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PG&E Gas R&D Hydrogen Efforts

2021-03-18
R&D Hydrogen Roadmap
Hydrogen: Portfolio of production technologies and applications

2019  2020  2021  2022  2023  2024  2025

- Develop production technologies
- Develop hydrogen to methane technologies

Legend:
△ = Paper Study  ○ = Lab Test  ● = Field Demo  ★ = Deployment  ▼ = Completed Paper Study
Hydrogen: Establish transportation using natural gas system

- Develop hydrogen engineering and blending standards
- Evaluate impact on pipeline integrity
- Develop separation techniques
- Evaluate interaction with reservoir caprock storage
- Develop gas measurement devices
- Develop the interconnection process, requirements and standardized skid
- Evaluate safety related impacts of hydrogen injection
- Evaluate pipeline capacity
- Develop maintenance processes for hot tapping and in service welding and maintenance frequency

2019
2020
2021
2022
2023
2024
2025

NEW! = Paper Study
NEW! = Lab Test
NEW! = Field Demo
NEW! = Completed Paper Study
NEW! = Deployment

Up to 5%
Hydrogen: Establish customer utilization infrastructure

2019  2020  2021  2022  2023  2024  2025

Develop hydrogen vehicle fueling stations

Adapt NG vehicles to run on mixed gas (natural gas & hydrogen) → 2028

Adapt customer appliances to run on mixed gas (natural gas & hydrogen)

NEW!

Develop hydrogen / RNG flexible advanced burner

NEW!

Develop hydrogen fueled heat and hydrogen-based direct reduction in the steel production process

NEW!

= Paper Study  ○ = Lab Test  □ = Field Demo  ★ = Deployment

△ = Completed Paper Study  Up to 5%
Pipeline Research Council International, Inc.

MEAS 15-02

Emerging fuels – Hydrogen SOTA, Gap Analysis, Future projects, Roadmap

Project Final Results
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. H2/NG Separation
8. Underground Gas Storage

Methodology
1. Mapping
2. State-of-the-art Analysis
3. Gap Analysis
4. Roadmap
### Key Results & Gap Analysis

#### Hydrogen Injection

<table>
<thead>
<tr>
<th>Key Challenges</th>
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<th>5%</th>
<th>10%</th>
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<td>Underground Gas Storage</td>
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The green bars display current knowledge coverage for each key challenge and different levels of injection.
# Conclusions & Recommendations

## Top 3 Challenges

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<thead>
<tr>
<th>Gas Measurement &amp; Quality</th>
<th>2021 PRCI Project Ideas</th>
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<tbody>
<tr>
<td>Impact on flow meter accuracy in transmission operating conditions</td>
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<tr>
<td>Develop gas composition analysis tools</td>
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<td>Verify compatibility with USM sensor material and performance/accuracy</td>
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<tr>
<th>Compression</th>
<th>2021 PRCI Project Ideas</th>
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<tr>
<td>Field and lab tests of compressor performance</td>
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<td>Evaluate material compatibility and integrity for compressors</td>
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<tr>
<th>Inspection &amp; Maintenance</th>
<th>2021 PRCI Project Ideas</th>
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<td>Assess and define acceptability criteria for defects and third-party damage</td>
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<td>Develop more sensitive NDT/ILI tools to detect newly defined critical defects</td>
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<td>Assess integrity of repair techniques in transmission operating conditions</td>
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CEC Hydrogen Blending Scoping Workshop Questions
Scale and priorities for demonstration
• Refer to Chapter 4 Testimony H2 Application
• Transmission – complex, lot of knowledge gaps
• Distribution – less complex, portions polyethylene sys may already be compatible

Key challenges for identified priorities and approach to technical tasks
• Refer to Chapter 4 Testimony H2 Application
• Testing and verification of all downstream components (including customer appliances) beforehand
• New development

Outcomes of demonstration and performance metrics
• Energy & efficiency
• Air quality – from utilization (e.g., customer appliances)
• Safety & reliability – risk, degradation, system capacity
• Economics – rates
• Scalability – existing gas system

Considerations for future GFOs
• Collaboration with industry, including within sectors of CEC
• Technical Advisory Committee (TAC)
Thank you