OTD
Operations
Technology
Development

PHMSA R&D Working Group #4

Hydrogen Network Components

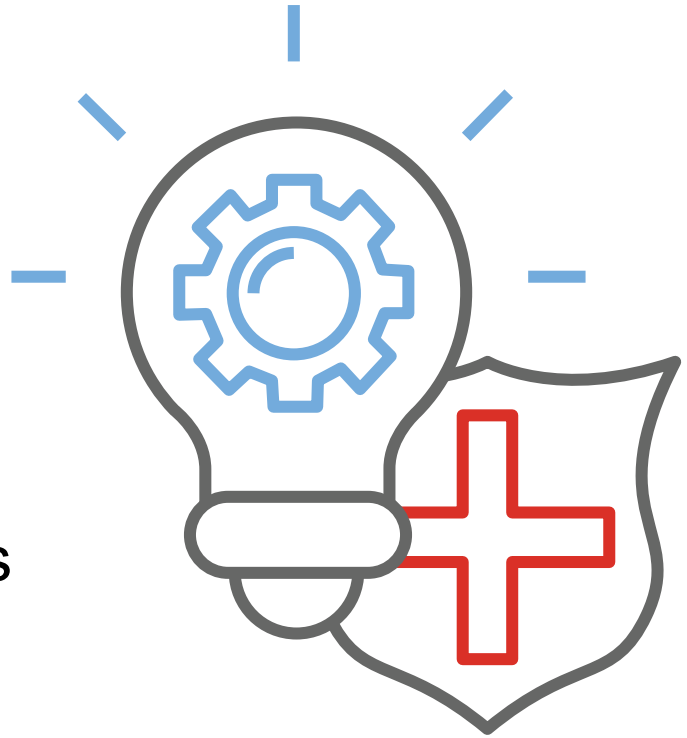
December 2021

Dennis Jarnecke
Director R&D

OTD Mission and Goals

Mission

- Identify, select, fund, and oversee research projects resulting in innovative solutions and the improved safety, reliability, and operational efficiency of natural gas systems



Goals

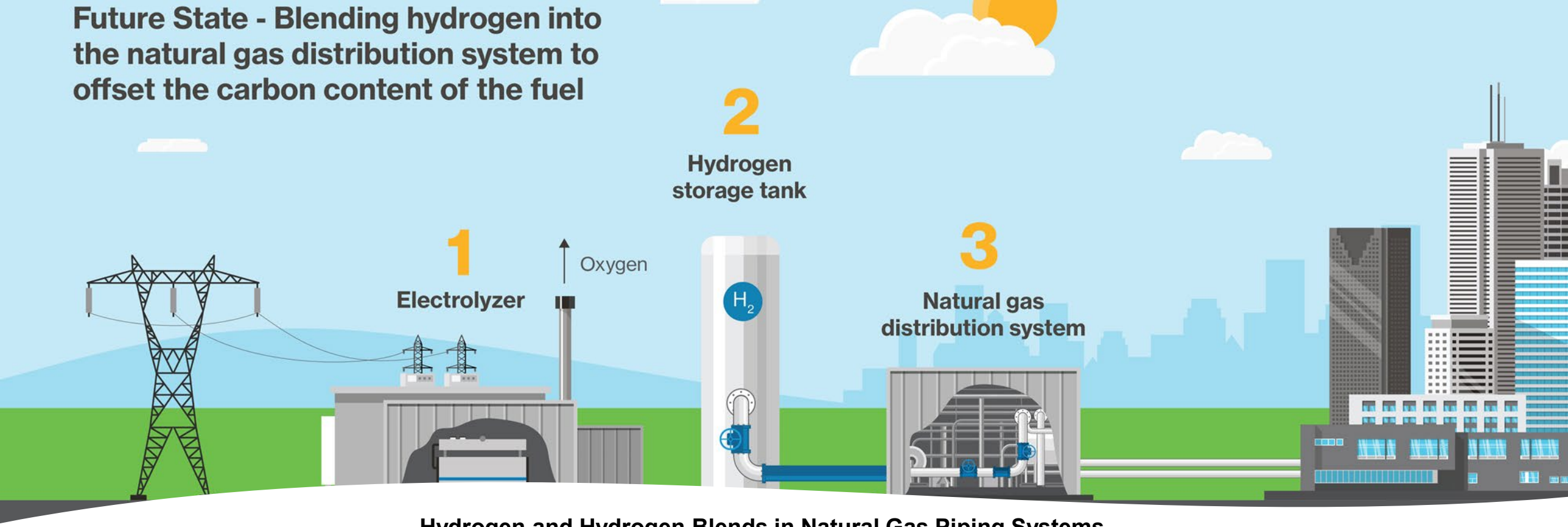
- Enhance safety
- Enable operational excellence
- Minimize environmental impact
- Practice good science

OTD Operations Technology Development

OTD Members

Serving 50 million gas consumers in the U.S., Canada and France

Research Foundation	Southern California Gas Company, A Sempra Energy utility	Pacific Gas and Electric Company	ATMOS energy	SOUTHWEST GAS
Ameren FOCUSED ENERGY. For life.	conEdison	CenterPoint Energy	Entergy	PEOPLES GAS NATURAL GAS DELIVERY
INTERMOUNTAIN GAS COMPANY	NYSEG RG&E	National Fuel	AVISTA	MiSource
NW Natural We grew up here.	Dominion Energy	Oklahoma Natural Gas. A Division of ONE Gas	ENBRIDGE	Washington Gas A WGL Company
Nicor Gas	TECO PEOPLES GAS AN EMERA COMPANY	DUKE ENERGY	spire	nationalgrid
Liberty	Black Hills Energy	GRDF GAZ RÉSEAU DISTRIBUTION FRANCE		



FOCUS

Hydrogen and Hydrogen Blends in Natural Gas Piping Systems

- To advance the safe transportation of hydrogen gas and/or hydrogen/natural gas blends through our Nation's pipeline network.

How Much Hydrogen Can Be Blended Into the Existing Gas Pipelines?

- The maximum hydrogen concentration depends on materials, age, pressures, defects, and various other factors.
- However, prior work and knowledge indicates that certain blending percentages of H2 (e.g. 2% - 12%) are technically feasible.
- Although additional work is needed to consider blends of H2 up to 20% and beyond.

OTD Operations Technology Development

Hydrogen Blending Focus Areas

Materials & Equipment	Operations & Maintenance	Safety & Environment
• Metals • Plastics • Pipes • Fittings • Joints • Valves • Meters • Regulators • Elastomers • Various other components	• Leak Detection • Pressure Regulation • Odorization • Purging • Tapping • Stopping/Squeeze • Hot Work • Repair • Other	• Codes & Stds. • Blending • Employee, customer, and general public safety • Environmental considerations

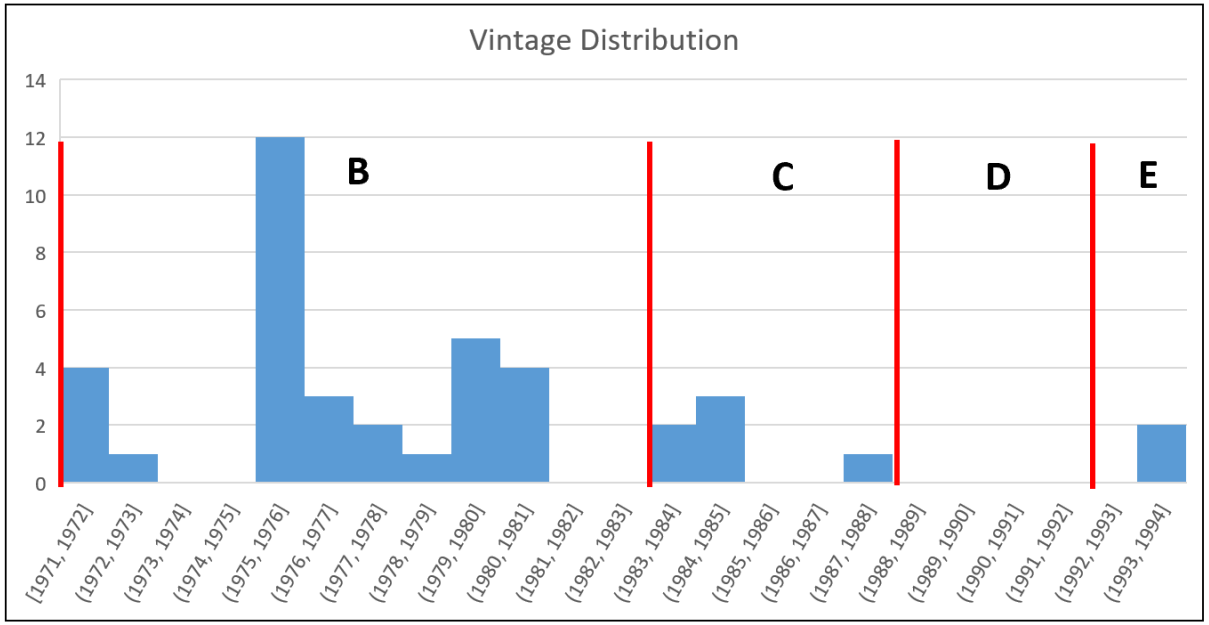
OTD Operations Technology Development

OTD Projects – Hydrogen Related

Project Title	Brief Description
Hydrogen Working Group	Roadmap of hydrogen efforts with OTD members
Hydrogen Blending, Ph. 2	Literature Review and Design of Experiments for vintage pipeline steels
Hydrogen Blending Impact on Vintage Plastic Pipe	Testing of vintage plastic materials exposed to different H-CH4 blends. Starting with Aldyl-A and continuing with M8000
Impact on RMD Performance form Hydrogen Blended into Natural Gas	Residential Methane Detectors (RMDs) will be tested at various methane/hydrogen blends in a controlled lab setting to determine their effectiveness at detection
PGMs Performance Interferences and Hydrogen Impact	Testing program of commercially availabel Personal Gas Monitors (PGMs) and evaluate the impact of hydrogen blended into natural gas with testing at 5% hydrogen and 95% methane
Accuracy of Hydrogen Analyzers and Survey Instruments	Laboratory evaluation on the precision, accuracy, and bias of analytical equipment for natural gas blended with hydrogen at concentrations between 5%-20%.
Effect of hydrogen blended natural gas on the performance of gas meters and diaphragm type service regulators- Phase 1	Impact of hydrogen blended natural gas on gas meter and service regulator performance
Hydrogen Standards and Regulations	
Assessing Performance Impacts and Leak Rates of System Components	Observe the impacts of hydrogen blended natural gas on specific components in the distribution system, specifically low-pressure thread sealants typically used on meter set assemblies (MSAs).
Assessing Performance Impacts and Leak Rates of System Components	Observe the impacts of hydrogen blended natural gas on specific components in the distribution system, specifically low-pressure thread sealants typically used on meter set assemblies (MSAs).
Odor Fade and Odor Masking from H2 Blends	Literature review of effects of hydrogen in odorant.
Assessing Performance Impacts of Blended Hydrogen on Thread Sealants	Observe the impacts of hydrogen blended natural gas on specific components in the distribution system thread sealants typically used on meter set assemblies (MSAs)..
Hydrogen Embrittlement Model for Steel Piping	
Effects of Blended Hydrogen and Natural Gas Fuel on Natural Gas Leak Detection Equipment	Accessing the impact on leak detection devices with the introduction of hydrogen gas blends to the natural gas system

Hydrogen Blending Impact on Aldyl-A and HDPE Pipes

- Understanding of the impact of hydrogen blends on the existing PE infrastructure is crucial for maintaining the integrity and safety gas distribution pipelines.
- Objective to develop a lifetime-prediction and risk model for vintage PE (Aldyl-A and vintage HDPE) pipes pressurized with a natural-gas/hydrogen blend.



	Aldyl-A vintages (per CPUC report)	Rank 1	Rank 2	Rank 3	Rank 4
A	1965 -1970	-	-	-	-
B	1970 - 1983	19	6	25	-
C	1983 - 1988	8	-	2	-
D	1988 - 1992	-	-	-	-
E	1992 -1999	4	-	-	-

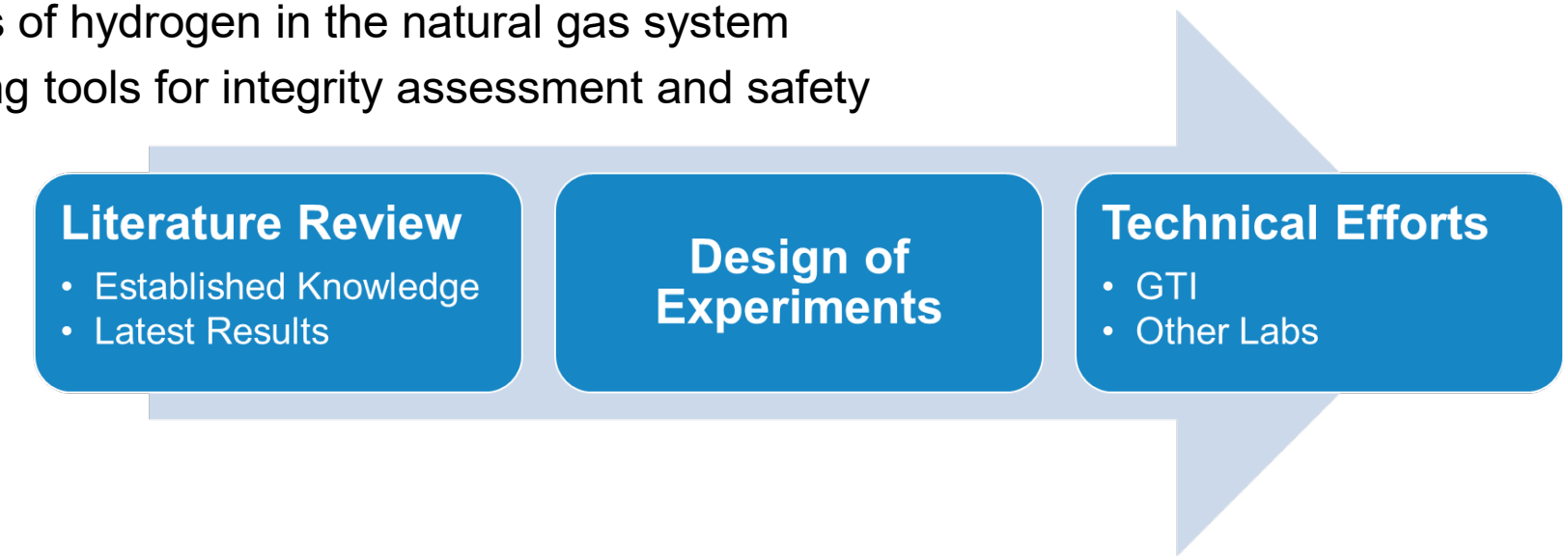
Ranking Description

1 To be tested
2 To be tested if more samples are needed to fulfill the proposal requirements
3 Need to review pipe closely due to short length and gouges/squeeze off/other defects present
4 Cannot be tested due to pipe condition

OTD Operations Technology Development

Hydrogen Effects on Metallic Materials (Phase 2)

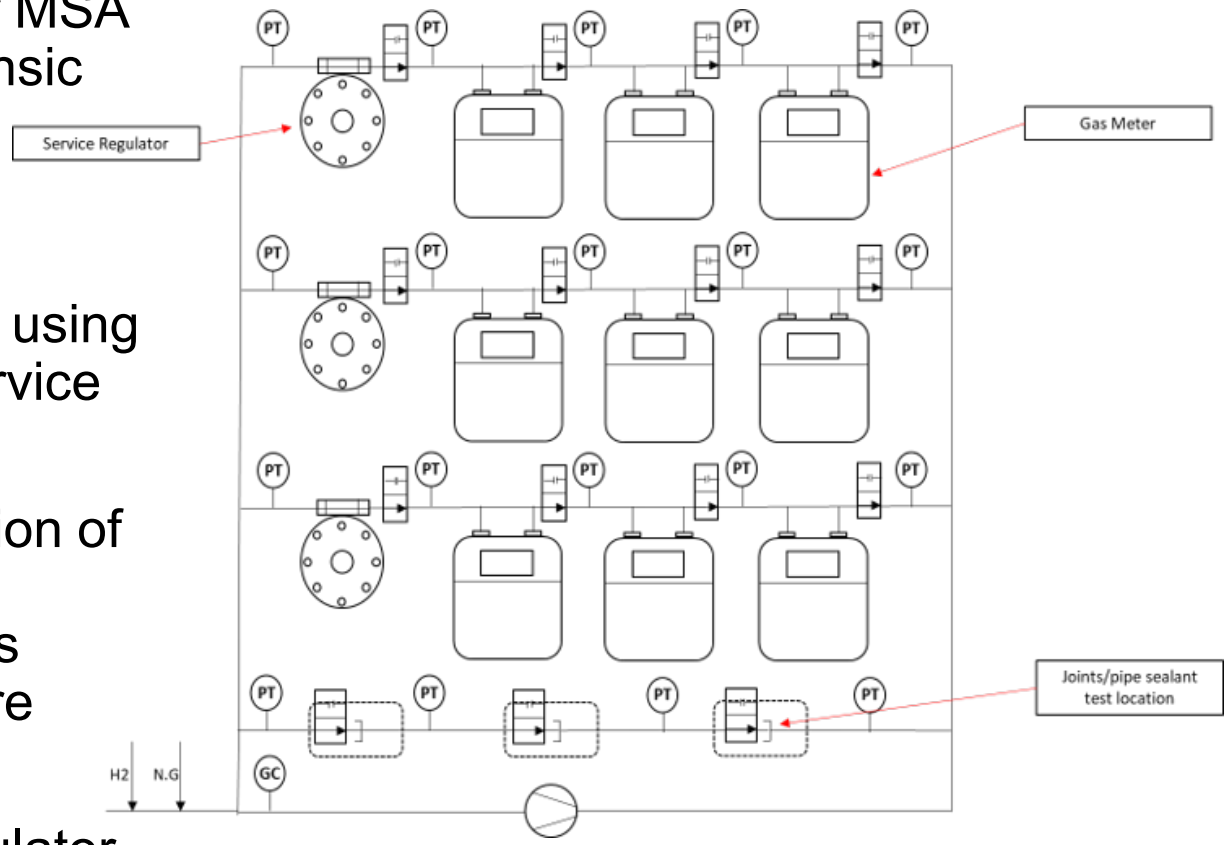
- Focusing on
  - Pipeline steels
    - Base metal
    - Welds (future effort)
  - Experimental methods used for integrity assessments and system characterization
  - Develop practical results that pipeline operators can apply in their integrity management plans
    - Failure Assessment Diagrams, Critical Flaw Curves, and Crack Growth Rate Plots
  - Establish baseline and conduct physical testing to:
    - Assess the impacts of hydrogen in the natural gas system
    - Develop engineering tools for integrity assessment and safety



Effect of Hydrogen Blended Natural Gas on the Performance of Gas Meters and Service Regulators

- To examine the effect of hydrogen blended natural gas on the performance of gas meters, regulators, and other MSA components in terms of measurement accuracy, intrinsic safety through extensive, long duration testing.

- Value proposition:
  - Know-how: Understand the long-term impact of using blended gas on the durability of gas meters, service regulators, and other components.
  - Findings to support operators with implementation of blended gas initiatives in their service area and provide basis for public relation communications considering the components being evaluated are customer facing.
  - Provide test data specific to gas meter and regulator models that are widely used in the North American gas industry.



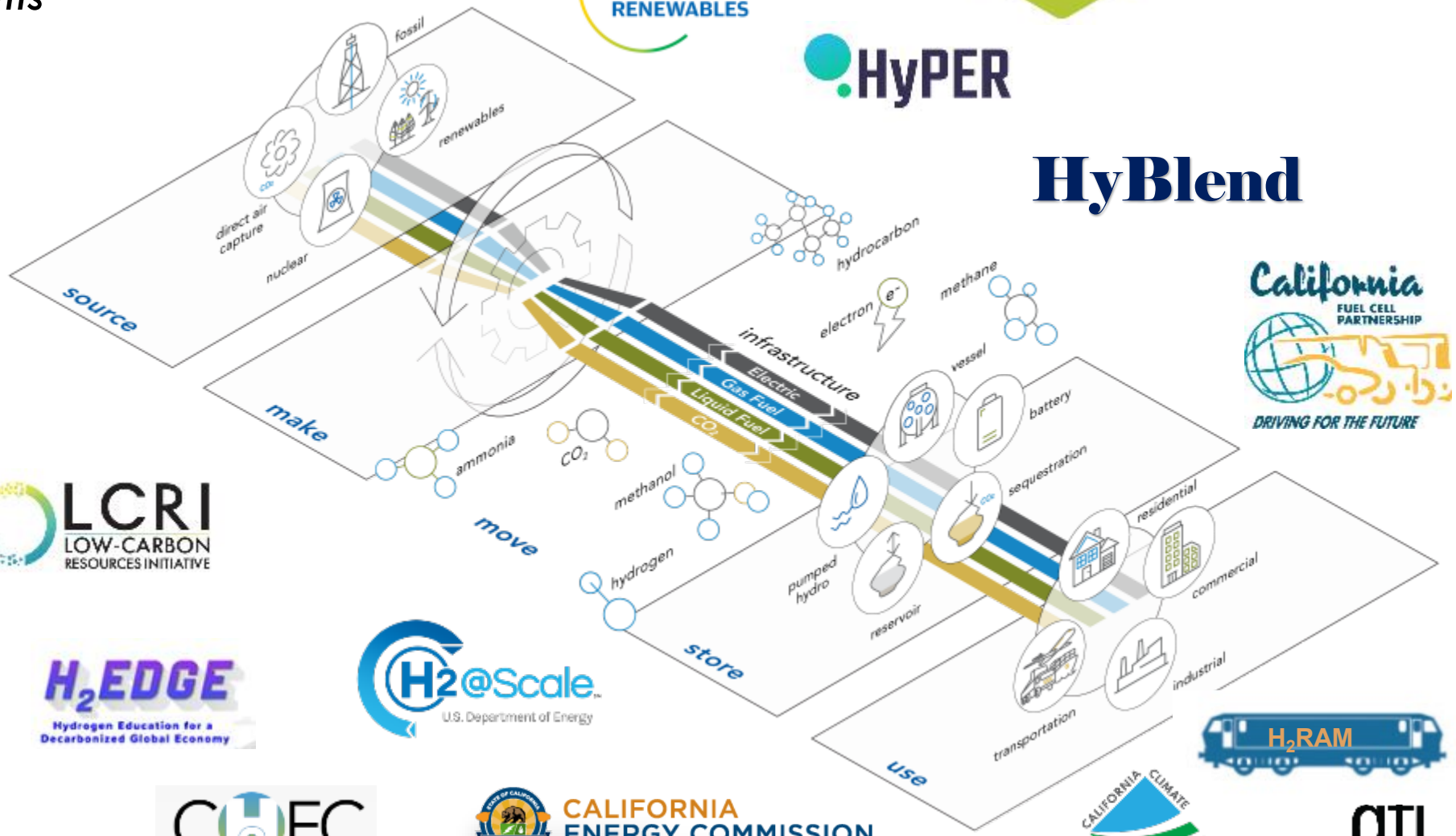
OTD Operations Technology Development

Integrated Energy System

Low-Carbon, Low-Cost

Hydrogen Energy Systems

GTI's Hydrogen Technology Center offers integrated hydrogen testing and demonstration facilities across the entire value chain—leveraging deep expertise to bring real solutions to the market.



HYDROGEN TECHNOLOGY CENTER

SunGas RENEWABLES

HyPER

HyBlend

California FUEL CELL PARTNERSHIP DRIVING FOR THE FUTURE

LCRI LOW-CARBON RESOURCES INITIATIVE

Zero-Carbon Power & Hydrogen for Illinois' Energy Future

H_2EDGE Hydrogen Education for a Decarbonized Global Economy

H2@Scale U.S. Department of Energy

H_2RAM

www.H2TechCenter.energy

C2FC

CALIFORNIA ENERGY COMMISSION

OTD Operations Technology Development

gti

R&D Collaborative Program

Low-Carbon Resources Initiative

The **Low-Carbon Resources Initiative** (LCRI) is a five-year, focused R&D commitment to develop the pathways to advance low-carbon technologies for large-scale deployment. This initiative is jointly led by EPRI and GTI. The goal of the initiative is to enable a risk-informed understanding of options and technologies enabling significant economy-wide decarbonization through global partnerships and demonstrations, applied engineering developments, and technology acceleration of the most promising options.

WHY

Enable infrastructure for future low-carbon fuel options

Decarbonize sectors such as bulk transportation, large industries, and heating networks in cold climates

Large-scale clean power utilizing combustion turbines

Production

- Electrolysis from clean energy sources
- Biofuel and low-carbon processes
- Carbon capture & storage
- Innovative technologies

Storage & Delivery

- Pipeline blending
- Safety and codes/ standards
- Underground & aboveground storage
- Chemical storage

Integration

- Energy system modeling & analysis
- Grid electricity, renewables & nuclear energy
- Gas networks/ infrastructure
- Consumer optionality

End Use

- Transportation
- Industrial
- Power Generation
- Heating
- Commercial
- Residential

Hydrogen **Ammonia** **Synthetic/Derivative Fuels** **Biofuels**

VALUE

Individual commitment to environmental, social, and governance (ESG) efforts

Increase optionality of low-carbon solutions

Leverage investments across relevant sectors

Enable resiliency and affordability of low-carbon energy system

EPRI ELECTRIC POWER RESEARCH INSTITUTE gti

Some Additional Collaboration Projects Focused on H2

- DOE EERE - HyBlend Collaborative Research Partnership:
  - NREL Lead, GTI Industry Lead
  - High-level objectives include: H2 impact on metals & polymers, Life-cycle analysis, Techno-economic analysis, and end-use equipment impacts.
- DOE/NETL Office of Fossil Energy – Integrated Hydrogen Energy Storage System (IHESS) for Power Generation on Texas Gulf Coast – Linde, UT-CEM, Dow, Siemens, MHI
  - Determine the hydrogen supply, storage, and pipeline operating conditions necessary to provide at least 10 MWh of hydrogen energy for combined heat and power generation.
  - The study will leverage existing hydrogen generation and supply assets in the area.
- CPUC funded Hydrogen Impact Study – UC Riverside and GTI led hydrogen effort
  - Assess safety concerns associated with injecting hydrogen into the existing natural gas pipeline system at various percentages
- DOE Fossil – Net Zero Carbon Electricity and Hydrogen Plants
  - Wabash Valley Resources is the lead, GTI is a project partner – Terre Haute gasification facility

Research Gaps and Needs

- Operators have set goals but have a huge gap to fill to address the system readiness in order to meet these goals.
  - Develop a roadmap/vision in a comprehensive and collaborative way.
  - As an industry we need to collaboratively identify the goals and objectives/actions needed to meet these 2050 net zero carbon goals.
- A need to move from bench studies to simulated real world condition evaluations of H2 and H2 blended systems.
- What level of blending of hydrogen is safe under what circumstances?
- Some additional “focused” needs:
  - Hot work – concern of working on systems pressurized with H2 or H2 blends
  - Metering and billing – Impact of H2, RNG, and other forms of gas on metering and billing
  - Weld performance and welding procedures (vintage and new installations)
  - Purging operations – guidance and safety considerations
  - Various components – validation of performance with H2 blends
  - H2 gas and changes to flow characteristics
    - Static build up in PE piping system
    - Transfer of debris and erosion of components
  - Chemical interactions – odorant, pipe sealants, etc.

Dennis Jarnecke
Director R&D
djarnecke@gti.energy
(847) 768-0943

www.gti.energy

Questions / Comments