DOCKETED	
Docket Number:	23-IEPR-06
Project Title:	Hydrogen
TN #:	252163
Document Title:	Presentation - Hydrogen R&D Projects
Description:	Peter Chen Supervisor, Energy Infrastructure Integrity and Sustainability Energy Research and Development Division September 8, 2023
Filer:	Raquel Kravitz
Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	9/7/2023 2:52:07 PM
Docketed Date:	9/7/2023

Hydrogen R&D Projects

IEPR Commissioner Workshop on the Potential Growth of Hydrogen

Peter Chen
Supervisor, Energy Infrastructure Integrity and Sustainability
Energy Research and Development Division
September 8, 2023

Research and Development Division Hydrogen Investments

Mission: strategically invest funds to advance clean energy technology and accelerate achievement of policy goals

Funding: three primary programs with hydrogen-related investments

- **Clean Hydrogen Program**:
  $100M one-time, General Funds
- **Gas R&D Program**:
  $24M per year, Gas IOU Ratepayer Funds
- **Electric Program Investment Charge (EPIC)**:
  $130M per year, Electric IOU Ratepayer Funds

Clean Hydrogen Program

- Funding for in-state demonstration/scale-up of production, conveyance, and end use of eligible hydrogen
- Per Assembly Bill (AB) 209

Program Component	Tentative Budget	Tentative Schedule
Large Scale Centralized Hydrogen Production	$30-40M	Q4 2023
Onsite Hydrogen Production and Use	$20-30M	Q1 2024
Federal Cost Share	$20M	Q2 2023

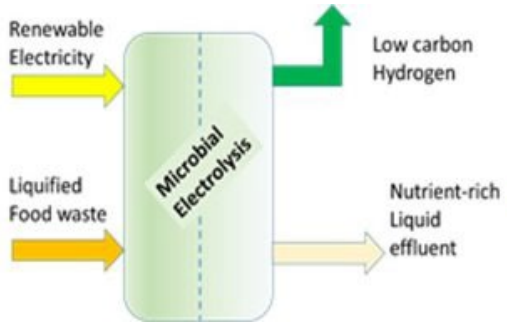
Clean Hydrogen Program
Federal Cost Share

- Federal cost share for DE-FOA-0002922: Bipartisan Infrastructure Law: Clean Hydrogen Electrolysis, Manufacturing, and Recycling.
- GFO-22-903 released May 23, 2023.
- Provided 3 letters of intent totaling $3.1M in cost-share, which would leverage over $20M federal funds.
- If awarded by DOE, these projects will improve efficiency, durability, and costs of electrolytic hydrogen production technologies.

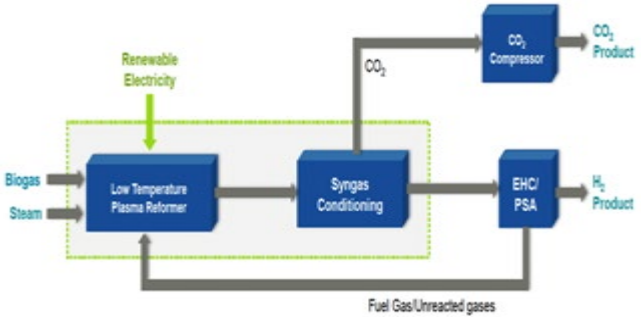
Gas R&D Program

- Research and development to support greater gas reliability, lower costs, and increased safety.
  - Benefits California citizens and supports state energy policy.
  - Not adequately addressed by competitive or regulated entities.
- $24 million annual budget, funded by an IOU surcharge on gas consumption.
- **Hydrogen connection:**
  - Potential pathway for gas system decarbonization.
  - Assess effects of delivering hydrogen through existing gas pipeline network, including impacts on pipeline facilities, generators, and end-use appliances.

Gas R&D Program
Biomass to Hydrogen

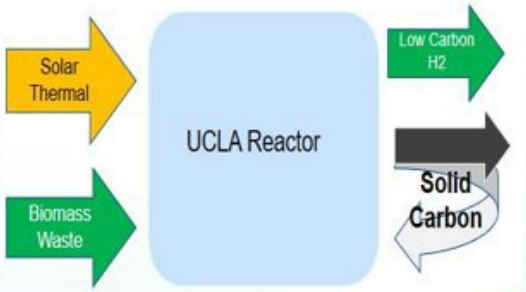


Credit: Electro-Active Technologies



Credit: SoCalGas

Credit: Technology and Investment Solutions



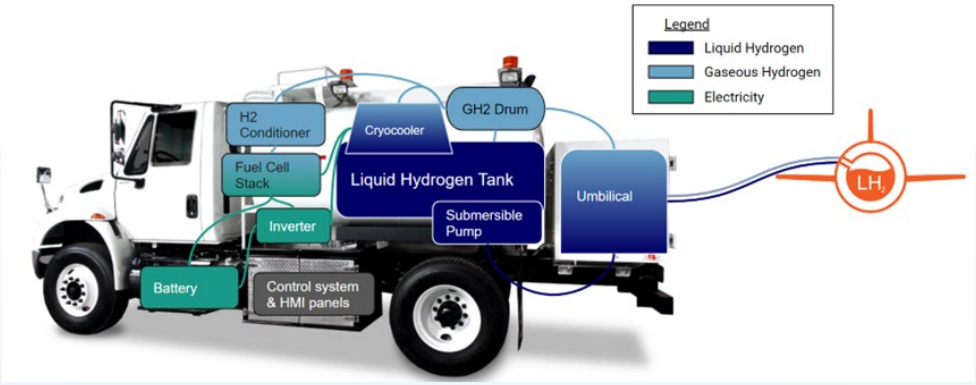
Credit: UCLA

- **Electro-Active Technologies:** conversion of organic waste to hydrogen through microbial electrolysis pathway.
- **SoCalGas**: conversion of biogas to hydrogen using low temperature plasma reactor
- **Technology & Investment Solutions:** biogas to hydrogen production by integrating catalytic reformer and other proven components.
- **UCLA:** direct solar conversion of biogas to hydrogen and solid carbon

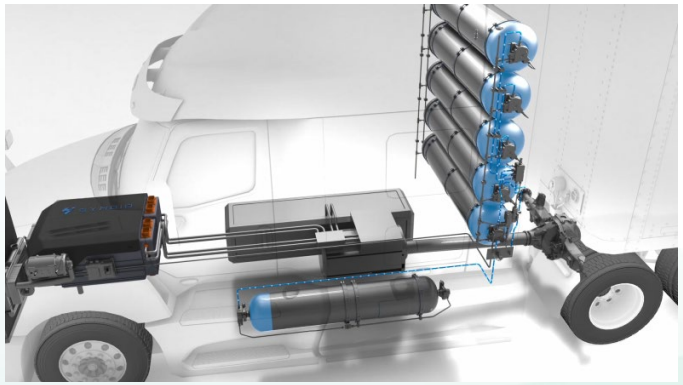
Gas R&D Program
Hydrogen for Heavy Transportation

- Potential pathway for decarbonizing the gas system, which can play a future role in hydrogen conveyance for transportation end-uses.
- Pre-commercial heavy-duty hydrogen fuel cell vehicle and refueling technology demonstrations.

Credit: Sierra Northern Railway



Credit: ZeroAvia Federal



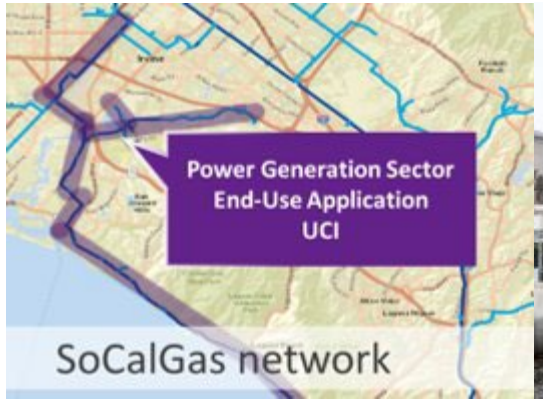
Credit: Symbio

Credit: Crowley

Hydrogen Blend Impacts
Gas Pipeline Network for Targeted Use Cases

Credit: UCLA

Credit: GraniteRock



Credit: UCLA

Credit: UCI

- Quantitative risk assessment of hydrogen blending at material, component, and system levels.
- Appy risk assessment to industrial and power generation use cases from point of injection to end use.
- Technoeconomic analysis comparing cost/benefit of retrofitting existing gas pipelines, new purpose-built hydrogen pipelines, and hydrogen conversion.

Hydrogen Blend Impacts
Large Commercial and Industrial Equipment

Water Heaters Furnaces Cooking Equipment

GTI ENERGY
solutions that transform
PRIME RECIPIENT

TAC
INDUSTRY SUPPORT

AHRI
AIR-CONDITIONING, HEATING, & REFRIGERATION INSTITUTE
INDUSTRY OUTREACH

EPRI
TEA LEAD

UCIRVINE
TESTING SUPPORT
MODELING LEAD

LCRI LOW-CARBON RESOURCES INITIATIVE

UTD Utilization Technology Development

SoCalGas

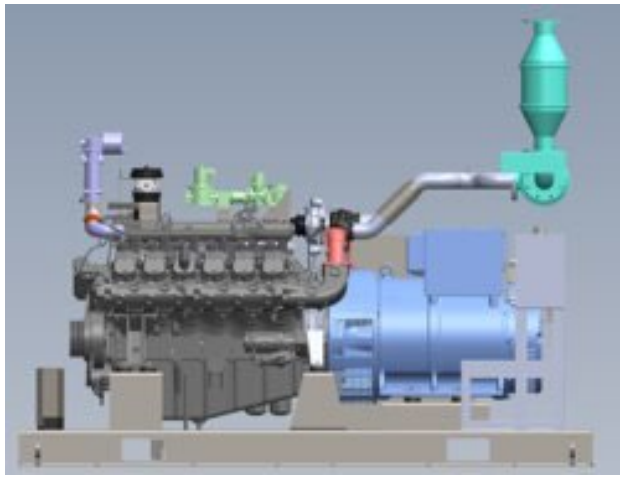
PG&E Pacific Gas and Electric Company

SOUTHWEST GAS

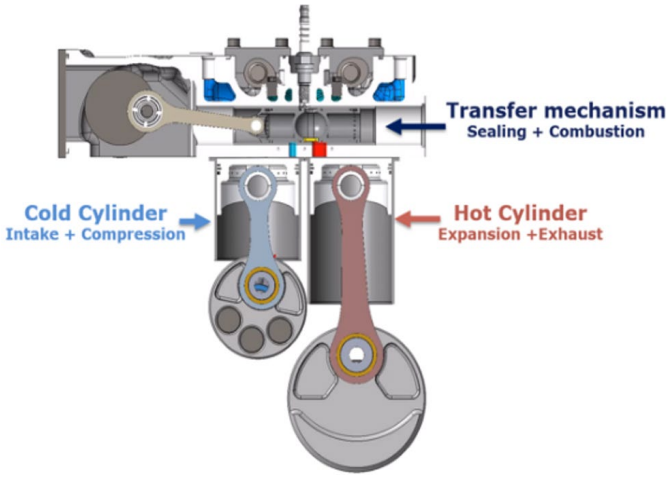
- Identify impacts of H2/gas blends on existing and new appliances that can be handled with and without modification.
- Inform policymakers and industry of the technoeconomic feasibility of H2/gas blends for decarbonizing hard-to-electrify large commercial and industrial equipment in California.
- Laboratory testing to evaluate technical limitations of H2/gas blends in current equipment and evaluate emissions impacts.

Hydrogen Blend Impacts
Power Generation

Credit: Noble Thermodynamic Systems



Credit: Enchanted Rock



Credit: Tour Engine

Noble Thermodynamic Systems: Retrofittable Argon power cycle for hydrogen-fueled power generation.

Enchanted Rock: In-cylinder combustion optimization and cooled high pressure Exhaust Gas Recirculation for hydrogen blends.

Tour Engine: Split-cycle combustion using a lean NOx trap in a hybrid engine-generator-battery system.

Upcoming Research

- **Industrial hydrogen clusters**
  - Study to characterize optimal co-location of industrial hydrogen clusters to share infrastructure and reduce costs.
- **Large-volume hydrogen storage**
  - Assess technoeconomic feasibility of underground geologic hydrogen storage in California.
- **Gas leakage monitoring and mitigation (pending CPUC approval)**
  - Hydrogen sensor technologies for leakage monitoring and quantification.
  - Leakage mitigation and prevention for hydrogen blends.

EPIC Program

- Supports development of new, emerging, and pre-commercial clean energy innovations in California.
  - Provide ratepayer benefits by improving safety, reliability, affordability, environmental sustainability, and equity.
  - Drive science and technology advancements that accelerate achievement of state energy policy goals.
- Invests ~$130 million annually, funded by an IOU surcharge on electricity consumption.
- **Hydrogen Connection:**
  - Zero-carbon firm dispatchable resource or long duration energy storage technology.
  - Renewable integration opportunities, grid impacts of hydrogen production.

EPIC Program
Hydrogen as Energy Storage

- EPIC 3 projects testing and validating green electrolytic hydrogen energy storage systems for various use cases:
  - Renewable integration
  - Microgrids and resilience
  - Peak shaving
  - Mobile backup power
  - EV charging support

Credit: Technology & Investment Solutions

Credit: EPRI

EPIC Program
Assessing Hydrogen's Role in the Electric Sector

- EPIC Interim projects with **RAND** and **E3** to assess hydrogen's potential role in electric sector applications.
- Understand cross-sector impacts and benefits of potential hydrogen demand for electricity, transportation, and industrial.
- Assess value proposition of storing hydrogen in geologic formations to meet time-varying demand across sectors.
- Develop actionable recommendations for future EPIC investments.
- Coordinate with CEC SB 1075 team.