

**DOCKETED**

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# PG&E Gas R&D Hydrogen Efforts

2021-06-17



Together, Building  
a Better California

## GTI Compact Hydrogen Generator

*2019 – Present*

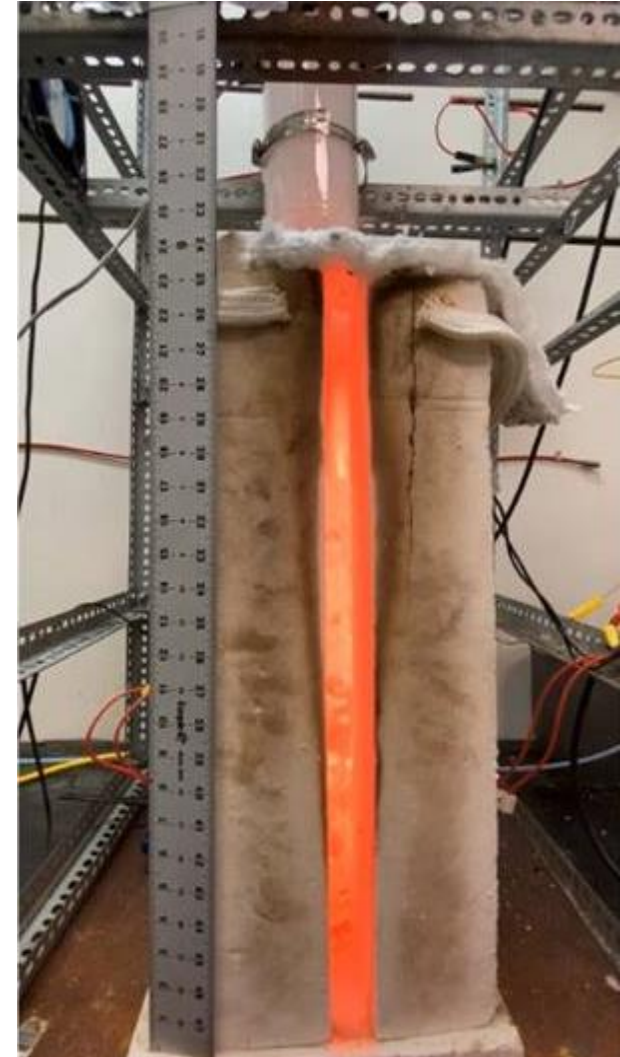
- Modular heat engine for direct conversion of natural gas to hydrogen and power using hydrogen turbines
- Phase 1 – Technoeconomics of system
- Phase 2 – demo in-situ H<sub>2</sub> storage for load following and clean power generation



## CZERO Methane Pyrolysis

*2019 – 2020*

- Generate hydrogen and solid carbon from natural gas through methane pyrolysis using molten salts.
- Scale-up reactor and explore cement market for carbon co-product .



## HYREADY Joint Industry Project – Engineering guidelines for hydrogen blending

2017 - Present

- Complete: Transmission, Distribution, End use equipment, Compression
- In Progress: UGS, Interconnection Facilities, 100% Transmission

HyReady Single point of knowledge for mixing hydrogen in natural gas systems

Zoeken

Log out

HOME GUIDELINES COMPONENTS MATERIALS SYSTEM LEVEL ASPECTS PROJECTS  
REFERENCES ABOUT

HOME / GUIDELINES

### Guidelines

**Filters**

YOUR INFRASTRUCTURE FOCUS  
Any

COMPONENT  
Any

MATERIAL ISSUES  
Any

STATE OF KNOWLEDGE  
Any

Sort by risk  
AIMED H<sub>2</sub> FOR YOUR SYSTEM  
Any 2% 5% 10%  
20% 30%

SORT ORDER  
High to low risk

Go

TRANSMISSION  
**8.1.3. High strength steel >**  
Adding hydrogen to pipelines made of material X80 and higher is not recommended. Small amounts of hydrogen can influence toughness of the steel considerably [7].  
Applicable to: Steel pipe

2 vol% H<sub>2</sub> 5 vol% H<sub>2</sub> 10 vol% H<sub>2</sub> 20 vol% H<sub>2</sub> 30 vol% H<sub>2</sub>

TRANSMISSION  
**8.3. Flanges >**  
For Flanges adding hydrogen up to 10% is acceptable for seals/gaskets used in the natural gas system [65]. The flange itself is made of material similar to the pipe material, refer to 8.1 for suitability. As hydrogen is a much smaller molecule as methane, permeation through the gasket will increase compared to methane.  
Applicable to: Flanges

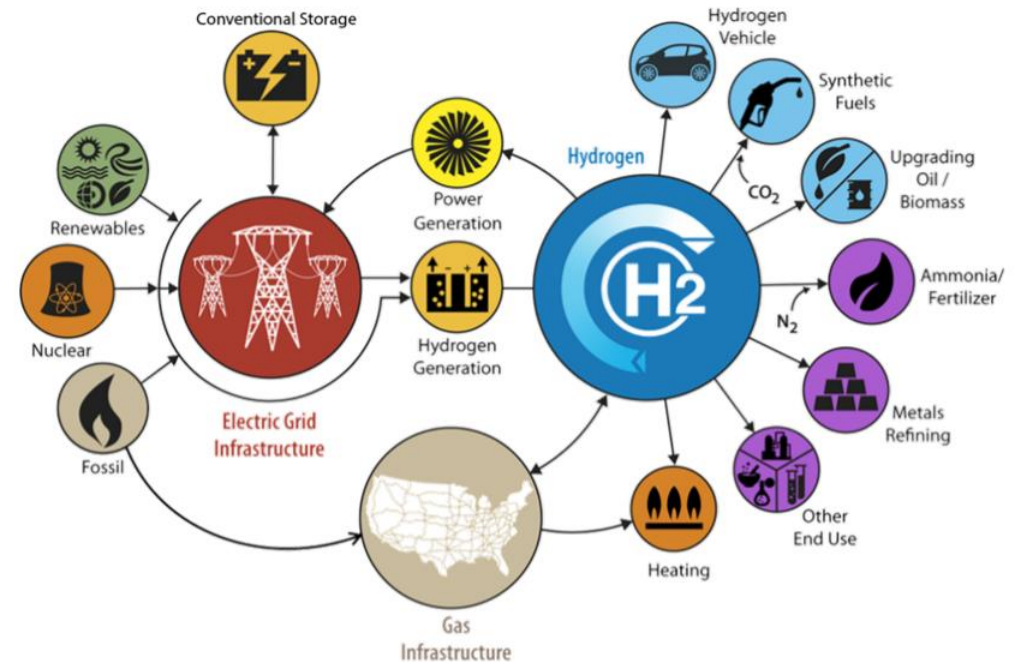
2 vol% H<sub>2</sub> 5 vol% H<sub>2</sub> 10 vol% H<sub>2</sub> 20 vol% H<sub>2</sub> 30 vol% H<sub>2</sub>

TRANSMISSION  
**8.1.2. Medium strength steel >**  
Adding hydrogen up to 20 vol% does not have negative effects on the integrity of medium strength steel pipelines under operating conditions up to 100 bar with 2 pressure cycles per day (delta K up to 11.3 MPa√m). Adding 30% hydrogen to a pipeline of X70 material influences fatigue behavior to such extent that it is not advised without further research. The expected load of the pipeline should be determined (pressure variations, frequency and lifetime) to determine crack growth rate. Before adding hydrogen the condition of the pipeline should be determined through inspections.  
Applicable to: Steel pipe

2 vol% H<sub>2</sub> 5 vol% H<sub>2</sub> 10 vol% H<sub>2</sub> 20 vol% H<sub>2</sub> 30 vol% H<sub>2</sub>

## NREL Joint Industry Project - HyBlend 2021 - 2023

- Address technical barriers to blending hydrogen in natural gas pipelines.
  - Hydrogen compatibility of piping and pipelines
  - Life-cycle analysis
  - Techno-economic analysis
- \$12.45M from DOE & \$4-5M from participants.







# Hydrogen Blending and Injection

## NYSEARCH RANGE Model Enhancement – Gas Interchangeability Analysis for Appliances

2019 – 2020

- Spreadsheet based interchangeability assessment model to project performance of in-service residential appliance populations
- Hydrogen-natural gas blend test data improve model's predictions for power-to-gas RNG

## NYSEARCH Hydrogen Impacts on Elastomers

2020 – 2021

- Determine if blending hydrogen (<20%) into a fuel gas will change the physical properties of elastomers used as materials of construction in a natural gas delivery system
- Include: material comparative tests

Driver	Limit Analysis	CO Sensitivity	Flame Sensitivity	Summary	Correlations	About	User Guide
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Gas Composition Input:						Limit Criteria (% of appliance population exceeding)X:						
	Min	Low	Base	High	Max							
Carbon Dioxide	4.000	1.000	1.541	0.000	0.000	ANSI CO Standard					6.0	
Oxygen	0.000	0.000	0.000	0.000	0.000	50% of ANSI CO Standard					15.0	
Nitrogen	0.000	2.000	0.000	0.000	0.000	Yellow Tipping					5.0	
Methane	93.000	95.000	94.995	94.000	91.000	Lifting					1.0	
Ethane	2.500	1.000	1.212	4.500	6.000	Pass/Fail Relative To Limit Criteria:						
Propane	0.500	0.500	1.428	1.500	3.000							
i-Butane	0.000	0.500	0.000	0.000	0.000							
n-Butane	0.000	0.000	0.000	0.000	0.000	ANSI CO	2.7%	3.2%	3.7%	5.7%	6.9%	3.9%
i-Pentane	0.000	0.000	0.000	0.000	0.000	50% ANSI	6.0%	7.8%	8.9%	12.0%	13.3%	8.9%
n-Pentane	0.000	0.000	0.000	0.000	0.000	Yellow Tip	1.3%	1.6%	1.6%	2.7%	4.1%	1.6%
C6+ (as n-C6)	0.000	0.000	0.000	0.000	0.000	Lifting	0.8%	0.4%	0.4%	0.3%	0.2%	0.4%
Total	100.000	100.000	99.176	100.000	100.000							





# Hydrogen Blending and Injection

## PRCI Hydrogen State-Of-The-Art Study

2020

**Objective:** Identify R&D needed for companies to safely & reliably inject hydrogen into their pipelines at certain blend levels.

### Technical Subjects

1. Integrity
2. Safety
3. End Uses
4. Metering
5. Network Management
6. Maintenance and Inspection
7. H<sub>2</sub>/NG Separation
8. Underground Gas Storage

[Link to report](#)



# Hydrogen Utilization

## UCR Heavy-Duty Truck Engine Blend Study

2021 – 2022

- Test the impacts of blending hydrogen in natural gas up to 5% H<sub>2</sub> on the emissions and durability of a Cummins L9N 8.9 liter near-zero natural gas engine.
- Phase 1: Emissions Testing
- Phase 2: Durability Testing



## GTI High Hydrogen-Content Fuel in Residential / Commercial Combustion Equipment

2020 – 2022

- Adapt and demonstrate solutions to utilize high-hydrogen (H<sub>2</sub>) blends (> 50% H<sub>2</sub> by volume) and 100% H<sub>2</sub> in residential and commercial combustion equipment



# Thank you

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