STATE OF CALIFORNIA GAVIN NEWSOM., *Governor*

PUBLIC UTILITIES COMMISSION
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TO PARTIES OF RECORD IN RULEMAKING 13-02-008:

This is the proposed decision of Commissioner Clifford Rechtschaffen. Until and unless the Commission hears the item and votes to approve it, the proposed decision has no legal effect. This item may be heard, at the earliest, at the Commission's December 15, 2022 Business Meeting. To confirm when the item will be heard, please see the Business Meeting agenda, which is posted on the Commission's website 10 days before each Business Meeting.

Parties of record may file comments on the proposed decision as provided in Rule 14.3 of the Commission's Rules of Practice and Procedure.

/s/ MICHELLE COOKE
Michelle Cooke
Acting Chief Administrative Law Judge

MLC:mef
Attachment

Decision **PROPOSED DECISION OF COMMISSIONER RECHTSCHAFFEN**
(Mailed 11/10/2022)

BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking to Adopt Biomethane Standards and Requirements, Pipeline Open Access Rules, and Related Enforcement Provisions.	Rulemaking 13-02-008

DECISION DIRECTING BIOMETHANE REPORTING AND DIRECTING PILOT PROJECTS TO FURTHER EVALUATE AND ESTABLISH PIPELINE INJECTION STANDARDS FOR RENEWABLE HYDROGEN

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DECISION DIRECTING BIOMETHANE REPORTING AND DIRECTING PILOT PROJECTS TO FURTHER EVALUATE AND ESTABLISH PIPELINE INJECTION STANDARDS FOR RENEWABLE HYDROGEN

Summary

The Commission directs California's four large gas investor-owned utilities to continue to file with the California Public Utilities Commission previously ordered biomethane-related reports regarding interconnected projects and procurement details, as well as information pertaining to factors identified in Decision 22-02-025, combined into a single consolidated report due annually starting May 1, 2024.

This decision also adopts an interim definition for renewable hydrogen and directs the development of pilot projects to further evaluate standards for the safe injection of renewable hydrogen into California's common carrier pipeline system by specifying permissible injection thresholds, locations, testing requirements, and independent analysis. We do not authorize system-wide injection of renewable hydrogen into California's common carrier pipeline system or the procurement of hydrogen on behalf of utility customers, instead saving such considerations for later in this proceeding or in a subsequent new proceeding. This proceeding remains open.

1. Procedural History

This proceeding's origin traces back to the passage of Assembly Bill (AB) 1900 (Gatto, 2012), which established a procedure to ensure the safety of biomethane injected into California's common carrier pipeline system and directed the California Public Utilities Commission (CPUC or Commission) to require California's large gas investor-owned utilities (IOUs) – Pacific Gas and Electric Company (PG&E), Southwest Gas Corporation (SWG), Southern California Gas Company (SoCalGas), and San Diego Gas and

Electric Company (SDG&E) (collectively, the Joint Utilities) – to provide non-discriminatory open access to any producer wishing to interconnect to the common carrier pipeline system for the purpose of delivering biomethane to California customers.[1] Accordingly, on February 13, 2013, the Commission opened Rulemaking (R.) 13-02-008 (Order Instituting Rulemaking to Adopt Biomethane Standard and Requirement, Pipeline Open Access Rules, and Related Enforcement Provisions). Since that time, R.13-02-008 has resulted in a number of decisions pursuant to "Phases" added as the proceeding was extended to address various considerations relating to renewable gas and implement related legislation.

In Phase 1 of R.13-02-008, the Commission issued Decision (D.) 14-01-034 on January 16, 2014. D.14-01-034 determined that biomethane could be safely injected into the common carrier pipeline system and adopted injection standards for seventeen "constituents of concern" sometimes found in biomethane: twelve relating to human health and five relating to pipeline integrity. Consistent with the timing of updates to biomethane injection standards specified in California Health and Safety Code Section 25421, the Joint Utilities were directed to file a formal application to update their pipeline injection standards every five years, or sooner if the California Air Resources Board (CARB) and/or the Office of Environmental Health Hazard Assessment notified the Commission of a need to do so.

In Phase 2 of R.13-02-008, the Commission issued D.15-06-029 on June 11, 2015. D.15-06-029 allocated the costs of complying with the standards and protocols adopted in D.14-01-034 to biomethane producers and established a

[1] AB 1900 (Gatto, 2012). *See*: https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201120120AB1900.

$40 million monetary incentive program to facilitate interconnection of biomethane production facilities to the common carrier pipeline system. Soon after, in 2016, AB 2313 (Williams, 2016) increased the monetary incentive amounts and extended the program end date through the end of 2021.[2] These monetary incentive increases were implemented as part of D.16-12-043, issued December 15, 2016.

In Phase 3 of R.13-02-008, the Commission issued numerous decisions intended to facilitate the injection of biomethane. In D.19-05-018, issued May 20, 2019, the Commission ordered changes to permissible gas heating values and ordered the Joint Utilities to propose a standardized biomethane interconnection tariff. In D.19-12-009, issued December 11, 2019, the Commission established an incentive reservation system for the biomethane monetary incentive program established in D.15-06-029 and made incentive funding available through the end of 2026 pursuant to statutory directive. In D.20-08-035, issued September 4, 2020, the Commission approved a Standard Renewable Gas Interconnection Tariff (SRGIT). In D.20-12-031, issued December 21, 2020, the Commission approved a Standard Renewable Gas Interconnection Agreement, added an additional $40 million of funding for the biomethane monetary incentive, and ordered the Joint Utilities to file updates to the injection standards for constituents of concern relating to pipeline integrity.

Phase 4 of this proceeding was initiated by the Commission pursuant to Senate Bill (SB) 1440 (Hueso, 2018). SB 1440 required the Commission to consider adopting biomethane procurement targets or goals for the

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[2] *See* AB 2313 (2016, Williams), https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160AB2313.

Joint Utilities.[3] In response to the biomethane procurement issues raised in SB 1440, the Commission issued D.22-02-025 on February 24, 2022, establishing a Renewable Gas Standard for the Joint Utilities to meet by the end of 2030. In addition to procurement targets, D.22-02-025 established a cost-effective means of procurement and adopted provisions to achieve additional co-benefits.

In addition to SB 1440-related considerations, the original[4] Phase 4 Scoping Ruling, issued November 21, 2019, also introduced certain hydrogen-related issues. D.14-01-034 previously determined hydrogen to be one of the five constituents of concern relating to pipeline integrity and established a hydrogen "trigger level"[5] of 0.1 percent but did not establish either a "lower action level"[6] or an "upper action level"[7] for hydrogen. Ordering Paragraph

[3] In accordance with SB 1440, biomethane may be produced through different processes. Pursuant to Public Utilities (Pub. Util.) Code § 651 and Health & Public Safety Code § 39730.8, biomethane may be the end product of technologies such as anerobic biodigesters or gasification applied to black carbon, landfill diversion, and dairy methane.

[4] The Phase 4 Scoping Ruling was subsequently amended on June 5, 2020, to add seven additional biomethane-related considerations.

[5] Per D.14-01-034 at 81: "The trigger level is the acceptable concentration level for each constituent. If the trigger level is exceeded for a constituent, routine monitoring of the constituent of concern is required."

[6] Per D.14-01-034 at 82: "The lower action level is used to screen biomethane suppliers during the initial gas quality review and as an ongoing screening level during the periodic testing. During the initial gas quality review, the constituents of concern in the biomethane will need to be below the lower action level before biomethane can be injected into the pipeline. Afterwards, if a constituent exceeds the lower action level concentration three times within a 12-month period, the biomethane supplier will be shut-off and will be required to repair its biogas processing facility until the biomethane meets the trigger level."

[7] Per D.14-01-034 at 82: "The upper action level establishes the point at which an immediate shut-off of the biomethane supply occurs. This occurs when the concentration amount for a constituent reaches that level. The pipeline will shut-off access when the upper action level is reached, and the biomethane supplier will be required to shut-off the biomethane supply, and to repair its biogas processing facility until the biomethane meets the trigger level concentrations."

(OP) 11 of D.20-12-031 determined that "Upper and lower action levels of hydrogen will be established pursuant to Phase 4 of this proceeding." The original Phase 4 Scoping Ruling stated that "more technical expertise is needed to determine the maximum safe level of hydrogen blend in pipelines"[8] and ordered that "Independent from the process of establishing a Preliminary Hydrogen Injection Standard, the [Commission's] Energy Division will arrange, and oversee an independent technical study to address the potential impacts of increased hydrogen concentration in California's natural gas storage and delivery system."[9] Per the original Phase 4 Scoping Ruling, "[a]fter the technical study is completed and evaluated, the Commission will consider further revisions to the injection standards for hydrogen."[10]

On July 18, 2022, the assigned Administrative Law Judge (ALJ) issued a ruling (Phase 4B Ruling) releasing the commissioned technical study to the public and inviting comment on the study's findings. In addition to 11 questions relating to the technical study, the Phase 4B Ruling also highlighted inconsistencies in adopted biomethane reporting requirements, and asked parties to respond to two questions regarding (1) ways to reconcile those inconsistencies and (2) possible modifications to reporting requirements.

1.1. Summary of UC Riverside Study

The original Phase 4 Scoping Ruling provides the following guidance regarding the scope of the technical study required to assess safe injection standards for hydrogen:

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[8] Phase 4 Scoping Ruling at 8.

[9] *Id*. at 13.

[10] *Id*. at 8.

The study shall assess the safety concerns associated with injecting hydrogen into the existing natural gas pipeline system at a variety of percentages and is expected to address the following topics:

a. A recommended maximum hydrogen percentage at which no or minor modifications are needed for natural gas infrastructure and end-use systems, and an assessment of the types of modifications that may be required for higher percentages of hydrogen.

b. An assessment of the impacts on end-use appliances, potential impact on customers' fuel costs, and safety implications.

c. An assessment of the impacts, including degradation, on durability of the existing natural gas pipeline system.

d. An assessment of any impact on natural gas pipeline leakage rates.

e. An assessment of any impact on valves, fittings, materials, and welds due to hydrogen embrittlement.

f. An assessment of any impact on natural gas storage facilities.

g. An assessment of any impact on pipelines under cathodic protection.

h. A survey and analysis of national and international hydrogen blending and injection studies, activities, and regulations.[11]

In furtherance of the guidance provided in the original Phase 4 Scoping Ruling, the Commission's Energy Division commissioned the required technical study from researchers at the University of California (UC) Riverside after identifying UC Riverside as having adequate knowledge and skill to prepare an analysis of existing literature and ability to conduct laboratory testing

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11 *Id*. at 13-14.

regarding hydrogen blended into a natural gas pipeline. UC Riverside relied on existing and additional investigatory work and prepared a 2022 Hydrogen Blending Impacts Study (UC Riverside Study) as commissioned. Completion of the UC Riverside Study involved The Gas Institute as a subcontractor and was aided by a technical advisory committee.[12]

The UC Riverside Study aimed to assess the operational and safety concerns associated with injecting hydrogen into the existing common carrier pipeline system at various percentages. Hydrogen has significantly different properties than methane and is known to have a degrading effect on materials used in the common carrier pipeline system.[13] The UC Riverside Study conducted a combination of literature review, modeling, and experimental work in the areas of leakage rates of methane and hydrogen blends as compared to pure methane, hydrogen impacts on polymeric materials, and hydrogen impacts on metals and alloys.

The UC Riverside Study's primary findings and recommendations are excerpted as follows:

> Completion of the project tasks has led the project team to conclusions and recommendations that are influenced by many overlapping variables and conditions. A single injection standard that applies systemwide would have to consider the most susceptible conditions observed throughout all infrastructure components. This type of scenario would also be required to consider all end-uses, appliances, and associated industrial processes. This systemwide blending injection scenario becomes concerning as hydrogen blending approaches 5% by volume. As the percentage of hydrogen

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[12] The UC Riverside Study is available on the Commission's website at: https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M493/K760/493760600.PDF

[13] UC Riverside Study at 1.

increases, end-use appliances may require modifications, vintage materials may experience increased susceptibility, and legacy components and procedures may be at increased risk of hydrogen effects.

Hydrogen blending into California's natural gas pipeline infrastructure can help accelerate the transition towards the use of clean hydrogen as a fuel and energy storage medium, and help the state meet a number of climate and air quality goals. However, the hydrogen blending must be carefully planned and conducted in stages to address the effect of hydrogen on materials, components, facilities, and equipment. As there are knowledge gaps in several areas, including those that cannot be addressed through modeling or laboratory scale experimental work, it is critical to conduct real world demonstration of hydrogen blending under safe and controlled conditions. [14]

Recommendations

It is necessary to conduct case-by-case studies to determine the appropriate blend percentage suitable to mitigate operational risks, public safety, durability and integrity of the network and prevent negative impacts to appliances. Existing standards applicable to the natural gas transmission and distribution network, including Title 49 Code of Federal Regulations Part 191 and 192, California General Orders No. 58-A, No. 58-B, and No. 112-F, may need to be updated to reflect the forthcoming use of hydrogen to identify knowledge gaps in materials and safety operating under possibly higher network pressures that may be needed to maintain gas quality. Other standards that may be indirectly impacted by the injection of hydrogen in the natural gas infrastructure include California Residential Code,

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[14] *Id.* at 1-4 (from the Executive Summary).

California Plumbing Code, California Fire Code, and California Building Energy Efficiency Standards.[15]

The UC Riverside Study states that a single injection standard that applies systemwide must consider the most susceptible conditions observed throughout all infrastructure components. Any hydrogen injection standard must also consider all end-uses, appliances, and associated industrial processes. Risks associated with methane-hydrogen blending increase as hydrogen blending approaches five percent by volume. As such, any hydrogen blending must be carefully planned and conducted in stages to address the effect of hydrogen on materials, components, facilities, and equipment. To address knowledge gaps in several areas, the UC Riverside Study emphasizes the need to conduct real world demonstrations of hydrogen blending under safe and controlled conditions.

1.2. Parties Responding to Phase 4B Ruling

The Phase 4B Ruling established two sets of comment deadlines for the two distinct topics that the Ruling addressed. Opening comments on the two questions pertaining to biomethane reporting requirements were due no later than July 29, 2022, with reply comments due no later than August 5, 2022. Opening comments on the eleven questions pertaining to hydrogen injection considerations were due no later than August 12, 2022, with reply comments due no later than August 26, 2022. A follow-up ALJ ruling issued August 10, 2022, extended the deadline for filing opening comments on hydrogen injection considerations to August 19, 2022, with reply comment due no later than September 2, 2022.

[15] *Id.* at 126.

On July 29, 2022, opening comments on biomethane reporting requirements were received from the Joint Utilities and Environmental Defense Fund (EDF).

On August 5, 2022, reply comments on biomethane reporting requirements were received from the Joint Utilities, EDF, and Sierra Club.

On August 19, 2022, opening comments on hydrogen injection considerations were filed by Air Products and Chemicals, Inc. (Air Products), AquaHydrex, Inc. (AquaHydrex), ATCO Gas (ATCO), Bloom Energy Corporation (Bloom), Public Advocates Office (Cal Advocates), Coalition for Renewable Natural Gas (CRNG), EDF, Independent Energy Producers Association (IEP), the Joint Utilities, Sierra Club, Wartsila North America, Inc. (Wartsila), the National Fuel Cell Research Center (NFCRC), Green Hydrogen Coalition (GHC), and California Hydrogen Business Council (CHBC).[16]

On September 2, 2022, reply comments on hydrogen injection considerations were filed by AquaHydrex, EDF, the Joint Utilities, NFCRC, GHC, CHBC, Sierra Club, Wartsila, Bioenergy Association of California (BAC) and California Association of Sanitation Agencies (CASA).[17]

2. Issues Before the Commission

2.1. Issues Relating to Biomethane Reporting Requirements

The original Phase 4 Scoping Ruling, issued November 21, 2019, and the amended Phase 4 Scoping Ruling, issued June 5, 2020, together directed parties to address fourteen separate issues relating to biomethane procurement and the implementation of SB 1440. After considering party comments and the

[16] NFCRC, GHC, and CHBC filed a joint Opening Comment.

[17] BAC and CASA filed a joint Reply Comment.

recommendations of an Energy Division Staff Proposal, the Commission issued D.22-02-025, establishing a biomethane procurement program for the Joint Utilities.

As noted in the Phase 4B Ruling, OP 31 of D.22-02-025 directed the Joint Utilities to update the annual reports that were originally ordered by D.15-06-029 – and subsequently modified by D.16-12-043 – to include new information pertaining to "actual biomethane procurement levels, ratepayer bill impacts, incremental capital infrastructure and/or operations and maintenance costs for the prior year compared to the estimated levels that were approved in their respective [Renewable Gas Procurement Plans]."[18] However, the Joint Utilities' annual reporting obligation has a sunset date, whereas the reporting requirement in OP 31 of D.22-02-025 does not. As such, the Commission must clarify this discrepancy.

Biomethane reporting requirements are addressed below in Section 3.1.

2.2. Issues Relating to Hydrogen Injection

The original Phase 4 Scoping Ruling issued November 21, 2019, stated that R.13-02-008 "should establish safe standards that will enable injection of renewable hydrogen into gas pipelines to reduce the carbon intensity of the gas used in the state."[19]

The Phase 4 Scoping Ruling goes on to state the following:

> The existing efforts and research status on hydrogen affirm that the issue is ripe for consideration. Accordingly, the new phase of this proceeding will establish injection standards and interconnection protocols for renewable hydrogen connecting to the natural gas pipeline system to ensure safety and

[18] Phase 4B Ruling at 2.

[19] November 21, 2019, Scoping Ruling at 6.

> integrity of the gas delivery system and compatibility with end-uses. As part of this effort, it may also be appropriate to re-evaluate the hydrogen standard for biomethane injected into pipelines.[20]

Hydrogen injection considerations are addressed below in Section 3.2.

3. Discussion and Analysis

3.1. Biomethane Reporting Requirements

The Phase 4B Ruling asked parties two separate questions regarding biomethane reporting requirements. We address each question in turn.

3.1.1. Reinstatement of Biomethane Reporting Requirements

Parties were asked the following question regarding the possible reinstatement of biomethane reporting requirements:

> *Should the Commission reinstate a biomethane procurement reporting requirement, which would also include the information required pursuant to D.22-02-025?*

3.1.1.1. Party Responses to Reinstatement of Biomethane Reporting Requirements

All parties that commented on the matter agree that previously ordered reporting requirements should remain in place. However, parties disagree on when, how, and for how long reporting should take place.

The Joint Utilities recommend a bifurcation of reporting requirements. They assert that the new reporting requirements specified in OP 31 of D.22-02-025 serve a different purpose and have different timing considerations vis-à-vis the original reporting requirements. As such, the original reporting requirements should remain in place with a January 15 due date and a sunset after 2027, while the new reporting requirements should commence on

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[20] *Id*. at 7.

May 1, 2024, and continue in perpetuity unless or until modified by a future Commission order. The Joint Utilities assert that a May 1 reporting date is necessary "to allow each utility to complete end-of-year invoicing, settlement, reconciliation, and quality assurance prior to finalizing its procurement data for reporting to the Commission."[21]

EDF agrees that all previously ordered reporting requirements should continue but asserts that it would be inappropriate to end the original reporting requirements after January 15, 2027. Instead, EDF states that "it would be more prudent and convenient for the Commission to examine the need for any revisions and modifications to reporting requirements during the planned medium-term target review of biomethane procurement scheduled to commence in 2025."[22] EDF further opposes bifurcating the two sets of reporting requirements and asserts that "there is convenience and utility in combining the two"[23] even if that requires shifting the previously established reporting deadlines. Finally, EDF recommends that reporting switch from occurring annually to biannually. Sierra Club concurs with EDF's position.

3.1.1.2. Adopted Course of Action on Reinstatement of Biomethane Reporting Requirements

We agree with EDF and Sierra Club that both the original reporting requirements and the new reporting requirements should be combined into a single annual report. However, we also agree with the Joint Utilities that the new reporting requirements need not be filed until May 1, 2024. As such, we

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21 Joint Utilities Opening Comments on Continued Biomethane Procurement Reporting at 4.

22 EDF Reply Comments on Continued Biomethane Procurement Reporting at 2.

23 *Id*.

require the original reporting requirements to next be filed on or before January 15, 2023, and subsequent annual reports to be filed on or before May 1 that are inclusive of both the original reporting requirements and the new reporting requirements. We decline to order reporting more than once per year.

We will revisit the matter of reporting requirements as part of the review ordered by OP 21 of D.22-02-025 of the medium-term biomethane procurement targets. Until then, however, we find it appropriate for the consolidated annual report to sunset the original reporting requirements after May 1, 2027.

3.1.2. Modifications to Biomethane Reporting Requirements

Parties were asked the following question regarding modifications to biomethane reporting requirements:

> *If a biomethane procurement reporting requirement for gas utilities is reinstated, should that reporting requirement be modified, and if so, how?*

3.1.2.1. Party Responses to Modifications to Biomethane Reporting Requirements

Parties had differing perspectives as to how reporting requirements should be modified. In their opening comments, the Joint Utilities do not propose any substantive modifications to the biomethane reporting requirements. Both EDF and Sierra Club, however, propose changes.

EDF proposes additional reporting related to environmental impacts of biomethane procurement to guarantee the program's environmental benefits, as required under certain D.22-02-025 OPs stemming from implementation of SB 1440. EDF's proposed additional reporting includes: (1) impacts on disadvantaged communities; (2) related vehicle emissions; (3) emissions regarding carbon monoxide, carbon dioxide, and hydrogen sulfide; (4) water and air quality impacts on nearby communities; (5) air and water pollution and purpose-grown crops control standards attestation; (6) waste byproducts used; and (7) methane leaks and related information.[24]

Sierra Club echoes the suggestions of EDF and adds one additional item. They suggest that "the utilities should annually solicit assurance from the Regional Water Board and Regional Air District that diary biomethane sources are not adversely impacting air or water quality" and that "these factual determinations should be included in one of the two biannual reports submitted by the utilities."[25]

In their reply comments, the Joint Utilities state that EDF's reporting proposal is already required under D.22-02-025 pursuant to their Standard Biomethane Procurement Methodology assessments. They further assert that requiring such reporting in an annual report would be burdensome, beyond their jurisdiction over third-party biomethane producer facilities and operations, and that the proposed information is already captured in their Renewable Gas Procurement Plan activities, supply contract terms and conditions, and in the SRGIT.[26]

3.1.2.2. Adopted Course of Action on Modifications to Biomethane Reporting Requirements

Upon review of the existing decision-based reporting requirements, including both the original reporting requirements established by D.15-06-029 and the new reporting requirements established by D.22-02-025, as well as the additional environmental impact reporting requirements found in various

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[24] EDF Opening Comments at 4-5.

[25] Sierra Club Reply Comments at 2.

[26] Joint Utilities Reply Comments at 2-4.

D.22-02-025 OPs and referenced by EDF in its opening comments, it is clear that the Joint Utilities already provide, or will soon provide, the Commission and interested parties with all such information through their various required reports. We therefore conclude that it is neither unduly burdensome nor unduly administratively costly to gather all such information into a single report (and may prove both less burdensome and less administratively costly to do so). The Joint Utilities shall file annual reports with the following biomethane information starting May 1, 2024: details of actual biomethane procurement levels; ratepayer bill impacts; incremental capital infrastructure and/or operations and maintenance costs for the prior year compared to the estimated levels that were approved in their respective RGPPs; impacts on disadvantaged communities; related vehicle emissions; emissions regarding carbon monoxide, carbon dioxide, and hydrogen sulfide; water and air quality impacts on nearby communities; air and water pollution and purpose-grown crops control standards attestation; waste byproducts used; and methane leaks and related information.

3.2. Hydrogen Injection Considerations

The Phase 4B Ruling asked parties eleven separate questions regarding hydrogen injection considerations. Before addressing each question in turn, we summarize the findings and recommendations of the UC Riverside Study and the next steps we find appropriate towards establishing a system-wide injection of renewable hydrogen into California's common carrier pipeline system.[27]

The UC Riverside Study involved a combination of literature review, modeling, and experimental work. The UC Riverside Study finds that the literature review supports hydrogen blends up to five percent, in that these

[27] The UC Riverside Study is a technical scientific report, and this summary does not attempt to reflect all of the details of the study.

relatively low concentrations may be injected without significantly increasing risk factors to storage and transmission with no modification, or only minor modification, to the existing natural gas system.[28, 29] The UC Riverside Study also notes that the current understanding of the real-world implications of the use of hydrogen in California's gas system is limited, and recommends further study before adopting a system-wide safe hydrogen injection standard. Finally, the UC Riverside Study comments that hydrogen blending can be an important decarbonization strategy for the energy and transportation sectors.[30]

The UC Riverside Study recommends the following four activities be the undertaken concurrently:

- Large scale and targeted demonstration projects to evaluate impacts of hydrogen gas on all materials and components involved, and to develop mitigation strategies.
- Research and development on the impacts of different percentages of hydrogen blending on all aspects of California's gas infrastructure.
- Planning for system-wide hydrogen injection considering the most susceptible conditions observed throughout all infrastructure components and developing new safety and operational procedures.
- Stakeholder and public engagement to address technological, societal, economic, and safety concerns.

The UC Riverside Study provides support for pursuing hydrogen blending as part of a decarbonization strategy, while at the same time, outlining

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[28] UC Riverside Study at 107.

[29] It is important to note that even if hydrogen blending gets to its maximum blend level at the injection point, hydrogen gets diluted with natural gas once it enters the natural gas pipeline. This means that blending five percent of hydrogen at an injection point, for example, is not directly comparable to a five percent concentration of hydrogen by volume systemwide.

[30] UC Riverside Study at 111.

thoughtful and prudent next steps before establishing a system-wide injection standard. In light of the UC Riverside Study, and parties' comments on the report, we direct the Joint Utilities to propose hydrogen blending pilot projects, taking into account the UC Riverside Study recommendations, as well as further guidance below. The results of these pilots will inform our ongoing consideration of a safe hydrogen injection standard.

3.2.1. Adoption of a Safe Hydrogen Injection Standard

Parties were asked the following question regarding the adoption of a safe hydrogen injection standard:

> *Does the UC Riverside Study provide enough information for the Commission to consider adopting a safe injection standard for hydrogen in the common carrier pipeline system? If so, what should that standard be, and why do you think that standard is appropriate?*

3.2.1.1. Party Responses to Adoption of a Safe Hydrogen Injection Standard

Parties' comments on the threshold issue of whether to adopt an injection standard reflect a range of perspectives that generally fall into three camps: (1) the UC Riverside Study supports an injection level of up to five percent, (2) demonstration testing is necessary as a first step, and (3) the UC Riverside Study does not provide substantial evidence to support a safe injection standard.

NFCRC, GHC, and CHBC assert that setting the hydrogen injection standard at a volume of five percent would be consistent with the UC Riverside Study findings, with further assessment needed to determine what level above five percent can be accommodated.[31] These parties further assert

[31] NFCRC, GHC, and CHBC Opening Comments at 3.

(1) any leakage of hydrogen in the place of methane leads to a reduction in global warming potentials, (2) hydrogen leak rate relative to methane in a typical gas infrastructure is still in debate, and (3) these concerns are not relevant at a five percent rate. AquaHydrex and IEP also support a five percent injection standard and the use of pilot projects and real-world applications.

The Joint Utilities assert that the UC Riverside Study provides a detailed review of hydrogen blending considerations and note certain gaps that need to be addressed for a blending standard. They recommend further hydrogen blending demonstration and research utilizing typical equipment found in California gas infrastructure before establishing a safe injection standard for hydrogen.[32] The Joint Utilities replied to Sierra Club's comments that suggest blending five to -20 percent can lead to unacceptably high risk of explosions, and cite evidence from Hawaii Gas, Hong Kong's Town Gas, and Singapore's gas service providers that have operated with gas blends containing hydrogen for decades without any increased explosions in homes.[33]

Cal Advocates, Sierra Club and EDF take the position that it is premature to set an injection standard without more thorough research. Cal Advocates expressed concern that blending hydrogen is likely to increase the number of pipeline ignition incidents, that required increased pipeline pressures may lead to more pipeline ruptures, that pipeline materials have not been thoroughly studied, and emphasized in the fact that no method is currently available to monitor embrittlement.[34]

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[32] Joint Utilities Opening Comments at 2.

[33] Joint Utilities Reply Comments at 5.

[34] Cal Advocates Opening Comments at 2-7.

EDF offers that the Commission should begin with certain "guiding principles" including regarding "[t]he intended purpose of the hydrogen…The suitability of hydrogen for end uses and end users. The appropriate process for evaluating hydrogen projects."[35] Sierra Club in reply comments expressed similar caution regarding the primary review of potential impacts on the environment, including greenhouse gas (GHG) emissions, prior to setting an injection standard.

3.2.1.2. Adopted Course of Action on Adoption of a Safe Hydrogen Injection Standard

The UC Riverside Study finds that before a hydrogen injection standard can be safely established for California's common carrier pipeline system, a fuller understanding of real-world safety and operational impacts is desirable. Pilot projects and further study can help the development of the renewable hydrogen market, enable a variety of use cases, and contribute to achieving California's climate goals.

We agree with parties that the UC Riverside Study identifies important safety considerations associated with hydrogen blending, especially related to embrittlement and leakage. While the UC Riverside Study finds this particularly important for percentages above five percent, the Study notes the overarching importance of collecting information from real-world hydrogen blending projects. As such, we find it appropriate to order additional testing through pilot projects as discussed in greater detail below in Sections 3.2.4.3. and 3.2.7.2. Consequently, this decision continues the process that began in D.14-02-034 to establish safe injection standards for all identified constituents of concern using best available scientific data.

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[35] EDF Opening Comments at 3-4.

3.2.2. Leakage Considerations

The UC Riverside Study notes that hydrogen may leak and can migrate through materials in several ways.[36] The UC Riverside Study finds that the percentage of hydrogen in a methane-hydrogen blend leaking through a pipe orifice stayed constant, with no more hydrogen leaking from the blend than methane. It did find, however, that from five to twenty percent gas blend, hydrogen-methane blend leak flow rate increases with increasing concentration of hydrogen in the gas blend.[37]

Parties were asked the following question regarding leakage considerations:

> *Are there leakage-related considerations that the Commission should consider?*

3.2.2.1. Party Responses to Leakage Considerations

All parties that commented on leakage agree that there are serious considerations to be weighed, and that precautions to measure and monitor against such leakage is required for all producers wishing to inject a methane-hydrogen blend into California's common carrier pipeline system.

Air Products notes that the introduction of hydrogen into the system has to be carefully reviewed given the age of California's pipeline system and its

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[36] UC Riverside Study at 12, discussing hydrogen permeation through metals, polymer pipes, threaded fittings, and sealing systems such as gaskets. For example, "[w]ith respect to hydrogen gas, permeation through metals consists of adsorption on the metal surface, dissociation of hydrogen molecule, diffusion of hydrogen atoms through the metal, reassociation of molecules and desorption on the opposite side of the metal. On the other hand, the permeation of hydrogen gas through polymer materials is accomplished by molecular diffusion. Pneumatic leaks occur through transfer of gas through a physical opening at the presence of a pressure gradient."

[37] UC Riverside Study at 33-36.

intended use with natural gas.[38] Sierra Club and EDF raise environmental concerns with leakage, noting that hydrogen is an indirect GHG with underestimated climate impacts and with a climate warming potential 30 times that of CO2.[39]

The Joint Utilities state that the tests performed by the UC Riverside Study were in low-pressure pipelines, and that additional research is needed.[40]

3.2.2.2. Adopted Course of Action on Leakage Considerations

Consistent with the UC Riverside Study recommendations, hydrogen blending activities authorized through this decision will be carefully designed and monitored to better understand leakage. We agree with all parties that adopting a safe injection standard requires the appropriate measurement and monitoring of leakage.

The UC Riverside Study's conclusions highlight the importance of understanding the safety-related properties of different blends, identifying methods and strategies (*e.g.*, use of odorants) for prompt detection, and developing effective safety procedures for the monitoring, identification, and repair of leaks to reduce safety risks.[41]

Accordingly, any proposed pilot project must include rigorous testing protocols consistent with the UC Riverside Study and should take into account parties' comments and further stakeholder input.

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[38] UC Riverside Study at 38 mentions that pipeline infrastructure is over 80 years old; *see also* Cal Advocates opening comments at 4 and Air Products opening comments at 5-6.

[39] Sierra Club Opening Comments at 6.

[40] Joint Utilities Opening Comments at 2.

[41] UC Riverside Study at 107.

3.2.3. Heating Value Considerations

Hydrogen has a heating value about one third the heating value of natural gas, and therefore three times the amount of hydrogen is required to replace the energy of the natural gas that the hydrogen displaces in order to provide the same amount of heat value. Heating value considerations are relevant because different flow and pressure in parts of the system may present challenges to the operation of the natural gas infrastructure and affect equipment once hydrogen in injected. The UC Riverside Study does not evaluate the potential impacts of heating value and the options for addressing those impacts.

Parties were asked the following question regarding heating value considerations:

Are there heating value-related considerations that the Commission should consider?

3.2.3.1. Party Responses to Heating Value Considerations

All parties that commented on the matter agreed that hydrogen's heating value characteristics need to be considered for the safe operation of natural gas infrastructure. Air Products pointed out that a different flow and pressure could affect equipment and create pressure regimes where potential piping material degradation may become a greater likelihood.[42]

The Joint Utilities state that new heating value districts may need to be established depending on the interconnection, location, and production volume.[43] Further, heating value measurement devices may need to be modified for accurate billing.

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[42] Air Products Opening Comments at 6-7.

[43] Joint Utilities Opening Comments at 3.

3.2.3.2. Adopted Course of Action on Heating Value Considerations

Heating value requires additional consideration to address the UC Riverside Study finding that increasing pressure of hydrogen blends to increase heating value "demonstrate increased risk to embrittlement, fatigue crack growth, and failure in high strength steels. Similarly, poorer creep performance in polymers has been demonstrated for a 20 percent hydrogen blend."[44] However, ATCO contends that hydrogen-methane blends do not require increased pressure to adjust heating values. It asserts that the UC Riverside Study "overlooks the significance of density and viscosity of hydrogen."[45] Thus, "gas transmission and distribution systems carrying a blend of hydrogen and natural gas do not need to be operated at higher pressures than systems carrying only natural gas today" because "most natural gas systems have adequate spare capacity to accommodate the decrease in volumetric energy density [*e.g.,* heating value] associated with hydrogen blending."[46]

The Joint Utilities mention that "approved heating value measurement devises for billing cannot detect and measure hydrogen. SoCalGas is evaluating two new gas chromatographs that are capable of detecting hydrogen. PG&E is also involved in a study evaluating chromatographs to analyze hydrogen."[47] We require SoCalGas and PG&E to present their evaluations of their new gas chromatographs and for those devices that pass evaluation, submit to the CPUC for approval per General Order (GO) 58-A and GO 58-B.

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[44] UC Riverside Study at 109.

[45] ATCO Opening Comments at 4.

[46] *Id.* at 4-5.

[47] Joint Utilities Opening Comments at 3.

Any proposed pilot project shall include new or revised heating values, as necessary. The Joint Utilities shall further clarify when proposing pilot projects whether they intend to modify heating values of gas through the use of propane or other means, and whether such modifications to heating value can be done safely.

3.2.4. Hydrogen Blending Limitations

The UC Riverside Study states that a single, system-wide blending standard would have to consider the most susceptible conditions observed throughout all infrastructure components, and that it is critical to conduct real world demonstration of hydrogen blending under safe and controlled conditions.

Parties were asked the following question regarding hydrogen blending limitations:

> *Should there be limitations set on when, where, and/or how much hydrogen can be blended into the natural gas system? For example:*
>
> *a. Should hydrogen be blended into natural gas that travels into transmission pipelines, high pressure distribution pipelines, storage facilities, etc.?*
>
> *b. Are there particular types of customers that should never be delivered natural gas that has been blended with hydrogen?*
>
> *c. Are there appliance-specific end use considerations that the Commission should make?*

3.2.4.1. Party Responses to Blending Limitations

All parties agreed that there should be limitations on where, when, and/or how much hydrogen can be injected into the common carrier pipeline system. EDF recommends hydrogen-only infrastructure for preliminary research, development, and deployment or localized hydrogen projects limited in distance (*i.e.*, hydrogen hub model) in lieu of hydrogen-methane blending projects.[48]

The Joint Utilities point to the many varied studies that had been performed, with no consistent global data due to varying infrastructure. Further, they pointed out that customers reliant upon methane as a feedstock require additional research to determine the impact of hydrogen blending. This research should take place in parallel with research into hydrogen separation technology that requires additional costs and results in energy loss.[49]

Sierra Club states that it is premature to consider specific limitations on when, where, or how much hydrogen can be blended, when there is insufficient data to support hydrogen blending. They consider hydrogen blending to be inconsistent with the Zero-Carbon Energy scenario in E3's Achieving Carbon Neutrality study which calls for "a complete retirement of the low-pressure gas distribution system by 2045."[50]

IEP states that injection should not occur at any portions of the natural gas system that are known to experience leakage rates that are much higher than the system average.

The Green Hydrogen Coalition, the National Fuel Cell Research Center, and the California Hydrogen Business Council argue that enabling the injection of hydrogen at five percent is critical to maximizing the value and minimizing the cost of hydrogen.[51] They advocate for blending right away up to five percent

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[48] EDF Opening Comments at 6.

[49] *Id*. at 4-5, including footnotes 7-9.

[50] Sierra Club Opening Comments at 10-11. Sierra Club adds that that "more than 15 studies advise that hydrogen is not a competitive climate strategy for heating buildings." *See also* footnotes 43-46.

[51] NFCRC, GHC, and CHBC Opening Comments at 8.

in the common pipeline, not in any localized project or hub. They acknowledge that hydrogen blending for all purposes should not be the Commission's focus, stating instead that the Commission's efforts regarding hydrogen blending should be to prioritize on the "difficult to decarbonize" sectors.[52]

3.2.4.2. Adopted Course of Action on Blending Limitations

Consistent with the UC Riverside Study, we find that pilot projects should be used to evaluate hydrogen injection at blends between one and five percent, and between five and twenty percent, as further specified in this decision. Any proposed pilot project should be designed to avoid hydrogen from reaching natural gas storage areas and electrical switching equipment directly or through leakage. Real-world pilot projects should be performed in either a closed system or in a mock-up of a real-world system using typical equipment and materials found in California gas infrastructure. Additionally, the pilot projects must be designed to evaluate whether hydrogen blending will pose minimal risk to distribution and transmission pipeline integrity and whether blending fuel use will result in end user appliance malfunctions. Pilot projects should focus on ensuring long-term safety of the California pipeline, hydrogen leakage, and hydrogen monitoring, as well as the dilution rate and other mechanical characteristics of hydrogen blends in the natural gas pipeline stream.

3.2.5. Measurement, Monitoring, and Reporting Requirements

New endeavors, especially those that raise safety concerns, benefit from regular measurement, monitoring and reporting. The UC Riverside Study

[52] *Id*. at 9-10.

recommends that the gas utilities modify "existing integrity management systems, including monitoring and maintenance schedules and practices."[53]

Parties were asked the following question regarding measurement, monitoring, and reporting requirements:

> *How should the gas utilities be required to measure, monitor, and/or report the amount of hydrogen that is blended into the natural gas system?*

3.2.5.1. Party Responses to Measurement, Monitoring, and Reporting Requirements

Both Sierra Club and the Joint Utilities comment that the Commission needs carefully crafted rules to measure, monitor, and report the amount of hydrogen blended and that regular reporting should be required. The Joint Utilities propose aligning with the SRGIT, testing at 12-month intervals, unless blending exceeded targets, which would result in quarterly testing, along with trace constituents monitored as per existing SRGI Tariffs. The Joint Utilities state that for flow monitoring for volume and energy calculations pursuant to the standard American Gas Association (AGA) reports generally available for gas pipelines, "[i]t is not yet known how to accurately measure volume [for blended hydrogen] using the existing flow computers pre-programmed with various AGA algorithms."[54]

Cal Advocates commented that the Commission should leverage ratepayer-funded research, development, and demonstration opportunities to evaluate the best use of hydrogen. With the heightened interest in hydrogen as

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[53] UC Riverside Study at 7.

[54] Joint Utilities Opening Comments at 6-7.

an energy source, there is a growing body of research occurring in California, nationally and internationally.

Sierra Club asserts that to determine how much of the hydrogen reaches customers without being lost to leakage, the Commission should require regular public reporting, to the amount of hydrogen injected (by mass) and their blend rates (by volume), and the blend rates of the gas that customers actually receive.[55]

3.2.5.2. Adopted Course of Action on Measurement, Monitoring, and Reporting Requirements

Consistent with the UC Riverside Study and party comments, we find that hydrogen injection and blending require careful attention, monitoring and reporting, and the long-term impacts of hydrogen injection should also remain under study since there could be delayed undetected effects.

The UC Riverside Study noted that five to twenty percent hydrogen blends leak faster, therefore requiring real-world demonstrations in various parts of the pipeline to better understand higher percentage blend leak conditions and consequences. We agree with EDF that the scale of testing is relevant because the longer the pipeline, the higher the possibility of leakage and the more difficult it would be to monitor. The UC Riverside Study recommends testing on isolated gas pipelines for concentrations of hydrogen between five to twenty percent, and monitoring and validation programs should be established to confirm performance and inform future increases in the blend limit.

Proposed pilot projects must be designed to facilitate measurement, monitoring, and reporting during the pilot project, and provide for an

[55] Sierra Club Opening Comments at 12.

independent technical assessment. The utility pilot measurement, monitoring, and reporting program must incorporate the direction in this decision.

Further, we direct the Joint Utilities to monitor the national and international ongoing research and to jointly file a Hydrogen Blending Compendium Report within two years from the issuance date of this decision. The Hydrogen Blending Compendium Report should identify existing studies and regulatory proceedings that are complete and underway with a summary of each scope and relevant findings. The Hydrogen Blending Compendium Report should include findings related to: (1) safety performance, safety thresholds, and integrity threat levels on various pipeline network components associated with hydrogen injection, at various hydrogen blend percentages; (2) leakage rates of the methane and hydrogen blend compared to pure methane; (3) modeling to quantify lost hydrogen due to leakage; (4) hydrogen permeation rates through polymer materials as compared to the natural gas permeation rates, and assessment of technologies for preventing or mitigating methane and hydrogen blend leakage in polymer and other pipeline materials; (5) impact on storage fields, and modifications that may be necessary to maintain safety; (6) analysis of the best equipment to monitor, detect, and control hydrogen leakage, and assessment of new hydrogen leak detection technologies; (7) analysis of the impact of hydrogen dilution on heating value, and the required modifications of end-user equipment and appliances; and, (8) any and all human health issues identified.

3.2.6. Rule/Tariff Modifications

Parties were asked the following question regarding rule/tariff modifications:

What existing rules and/or tariffs need to be modified to allow hydrogen to be blended into natural gas? Should hydrogen that is intentionally blended into natural gas be treated differently than hydrogen that may be present in biomethane or fossil natural gas?

3.2.6.1. Party Responses to Rule/Tariff Modifications

Cal Advocates state that rules covering renewable gas interconnection and transportation of gas would need to be modified to allow hydrogen to be blended with natural gas.

The Joint Utilities comment that existing tariffs would need to be modified for hydrogen blending. As discussed above, the Joint Utilities state that the current minimum heating value may need to be modified because gaseous hydrogen has approximately one-third the energy content of natural gas. The Joint Utilities currently have a 0.1 percent trigger level and to-be-determined Lower Action and Upper Action Levels for hydrogen.[56] The trigger level is the acceptable concentration level for each constituent. If the trigger level is exceeded for a constituent, routine monitoring of the constituent of concern is required.

3.2.6.2. Adopted Course of Action on Rule/Tariff Modifications

While we decline to adopt an injection standard beyond the existing trigger level for hydrogen in biomethane at this time, we find it appropriate to adopt new lower and upper action levels for the existing trigger level. Hydrogen is currently identified as a constituent of concern in biomethane and is limited to

[56] Joint Utilities Opening Comments at 8. Trigger levels, lower action levels, and upper action levels are defined in D.14-01-034 and above in footnotes 5-7.

0.1 percent by the SRGIT.[57] We maintain the existing trigger level standard of 0.1 percent and establish a lower action level of a one percent hydrogen content and an upper action level of a five percent hydrogen content (as these are defined in D.14-01-034 and above in footnotes 4-6). By establishing such thresholds, we add a degree of additional safety without authorizing any additional hydrogen than is already permitted. The Joint Utilities shall file a joint Tier 1 AL no later than 60 days from the issuance date of this decision updating the SRGIT to reflect these changes.

3.2.7. Additional Testing Requirements

Parties were asked the following question regarding additional testing requirements:

> *Is there a need for additional testing on one or more gas utility's pipeline systems before hydrogen is allowed to be blended into natural gas?*

3.2.7.1. Party Responses to Additional Testing Requirements

Most parties that commented on the matter assert that further testing is required and note that one of the UC Riverside Study's primary recommendations is to conduct real-life demonstrations of hydrogen blending. The parties disagree on the parameters of any additional testing requirement.

The Joint Utilities assert that real-life demonstrations in isolated parts of the gas system would provide valuable operational data, tools, and information to support fitness for service assessment. This information can be used to repurpose existing natural gas infrastructure and update safety requirements.[58]

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[57] D.20-12-031. The corresponding tariff numbers for each of the utilities are: SoCalGas Rule 45, SDG&E Rule 45, Southwest Gas Rule 22, and PG&E Gas Rule 29.

[58] *Id*. at 8-9.

Air Products recommends real-world demonstrations under safe and controlled conditions. They consider the UC Riverside Study's proposal of three years of testing to be a minimum and notes that some jurisdictions (*i.e.*, Enbridge, Canada) are testing over a five-year period at a low concentration of two percent.[59]

On the other hand, the National Fuel Cell Research Center, the Green Hydrogen Coalition, and the California Hydrogen Business Council believe that testing on the Joint Utilities' pipelines should be performed for concentrations of hydrogen between 5-20 percent.[60] They also recommend establishing monitoring and validation programs to confirm performance in concentrations lower than five percent.

3.2.7.2. Adopted Course of Action on Additional Testing Requirements

As the UC Riverside Study recommends and many parties note, real-world demonstration projects with monitoring and controls can provide useful information on the impacts of higher blends, specific locations on the gas system, storage facilities, and at specific end uses. Any proposed pilot projects must include a detailed testing program informed by the UC Riverside Study and other appropriate sources. As discussed above in Section 3.2.1.2., in light of the UC Riverside Study and parties' comments on the report, we direct the Joint Utilities to propose hydrogen blending pilot projects, taking into account the UC Riverside Study and direction in this decision. The results of these pilots will inform future consideration of a safe hydrogen injection standard.

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59 Air Products Opening Comments at 8-9 (footnotes omitted).

60 NFCRC, GHC, and CHBC Opening Comments at 11.

Therefore, the Joint Utilities shall file a Joint Application no later than two years from the issuance date of this decision for testing of hydrogen blended into natural gas at concentrations above the existing trigger level in increasing increments from one to five and five to 20 percent. The Joint Application shall be consistent with the other adopted courses of action specified in this decision for pilot projects relevant to leakage, reporting, heating value, system safety, environmental considerations, etc., and include a proposed methodology for performing a Hydrogen Blending System Impact Analysis that can ensure that any hydrogen blend will not pose a risk to the common carrier pipeline system.

The Energy Division should explore contracting options for an independent research organization such as one of the national labs, or hiring of the California Council of Science and Technology or another independent entity, as an independent body to review the results of the blending pilot projects. The research organization should produce a report as to its findings and conclusions within four years from the issuance date of this decision. This report will help the Commission determine possible next steps including allowing injections of higher blends of hydrogen in the natural gas system. Energy Division will present its recommendations in a draft resolution for Commission approval.

Finally, to gather further input from members of the public, the Joint Utilities shall host a workshop no later than six months from the issuance date of this decision to obtain feedback from a diverse group of stakeholders on how to proceed with assembling safe and meaningful pilot projects for testing of hydrogen blends. Among other inputs received, the workshop should inform the design and implementation of the pilot projects' necessary testing and monitoring systems. The Joint Utilities shall coordinate workshop details with the Commission's Energy Division.

3.2.8. Cost and Environmental Considerations

Parties were asked the following question regarding cost and environmental considerations:[61]

> *Is there a need to weigh any cost-related or environmental-related considerations at this time if the Commission does not yet intend to mandate a level of hydrogen procurement? If so, what are those considerations?*

3.2.8.1. Party Responses to Cost and Environmental Considerations

Most parties agreed that there is a need to consider cost and environmental issues related to hydrogen blending.

Air Products commented that "[r]egardless of whether a [hydrogen] procurement target is set at this time, it would be useful for all the parties involved for the Commission to study and include these topics for discussion in the proceeding."[62]

IEP stated that "the Commission should keep in mind that hydrogen itself acts as an indirect greenhouse gas, with a 100-year global warming impact 6-16 times greater than CO_2 per unit of mass according to one recent study."[63]

EDF commented that "affordability requires a next step: an analysis of whether the proposed hydrogen solution results in just and reasonable rates and customer affordability."[64]

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61 The UC Riverside Study did not address this question.

62 Air Products Opening Comments at 9.

63 IEP Opening Comments at 3-4.

64 EDF Opening Comments at 21.

The Joint Utilities pointed to the UC Riverside Study's recommendation to next begin such economic and environmental considerations through stakeholder engagement activities.[65]

Sierra Club wrote that "[t]he most optimistic case for hydrogen blending is that it could enable slight incremental reductions in carbon emissions from burning pipeline gas. This modest benefit likely comes at economic, environmental, and public health costs that render pipeline blending bad policy…Any meaningful analysis of whether the costs of hydrogen blending are worthwhile will consider alternatives for achieving similar GHG reduction…The Commission should be especially reluctant to authorize dead-end investments in the gas system because of the potential that these costs will fall disproportionately on lower and fixed-income households that may face difficulty transitioning off the gas system."[66]

AquaHydrex takes the position that it is reasonable to question the cost effectiveness of hydrogen blending but, in the present, there is no need for final answers and noted that emerging climate strategies are more costly than conventional technologies until they reach market scale.

3.2.8.2. Adopted Course of Action on Cost and Environmental Considerations

We consider the cost and environmental consideration within the limited scope of this proceeding and this decision. Cost and environmental considerations will be far more important — indeed, central — if the Commission requires hydrogen procurement in the future.

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[65] Joint Utilities Opening Comments at 9, including footnote 22.

[66] Sierra Club Opening Comments at 13-18.

We are not authorizing hydrogen procurement for the Joint Utilities at this time, and the volume of hydrogen in the system associated with any pilot project will be at very small volumes and even smaller, if not negligible, at end-use applications. The scale of the pilot projects should not have any bearing on the extent to which gas infrastructure stays in service, but will reduce carbon emissions, all else being equal, and the pilots will produce important information about the potential for more significant carbon reductions if system-wide hydrogen injection standard is deemed appropriate. Any proposed pilot program must also provide for testing to control local emissions, and the costs of the proposed pilots be considered as part of the Commission's evaluation of the utility applications.

Broader policy issues related to long-term gas planning, including the potential role of renewable hydrogen, are being addressed in R.20-01-007 (as well as other agency processes, including implementation of SB 1075).[67]

We agree with the Joint Utilities that environmental impact to customers and communities should be considered during the stakeholder engagement activities as recommended in the UC Riverside Study. We direct the Joint Utilities to develop a detailed stakeholder engagement plan to be submitted as part of their hydrogen blending pilot project application. Such a plan must contain a timeline of planned stakeholder outreach activities and detail how stakeholder input will be considered for incorporation into pilot project design and execution.

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[67] SB 1075 added Health and Resources Code Section 38561.8 and Public Resources Code Section 25307, and amended Public Utilities Code Section 400.3. The statutes generally require the evaluation of green hydrogen role in achieving California's climate objectives. *See*: https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=202120220SB1075

3.2.9. Appropriate Next Steps

The UC Riverside Study proposes a three-year timeline to conduct: (1) live demonstrations for five to twenty percent hydrogen blends to analyze the effect of weather induced temperature changes, pressure cycling, length of exposure, effect of natural gas components and contaminants, and potential mitigation techniques; (2) research and development on higher percentage blends with immediate focus on zero-twenty percent and 20-50 percent; (3) engagement with gas utilities, material and equipment manufacturers, suppliers, and regulatory agencies to update existing manufacturing, procurement, installation, maintenance, and safety procedures; and (4) engagement with stakeholder groups including community and environmental organizations, industry, government, academia, and the general public to provide perspectives on hydrogen blending, conduct outreach to address technological, societal, economic, and safety concerns regarding hydrogen-methane production, storage, transport, and use.

Parties were asked the following question regarding appropriate next steps:

> *What next steps should the Commission take in response to the findings in the report?*

3.2.9.1. Party Responses to Appropriate Next Steps

The majority of parties agree that further study of the impacts of hydrogen blending on the common carrier pipeline system is necessary. However, the parties disagree about the approval of a hydrogen injection standard and the percentage that real-world demonstration projects should test, and some parties oppose further study without more certainty regarding the ratepayer benefits.

EDF recommends that the Commission evaluate hydrogen blending with other alternatives and its costs and benefits and if a safe injection standard is approved, to implement regular checkpoints to ensure that any proposed hydrogen project guarantees affordability and environmental integrity.[68]

The Joint Utilities support the UC Riverside Study's recommendation to conduct real world demonstration projects to address knowledge gaps and assess higher hydrogen blending percentages, develop mitigation strategies, and undertake stakeholder engagement activities.[69]

IEP states that a monitoring and validation program should be established to confirm performance to expectations and inform future increases in the blend limit."[70]

In contrast, Cal Advocates, EDF, and Sierra Club argue that the Commission should not devote ratepayer funding to further research into hydrogen blending unless the Joint Utilities can prove that it is a least-cost decarbonization pathway.

Wartsila adds that the Commission should investigate other renewable fuels, as permitted by the end-use. It contends that for applications in the power sector, renewable hydrogen has gained popularity because it can provide clean dispatchable power, but these benefits are not exclusive to hydrogen and that the Commission should adopt a fuel-agnostic approach to decarbonizing fossil fuels.[71]

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68 EDF Opening Comments at 22.

69 Joint Utilities Opening Comments at 9-10.

70 IEP Opening Comments at 11.

71 Wartsila Opening Comments at 3.

3.2.9.2. Adopted Course of Action on Appropriate Next Steps

The parties' comments highlight both the growing interest in hydrogen as an energy source and the wide range of perspectives on the risks and opportunities; however, most of the issues raised in response to this question go beyond the scope of this rulemaking.

As the UC Riverside report finds, renewable hydrogen can be a beneficial fuel and energy storage medium that can help California meet its climate goals. The CPUC and other state agencies, including the California Air Resources Board, the California Energy Commission, and the Governor's Office of Business and Economic Development, are examining and advancing renewable hydrogen's role in California's energy future through various efforts including implementation of Senate Bill 1075 (Skinner, 2022), the development of the new renewable hydrogen demonstration program pursuant to Assembly Bill 209 (Committee on Budget, 2022) and Assembly Bill 179 (Ting, 2022), and the launch of the Alliance for Renewable Clean Hydrogen Energy Systems (ARCHES) initiative.

This proceeding remains open to further consider renewable hydrogen issues, which may include additional injection standards and the role of the utility in advancing renewable hydrogen. The proceeding will also address additional Phase 4-related considerations.

3.2.10. Additional Considerations

Parties were asked the following question regarding additional considerations:

> *What additional comments do you have that you believe the Commission should consider when determining what a safe standard of hydrogen is to be blended into natural gas or otherwise allowed to be present in the common carrier pipeline system?*

3.2.10.1. Party Responses to Additional Considerations

Cal Advocates asserts that the Commission should leverage ratepayer-funded research, development, and demonstration opportunities to evaluate the best use of hydrogen. Additionally, it believes that the Commission should require PG&E to submit its Hydrogen to Infinity project reports and findings to provide an opportunity for parties to comment on the project in R.13-02-008. Cal Advocates further recommends that the Commission only approve the injection of hydrogen to the extent that such injection does not increase NOx emissions, mitigates global warming, and is cost-effective.[72]

EDF notes that the safety risks to infrastructure and climate disproportionately impact communities of color and low-income populations.[73]

Sierra Club recommends that the Commission should establish a system for utilities to provide compensation to customers whose equipment, premises, or persons are injured as a result of hydrogen blending.

The Joint Utilities recommend extending the duration of the UC Riverside Study's proposed three-year timeline to complete the four recommended tasks to adopt a hydrogen blending standard, since three years may not be sufficient time to develop and conduct a live blending pilot and analyze data collected to establish a hydrogen blending standard for the distribution gas system given regulatory or permitting processes. The Joint Utilities suggest completion of live hydrogen blending pilots and associated data analysis and development of a distribution hydrogen blending standard.[74]

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72 Cal Advocates Opening Comments at 10-12.

73 EDF Opening Comments at 23.

74 Joint Utilities Opening Comments at 10.

3.2.10.2. Adopted Course of Action on Additional Considerations

We appreciate parties' thoughtful responses to this open-ended question. The proposed pilot projects required by this decision must take into account the UC Riverside Study, existing and ongoing hydrogen research, development, and demonstration activities, and stakeholder feedback. We also require that the pilot project include in their scope the consideration of impacts on disadvantaged communities. PG&E should be required to submit its Hydrogen to Infinity project reports and findings to the Service List in this proceeding to provide an opportunity for parties to comment on the project.

3.2.11. Renewable Hydrogen Definition

Parties were asked the following question regarding a renewable hydrogen definition:

> *What definition should the Commission use for "renewable" hydrogen? If you previously recommended a definition for "renewable" hydrogen in comments filed in A.20-11-004, please either restate that recommendation or provide an updated recommendation.*

3.2.11.1. Party Responses to Renewable Hydrogen Definition

While there was considerable overlap among the large number of party comments, and some common themes, there was no specific agreement between all parties regarding what an appropriate definition for renewable hydrogen might be.

Air Products proposes a definition for renewable hydrogen based upon feedstock (*i.e.,* water, natural gas, biomethane, ammonia, etc.), the power source used to break the pure hydrogen away from the larger molecules (*i.e.,* excess solar versus fossil-fuel-generated power), and mitigation factors (*i.e.,* carbon capture and sequestration), all based upon carbon-intensity life-cycle analysis (and including external issues, such as impact on water supplies).[75]

AquaHydrex proposes treating all production methods equally, requiring both feedstocks and process energy to be renewable and defining carbon intensity, and aligning with federal definitions, but prioritize electrolysis in an initial injection standard through 2030.[76]

BAC and CASA proposes that to be considered renewable hydrogen, all energy inputs and feedstock used in the production and delivery of the hydrogen must be consistent with the latest Renewables Portfolio Standard (RPS) and any electricity used shall be from an eligible renewable energy resource.[77] NFCRC, GHC, and CHBC also propose defining renewable hydrogen to refer to feedstock and production energy definitions consistent with the RPS program and Section 25741 of the Public Resources Code.[78] Parties recommend that the Commission should allow electrolysis powered by behind-the-meter renewable resources. However, there is disagreement between parties[79] on the inclusion of large hydropower generation (large hydro)[80] as an eligible energy source for renewable hydrogen projects.

Cal Advocates proposes using the term "clean hydrogen" instead of renewable hydrogen (pointing out that there are a plethora of hydrogen types

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75 Air Products Opening Comments at 10-11.

76 AquaHydrex Opening Comments at 4-5.

77 Bloom Opening Comments at 3-7.

78 NFCRC, GHC, and CHBC Opening Comments at 13.

79 Parties that agree that large hydro should be included in the renewable hydrogen definition are: National Fuel Cell Research Center, Green Hydrogen Coalition, and California Hydrogen Business Council.

80 Large hydro projects are those larger than 30 Megawatts (MW) of generation capacity.

and colors) and defining it by lifecycle GHG emissions-intensity approach aligned with CARB's 2022 draft Scoping Plan and federal legislative incentives. Cal Advocates adds that the Commission should also expressly label some as "electrolytic hydrogen."[81]

EDF cite to the multiple federal standards, and to multiple European standards, and propose using terminology such as "low carbon hydrogen" and states that the Commission should focus on lifecycle carbon intensity and use that term rather than the now-confusing terms "renewable," "clean," and "green."[82]

The IEP cites to the renewable hydrogen definition used in the Self-Generation Incentive Program from D.21-06-005, that is (1) hydrogen produced through non-combustion thermal conversion of biomass, excluding purpose-grown crops, or (2) electrolysis using 100 percent renewable electricity as defined by RPS, stating that if the renewable electricity is not generated on-site by a facility that does not produce RPS-eligible RECs, the electrolyzer facility, or the load serving entity procuring electricity on its behalf should retire RPS-eligible RECs equivalent to the amount of electricity consumed by the electrolyzer facility to produce hydrogen without counting the retired RECs toward compliance with the RPS program.[83] IEP opposes the inclusion of large hydro because California does not have an enforceable Clean Energy Standard that includes large hydro.

The Joint Utilities propose defining renewable hydrogen as: (1) energy that uses as an energy input electricity that is eligible under the California RPS or

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[81] Cal Advocates Opening Comments at 13-15.

[82] EDF Opening Comments at 23-24.

[83] IEP Opening Comments at 7.

energy other than electricity that is produced from sources described in Section 25741 of the Public Resources Code, (2) the process uses material feedstock (either water or material described in Section 25741 of the Public Resources Code), (3) for a process that uses landfill gas or digester gas to generate energy input or to provide feedstock, the procurement of that gas is consistent with Section 399.12.6 of the Public Utilities (Pub. Util.) Code, (4) for a process that uses biomass to generate energy input or to provide feedstock, the production of the energy or feedstock is by biomass conversion, as defined in Public Resources Code Section 40106, and forest waste biomass is consistent with the guidelines adopted by the CPUC to define the byproducts of sustainable forestry pursuant to Section 399.20(f)(2)(A)(iii) of the Pub. Util. Code, and (5) any other process yielding hydrogen from only renewable inputs.[84]

Sierra Club proposes defining hydrogen as renewable if: (1) the hydrogen is derived from electrolysis of water using RPS-eligible renewable electricity, purchased pursuant to a contract that provides for the RPS-eligible renewable electricity to be delivered in the same hour that it is used for hydrogen production, (2) the hydrogen producer retires the Renewable Energy Credits (RECs) for all the electricity used to produce the hydrogen.[85]

3.2.11.2. Adopted Course of Action on Renewable Hydrogen Definition

We agree with the general consensus of parties that any hydrogen injected into the common carrier pipeline system should be required to meet a standard of lifecycle-based (*i.e.,* well-to-gate) carbon intensity. As stated by Air Products, "Only a definition based on carbon-intensity can take into account the various

[84] Joint Utilities Opening Comments at 11-12.

[85] Sierra Club Opening Comments at 20.

factors and complexity. Such a definition will also preclude unintended consequences, perverse outcomes, or stifling innovation."[86]

We look to the federal government for guidance in determining an appropriate lifecycle-based carbon intensity standard. As noted by EDF, recent federal legislation has introduced a "clean hydrogen" standard based on carbon intensity for the purposes of incentivizing hydrogen production and encouraging the development of hydrogen hub projects nationwide. To remain consistent with the federal standard for hydrogen production incentives recently approved as part of the Inflation Reduction Act, we adopt the "qualified clean hydrogen" standard of a lifecycle GHG emissions rate that is not greater than 4 kilograms of CO_2e per kilogram of hydrogen produced.

While we agree with parties on the importance of using a lifecycle-based carbon intensity metric for any hydrogen injected into the common carrier pipeline system, we do not believe that carbon intensity should be the sole factor used to determine eligibility for injection. Rather, we agree with the bulk of party sentiment that any adopted definition of renewable hydrogen must take into consideration both feedstock and production energy used. Rather than endorse specific production methods, we opt to remain technology-neutral in acknowledgement of the fact that there are numerous new production technologies in development, and we should not need to update a list of eligible production methods as new production technologies emerge. To further this objective, we require both feedstock and production energy used in the production of renewable hydrogen to not use fossil fuel.

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[86] Air Products Opening Comments at 10-11.

We adopt the following interim definition for renewable hydrogen: "Hydrogen which is produced through a process that results in a lifecycle (*i.e.,* well-to-gate) GHG emissions rate of not greater than 4 kilograms of CO2e per kilogram of hydrogen produced and does not use fossil fuel as either a feedstock or production energy source." The term "fossil fuel" is consistent with the definition found in Pub. Util. Code § 2806. The prohibition on the use of fossil fuel does not apply to an eligible renewable energy resource that uses a de minimis quantity of fossil fuel, as allowed under Pub. Util. Code § 399.12 (h)(3).

This definition shall be revisited at a later date. As Air Products notes, SB 1075 (Skinner, 2022) requires CARB, in conjunction with the CPUC and the California Energy Commission (CEC), to provide policy recommendations regarding the use of hydrogen to help achieve California's climate, clean energy, and clean air objectives. One of the bill's requirements is to evaluate the potential of various forms of hydrogen. As such, once the required evaluation is complete, the CPUC will consider whether modifications to the definition adopted by this Decision are merited. When the Commission revisits its definition for "renewable hydrogen," it shall also examine whether additional production restrictions (*e.g.,* prohibiting the use of large hydro and/or biomethane derived from purpose-grown crops, as suggested by IEP) are merited.

The Joint Utilities shall jointly file a Tier 1 AL no later than 60 days from the issuance date of this decision to modify the SRGIT to reflect the new "renewable hydrogen" definition. The AL filing may be combined with the AL filing required pursuant to Section 3.2.6.2 of this Decision, which also modifies the SRGIT.

4. Comments on Proposed Decision

The proposed decision of Commissioner Clifford Rechtschaffen in this matter was mailed to the parties in accordance with Section 311 of the Pub. Util. Code and comments were allowed under Rule 14.3 of the Commission's Rules of Practice and Procedure. Comments were filed on __________, and reply comments were filed on _____________ by ________________.

5. Assignment of Proceeding

Clifford Rechtschaffen is the assigned Commissioner in this proceeding and Karl J. Bemesderfer and Jason Jungreis are the assigned Administrative Law Judges.

Findings Of Fact

1. Senate Bill 1440 gives the Commission authority to adopt biomethane procurement goals and direct reporting related to biomethane procurement.
2. Health and Safety Code Section 25421 authorizes the Commission to direct utilities regarding pipeline and pipeline facility integrity and safety, including adopting the monitoring, testing, reporting, recordkeeping, and updating requirements related to biomethane injection outlined in this decision.
3. SB 1075 requires the evaluation of the role of green hydrogen in achieving California's climate objectives.
4. OP 31 of D.22-02-025 directed the Joint Utilities to update the annual reports that were originally ordered by D.15-06-029 – and subsequently modified by D.16-12-043 – to include new information pertaining to "actual biomethane procurement levels, ratepayer bill impacts, incremental capital infrastructure and/or operations and maintenance costs for the prior year compared to the estimated levels that were approved in their respective [Renewable Gas Procurement Plans]."

5. The Joint Utilities' annual reporting obligation has a sunset date, whereas the reporting requirement in OP 31 of D.22-02-025 does not.

6. The Joint Utilities already provide, or will soon provide, the Commission and interested parties with all such information through their various required reports; thus, it is neither unduly burdensome nor unduly administratively costly to gather all such information into a single consolidated report (and may prove both less burdensome and less administratively costly to do so).

7. D.14-01-034 previously determined hydrogen to be one of the five constituents of concern relating to pipeline integrity and established a hydrogen "trigger level" of 0.1 percent but did not establish either a "lower action level" or an "upper action level" for hydrogen.

8. OP 11 of D.20-12-031 determined that "Upper and lower action levels of hydrogen will be established pursuant to Phase 4 of this proceeding."

9. Hydrogen has significantly different properties than methane and is known to have a degrading effect on materials used in the common carrier pipeline system.

10. The UC Riverside Study aimed to assess the operational and safety concerns associated with injecting hydrogen into the existing common carrier pipeline system at various percentages.

11. The UC Riverside Study conducted a combination of literature review, modeling, and experimental work in the areas of leakage rates of methane and hydrogen blends compared to pure methane, hydrogen impacts on polymeric materials, and hydrogen impacts on metals and alloys.

12. The UC Riverside Study states that a single injection standard that applies systemwide must consider the most susceptible conditions observed throughout all infrastructure components, recommending that any hydrogen injection

standard also consider all end-uses, appliances, and associated industrial processes. Risks associated with methane-hydrogen blending increase as hydrogen blending approaches five percent by volume.

13. UC Riverside Study concluded that any hydrogen blending must be carefully planned and conducted in stages to address the effect of hydrogen on materials, components, facilities, and equipment.

14. To address knowledge gaps in several areas, the UC Riverside Study emphasizes the need to conduct real world demonstrations of hydrogen blending under safe and controlled conditions.

15. The UC Riverside Study finds that the literature review supports hydrogen blends up to five percent, in that these relatively low concentrations may be injected without significantly increasing risk factors to storage and transmission with no modification, or only minor modification, to the existing natural gas system.

16. The UC Riverside Study also notes that the current understanding of the real-world implications of the use of hydrogen in California's gas system is limited, and recommends further study before adopting a system wide safe hydrogen injection standard.

17. The UC Riverside Study comments that hydrogen blending can be an important decarbonization strategy for the energy and transportation sectors.

18. The UC Riverside Study recommends the following four activities be the undertaken concurrently:

a. Large scale and targeted demonstration projects to evaluate impacts of hydrogen gas on all materials and components involved, and to develop mitigation strategies.
b. Research and development on the impacts of different percentages of hydrogen blending on all aspects of California's gas infrastructure.

c. Planning for system-wide hydrogen injection considering the most susceptible conditions observed throughout all infrastructure components and developing new safety and operational procedures.
d. Stakeholder and public engagement to address technological, societal, economic, and safety concerns.

19. The UC Riverside Study provides support for pursuing hydrogen blending as part of a decarbonization strategy, while at the same time, outlining thoughtful and prudent next steps before establishing a system wide injection standard.

20. The UC Riverside Study identifies important safety considerations associated with hydrogen blending, especially related to embrittlement and leakage. While the UC Riverside Study finds this particularly important for percentages above five percent, the Study notes the overarching importance of collecting information from real-world hydrogen blending projects.

21. The UC Riverside Study's conclusions highlight the importance of understanding the safety related properties of different blends, identifying methods and strategies (e.g., use of odorants) for prompt detection, and developing effective safety procedures for the monitoring, identification, and repair of leaks to reduce safety risks.

22. There are serious considerations to be weighed, and precautions to measure and monitor against leakage is required for all producers wishing to inject a methane hydrogen blend into California's common carrier pipeline system.

23. Adopting a safe injection standard requires the appropriate measurement and monitoring of leakage.

24. Hydrogen has a heating value about one third the heating value of natural gas, and therefore three times the amount of hydrogen is required to replace the energy of the natural gas that the hydrogen displaces in order to provide the same amount of heat value. Heating value considerations are relevant because different flow and pressure in parts of the system may present challenges to the operation of the natural gas infrastructure and affect equipment. The UC Riverside Study does not evaluate the potential impacts of heating value and the options for addressing those impacts.

25. Heating value requires additional consideration to address the UC Riverside Study finding that increasing pressure of hydrogen blends to increase heating value "demonstrate increased risk to embrittlement, fatigue crack growth, and failure in high strength steels.

26. SoCalGas is evaluating two new gas chromatographs that are capable of detecting hydrogen, and PG&E is also involved in a study evaluating chromatographs to analyze hydrogen.

27. The UC Riverside Study states that a single, system wide blending standard would have to consider the most susceptible conditions observed throughout all infrastructure components, and that it is critical to conduct real world demonstration of hydrogen blending under safe and controlled conditions.

28. All parties agreed that there should be limitations on where, when, and/or how much hydrogen can be injected into the common carrier pipeline system.

29. The UC Riverside Study recommends that the gas utilities modify "existing integrity management systems, including monitoring and maintenance schedules and practices."

30. Hydrogen injection and blending require careful attention, monitoring and reporting, and the long-term impacts of hydrogen injection should also remain under study since there could be delayed undetected effects.

31. The UC Riverside Study noted that blends with five to twenty percent hydrogen blends leak faster, and therefore require real-world demonstrations in various parts of the pipeline to better understand higher percentage blend leak conditions and consequences.

32. The UC Riverside Study noted that five to twenty percent hydrogen blends leak faster, therefore requiring real-world demonstrations in various parts of the pipeline to better understand higher percentage blend leak conditions and consequences.

33. The longer the pipeline, the higher the possibility of leakage and the more difficult it would be to monitor.

34. The UC Riverside Study recommends testing on isolated gas pipelines for concentrations of hydrogen between five to twenty percent, and for monitoring and validation programs to be established to confirm performance and inform future increases in the blend limit.

35. Hydrogen is currently identified as a constituent of concern in biomethane and is limited to 0.1 percent by the SRGIT.

36. Real-world demonstration projects with monitoring and controls can provide useful information on the impacts of higher blends, specific locations on the gas system, storage facilities, and at specific end uses.

37. Additional testing through pilot hydrogen blending projects is needed, as discussed in this decision, to continue the process that began in D.14-02-034 to establish safe injection standards for all identified constituents of concern using best available scientific data.

38. In additional to safety concerns, cost and environmental considerations will be necessary subjects of examination if the Commission is to consider requiring hydrogen procurement in the future.

39. The scale of the pilot projects should not have any bearing on the extent to which gas infrastructure stays in service, but will reduce carbon emissions, all else being equal, and the pilots will produce important information about the potential for more significant carbon reductions if system wide hydrogen injection standard is deemed appropriate.

40. Broader policy issues related to long term gas planning, including the potential role of renewable hydrogen, are being addressed in R.20-01-007 (as well as other agency processes, including implementation of SB 1075).

41. We look to the federal government for guidance in determining an appropriate lifecycle-based carbon intensity standard.

42. Recent federal legislation has a "clean hydrogen" standard based on carbon intensity for the purposes of incentivizing hydrogen production and encouraging the development of hydrogen hub projects nationwide.

43. Carbon intensity is not the sole factor used to determine eligibility for injection.

44. Any adopted definition of renewable hydrogen needs to take into consideration both feedstock and production energy used.

45. We opt to remain technology neutral in acknowledgement of the fact that there are numerous new production technologies in development, and we decline to update a list of eligible production methods as new production technologies emerge.

46. SB 1075 (Skinner, 2022) requires CARB, in conjunction with the CPUC and the CEC, to provide policy recommendations regarding the use of hydrogen to

help achieve California's climate, clean energy, and clean air objectives. One of the bill's requirements is to evaluate the potential of various forms of hydrogen.

Conclusions Of Law

1. It is reasonable to require the Joint Utilities to begin preparing and filing, starting May 1, 2024, consolidated annual reports that comply with and include the original biomethane reporting requirements and the new reporting requirements.

2. By or before January 15, 2023, the Joint Utilities should file their next annual report to the Commission on annual biomethane reporting that is compliant with D.15-06-029 requirements.

3. Starting in 2024 and by May 1 of each year thereon, the Joint Utilities should prepare and file new consolidated annual reports which comply with and include both the original biomethane reporting requirements and the new reporting requirements, with the understanding that the original reporting requirements sunset after May 1, 2027.

4. The Commission should direct the Joint Utilities to file a joint application for testing of hydrogen blended into natural gas at concentrations above the existing trigger level in increasing increments from one to five and five to twenty percent.

5. The existing trigger level standard of 0.1 percent should remain unchanged.

6. The SRGIT should be modified as follows: as organized and defined in D.14-01-034, hydrogen, a constituent of concern in biomethane, is to maintain its current 0.1 percent trigger level standard, its lower action level should be reestablished as one percent content by volume, and its upper action level should be reestablished as five percent content by volume.

7. The Joint Utilities should propose hydrogen blending pilot projects, taking into account the findings and recommendations of the UC Riverside Study, existing and ongoing hydrogen research, development, and demonstration activities, and stakeholder feedback as well as all guidance set forth in this decision.

8. Proposed pilot projects should include in the scope the consideration of impacts on disadvantaged communities as well as environmental impact to customers and communities.

9. Proposed pilot projects should aim to evaluate hydrogen injection at blends between one and five percent, and between five and twenty percent, as further specified in this decision.

10. Proposed pilot projects should provide for testing to control local emissions, and the costs of the proposed pilots be considered as part of the Commission's evaluation of the utility applications.

11. Proposed pilot projects should include a detailed testing program informed by the UC Riverside Study and other appropriate sources.

12. Hydrogen blending activities undertaken as part of any pilot project authorized by this decision should be carefully designed and monitored to better understand leakage.

13. Proposed pilot projects should be required to include rigorous testing protocols consistent with the UC Riverside Study and should take into account parties' comments and further stakeholder input.

14. Hydrogen's heating value characteristics should be considered for the safe operation of natural gas infrastructure.

15. Proposed pilot projects should include new or revised heating values, as necessary.

16. Proposed pilot projects should be designed to prevent hydrogen from reaching natural gas storage areas and electrical switching equipment directly or through leakage.

17. Proposed pilot projects should be performed in either a closed system or in a mock-up of a real-world system using typical equipment and materials found in California's gas infrastructure.

18. Proposed pilot projects should evaluate whether hydrogen blending will pose minimal risk to distribution and transmission pipeline integrity and whether blending fuel use will result in end user appliance malfunctions.

19. Proposed pilot projects should focus on ensuring long-term safety of the California pipeline, hydrogen leakage, and hydrogen monitoring, as well as the dilution rate and other mechanical characteristics of hydrogen blends in the natural gas pipeline stream.

20. Proposed pilot projects should include a contemporaneous measurement, monitoring, and reporting program and provide for an independent technical assessment. The measurement, monitoring, and reporting program should incorporate the directions in this decision.

21. When proposing pilot projects, the Joint Utilities should indicate whether they intend to modify heating values of gas through the use of propane or other means, and whether such modifications to heating value can be done safely.

22. The Joint Utilities should be directed to monitor the national and international ongoing research and to jointly file a Hydrogen Blending Compendium Report within two years from the issuance date of this decision.

23. The Hydrogen Blending Compendium Report should identify existing studies and regulatory proceedings that are complete and underway with a summary of each scope and relevant findings.

24. The Hydrogen Blending Compendium Report should include findings related to: (a) safety performance, safety thresholds, and integrity threat levels on various pipeline network components associated with hydrogen injection, at various hydrogen blend percentages; (b) leakage rates of the methane and hydrogen blend compared to pure methane; (c) modeling to quantify lost hydrogen due to leakage; (d) hydrogen permeation rates through polymer materials as compared to the natural gas permeation rates, and assessment of technologies for preventing or mitigating methane and hydrogen blend leakage in polymer and other pipeline materials; (e) impact on storage fields, and modifications that may be necessary to maintain safety; (f) analysis of the best equipment to monitor, detect, and control hydrogen leakage, and assessment of new hydrogen leak detection technologies; (g) analysis of the impact of hydrogen dilution on heating value, and the required modifications of end-user equipment and appliances; and (h) any and all human health issues identified.

25. To add a degree of additional safety without authorizing any additional hydrogen than is already permitted, a new lower action level of a one percent hydrogen content and an upper action level of a five percent hydrogen content (as these are defined in D.14-01-034 and above in footnotes 5-7) should be adopted.

26. The Energy Division should explore contracting options for an independent research organization such as one of the national labs, or hiring of the California Council of Science and Technology or another independent entity, as an independent body to review and evaluate the hydrogen blending pilot projects authorized pursuant to this decision.

27. To gather further input from members of the public, the Joint Utilities should host a workshop no later than six months from the issuance date of this

decision to obtain feedback from a diverse group of stakeholders on how to proceed with assembling safe and meaningful pilot projects for testing of hydrogen blends. After analyzing the presentations of workshop participants, among other inputs received, the Joint Utilities should issue a workshop report addressing the design and implementation of the pilot projects' necessary testing and monitoring systems. The Joint Utilities should coordinate with the Commission's Energy Division in advance of the workshop.

28. The Joint Utilities should be directed to develop a detailed stakeholder engagement plan to be submitted as part of their hydrogen blending pilot project application. Such a plan should include a timeline of planned stakeholder outreach activities and detail how stakeholder input will be considered for incorporation into pilot project design and execution.

29. Workshop topics should include the environmental impact of hydrogen blending at various levels on customers and communities.

30. PG&E should submit its Hydrogen to Infinity project reports and findings to the Service List in this proceeding to provide an opportunity for parties to comment on the project.

31. To remain consistent with the federal standard for hydrogen production incentives recently approved as part of the Inflation Reduction Act, the following interim definition for renewable hydrogen should be adopted: "Hydrogen which is produced through a process that results in a lifecycle (i.e., well-to-gate) GHG emissions rate of not greater than 4 kilograms of CO2e per kilogram of hydrogen produced and does not use fossil fuel as either a feedstock or production energy source." The term "fossil fuel" is consistent with the definition found in Pub. Util. Code § 2806. The prohibition on the use of fossil fuel does not apply to an

eligible renewable energy resource that uses a de minimis quantity of fossil fuel, as allowed under Pub. Util. Code § 399.12 (h)(3).

32. PG&E and SoCalGas should present to the Commission's Energy Division staff their evaluations of their new gas chromatographs that are currently being evaluated for capability to detect hydrogen, and for those devices that pass evaluation, they should submit the devices to the Commission for approval per GO 58-A.

33. This proceeding should remain open.

O R D E R

1. On or before January 15, 2023, Pacific Gas and Electric Company, Southwest Gas Corporation, Southern California Gas Company, and San Diego Gas & Electric Company shall file a biomethane report compliant with Decision 15-06-029 requirements.

2. On or before May 1, starting in 2024, Pacific Gas and Electric Company, Southwest Gas Corporation, Southern California Gas Company, and San Diego Gas & Electric Company shall annually file a combined biomethane report that provides information regarding each of the following:

   a. Decision (D.) 15-06-029 biomethane reporting requirements, which shall sunset in 2027;
   b. D.22-02-025 biomethane reporting requirements;
   c. Biomethane procurement amounts and costs;
   d. Incremental capital infrastructure and/or operations and maintenance costs for the prior year compared to the estimated levels that were approved in their respective Renewable Gas Procurement Plans related to biomethane procurement;

e. Impacts on ratepayer bills related to biomethane procurement;

f. Impacts on disadvantaged communities related to biomethane procurement;

g. Impacts on vehicle emissions related to biomethane procurement;

h. Impacts on all other emissions related to biomethane procurement, including carbon monoxide, carbon dioxide, and hydrogen sulfide;

i. Impacts on water and air quality in communities near biomethane production facilities related to biomethane procurement;

j. Impacts regarding methane leaks related to biomethane facilities related to biomethane procurement;

k. Impacts regarding waste byproducts used in biomethane production related to biomethane procurement;

l. Attestation regarding air pollution impact related to biomethane procurement;

m. Attestation regarding water pollution impact related to biomethane procurement; and

n. Attestation regarding purpose-grown crop control standards impact related to biomethane procurement.

3. Decision 15-06-029 biomethane reporting requirements shall sunset after May 1, 2027.

4. The following interim definition for renewable hydrogen is adopted: "Hydrogen which is produced through a process that results in a lifecycle (*i.e.,* well-to-gate) greenhouse gas emissions rate of not greater than 4 kilograms of CO2e per kilogram of hydrogen produced and does not use fossil fuel as either a feedstock or production energy source." The term "fossil fuel" is consistent with the definition found in Pub. Util. Code Section 2806. The prohibition on the use of fossil fuel does not apply to an eligible renewable

energy resource that uses a de minimis quantity of fossil fuel, as allowed under Pub. Util. Code Section 399.12 (h)(3).

5. Within 60 days of the issuance date of this decision, Pacific Gas and Electric Company, Southwest Gas Corporation, Southern California Gas Company, and San Diego Gas & Electric Company shall jointly file a Tier 1 Advice Letter to modify the Standard Renewable Gas Interconnection Tariff to reflect a new "renewable hydrogen" definition as identified in Ordering Paragraph 4 of this decision.

6. Within 60 days of the issuance date of this decision, Pacific Gas and Electric Company, Southwest Gas Corporation, Southern California Gas Company, and San Diego Gas & Electric Company shall file Tier 1 Advice Letters modifying the Standard Renewable Gas Interconnection Tariff (Southern California Gas Company Rule 45, San Diego Gas & Electric Company Rule 45, Southwest Gas Corporation Rule 22, and Pacific Gas and Electric Company Gas Rule 29) as follows: as organized and defined in Decision 14-01-034, hydrogen, a constituent of concern in biomethane, is to maintain its current 0.1 percent trigger level standard, its lower action level is now established as one percent content by volume, and its upper action level is now established as five percent content by volume.

7. Within two years from the issuance date of this decision, Pacific Gas and Electric Company, Southwest Gas Corporation, Southern California Gas Company, and San Diego Gas & Electric Company shall file a joint application proposing pilot programs to test hydrogen blending in natural gas at concentrations above the existing trigger level, as ordered in this decision, that:

a. Ensures the long-term safety of the California pipeline, the prevention of hydrogen leakage, the inclusion of hydrogen monitoring, the consideration of the dilution rate, and the monitoring and reporting of all mechanical characteristics of hydrogen blends in the natural gas pipeline stream;

b. Prevents hydrogen from reaching natural gas storage areas and electrical switching equipment directly or through leakage;

c. Avoids end user appliance malfunctions;

d. Evaluates hydrogen injection at blends between one and five percent; such evaluations must adhere to approved monitoring, reporting, and long-term impact study in accordance with the approval of the pilot project application, and must include validation programs to confirm performance;

e. Evaluates hydrogen injection at blends between five and twenty percent; such evaluations must solely involve testing on isolated gas pipelines, and must adhere to approved monitoring, reporting, and long-term impact study in accordance with the approval of the pilot project application and include validation programs to confirm performance;

f. Specifies the amounts of funding necessary to complete all aspects of the proposal and proposes testing durations adequate to draw meaningful conclusions;

g. Is consistent with all directed courses of action specified in this decision relevant to leakage, reporting, heating value, system safety, environmental considerations, end-use emissions, and all other elements enumerated in this decision;

h. Proposes rigorous testing protocols consistent with the UC Riverside Study;

i. Takes into account parties' comments and further stakeholder input;

j. Proposes a methodology for performing a Hydrogen Blending System Impact Analysis that can ensure that any hydrogen blend will not pose a risk to the common carrier pipeline system;

k. Includes new or revised heating values and discusses whether heating values would be modified through the use of propane or other means and whether such modifications to heating value can be done safely;

l. Describes rigorous hydrogen leak testing protocols that are consistent with leak testing and reporting elements identified in the University of California at Riverside's 2022 Hydrogen Blending Impacts Study, identifies and addresses the comments presented by parties in this proceeding regarding leak issues, and identifies and addresses the comments presented by workshop stakeholders in this proceeding regarding leak issues; and

m. Contains an independent research plan for assessment, measurement, monitoring, and reporting through an independent party, which must be engaged in such activities during the development, construction, operational life, and decommissioning of the pilot project.

8. Upon issuance of this decision, the Energy Division will explore contracting options for an independent research organization such as one of the national labs, or hiring of the California Council of Science and Technology or another independent entity, as an independent body to review and evaluate the hydrogen blending pilot projects authorized pursuant to this decision.

9. Within four years from the issuance date of this decision, a contractor or hiree selected pursuant to Ordering Paragraph 8 of this decision shall prepare and submit a comprehensive report to the Energy Division, which will thereafter prepare its recommendations on possible next steps in a draft resolution to be presented for Commission approval. The following four natural gas utilities shall pay their proportionate share for the contractor or hiree based on the utilities' gas throughput in the 2016 California Gas Report: Pacific Gas and Electric Company (50.89%), San Diego Gas & Electric Company (6.43%),

Southern California Gas Company (41.92%), and Southwest Gas Corporation (0.77%).

10. Pacific Gas and Electric Company, Southwest Gas Corporation, Southern California Gas Company, and San Diego Gas & Electric Company shall jointly file a Hydrogen Blending Compendium Report within two years from the date of the issuance of this decision to identify existing studies and regulatory proceedings that are complete and underway and include findings related to:

    a. safety performance, safety thresholds, and integrity threat levels on various pipeline network components associated with hydrogen injection, at various hydrogen blend percentages;
    b. leakage rates of the methane and hydrogen blend compared to pure methane;
    c. modeling to quantify lost hydrogen due to leakage;
    d. hydrogen permeation rates through polymer materials as compared to the natural gas permeation rates, and assessment of technologies for preventing or mitigating methane and hydrogen blend leakage in polymer and other pipeline materials;
    e. impact on storage fields, and modifications that may be necessary to maintain safety;
    f. analysis of the best equipment to monitor, detect, and control hydrogen leakage, and assessment of new hydrogen leak detection technologies;
    g. analysis of the impact of hydrogen dilution on heating value, and the required modifications of end-user equipment and appliances; and
    h. any and all human health issues identified.

11. Within six months from the issuance date of this decision, Pacific Gas and Electric Company, Southwest Gas Corporation, Southern California Gas Company, and San Diego Gas & Electric Company shall coordinate with the

Commission's Energy Division and host a workshop to obtain feedback from a diverse group of stakeholders regarding how to proceed with assembling safe and meaningful pilot projects for testing of hydrogen blends and how to assess environmental impacts to customers and communities, including disadvantaged communities: among other inputs received, the workshop must inform the design and implementation of the pilot projects' necessary testing and monitoring systems.

12. Within 60 days of completing evaluations of their new gas chromatographs which are currently underway, Pacific Gas and Electric Company and Southern California Gas Company shall present to the Commission's Energy Division staff their evaluations of their new gas chromatographs that are being evaluated for capability to detect hydrogen, and for those devices that pass evaluation, they must submit the devices to the Commission for approval per General Order 58-A.

13. Pacific Gas and Electric Company shall submit its Hydrogen to Infinity project reports and findings to the Service List in proceeding Order instituting Rulemaking 13-02-008 to provide an opportunity for parties to comment on the project.

14. This proceeding remains open.

Dated ___________ at San Francisco, California.