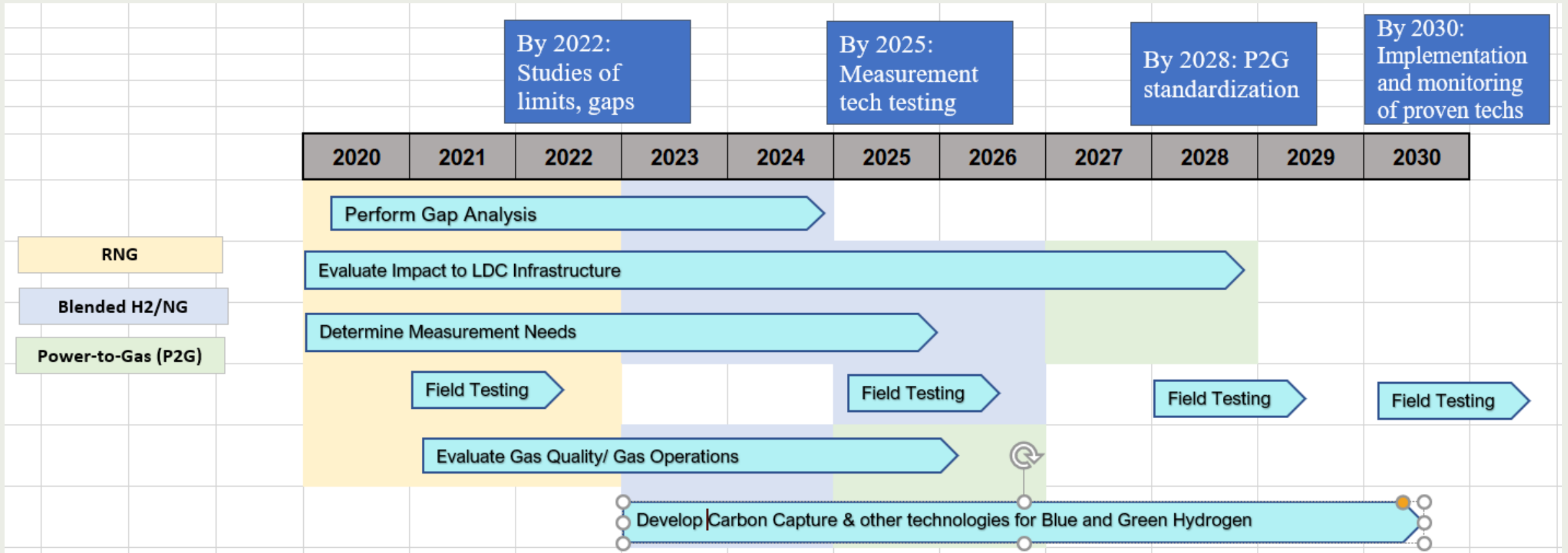
Partial Reduction; more results on realistic technical and economic potential of reaching aggressive goals

Net Zero Carbon Emissions in selected states? 80% reduction in others?



Green H2 using RNG, renewables, etc.

NYSEARCH Program Timeline



2021 Low Carbon Fuels Program Objective: Explore Paths to Carbon Neutrality and Conversion of Infrastructure

Gaps

- Full inventory and knowledge gathering on impacts of Emerging Fuels on Gas Operations
- Scaling of laboratory work to testing live conditions in the Field
- Assessment and Improvement of economics that lead to practical application of Green Hydrogen and Expanded application of Renewable Natural Gas (RNG)
- Pilot tests & implementation
 - Blended Hydrogen at 20% blends and higher
 - Carbon Capture Options
 - Advanced Technologies to Reduce Methane Emissions

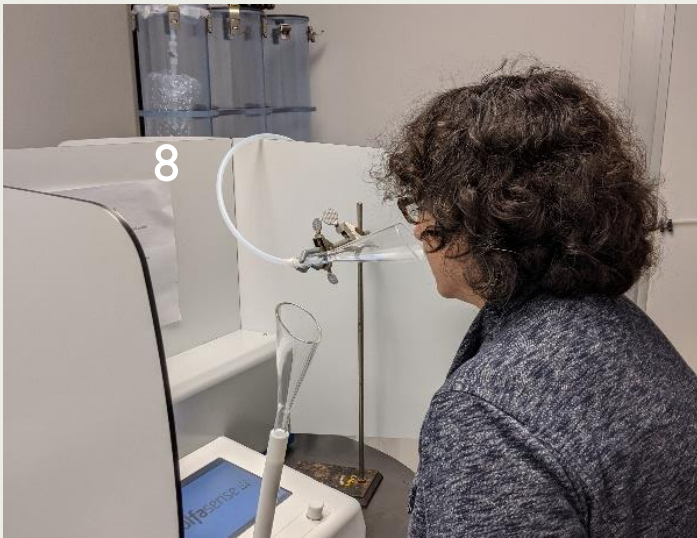
NYSEARCH FUNDED PROJECTS

Hydrogen - Natural Gas Living Lab

- **Objective:** To analyze & report data on the impacts of hydrogen blending (greater than 20 vol%) by evaluating safety, maintenance and emergency response on gas distribution infrastructure and appliances
- **Project Basis:** Controlled testing to evaluate any impact to typical pipeline components exposed to higher levels of hydrogen
- **Expected Outcomes:** Determine feasibility of blending and injecting hydrogen (up to 20% by vol. or more) into the existing natural gas infrastructure by simulating system operations



Odor Detection Study – Effect of Hydrogen Blends on Odorizing NG

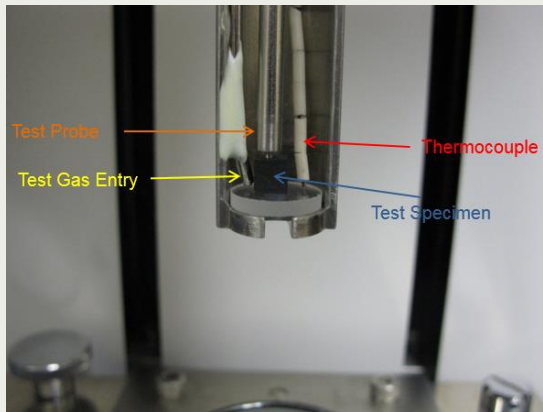


- **Objective:** To determine the detectability and recognizability of some primary NG odorant/odorant blends in the presence of hydrogen (Example blends: TBM/THT, Scentinel-N, Scentinel F-25)
- **Contractor:** Monell Senses Center
- **Expected Outcomes:** Comparable data for different blends of H₂ starting at 10% using TBM/THT (and other mercaptans) to traditional Odor Detection and Recognition Threshold information from base project
- **Timing to achieve results:** June 2022
- **Potential Future/Related Project(s):** If warranted by funders, test additional blends or 100% H₂ using same Odor Detection and Recognition Threshold protocols

Impact of Hydrogen/Natural Gas Blends on LDC Infrastructure Integrity



- **Objective:** Determine if blending hydrogen into a fuel gas will change the physical properties of elastomers used as materials of construction in a natural gas delivery system
- **Contractor:** Gas Technology Institute (GTI)
- **Expected Outcomes:** Knowledge and quantification of changes to physical properties of elastomers in LDC networks
- **Timing to achieve results:** June 2022
- **Potential Future/Related Project(s):** If warranted by funders, test additional H₂/NG blends using same or expanded materials testing protocols (e.g. wider range of temperatures and pressures)

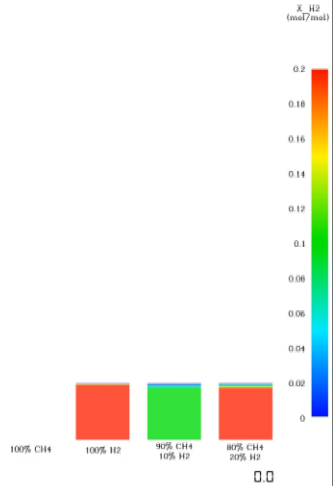


Impact of Blended H₂ on Threaded Connections

- **Challenge:** Does blended hydrogen increase the risk of leaks at threaded connections and is the flow rate of the leak greater?
- **Objective:** Evaluate the impact of blended hydrogen at threaded connections by determining failure rate and flow rate through experimentation and statistical analysis.
- **Expected Outcomes:** Insight into leak behavior at threaded connections with blended hydrogen
- **Timing to achieve results:** December 2022



Impact Of Hydrogen On Natural Gas Dispersion In A Residential Structure



Objective: Study physics of hydrogen and map dispersion of Natural gas blended with up to 100% Hydrogen.

Contractor: Fire Risk & Alliance

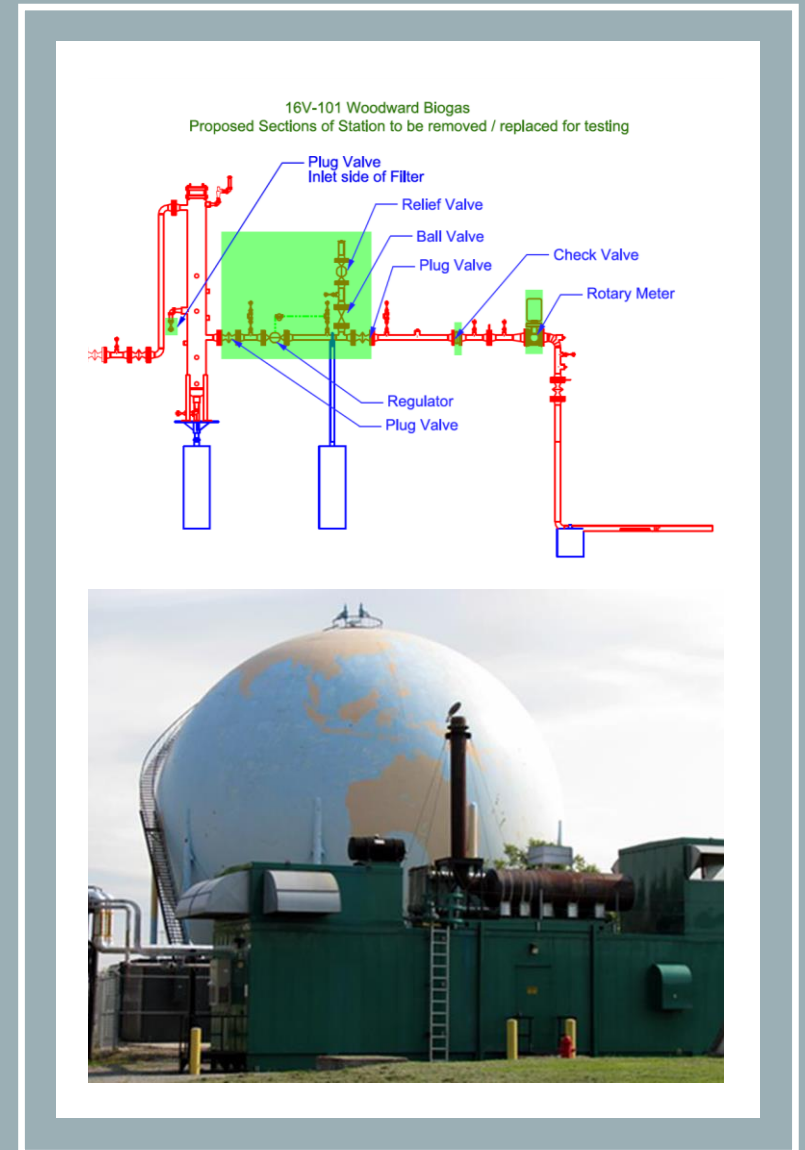
Expected Outcomes: Characterization of Natural gas-hydrogen gas blend behavior post leak in a residential setting & response time of a methane detector

Results of current phase: Dec 2021

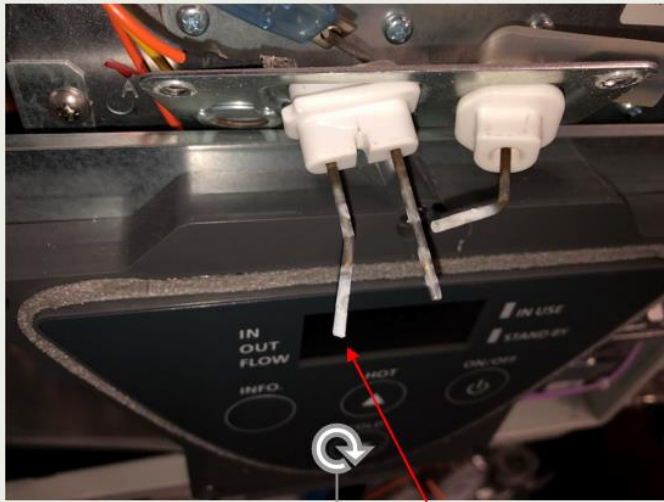
Interim Results: Bench Top Testing Complete – No separation of NG-H₂ blend observed at low emission rates

Biomethane Data Collection Project - Completed

- **Objective:** Collect and share data about the impact of biomethane from various feedstocks at varying levels of blending with pipeline gas on a) at the point of custody transfer b) on piping components and materials that are part of the downstream line system (between custody transfer and end use meter)
- **Project Basis:** Umbrella Project to gather data on RNG injection effects and feedstock relation
- **Outcome:** Analysis of material integrity
- **Results:** RNG produced by the Hamilton wastewater treatment plant had no significant detrimental impact on the components & associated materials



Testing Of Residential Appliances For Impact Of Siloxanes - Completed



Silica deposits on flame rod and on flame holder. Images from first failure at 519 fired hours.



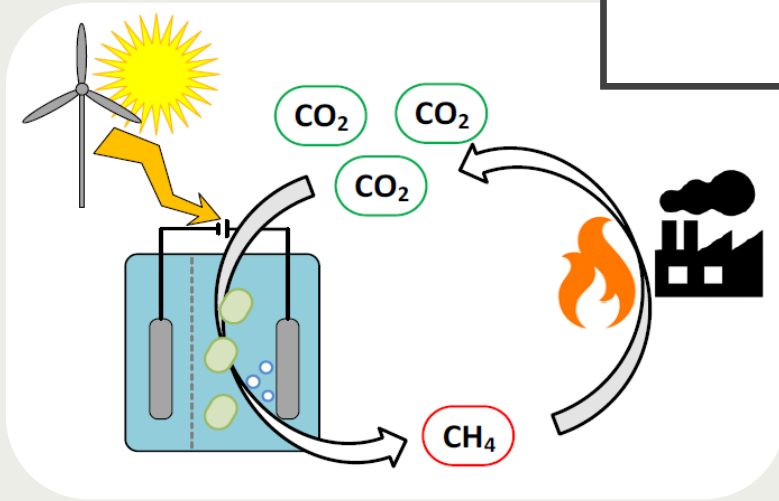
- **Objective:** To determine the maximum concentration of siloxanes in RNG that precludes significant safety, reliability, performance, and maintenance impacts to North American residential appliances.
- **Contractor:** eTa Partners, Primaira Labs, DNV
- **Project Basis:** Risk Assessment studies by DNV on European **Appliances**, difference in materials & function of North American gas appliances
- **Outcome:** Define maximum concentration of siloxanes in RNG that precludes significant safety, reliability, performance, and maintenance impacts to residential appliances.
- **Results:** Limit set at 0.1 mg Si/m^3 . Identified one sensitive appliance type at extreme conditions.

Study Impact of Trace Constituents in RNG

- **Challenge:** Define Interchangeability for RNG
- **Objective:** Study the impact of trace constituents in RNG and traditional pipeline gas on LDC infrastructure and customer appliances
- **Expected Outcomes:** Appropriate trigger limits for the deleterious trace constituents to preclude any safety or maintenance risks on LDC infrastructure and gas appliances
- **Interim Results:** Gap Analysis on impact to network integrity & end use gas appliances – COMPLETE
- **Status:** Experimental Testing planned for Ammonia, Halides, Terpenes, Aldehydes & Ketones



Scaling of Microbial Power-to-Gas Conversion for Long-Term Operation



- **Challenge:** Can the natural gas infrastructure be adapted with localized microbial power to gas units to convert and store excess renewable electricity as RNG?
- **Objective:** To evaluate microbial electromethanogenesis as a viable method for power-to-gas operations specifically evaluating the chemical and biological changes associated with electricity intermittency
- **Contractor:** Stanford University
- **Expected Outcomes:** A deep technical understanding of how the *maripaludis* microbes behave under stress and during starvation periods in production of natural gas. With this knowledge, pursue scale up efforts for testing and application within gas distribution system.
- **Timing to achieve results:** December 2022

Identification & Development of a Siloxane Analyzer

- **Challenge:** Measure siloxane concentration in RNG with accuracy and precision.
- **Objective:** To identify a suitable technology, technology provider and workplan to develop a siloxane tool, preferably portable, that can measure concentrations of siloxanes at regulated threshold levels (as low as 0.1 mg Si/m³)
- **Project Basis:** Wide range of limits across LDC's in North America. California CPUC requesting scientific justification of existing limits
- **Expected Outcomes:** Identify a pre-commercial siloxane analyzer prototype that fits LDC needs





Renewable Natural Gas (RNG) Living Lab

- **Challenge:** Ensure operational safety & reliability while injecting RNG into the distribution system
- **Objective:** To monitor the immediate and long-term impacts of direct injection of biomethane on LDC's infrastructure systems via a "living laboratory" environment
- **Project Approach:** Demonstration to evaluate any impact to typical pipeline components exposed to 100% RNG & NG over a period of (5) years
- **Expected Outcome:** Real time comparison of the effects on materials in the gas infrastructure



Summary & Recommended Gaps



- High interest from NYSEARCH members in our collaborative playing a role in DeCarbonization particularly in gas operational areas where we have base programs
- Need for fast paced project development and implementation
- Need for government funding and support of DeCarbonization pilot programs
 - H2 Living Lab
 - Pilot tests for Carbon Capture & Sequestration
 - Pilot tests for Technologies that Reduce/Eliminate Methane Emissions