ET Summit 2024

Presented by

Natural Gas and Hydrogen Blends for Infrastructure

GTI ENERGY
solutions that transform

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GTI Energy

GTI Energy Role in Energy Market

Serving the energy industry since 1941

- Independent, not-for-profit research, technology development and deployment organization
- Areas of research include energy production and conversion, energy delivery, and end-use
- Technology development focus on safety, improving efficiency, and reducing emissions
- Research facilities
  - 18-acre campus near Chicago
  - Laboratories in Agoura Hills, CA and Davis, CA
  - Pilot and demo facilities worldwide

Delivery R&D Program

- GTI has an expanding R&D portfolio focused on industry priorities
  - **Safety**
  - **Integrity**
  - **Reliability**
  - **Operational Efficiency**
  - **Environment**
- Collaborative R&D efforts
  - Leverages collective intelligence and experience of funders to develop the best possible solutions
  - Highly cost effective

SAFETY & RISK MANAGEMENT

DIGITALIZATION & DATA UTILIZATION

MINIMIZING METHANE EMISSIONS

EXPANDING ROLE FOR RENEWABLE GAS & H2

U.S. DEPARTMENT OF ENERGY

PHMSA

OTD Operations Technology Development

CALIFORNIA ENERGY COMMISSION

Blending

Why blend hydrogen into natural gas systems?

- Near-term opportunity to decarbonize the pipeline infrastructure
- At 15-20% blending, existing infrastructure and appliances are generally compatible or will require limited retrofits
- Helps accelerate related decarbonization efforts (hydrogen production and use)
- Can be complemented by distributed 100% hydrogen, production, and use in the future

Assessing H_2 Compatibility with NG Delivery Network

Scope of current research

- Evaluate effects of H_2/NG blend on steel and non-metallic material properties and operational safety
- Determine safety factors for H_2 gas systems need to be established based on materials tests
- Develop engineering tools to allow an integrity assessment and a safety margin determination of H_2 blended gas use
- Determine operational impacts of a H_2 blend in pipelines, such as leak detection, surveys, emergency response
- Complement ongoing work at National Labs

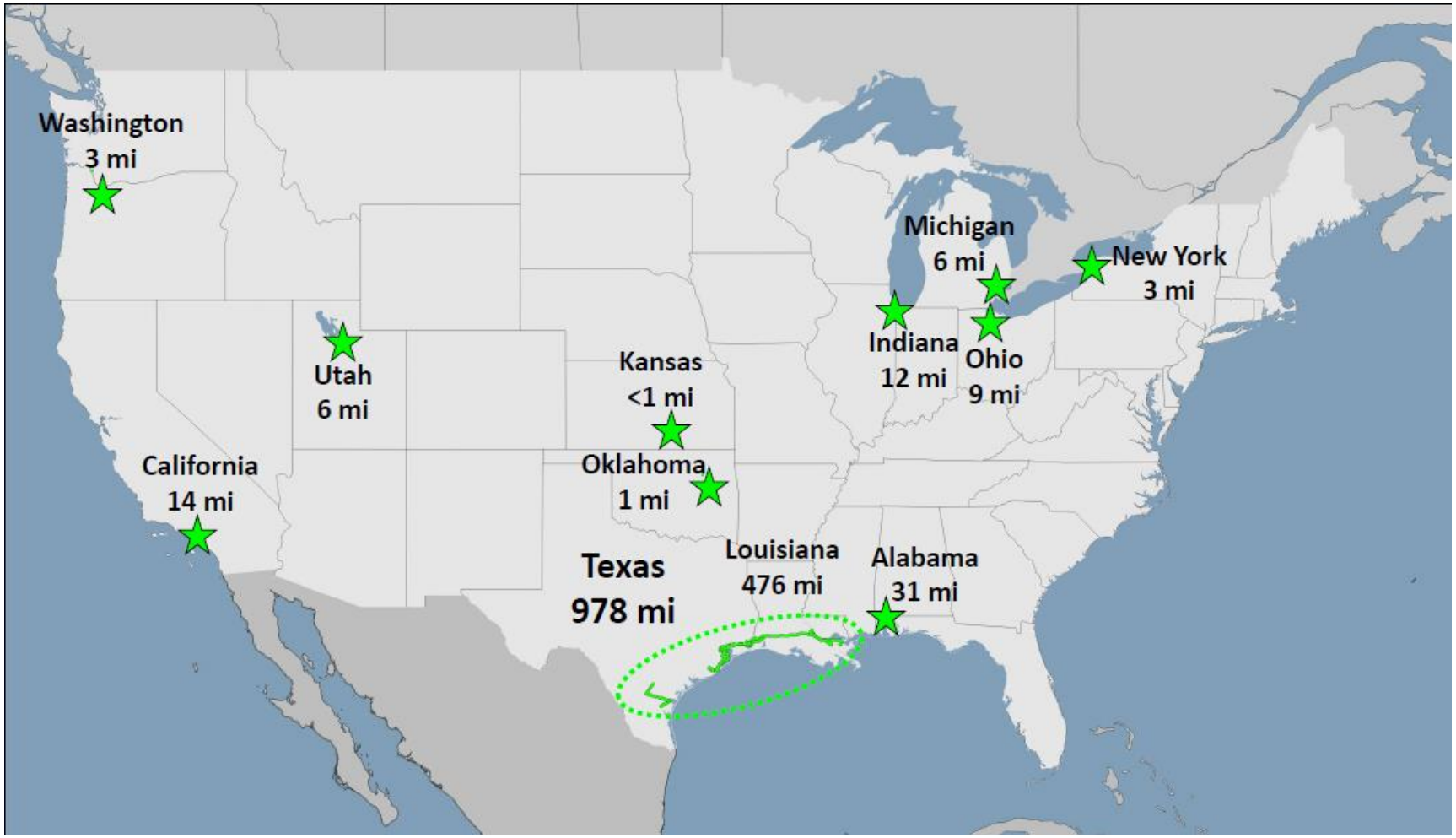
OTD Operations Technology Development
UTD Utilization Technology Development
The Flame of Innovation SMP
U.S. DEPARTMENT OF ENERGY
U.S. Department of Transportation
Pipeline and Hazardous Materials Safety Administration

Material properties most affected
Toughness
Reduction in Area
Crack Growth Resistance

HyBlend U.S. DEPARTMENT OF ENERGY

Location of Existing Hydrogen Pipelines

Approximately 1,600 miles of hydrogen pipelines in U.S.



Source: PHMSA

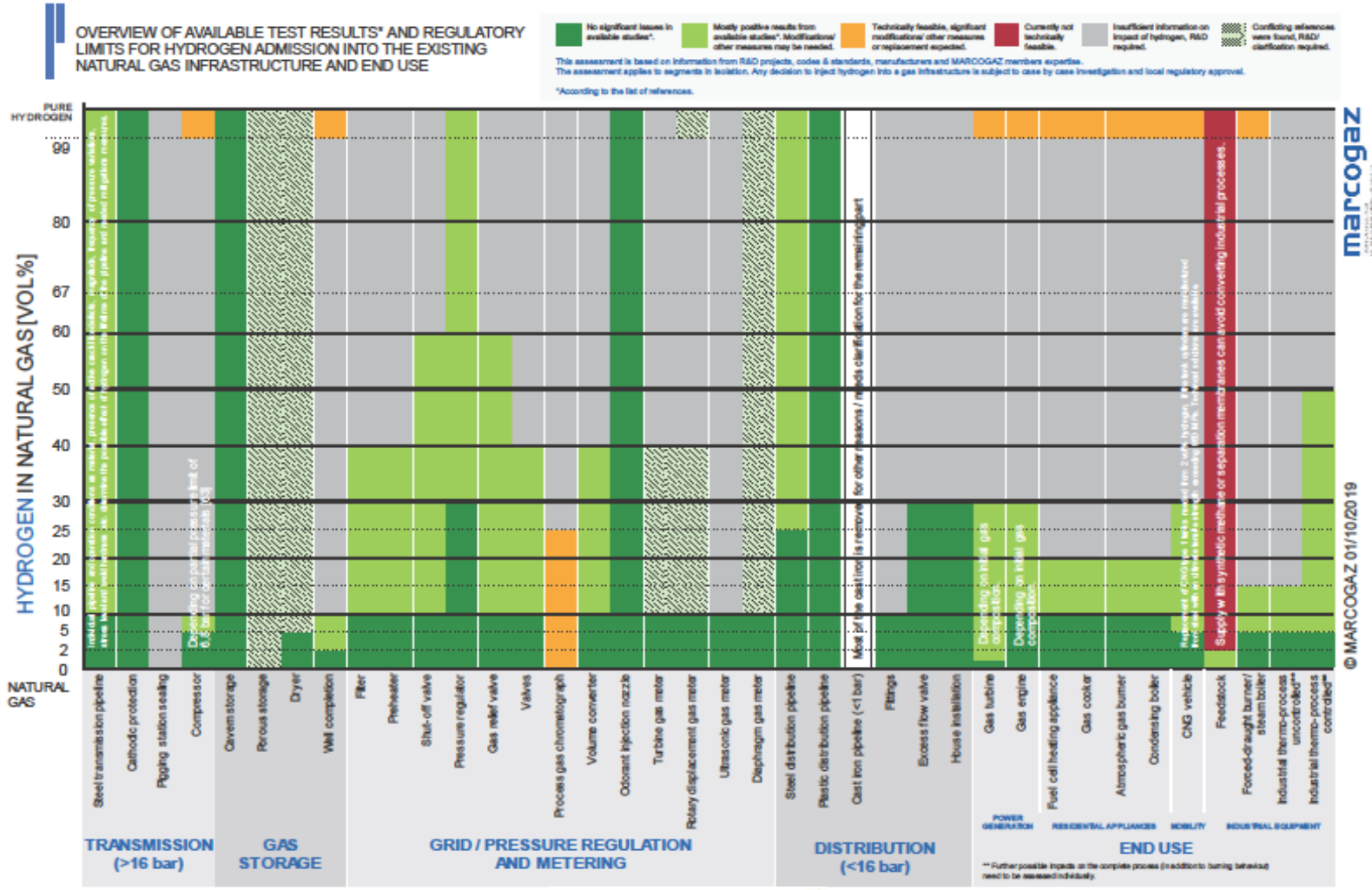
Europe: Allowable H_2 Blends in Gas Infrastructure?

Task Force Hydrogen (2018/2019)

- Infographic covering the impact of %H_2 in the different natural gas chain assets
  - Based on best available knowledge at the time
  - Well known reference in Europe

Task Force Hydrogen (2022/2023)

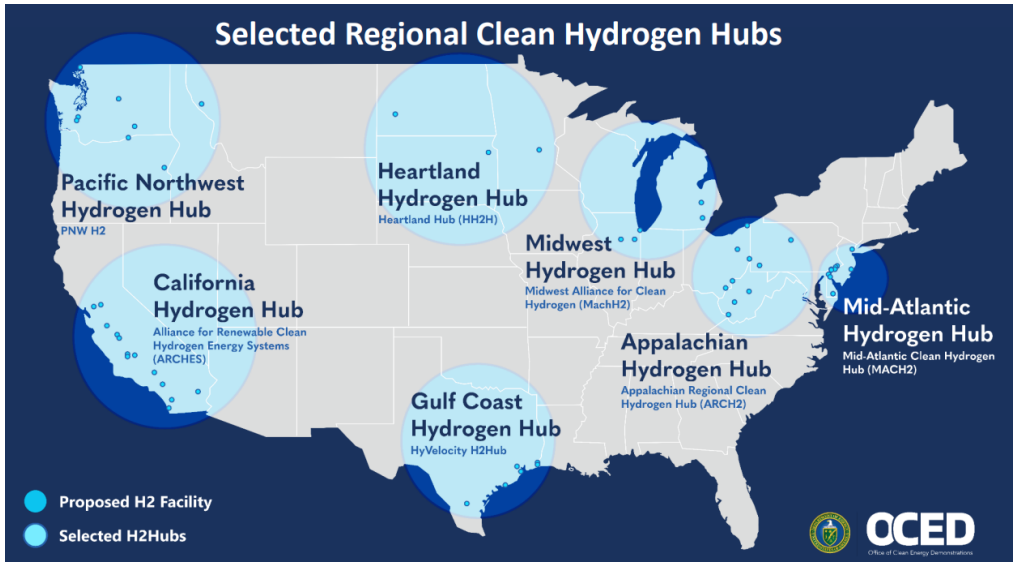
- Aim to update Infographic
  - Mitigation needs for utilization of H_2 and associated costs
  - Safety aspect



marcogaz

Clean Hydrogen Hubs

- 7 Regional Hubs awarded – contract negotiations
  - Some completed and others will be soon
- $7B federal funding and $40B cost share leverage from industry
  - Represents 3 million metric tons of H_2 production, 25 MMT of CO_2 reductions = ~5.5 million gasoline cars' emissions
- GTI Energy is a part of 3 regional Hydrogen Hubs
  - **HyVelocity** (Gulf Coast region)
    - Program management/hub lead & admin
  - **ARCH2** (Appalachian region)
    - Deputy Program Manager - Technical lead for engineering, data analysis, Justice40
  - **Mach H2** (Midwest region)
    - Develop and deploy the SWITCH project: Solutions Working to transform Industry and Transportation to Clean Hydrogen
    - Equity Justice Officer



HyVelocity Hub

MIDWEST ALLIANCE FOR CLEAN HYDROGEN

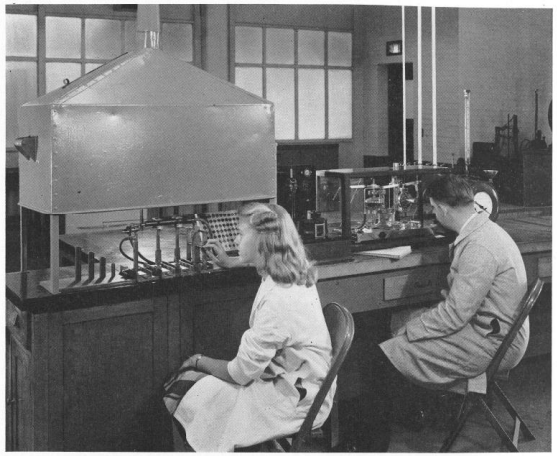
ARCH2 APPALACHIAN REGIONAL CLEAN HYDROGEN HUB

Blended Hydrogen - Background

Blending H_2 with delivered fuels is not new…

- Before "natural gas" there was "town gas"*
  - ~50% H_2, balance CH_4, CO, light HCs, etc.
  - Commonly gasified coal, for lighting, then indoor uses (cooking, heating, refrigeration, etc.)
- Manufactured gases phased out as natural gas grew post-WWII, though use continues
  - Hawaii Gas Co. delivers syngas, via refining oil, with ~15% H_2 since 1970s to ~30k customers
  - Design guidance (still used), based on data from ~50s from AGA Labs (pic), include manufactured gases
  - Many appliance standards also permit manufactured gases in addition to propane, etc.
- European appliances are certified with 23% H_2 to assure performance with wider range of gas qualities


Gas Works Park – Seattle (Decommissioned 1956)



*Illuminating Gas, City Gas, Manufactured Gas, etc.

Research on Hydrogen Blending Impact

GTI Energy project

Hydrogen Blending Impact on Aldyl-A and M8000 Pipes

- *Objective*: To develop a lifetime prediction and risk model for Aldyl-A and vintage HDPE pipes
  - Remaining life of Aldyl-A pipes exposed to 20% hydrogen blend
  - Impact on stabilizer consumption
  - Initial test data received and additional specimens still on test
- The test rig for testing pipes with hydrogen blends will also accommodate future investigation of joints/fittings, leak rates, and permeation rates

OTD Operations Technology Development

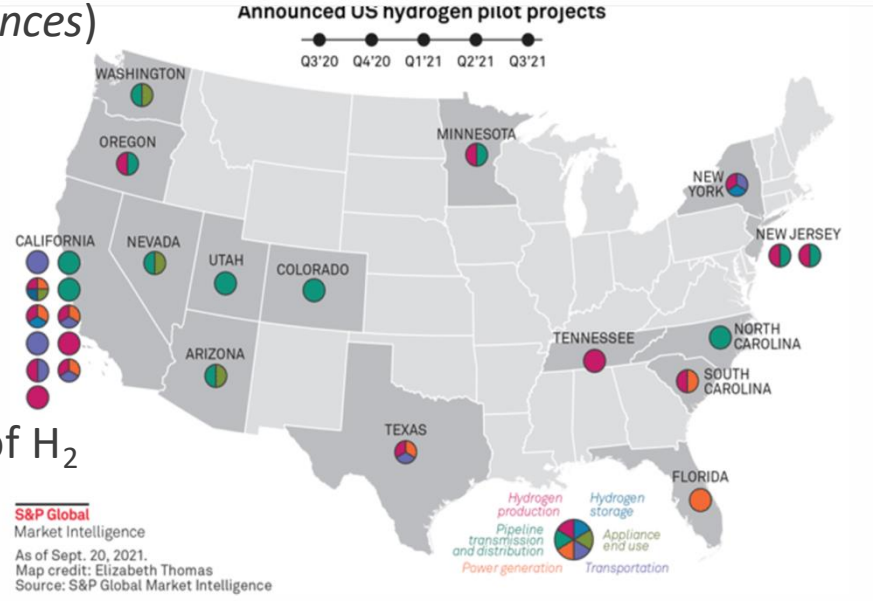
Additional Research on Hydrogen Blending Impact

GTI Energy projects

- **Testing meter-sets, service regulators, and threaded connections on MSAs**
  - Constructing two test rigs for flow recirculation of various H2 blends.
- **Evaluation of new "smart meters" and performance with various H2 blends**
  - Ultrasonic meters
  - Thermal mass flow meters
- **Addressing gaps in US Codes, Standards and Regulations for hydrogen blending and pipeline repurposing**
  - Using work in UK, Europe, Japan and Australia as benchmark approaches
- **Testing various non-pipe components (gaskets, seals, soft-goods, etc) for blended and 100% hydrogen service**

Stages of Utility Hydrogen Blending Pilots

- **Planning for blending into in-service utility systems (from 1% to 20%)**
  - System engineering design and material and component review (*tolerances*)
  - Sources of supply and blending options
  - Operational considerations (*purging, leak detection, odorization, etc*)
- **Operating and testing in simulated distribution system**
  - Testing of materials (*exposed and not exposed to various blends of H_2*)
  - Appliance testing and exhaust emissions analysis
  - Review of safety procedures and equipment related to various blends of H_2
- **On-line blending into customer serving distribution systems**
  - Dead-end or isolated portions of system
  - Well understood customer base and end-use equipment
  - Strive for operating experience gains, customer education, & variety of other reasons
- **Monitoring and assessing active blending operations**
  - End use equipment performance
  - Material Impacts
  - Operational procedure lessons
  - Stakeholder, regulators, public, etc. reactions



Lessons Learned from Blending Pilots

- **Existing leak detection equipment performs well**, some recalibration may be needed depending on sensor technologies employed
- Hydrogen was found to **interfere with carbon monoxide (CO) sensors** in some multi-function detectors, but % LEL (Lower Explosive Limit) not impacted
- **Appliance performance and emissions show no significant differences** within the limits of field measurements (*validation that ambient temperature, wind, humidity, and other weather conditions are difficult to compensate for in the field*)
- Achieving a blend can be accomplished in many ways, so **cost, logistics, availability, and run time duration, among other things need to be considered**
- Increased hydrogen in the natural gas infrastructure **may require changes in operations, engineering design, system maintenance procedures**, etc., and limits must consider end use equipment tolerances
- It is important to **educate and train** the workforce about hydrogen and how it might impact customers, the pipeline, and their day-to-day operations work

Questions / Comments

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