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CORRECTED REVISED PREPARED DIRECT TESTIMONY OF
BLAINE WAYMIRE
ON BEHALF OF SOUTHERN CALIFORNIA GAS COMPANY
(SOCALGAS'S HYDROGEN BLENDING DEMONSTRATION – CLOSED
SYSTEM PROJECT)

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

June 3, 2025

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1 **CHAPTER 1**

2 **CORRECTED REVISED PREPARED DIRECT TESTIMONY OF BLAINE WAYMIRE**
3 **(SOCALGAS’S HYDROGEN BLENDING DEMONSTRATION – CLOSED**
4 **SYSTEM PROJECT)**

5 **I. PURPOSE**

6 The purpose of this prepared direct testimony on behalf of Southern California Gas
7 Company (SoCalGas) is to provide the technical objectives, need, project implementation detail,
8 and costs for the proposed SoCalGas hydrogen blending demonstration project, which will be
9 held in an isolated portion of the natural gas distribution system (Closed System Project). This
10 testimony will focus on a description of the Closed System Project and how it will help inform a
11 future hydrogen injection standard and support SoCalGas’s, San Diego Gas & Electric
12 Company’s (SDG&E), Pacific Gas and Electric Corporation’s (PG&E), and Southwest Gas
13 Corporation’s (Southwest Gas) (collectively, the Applicants or Joint Utilities) focus on safety,
14 system integrity, and reliability, as well as adhering to the requirements set out by Decision (D.)
15 22-12-057 and guidance under D.21-07-005. This testimony will address the Closed System
16 Project’s purpose, how the live blending data collected will provide key technical, operational,
17 and safety information to support a future hydrogen injection standard, how SoCalGas will
18 collaborate with the University of California, Irvine (UC Irvine), the other investor-owned
19 utilities (IOUs), and other relevant stakeholders to integrate data collected from the
20 demonstration projects and prevent duplicative efforts, and provide project cost estimates. The
21 Closed System Project discussed is contingent upon the California Public Utilities
22 Commission’s (Commission) approval and will require further collaboration with UC Irvine to
23 refine project details through detailed engineering design and analyses.

24 The purpose of this Closed System Project is to demonstrate operational, live blending
25 and collect system performance data for blending from 5% to 20% hydrogen gas by volume¹ in
26 an isolated portion of a medium pressure² steel and plastic distribution pipeline system. Project
27 data will inform the feasibility of developing a hydrogen injection standard for steel and plastic

¹ In this testimony, all blend percentages mentioned are by volume.

² Medium pressure is defined as 60 pounds per square inch gauge or lower.

1 distribution systems that serve existing natural gas-powered appliances found in commercial
2 facilities.³

3 Testing on the steel pipeline system in SoCalGas’s territory is necessary because steel is a
4 common material used for pipeline mains in SoCalGas’s distribution pipeline system. At the
5 end of 2022, SoCalGas managed 25,913 miles of steel distribution mains, which makes up
6 approximately 49.9% of distribution pipeline mains. The other distribution pipeline mains are
7 made of plastic.⁴ While SoCalGas’s Closed System Project will also showcase polyethylene
8 (PE) pipeline, SDG&E and Southwest Gas’s proposed projects will address hydrogen blending
9 solely in a distribution-level PE plastic pipeline system, and at different climates.⁵ Further, the
10 project hosted by PG&E will aim to inform and support the development of a hydrogen
11 injection standard for transmission systems.⁶

12 SoCalGas is pleased to work with UC Irvine, a leading research university in the
13 sustainable energy and environmental space and home to the renowned Advanced Power and
14 Energy Program (APEP), to conduct a hydrogen blending demonstration project on the UC
15 Irvine campus. Refer to Exhibit 1B for the Amended and Restated Memorandum of
16 Understanding (MOU) with UC Irvine. A Director’s Message from APEP states, “The campus
17 and surrounding area act as a living laboratory where APEP practices the development and
18 deployment of efficient, environmentally sensitive, and sustainable power generation and
19 energy conversion.”⁷

20 The Closed System Project will provide validation on a local system of a strong base of
21 previous analysis, testing, and field demonstrations including comparable field testing performed

³ End-uses selected on UC Irvine’s campus consist of water heating equipment and commercial kitchen appliances.

⁴ Pipeline and Hazardous Materials Safety Administration, Gas Distribution, Gas Gathering, Gas Transmission, Hazardous Liquids, Liquefied Natural Gas (LNG), and Underground Natural Gas Storage (UNGS) Annual Report Data, available at: <https://www.phmsa.dot.gov/data-and-statistics/pipeline/gas-distribution-gas-gathering-gas-transmission-hazardous-liquids>.

⁵ See Direct Testimonies of Pooyan Kabir (Chapter 3) and Kevin Lang (Chapter 4).

⁶ See Direct Testimony of Danielle Mark (Chapter 5).

⁷ Advanced Power and Energy Program, *Director’s Message*, available at: https://www.a pep.uci.edu/Directors_Message.html.

1 in the United Kingdom⁸ and on the UC Irvine campus.⁹ The Closed System Project will begin
2 with an initial hydrogen blend level of 5% and will increase up to 20% over time. The gradual
3 increase of the blend volume will be based on safety and technical feasibility validated with data
4 collection throughout the project duration. This demonstration will provide valuable operational
5 data that will support the development of a hydrogen injection standard for gas distribution
6 systems. With the inclusion of both transmission-level and distribution-level hydrogen blending
7 projects at various climates, and in both open and closed systems, the proposed projects will
8 complement each other in providing meaningful data to inform a statewide hydrogen injection
9 standard.

10 **II. PROJECT DESCRIPTION**

11 In this section, SoCalGas outlines the details of the proposed Closed System Project
12 focused on blending hydrogen into an isolated mixed material natural gas distribution system.

13 SoCalGas intends to blend 5% to 20% hydrogen by volume with natural gas into the
14 nearby natural gas distribution system that will serve an isolated portion of the UC Irvine
15 campus. After collaborating with campus personnel, UC Irvine’s Anteater Recreation Center
16 (ARC) was identified as a well-suited location to isolate and receive the blended fuel. The ARC
17 is a large gymnasium and recreation complex on UC Irvine’s campus. The project will
18 demonstrate hydrogen blending under live operational conditions in both steel and plastic
19 pipeline infrastructure and also provide useful data on impacts to heating and cooking equipment
20 located in the selected buildings.

21 If approved, UC Irvine’s campus will be isolated such that only select university
22 buildings (in this case, the ARC) will receive the 5% to 20% hydrogen blend. The hydrogen
23 blend will be used for light commercial equipment, such as boilers, water heaters, and cooking
24 equipment. To blend up to 20% hydrogen, SoCalGas utilized the historical natural gas usage for
25 the select buildings on UC Irvine campus based on the years 2021-2023 to size equipment
26 capable of meeting and blending the hydrogen/natural gas blends. The Closed System Project is
27 proposed to be implemented over 18 months during which SoCalGas will collect data and

⁸ HyDeploy, *First UK trial of hydrogen blended gas hailed a success* (September 8, 2021), available at: <https://hydeploy.co.uk/about/news/first-uk-trial-of-hydrogen-blended-gas-hailed-a-success/>.

⁹ UCI News, *In a national first, UCI injects renewable hydrogen into campus power supply* (December 6, 2016), available at: <https://news.uci.edu/2016/12/06/in-a-national-first-uci-injects-renewable-hydrogen-into-campus-power-supply/>.

1 evaluate for seasonal demand conditions. The hydrogen blend volume will be gradually
 2 increased over the course of the demonstration through frequent monitoring of gas quality,
 3 leakage, end-use equipment, pipelines, and pipeline components.

4 The proposed Closed System Project will be divided into four chronological phases with
 5 defined budgets for each phase. The phases are briefly summarized in Table 1 and defined in
 6 detail in subsequent testimony.

7 **Table 1: Summary of the Closed System Project Phases**

Phase & Activity	Description	Estimated Duration
0. Pre-development	All efforts supporting this Amended Application submittal are considered “Pre-development.” Upon Commission approval, the project will move on to subsequent phases	Pre-application submittal
1. Design, Construction, and Commissioning	Hydrogen production and blending equipment is designed; detailed safety and feasibility analyses are performed. Stakeholder engagement will be conducted throughout the project’s lifespan. Following design and feasibility, equipment is procured, constructed, and commissioned on campus; pre-demo equipment and pipeline system inspections and any necessary remediation are conducted	18 months
2. Demonstration and Data Collection	Hydrogen is blended in system on a data analysis schedule; data is collected; periodic inspection of equipment and pipelines; test pipelines and components pre-, during, and post-hydrogen blend exposure	24 months (18 months live blending and 6 months asset inspection and validation)
3. Decommissioning, Equipment Removal, and System Restoration	Hydrogen equipment is removed from campus, unless otherwise agreed upon with UC Irvine	6 months
4. Data Analysis and Dissemination	Data from pilot is analyzed and a public report will be released	9 months

8 Figures 1 to 3 show the potential project site layout, potential solar siting proposal, and
 9 the location of pipelines involved in the demonstration. The project site and layouts shown in
 10 Figures 1 to 3 provide the most technical, spatial, and construction feasibility in order to serve
 11 blends to the predetermined isolated buildings on UC Irvine campus.

1
2

Figure 1: Potential SoCalGas Hydrogen Blending Demonstration Site Layout on UCI campus



3

Equipment Type	Color
Electrolyzer	Green
SCADA Building	Orange
Storage Shed	Yellow
Bulk Hydrogen Storage (~150 kg)	Red
Chiller Unit	Purple
Gas Composition Analyzer	Brown
Blending Skid	Black
Hydrogen Compressor	Pink

4

1 The equipment layout and separation distances with fencing as initially proposed will
2 occupy an estimated space of 108 feet by 35 feet. Figure 1 illustrates the proposed site layout
3 with the safety distances, as well as equipment sizes. The proposed site would estimate 270 feet
4 from California Ave . Parking bollards would likely be required surrounding the entire
5 equipment layout. A fence would likely be utilized to contain the equipment on all sides. Initial
6 plans include solar panels that can be installed in in another space on campus to offset the site's
7 electrical loads, as outlined further in Figure 2.

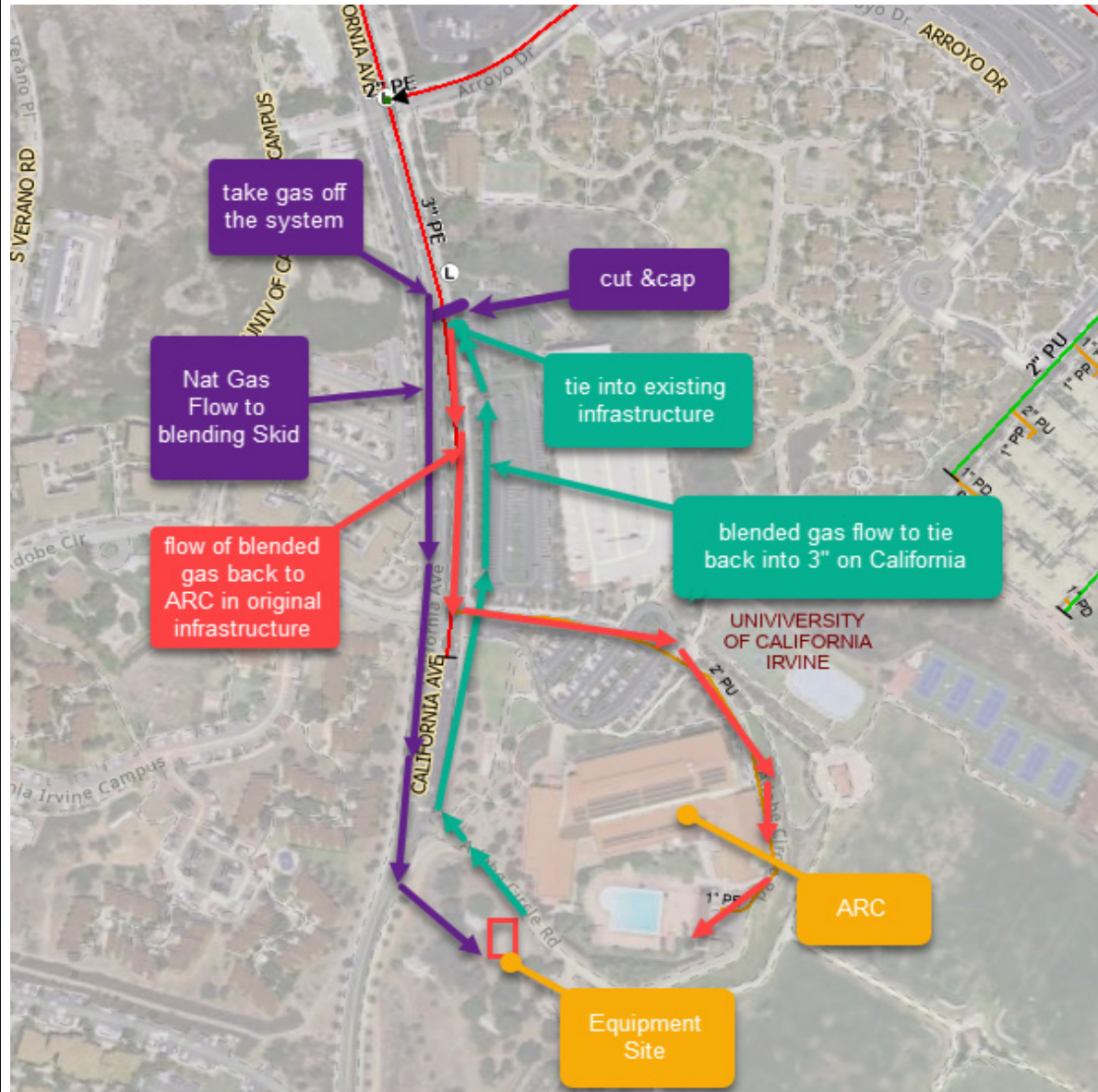
8 **Figure 2: Preliminary Solar Siting Proposal**



9
10 Figure 2 outlines a potential solar scenario to produce electricity for the hydrogen production
11 equipment. An exact solar location is still being finalized; however, preliminary review
12 indicates the Verano 8 parking structure as a suitable area for the solar installation.
13 Approximately 150 KW of solar is being proposed to offset the energy needs of the electrolyzer
14 to produce clean renewable hydrogen. Initial analysis indicates that there is adequate space to
15 install a 150 KW solar array needed for hydrogen production from the proposed electrolyzer.

1

Figure 3: Potential Location of Pipelines Performing the Demonstration



2

3 The proposed Closed System Project aligns with recommendations from UC Riverside’s
 4 Hydrogen Blending Impacts Study (UC Riverside Study),¹⁰ the requirements set out in D.22-12-
 5 057, and guidance in D.21-07-005. One of the key recommendations from the UC Riverside
 6 Study is to “[conduct a demonstration] in a section of the infrastructure that is isolated or is
 7 custom-built to include the commonly present materials, vintages, facilities, and equipment of
 8 the generic California natural gas infrastructure with appropriate maintenance, monitoring and

¹⁰ UC Riverside, *Hydrogen Blending Impacts Study* (July 2022); available at: <https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M493/K760/493760600.PDF>.

1 safety protocols over extended periods.”¹¹ The Closed System Project will follow the UC
2 Riverside Study’s recommendation and collect operational data on a mixed material pipeline
3 system that feeds typical light commercial gas equipment found in California.

4 **A. Phase 0: Pre-Development**

5 All efforts supporting this Amended Application filing are considered “Pre-
6 development.” Upon Commission approval, the Closed System Project will proceed to
7 subsequent phases.

8 To develop this Amended Application and testimony, SoCalGas collaborated with UC
9 Irvine personnel to identify a preferred preliminary site and scope. SoCalGas worked closely
10 with various stakeholders at UC Irvine when determining (i) a site that was suitable to host the
11 hydrogen blending equipment and (ii) an end-use that would provide meaningful load data.

12 When determining site locations, the following factors were considered:

- 13 • Pipe properties and operational history
- 14 • End-users and equipment
- 15 • Constructability (adequate space)
- 16 • Safety
- 17 • Summer load and yearly load (sufficient flow to blend)
- 18 • Time to survey pipeline system and load (pre-, during, and post-demonstration)
- 19 • UC Irvine Facilities support

20 **B. Phase 1: Design, Construction, and Commissioning**

21 Detailed engineering design and an independent safety review will be undertaken to
22 verify the feasibility of the initially proposed scope and location. The preliminary project design
23 and location will be finalized with a third-party expert as required. A third-party expert will be
24 involved in every step of the process to provide input on testing protocols and project design.
25 Additionally, faculty and student advisory committees formed by UC Irvine will review and
26 provide input on project design and construction activities.

27 During the construction period, the site will be prepared and equipment installed.
28 Construction will be coordinated with UC Irvine personnel. The Closed System Project will
29 include the following major equipment:

¹¹ *Id.* at 5.

- 1 • **Electrolyzer:** Hydrogen used in this demonstration will be produced onsite via a
2 dedicated electrolyzer. The electrolyzer will produce hydrogen using water and
3 electricity and will be sized to blend up to 20% hydrogen in the isolated system.
4 The electrolyzer will use electricity from solar installed on the campus along with
5 UC Irvine’s campus microgrid and local municipal water to create hydrogen and
6 store it onsite.
- 7 • **Hydrogen Blending Skid:** A blending skid will be required to inject hydrogen
8 into the pipeline system. SoCalGas will collaborate with a blending skid vendor
9 to design a blending skid suitable for the project. Commissioning blending skids
10 for the demonstration projects will be key to learn about sizing and operation of
11 these units that will likely be utilized for injection throughout the California
12 system when a final hydrogen injection standard is created.
- 13 • **Hydrogen Storage Vessels:** Hydrogen pressure vessels will be installed to meet
14 sufficient hydrogen supply so that hydrogen blending levels are consistent and
15 allow for efficient operation of the electrolyzer equipment.
- 16 • **Solar Array:** Initial design includes approximately 1.1 acres of solar array which
17 can be installed on the roof of a parking structure close to where the equipment is
18 sited in order to produce the majority of the electricity required for operation of
19 the electrolyzer, associated equipment, and hydrogen production. One-point-one
20 (1.1) acres translates to approximately 150 kW of power, which can be
21 interconnected to UC Irvine’s campus microgrid.¹² The campus microgrid will
22 serve as an alternative power source to supply the hydrogen production and
23 blending equipment power when solar power is not available.
- 24 • **New Steel Pipe:** Approximately 1,400 feet of steel pipe will be installed from the
25 outlet of the blending skid to the interconnection point of the PE pipeline located
26 on California Avenue. Because there is no steel infrastructure in this portion of
27 campus, SoCalGas will be installing new steel pipe to emulate a mixed material
28 demonstration.

¹² Calculations performed using NREL’s Land-Use Requirements for Solar Plants in the United States. Ong, S., Campbell, C., Denholm, P., Margolis, R., and Heath, Gavin, *Land-Use Requirements for Solar Powered Plants in the United States* (June 2013), available at: <https://www.nrel.gov/docs/fy13osti/56290.pdf>.

1 Additional equipment and instrumentation that will be utilized are Supervisory Control
2 and Data Acquisition (SCADA) RTU, chiller, de-ionizer (DI), gas analyzers, gas detectors, gas
3 compressors, fire detectors, pressure transmitters, and temperature transmitters. Much of the
4 listed equipment and instrumentation is for safety of the hydrogen production, storage, and
5 blending components. However, safety practices are discussed further in Section III.B below.

6 In order to deliver hydrogen blends to the specified UC Irvine end-user, in this case the
7 ARC, a portion of the campus is planned to be isolated from the rest of the distribution system
8 through a single cut and cap pipeline location. The planned temporary cut and cap location cut is
9 on California Ave., south of Arroyo Dr., to isolate the existing 3” plastic line on California Ave. and
10 prevent hydrogen blends from flowing to any facility other than UCI’s ARC. While there is only
11 one planned cut location, each side of the pipe would need a cap. The means of isolating the
12 pipeline infrastructure in this manner is designed so that only the ARC will receive the blended
13 gas.

14 In order to serve the blended gas to the isolated campus buildings via the existing 3”
15 plastic main in California Avenue, approximately 1,400 feet of 3” steel main would be run from
16 the outlet of the blending skid and run northbound. Exact sizing of the newly installed steel line
17 will be confirmed in the detailed engineering design phase. The 3” steel line would then be tied
18 into the 3” plastic line on California Avenue, south of the proposed cut and cap location. Please
19 reference Figure 3 above.

20 **1. Project Schedule**

21 Table 2 below provides an estimated project timeline; however, actual timeline and
22 schedule will vary depending on the regulatory process approval. Additionally, lead time for
23 materials and other items may have unforeseeable impacts to the project schedule.

1 (should it occur).¹³ The selected project site will allow the best opportunity for these objectives
2 to be achieved physically and operationally. More detail on the PSMS model can be found in
3 the Project Guidance Section (Section III.A) below.

4 Operational needs include education, additional leak surveying, gas handling, customer
5 service, routine customer interactions, and emergency response plans. Monitoring during
6 demonstrations will include both system monitoring as well as collecting feedback from UC
7 Irvine.

8 The PSMS “Check: Analysis of Data” step will analyze quantitative and qualitative data
9 and will include an analysis of knowledge gained from any operational changes. Such analysis
10 will inform SoCalGas’s recommendations for a statewide hydrogen injection standard. Many of
11 the items below have been assessed through literature review, laboratory testing, and/or vendor
12 surveying. The Closed System Project will allow for operational review and confirmation of the
13 following within the limitations of the proposed project site:

- 14 • Odorant compatibility
- 15 • Leak detection equipment compatibility
- 16 • Material compatibility
- 17 • Component (*e.g.*, fittings, valves) compatibility
- 18 • Blend consistency (hydrogen blending injection skid)
- 19 • End-use customer appliance compatibility
- 20 • Review of Gas Standards for the construction, maintenance, and operations of
- 21 hydrogen blended natural gas system
- 22 • Effects on metering
- 23 • Impact on emissions of end-use equipment

24 Table 3 below provides an overview of the type of data that SoCalGas will collect with
25 the Closed System Project. Each data element serves to validate past hydrogen blending
26 research. Data will be collected prior to, during, and after the project. The data will be analyzed
27 to provide insights to confirm hydrogen blending compatibility of the gas system and end-use

¹³ API, *Pipeline Safety Management Systems* (July 2015), available at:
<https://flipflashpages.uniflip.com/3/94156/1106646/pub/html5.html>.

1 equipment. More detailed information on SoCalGas’s preliminary data collection plan can be
 2 found in Exhibit 1A: Preliminary Data Collection Plan.

3 **Table 3: Preliminary Data Collection Plan**

Area	Objective	Frequency	Pre-Demo	During Demo	Post-Demo
Odorant sampling	Confirm hydrogen does not affect efficacy of current natural gas odorant	Monthly	✓	✓	
Leak surveys	Safety checks; repair any leaks prior to starting demo; determine if hydrogen blends affect leakage from fittings, valves, etc.	Monthly; And as needed for customer service calls	✓	✓	✓
Leak survey equipment	Evaluate performance of new leak survey equipment	Monthly; And as needed for customer service calls		✓	
Heating value measurement	Monitor and Analyze changes to heating value of gas supplied	Monthly	✓	✓	
Customer meters	Compare data from customer meters and blending skid data to evaluate accuracy	Monthly		✓	✓
Customer equipment evaluation	Confirm equipment is working properly; validate gas interchangeability	Monthly; And as needed for customer service calls	✓	✓	✓
Customer equipment checks for emissions	Perform measurement on emissions from heating and cooking equipment	Monthly	✓	✓	

4 Table 4 below summarizes the incremental hydrogen blending level increase schedule.
 5 Please note that the actual blend percentage will depend on available hydrogen production and
 6 usage demand. This blending schedule aligns with recommendations from the UC Riverside
 7 Study. Per the study, “[I]t is critical to conduct real world demonstration of hydrogen blending
 8 under safe and controlled conditions; and...[a] three year timeline is proposed to complete these

1 activities and the adopt a hydrogen blending standard.”¹⁴ Prior to the introduction of hydrogen, the
2 demonstration area will be baselined with regular natural gas. Data collection will start with a
3 target blend level of 5% and gradually increase up to 20%. Six months of data will be collected
4 for the lower blends (up to 10%) and 12 months of data will be collected for the higher blends
5 (10 to 20%).

6 **Table 4: Estimated Blending Intervals by Increments**

% Blending Level	Timeframe
Baselining at 0%	3 months prior to demo
Up to 5%	Months 1 to 3
Up to 10%	Months 4 to 6
Up to 15%	Months 7 to 12
Up to 20%	Months 13 to 18

7 **3. Billing Impacts**

8 Since introduction of hydrogen will have the potential to change the heating value of the
9 gas supplied to UC Irvine, SoCalGas plans to apply retroactive volumetric adjustments to UC
10 Irvine’s bill to accurately charge based on therm usage. SoCalGas intends to address this
11 directly with UC Irvine during project implementation.

12 **4. Asset Validation**

13 At the end of the data collection period and hydrogen blending has concluded,
14 leak surveys will be performed to verify no additional leaks have developed. SoCalGas will also
15 confirm with UC Irvine that end-use equipment is still in proper working order. SoCalGas and
16 the other IOUs will then work with an independent third-party to gather data collected and
17 disseminate results accordingly.

18 **D. Phase 3: Decommissioning, Equipment Removal, and System Restoration**

19 Phase 3 of the Closed System Project will commence at the conclusion of the Testing and
20 Demonstration period. Given that the project is a demonstration, the hydrogen blending
21 equipment is planned to be removed from the campus upon completion of the 18-month
22 demonstration, except for the installed solar array. However, should UC Irvine want to keep the
23 hydrogen blending equipment in place for further testing or demonstration purposes, SoCalGas

¹⁴ UC Riverside, *Hydrogen Blending Impacts Study* (July 2022), at 4; available at:
<https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M493/K760/493760600.PDF>.

1 can work with the campus to explore options for keeping it onsite, rather than moving forward
2 with the planned decommissioning.

3 Should decommissioning take place, equipment will be removed upon completion of the
4 18-month demonstration and SoCalGas will restore the site where the hydrogen equipment was
5 temporarily located as per terms and conditions to be developed with UC Irvine. Relevant
6 equipment will be warehoused and efforts will be made to redeploy or reutilize the assets. The
7 solar system supplying the electricity for the electrolysis process will be donated to the UC
8 Irvine campus to save decommissioning costs.

9 Lastly, if none of the assets shall remain in place, SoCalGas can decommission the
10 entirety of the site that was installed during Phase 1 and restore the area to its pre-demonstration
11 condition. Phase 3 cost estimates reflect this conservative scenario in which full
12 decommissioning might occur.

13 **E. Phase 4: Data Analysis and Dissemination**

14 After the demonstration's completion, all of the data collected will be analyzed to guide
15 any operations and maintenance updates needed for hydrogen blending and to support a future
16 hydrogen injection standard in the California gas system. Additionally, any impacts observed
17 will be documented via data collection protocols proposed above and in Exhibit 1A. The
18 Applicants will work accordingly with any selected independent research organizations to
19 provide necessary data and coordinate results that can be published for independent evaluation. A
20 report will be published and made available to the general public. A public workshop will be
21 held to share the project's findings.

22 **III. PROJECT GUIDANCE**

23 **A. API RP 1173 Pipeline Safety Management System**

24 Safety is at the core of this Amended Application, of paramount importance at SoCalGas,
25 and at the forefront of the Closed System Project. The Closed System Project follows the API
26 RP 1173 PSMS Plan-Do-Check-Act model¹⁵ and is currently in the "Plan" stage. SoCalGas will
27 move into the "Do" stage by initiating the controlled blending demonstration that has been
28 informed by the "Plan" stage. In advance of this Amended Application filing, SoCalGas has

¹⁵ API, *Pipeline Safety Management Systems* (July 2015), available at:
<https://flipflashpages.uniflip.com/3/94156/1106646/pub/html5.html>.

1 continually engaged various stakeholders to garner feedback on the technical details of the
2 proposed demonstration. This way, stakeholder feedback can be accurately incorporated into
3 any operational, safety, or data collection plans. Leading up to and during the “Do” stage,
4 SoCalGas will be establishing operational controls, training to operate with hydrogen blends,
5 documenting and recording data from the demonstration, and continuing to engage with
6 stakeholders, including the communities and end-users. Following this stage, the project leads
7 into the “Check” stage where SoCalGas will learn from the data collected, including utilizing the
8 data for an integrity/risk management analysis. Finally, during the “Act” stage, SoCalGas will
9 be reviewing and updating a potential hydrogen injection standard to allow for blended hydrogen
10 in the distribution system more broadly. SoCalGas will translate the knowledge gained from the
11 demonstration to safety policies and mitigations for the rest of our natural gas distribution system
12 and customer installed equipment. The Plan-Do-Check-Act model is a continuous loop and
13 SoCalGas intends to expand risk modeling, revise standards, policies, and procedures to safely
14 blend hydrogen, and consider future larger scale demonstrations.

15 **B. Overarching Safety Case**

16 Throughout the course of this demonstration, SoCalGas will implement safety protocols
17 in accordance with existing safety codes and standards. SoCalGas’s safety efforts to be taken
18 before, during, and after the Closed System Project include, but are not limited to:

- 19 • Hydrogen safety education for personnel
- 20 • Safety assessment for hydrogen storage and hydrogen components
- 21 • Survey end-use customer equipment to confirm behind-the-meter equipment
22 present is free of leakage and is operational
- 23 • Install appropriate gas detection alarm systems where indoor equipment is housed
- 24 • Conduct pre-, during, and post-implementation leak surveys
- 25 • Mitigation measures to prevent hydrogen or hydrogen blends from reaching
26 natural gas storage areas and electrical switching equipment
- 27 • Create hydrogen blending specific customer protocols and emergency response
28 plans
- 29 • Continuous remote monitoring of hydrogen production, storage, and blending
30 areas

- Automatic and remote shutdown capabilities for the hydrogen production and blending facility in the case an alarm is triggered or a leak is detected
- Conduct gas system operational tests and equipment tests (e.g., customer appliance leak, customer appliance flame-out, or pilot light failure), and other operational activities that occur in a natural gas distribution system
- Test existing and new leak survey equipment

C. United Kingdom’s HyDeploy Hydrogen Blending Trial

Another hydrogen blending demonstration has proven successful in the United Kingdom with Phase 1 of the HyDeploy hydrogen blending trial (HyDeploy Trial) at Keele University, which blended up to 20% hydrogen in a private distribution gas system and fed 100 homes and 30 university buildings for 18 months, concluding in March 2021.¹⁶ The project demonstrated that hydrogen blends of up to 20% can be safely delivered to and used by customers without changes to the gas system or end-use equipment. Phase 2 of the HyDeploy Trial took place in Winlaton, England, for 10 months and successfully served a 20% hydrogen blend to more than 650 homes and several small businesses.¹⁷

Building on the success of the HyDeploy Trial and the knowledge gained, SoCalGas proposes to conduct a similar demonstration where hydrogen blends are first introduced to a university distribution gas system. It is important to emphasize that although SoCalGas and other stakeholders can learn from the successful HyDeploy Trial, there is still a need to conduct a California-specific hydrogen blending demonstration due to potentially different designs in pipeline systems and end-use equipment.¹⁸ The operational data that will be collected and analyzed for the gas system and end-use equipment will validate past hydrogen blending research and facilitate future hydrogen blending in the wider gas distribution system in California.

¹⁶ HyDeploy, *Project Phases*, available at: <https://hydeploy.co.uk/project-phases/>.

¹⁷ *Id.*

¹⁸ For example, in the United Kingdom, gas appliances manufactured after 1996 have been designed to operate with hydrogen blends up to 23%. In North America, natural gas appliance manufacturers are not required to conduct hydrogen testing and certification for their equipment.

1 **D. Stakeholder Engagement Plan**

2 Stakeholder engagement is a vital component of the Closed System Project and SoCalGas
3 has taken a proactive approach in its outreach at UC Irvine and throughout Orange County.
4 SoCalGas aims to provide an educational platform in collaboration with UC Irvine to inform
5 stakeholders about the role hydrogen can play in a clean energy future and to obtain feedback as
6 it pertains to this project.

7 Since 2022, SoCalGas has conducted a series of community outreach efforts with various
8 stakeholders including UC Irvine staff, faculty, students, city and county officials, state
9 regulatory agencies, and legislators. Working in partnership with these stakeholder groups has
10 presented meaningful opportunities for deepening stakeholder collaboration and participation.
11 Outreach activities have included educational presentations, townhalls, project briefings, and
12 facilitating tours of SoCalGas’s H2 Innovation Experience [H2IE], North America's first-ever
13 clean hydrogen-powered home, including a microgrid and home which provides a real-world
14 example of an existing hydrogen blending facility. SoCalGas will continue with these types of
15 outreach activities including utilizing media and digital/virtual platforms to provide relevant
16 updates to stakeholders and the community throughout the project duration.

17 Pursuant to D.22-12-057, Ordering Paragraph (OP) 7(h), on June 13, 2023, Applicants
18 hosted a public stakeholder workshop to solicit feedback from interested parties so that
19 Applicants could address questions submitted by stakeholders. Following the workshop,
20 Applicants collectively responded to outstanding questions submitted by attendees so all answers
21 would be recorded. In addition, to solicit best practices from industry experts and technical
22 stakeholders, on November 6, 2023, Applicants held a technical-focused workshop to receive
23 feedback on proposed data collection and test plans. Follow-up questions submitted by
24 stakeholders were addressed by the Applicants in a timely manner. Through these various
25 engagement techniques, SoCalGas was able to gather information and inform additional details
26 about the project implementation. SoCalGas will continue performing stakeholder outreach in
27 collaboration with UC Irvine after the Amended Application is filed so that the campus and
28 community stays informed and engaged throughout the demonstration period.

29 Also, the relationship between SoCalGas and UC Irvine creates an opportunity to
30 collaborate on research projects related to hydrogen blending and associated equipment, which
31 will provide a robust ample learning environment for students, faculty, and community at large.

1 Because the Closed System Project will take place on campus, this will also compliment UC
2 Irvine’s APEP and its National Fuel Cell Research Center (NFCRC) because these departments
3 have been internationally recognized for their leadership in energy and are national pioneers in
4 researching, educating, evaluating, and deploying clean energy technologies and systems.
5 SoCalGas first partnered with UC Irvine’s NFCRC in 2016 for the first successful green
6 hydrogen blending project in the United States. Since then, hydrogen blending has been ongoing
7 at the UC Irvine campus and has successfully demonstrated that hydrogen could be safely
8 blended with natural gas.

9 SoCalGas will work with the local community to identify relevant community-based
10 organizations (CBO) for project engagement and will hold stakeholder meetings for participation
11 of relevant CBOs. CBO collaborations will be formalized through MOUs. SoCalGas will
12 provide compensation for CBOs based at \$150/hour.¹⁹ SoCalGas proposes CBO engagement
13 meetings not to exceed four (4) per year during Phase 1 and an additional three meetings, one at
14 the conclusion of each additional project phase, to share updates, conclusions, and findings.
15 SoCalGas will work with identified CBOs to determine appropriate workshop frequency.

16 Lastly, SoCalGas will develop a dedicated means of communicating with stakeholders
17 that provides easy accessibility for stakeholders to get in touch about the project.

18 **IV. ORDERING PARAGRAPH 7 COMPLIANCE**

19 D.22-12-057 outlined several requirements for the implementation of hydrogen blending
20 demonstration projects and the Applicants engaged the Commission’s Energy Division
21 throughout the development of this Amended Application to address any interpretation issues.
22 Below is a detailed discussion of how SoCalGas’s proposed Closed System Project complies
23 with OP 7 of D.22-12-057.

24 **A. OP 7a**

25 *Ensures the long-term safety of the California pipeline, the prevention of hydrogen*
26 *leakage, the inclusion of hydrogen monitoring, the consideration of the dilution rate, and*
27 *the monitoring and reporting of all mechanical characteristics of hydrogen blends in the*
28 *natural gas pipeline stream*

¹⁹ This hourly rate is consistent with CBO compensation outlined in SoCalGas Advice No. 6146G;
available at: https://tariff.socalgas.com/regulatory/tariffs/tm2/pdf/submittals/GAS_6146.pdf.

1 Within the Closed System Project, SoCalGas intends to take various steps to maximize
2 safety, prevent hydrogen leakage, monitor hydrogen production and storage facilities, measure
3 the hydrogen blends in the demonstration program, and monitor all mechanical characteristics.
4 As such, SoCalGas will perform enhanced leak detection protocols to verify that the introduction
5 of hydrogen is not compromising the safety of the gas system and associated end-use equipment
6 throughout the duration of the demonstration. As outlined in Section II.C.2, SoCalGas will
7 increase leak survey to a monthly basis compared to the standard annual frequency. SoCalGas
8 will deploy robust monitoring surrounding the hydrogen production, storage, and blending
9 facilities to detect leakage or issues with the hydrogen equipment. Remote and continuous
10 monitoring on these systems will notify SoCalGas of leakage to the hydrogen facilities and
11 prompt SoCalGas to respond to address any issues as necessary. If an alarm is triggered or
12 leakage is detected in the hydrogen production and storage area, the hydrogen system will go
13 into a shutdown mode, isolating equipment, stopping hydrogen production, and returning the
14 pipeline system to 100% natural gas. A gas measurement analyzer will be installed at the outlet
15 of the blending skid so that the blend percentage introduced into the system is accurate.
16 Additionally, gas sampling will be implemented by taking measurements downstream of the
17 introduction point to monitor the hydrogen blends at the customer meter. SoCalGas will
18 continually monitor the operation of the hydrogen blending, storage, production, and associated
19 electrical and water aspects of the project. SoCalGas intends to perform upfront inspections as
20 well as continuous inspections on various points of this demonstration. Exhibit 1A outlines
21 detailed data collection plans.

22 **B. OP 7b**

23 *Prevents hydrogen from reaching natural gas storage areas and electrical switching*
24 *equipment directly or through leakage*

25 The pipeline system will be isolated in a manner that no hydrogen or hydrogen blends
26 will reach any natural gas storage or electrical switching equipment. As mentioned in Section
27 II.B, SoCalGas will perform a cut and cap on the pipeline involved in the demonstration so that
28 no blended gas is reaching any customers other than UC Irvine's ARC, or any natural gas storage
29 fields. Hydrogen storage, production, and blending equipment will be sited in a lot just south of
30 UC Irvine's ARC and there is no known electrical switching equipment within proximity. The
31 site will be designed in a matter that if any electrical equipment switching equipment were to be

1 present, it will be located in unclassified areas or will be protected by classified enclosures per
2 applicable industry codes and standards. Lastly, independent risk analyses will be performed
3 prior to project implementation and will inform if any unforeseen risks are present regarding a
4 potential for hydrogen to reach natural gas storage or electrical switching equipment. If anything
5 is found during the risk assessment stages, design will be implemented for mitigation.

6 **C. OP 7c**

7 *Avoids end user appliance malfunctions*

8 When blending has commenced, SoCalGas will work closely with UC Irvine staff to
9 confirm that the appliances and equipment are in proper working order. Further, equipment will
10 be monitored for continued proper operation and SoCalGas will provide operational support if
11 needed. SoCalGas will establish a means of communication for UC Irvine Facilities to use
12 should they experience difficulties with their end-use equipment.

13 Additionally, research shows that common appliances can operate safely with blends
14 above 20% hydrogen. A study from GTI, which tested various partially premixed combustion
15 equipment with no adjustments, has shown that heating equipment "...was successfully operated
16 up to 30% hydrogen-blended fuels."²⁰ This demonstration is designed to further validate
17 previous research findings.

18 **D. OP 7d**

19 *Evaluates hydrogen injection at blends between 0.1 and five percent and five to twenty*
20 *percent; such evaluations must adhere to approved monitoring, reporting, and long-term*
21 *impact study in accordance with the approval of the pilot project application, and must*
22 *include validation programs to confirm performance*

23 The Closed System Project will evaluate blends from 5% to 20% in an isolated system.
24 In doing so, it will adhere to approved monitoring and reporting that are in alignment with the
25 UC Riverside Study. Please refer to Section II.C.2 and Exhibit 1A for complete details of a
26 preliminary data collection plan. SoCalGas's proposed Open System Project outlined in
27 Chapter 2 will evaluate hydrogen blends between 0.1 and 5%.

²⁰ Glanville, P., Fridlyand, A., Sutherland, B., Liszka, M., Zhao, Y., Bingham, L., and Jorgensen, K.,
Impact of Hydrogen/Natural Gas Blends on Partially Premixed Combustion Equipment: NOx
Emission and Operational Performance (February 24, 2022), available at:
<https://www.mdpi.com/1996-1073/15/5/1706>.

1 **E. OP 7e**

2 *Specifies the amounts of funding necessary to complete all aspects of the proposal and*
3 *proposes testing durations adequate to draw meaningful conclusions*

4 A level 5 cost estimate was performed to calculate the funding necessary for all four
5 phases of the Closed System Project detailed in this testimony. Section V summarizes the
6 project cost and Revised WP-1 provides a breakdown of the project cost.

7 Regarding the demonstration’s duration, SoCalGas’s Closed System Project is in line
8 with other notable hydrogen blending studies and would allow sufficient time to show changes in
9 seasonal gas flows. Testing duration is in line with previous successful demonstrations, such as
10 the HyDeploy Trial Phase I and Phase 2 demonstrations, that were performed for 18 months²¹
11 and 10 months,²² respectively. The Closed System Project will test at a minimum of three (3)
12 months for lower levels and six (6) months for greater hydrogen concentrations. This also aligns
13 with the three-year timeline to adopt a hydrogen blending standard proposed by the UC
14 Riverside Study.

15 **F. OP 7f**

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

19 The Closed System Project is consistent with the directed courses of action specified in
20 D.22-12-057. Details of how SoCalGas’s proposed Closed System Project addresses all courses
21 of action have been discussed throughout this prepared testimony and are summarized in Table 5
22 below.

23 **Table 5: Directed Courses of Action in D.22-12-057**

Topic	Recap of SoCalGas’s Action	Reference
Leakage	The project will be designed to minimize and monitor leakage for hydrogen, methane, and a hydrogen/methane blend with sensors, remote alerts, and other detection systems. Hydrogen production and storage will have 24/7 continuous monitoring.	Section II. C.2, IV.A and Exhibit 1A

²¹ HyDeploy, *Project Phases – Phase 1*, available at: <https://hydeploy.co.uk/project-phases/>.

²² *Id.* at Phase 2.

Reporting	The project's testing program explained will collect and analyze data, and will report the findings of the project. SoCalGas will work with a selected third-party and the Joint Utilities to report on findings.	Section II
Heating Value	Gas composition will be monitored after blending skid and at various points downstream of the injection point. Additionally, SoCalGas is evaluating gas chromatographs capable of detecting and measuring hydrogen up to 20 vol%.	Section II. C.2, IV.A and Exhibit 1A
System Safety	Various safety and alert systems are in place so that the project adheres to safety requirements, including a remote monitoring and alarm system. All relevant codes and standards will be applied.	Section III.B and IV.A
Environmental Considerations	The project will produce important information about the potential for carbon reductions using different blend percentages. Other emissions will be measured. Additionally, solar energy is being procured for production of clean renewable hydrogen throughout the duration of the project.	Section II, II.C.2
End-use Emissions	NOx, CO ₂ , CO, and Oxygen will be measured from the end-use equipment to monitor the emission performance.	Section II.C.2, Exhibit 1A
Blending Limitations	The project will evaluate hydrogen blending between 5% to 20% by volume in a closed system as directed in D.22-12-057 and recommended through the UC Riverside Study. The closed system is a real-world system using components of gas distribution pipeline. The project is focused on ensuring the long-term safety of the California pipeline.	Section I, II , IV.D
Additional Consideration	Section IV addresses how the project is in compliance with the directives of D.22-12-057.	Section IV

1 **G. OP 7g**

2 *Proposes rigorous testing protocols consistent with the UC Riverside Study*

3 The Closed System Project is consistent with all directed courses of action specified in
4 the UC Riverside Study as well as actions specified in D.22-12-057. Additionally, on
5 November 6, 2023, Applicants sought feedback on their data collection plans from stakeholders,
6 the public, and industry experts in their technical stakeholder workshop. Applicants incorporated
7 feedback from stakeholders into their respective data collection plans.

8 Rigorous testing protocols will be developed to address leakage rates, impacts on end-use
9 appliances, impacts to the existing natural gas pipeline system, impacts on fittings, and other
10 components. In addition, inputs from industry experts will be utilized to measure, test, and
11 report the most relevant data for the Closed System Project. Exhibit 1A demonstrates the data
12 collection and testing plan developed for different aspects of the project.

13 This filing represents pre-development of the Closed System Project. Upon application
14 approval, the Applicants will contract an independent party as directed to finalize a research plan
15 for assessment, measurements, monitoring, and reporting. This plan will consider feedback from
16 the technical workshop held on November 6, 2023, as well as the UC Riverside Study.

17 **H. OP 7h**

18 *Takes into account parties' comments and further stakeholder input and includes the*
19 *opportunity for compensation for parties and for community-based organizations*

20 SoCalGas has and will continue to consider parties' comments and stakeholder input.
21 Refer to Section III.D for more details on SoCalGas's stakeholder engagement activities to date,
22 plans for engagement post-Amended Application filing, and CBO compensation.

23 Applicants utilized public stakeholder workshops to gather feedback from the general
24 public. SoCalGas also worked closely with the impacted stakeholders, such as UC Irvine, to take
25 into account feedback from the campus community. The project will provide educational
26 materials and information sessions to disseminate knowledge on the technology, safety
27 measures, and progress on the project.

1 **I. OP 7i**

2 *Proposes a methodology for performing a Hydrogen Blending System Impact Analysis*
3 *that can ensure that any hydrogen blend will not pose a risk to the common carrier*
4 *pipeline system*

5 This System Impact Analysis would be a checklist for Joint Utilities and potential third
6 parties connecting to the gas system to use to confirm the common carrier pipeline system will
7 remain safe should a hydrogen injection standard be established.

8 The Joint Utilities propose developing a methodology for performing the Hydrogen
9 Blending System Impact Analysis upon completion of the projects. The proposed methodology
10 will provide a framework so that hydrogen blends do not compromise gas system integrity,
11 safety, or impact end-use equipment.

12 The methodology will benefit from using the data collected from the demonstration
13 projects. The proposed methodology for hydrogen blending will follow a similar framework as a
14 biomethane interconnection agreement. The framework will include, but will not be limited to:

- 15 • Identification of downstream systems.
- 16 • Potential materials.
- 17 • Operating pressures.
- 18 • Equipment (*e.g.*, valves, meters, etc.).
- 19 • Review of pipeline history and end-use equipment.
- 20 • Any further analysis that is deemed necessary by the interconnecting utility.

21 **J. OP 7j**

22 *Includes new or revised heating values and discusses whether heating values would be*
23 *modified through the use of propane or other means and whether such modifications to*
24 *heating value can be done safely*

25 Propane or other means will not be used to supplement heating values during the
26 demonstration. The composition of the blended gas will be measured at the outlet of the
27 blending skid and also downstream of the point of injection. This will inform any impacts to
28 heating value at the point of injection and also downstream at the customer’s meter. Specific
29 information is detailed in Section II.C.2 and impacts to bills are discussed in Section II.C.3.

1 **K. OP 7k**

2 *Demonstrates the ability to reliably detect leakage of any hydrogen, methane, or*
3 *hydrogen/methane blends and describes rigorous hydrogen leak testing protocols that*
4 *are consistent with leak testing and reporting elements identified in the University of*
5 *California at Riverside’s 2022 Hydrogen Blending Impacts Study, identifies and*
6 *addresses the comments presented by parties in this proceeding regarding leak issues,*
7 *and identifies and addresses the comments presented by workshop stakeholders in this*
8 *proceeding regarding leak issues*

9 The Closed System Project will include procedures to monitor, identify, and quickly
10 repair leaks to minimize safety risks, including appropriate methods for prompt and reliable leak
11 detection, such as the use of odorant. First, the project will utilize the appropriate design and
12 construction standards, as well as operating gas standards within the designed parameters to
13 minimize the risk of hydrogen leakage. In addition, continuous monitoring of the hydrogen
14 storage and production facilities will be deployed to detect leakage. Also, more frequent leak
15 detection will be utilized through the duration of the project for the blended gas lines, gas lines
16 downstream of the customer meter, and customer equipment. Instrumentation systems will be
17 utilized to measure performance of the system, including temperature, pressure, and gas quality.
18 More information can be found in Section II.C.2, IV.A and Exhibit 1A.

19 **L. OP 7l**

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

23 Upon approval of the Amended Application, Applicants will issue a request for proposals
24 (RFP) to solicit competitive bids from an independent party or parties to complete the
25 independent research plan. Given the differences in demonstration projects, different entities
26 might be contracted for development of the research plan. This application phase of the project
27 is pre-development, and therefore the cost of the independent party involvement will be assessed
28 and recovered after the Commission’s decision on the Amended Application through a
29 subaccount.

30 **V. COST ESTIMATES**

31 An unloaded direct cost estimate is provided in Table 6 below. The unloaded direct cost
32 includes all anticipated expenses, with contingency, for the entirety of the Closed System

1 Project. SoCalGas utilized Class 5 estimates based on AACEi recommended practices to
2 determine the proposed costs. The proposed costs are shown in 2023 dollars. Please see
3 Revised WP-1 for the detailed breakdown of cost estimates by project phase. Details on revenue
4 requirements are described in the Direct Testimony of Nasim Ahmed and Marjorie Schmidt-
5 Pines (Chapter 6).

6 **Table 6: Unloaded Direct Cost Estimate**

2025	2026	2027	2028	Total
\$16,357,612	\$5,660,911	\$ 949,936	\$1,451,947	\$24,420,406

7 **VI. CONCLUSION**

8 A live hydrogen blending demonstration is the next critical step to develop a hydrogen
9 injection standard for California. SoCalGas’s proposed Closed System Project will provide the
10 necessary operational and material data to support such a standard for using steel and plastic
11 distribution gas systems to transport natural gas and hydrogen blends. SoCalGas and UC Irvine
12 are looking forward to taking this next step to help California achieve its decarbonization goals.

13 This concludes my prepared direct testimony.

14 **VII. QUALIFICATIONS**

15 My name is Blaine Waymire. I am employed at SoCalGas as a Project Manager in the
16 Gas Engineering and System Integrity organization. Currently, I lead the Hydrogen Blending
17 Strategy Team’s planning for live hydrogen blending demonstrations and regulatory
18 applications. Prior to this, I have held positions within SoCalGas including Sr. Distributed
19 Energy Resources Advisor and Sr. Account Executive, with various engineering analysis and
20 regulatory responsibilities. I have been employed at SoCalGas since May 2012. I hold a
21 Bachelor of Science degree in Mechanical Engineering from California State University, Long
22 Beach. I am a licensed Professional Engineer in the State of California.

Exhibit 1A: Preliminary Data Collection Plan

Joint IOU Hydrogen Blending
Demonstration Application

Contents

- Goals 1
- Leakage 1
 - Odorization 1
 - Leak Survey 1
- Materials Testing..... 2
- Heating Value Measurement 2
- End Use Emissions..... 2

Goals

The purpose of this document is to create a data collection and test plan for the two proposed SoCalGas Hydrogen Blending Demonstration Projects in the medium pressure distribution system. For the purposes of these demonstrations, the medium pressure distribution system is defined as pipelines and components with operating pressures of 60 pounds per square inch gauge (psig) or less.

The first proposed SoCalGas Hydrogen Blending Demonstration Project (closed system) will be held in an isolated portion of the natural gas distribution system located at UC Irvine campus for blending hydrogen from 5 vol% to 20 vol%. The second SoCalGas Hydrogen Blending Demonstration Project (open system) will be held in an open portion of the natural gas distribution system located in the City of Orange Cove for blending hydrogen from 0.1 vol% to 5 vol%

This document presents our strategy for gathering data on four distinct topics aimed at validating knowledge derived from research studies. This will provide the essential data and operational insights required to facilitate the future expansion of hydrogen blending. The four topics encompass: leakage, material testing, heating value measurement, and end-use emissions. Every part of the demonstration will have its own respective test plan and data collection schedule to support the necessary data analysis.

Leakage

Odorization

For both open and closed system demonstration projects, hydrogen-natural gas blends will be odorized per Company Odorization Gas Standard. Odorant levels will be monitored upstream of the hydrogen injection point as base case and multiple locations downstream of the hydrogen injection point to verify odorant intensity throughout the pipelines. Four consecutive weekly odor intensity tests will be conducted, followed by monthly tests, which will confirm hydrogen compatibility and efficacy of the odorant.

Leak Survey

Leak survey will be conducted at frequencies listed in Table 1. Only Company Field Employees qualified through Gas Operations Training may perform the leak survey. Pipe joints, valves and meters will be leak surveyed. Downstream of the meter, pipe connections to the end use appliances will be leak surveyed as well to confirm safety, integrity, and reliability. SoCalGas will explore various leak survey technologies available on the market.

Table 1. Leak Survey Technologies and Frequency

Demo Project	Examples of Leak Survey Technologies to Explore	Leak Survey Frequency
Closed System	<ul style="list-style-type: none"> • Portable gas detectors • Fiber optic technology • Ground vehicle • Mass balance method 	<ul style="list-style-type: none"> • Pipeline: monthly • Pipe connections to appliances: monthly or by customer call
Open System	<ul style="list-style-type: none"> • Portable gas detectors • Ground vehicle • Aerial detectors 	<ul style="list-style-type: none"> • Pipeline: quarterly • Pipe connections to appliances: by customer call

Materials Testing

For both closed and open system demonstration projects, the effect of hydrogen on materials will be continuously monitored through leak surveys at various points within the system. If any leaks are detected during leak surveys, the affected section of the pipeline or specific components may be isolated for further material testing to assess any potential impact of hydrogen on the material's integrity. If an opportunity arises to remove specific sections of the pipeline or components at the conclusion of the demonstration, further material testing may be conducted.

Heating Value Measurement

The current gas chromatographs used for heating value measurement have a limitation to detect hydrogen. To ensure accurate gas composition measurement for customer billing purposes, it is essential to implement and incorporate compatible gas chromatographs.

For the closed system project, SoCalGas will monitor the caloric value of the blend both at the blending injection skid and at the meter set assembly of the Anteatser Recreation Center (ARC).

For the open system project, SoCalGas will monitor the calorific value of the blend at the blending injection skid and at strategically selected customer meter set assembly.

End Use Emissions

For both closed and open system projects, SoCalGas will perform emissions testing (CO₂, NO_x, CO, and O₂) per South Coast Air Quality Management District (SCAQMD) and San Joaquin Valley Air Pollution Control District (APCD) test methods to determine the appliance performance and combustion efficiency. SoCalGas also plans to visually inspect the change in flame appearance, flame ignition, and start-up and steady operation between 5 vol% to 20 vol% hydrogen blends. Table 2 summarizes End-Use equipment proposed testing. It should be noted that for the open system project, the frequency of testing will be determined following a comprehensive customer survey.

Table 2. End- Use Equipment Proposed Testing

Demo Project	End Use Equipment	Emissions Testing		Visual Testing	Frequency
		Monitored Parameters	Applicable Test Methods		
Closed system	Boilers, Water heaters, pool heaters, and food services	NOx, CO2, CO, O2	SCAQMD Rules	The change in flame color, longer cooking duration, the delayed ignition	Beginning and end of each phase or per Customer call
Open System	Common residential appliances, general commercial HVAC, and water heating	NOx, CO2, CO, O2	San Joaquin Valley APCD Rules	To be determined	To be determined

Exhibit 1B: Amended and Restated Memorandum of Understanding

Joint IOU Hydrogen Blending
Demonstration Application



AMENDED AND RESTATED MEMORANDUM OF UNDERSTANDING

By and Between

THE REGENTS OF THE UNIVERSITY OF CALIFORNIA, ON BEHALF OF THE ADVANCED POWER AND ENERGY PROGRAM AT ITS IRVINE CAMPUS (“UCI”) and SOUTHERN CALIFORNIA GAS COMPANY (“SoCalGas”)

RECITALS

WHEREAS UCI is an internationally recognized leading public research university;

WHEREAS UCI is a “living laboratory,” incubating numerous clean energy initiatives and technologies that contribute to future decarbonized energy systems;

WHEREAS the parties agree that clean hydrogen is a promising carbon-free fuel that may be critical to supporting California’s clean energy transition on the electric and natural gas systems;

WHEREAS the California Public Utilities Commission (“CPUC”) has asked investor-owned gas utilities, including SoCalGas, to inform on a safe hydrogen injection and blending standard for California’s natural gas pipeline system;

WHEREAS the CPUC has asked investor-owned gas utilities, including SoCalGas, to propose live hydrogen demonstration projects;

WHEREAS on February 29, 2024, UCI and SoCalGas entered into a Memorandum of Understanding (“Original MOU”) to collaborate on a proposed multi-year pilot demonstration program to inject and blend hydrogen in a portion of the natural gas distribution system on UCI’s campus;

WHEREAS the parties desire to amend and restate the Original MOU with this instant non-binding Amended and Restated Memorandum of Understanding (“Amended MOU”) to modify the location of the hydrogen production, storage, and blending equipment among other changes agreed upon by the parties;

NOW, THEREFORE, UCI and SoCalGas enter into this Amended MOU effective as of March 29, 2025.

I. PURPOSE

UCI and SoCalGas agree that this Amended MOU amends, restates, and supersedes the Original MOU in its entirety. The Original MOU is hereby terminated and shall have no further force or effect. The Amended MOU shall provide for the parties to continue collaboration on a proposed multi-year pilot demonstration program to inject and blend hydrogen in a portion of the natural gas distribution system on UCI's campus as further described in Exhibit A attached hereto (the "Project"). This non-binding Amended MOU summarizes principal terms of a proposed collaboration to be set forth in a future, definitive joint demonstration agreement (the "Future Agreement").

This proposed Project is part of a joint investor-owned gas utility ("IOU") CPUC application to study the impacts of hydrogen on California's natural gas infrastructure. Research is to be developed between the IOUs and University of California (UC) system campuses, including UCI, UC San Diego, and potentially others. The Project requires and is dependent upon approval by the CPUC.

II. GENERAL CONSIDERATIONS:

1. This Amended MOU does not supersede other existing agreements and/or memorandums of understanding between either of the parties other than the Original MOU.
2. Each party will retain its primary responsibility for meeting all legal and regulatory requirements pertaining to it and its property.
3. Participation in any phase of the Amended MOU is voluntary. Nothing contained in this Amended MOU shall obligate any party to continue participating in any phase of the Amended MOU and any party may terminate its participation in any phase of the Amended MOU at any time for any reason or for no reason.
4. This Amended MOU is not a contract, but merely a memorandum of the understanding of the parties to coordinate their efforts with respect to establishing the basis for the proposed Project. Neither party shall be bound with respect to any of the matters set forth in this Amended MOU. Nothing in this Agreement shall create, or be construed to be, a joint venture, association, partnership, franchise, or other form of business or contractual relationship. At no time will the employees, agents, or assigns of one party be considered the employees of the other party for any purpose, including, but not limited to, workers' compensation purposes. Neither party shall be authorized to act on behalf of the other party, or to make representations or commitments of any kind on behalf of the other party.
5. Amendments to this Amended MOU may be made by notification of the proposed changes to the other party and will become effective upon written execution by both parties, which may occur in counterparts.
6. This Amended MOU may be terminated by delivering written notice to the other party, effective thirty (30) calendar days following the date of delivery of such written notification.
7. This Amended MOU may be included as an Exhibit in SoCalGas' testimony or filings with the CPUC.
8. Neither party will use the name, abbreviation of the name, logo, seal, or other mark

of the other party (including in any advertisement, press release, or publicity related to this Amended MOU) without that other party's prior written approval. To seek approval, a party will submit a request to the other party's institutional contact, who will assist with obtaining any internal authorization required by their institution.

III. BOTH PARTIES SHALL WORK TOGETHER ON THE FOLLOWING TASKS:

1. Collaborate to establish Project plan and terms and conditions, including construction, siting, deployment, and removal of associated equipment and utilities and reasonable timelines. For clarity, execution of the Project will be subject to execution of the Future Agreement.
2. Collaborate to determine communications, education, safety, and fire safety protocols with campus staff and residents who may be affected by the Project.
3. Seek to find research collaboration areas to support student and faculty research.
4. To the extent that the implementation of any agreed-upon activity related to the Project requires a commitment of personnel, facilities, funding, intellectual property, or other institutional resources, the parties will negotiate and enter into Future Agreement signed by each party's authorized representative. Future Agreement will specify each party's commitment of resources and terms related to funding, equal opportunity, intellectual property, confidentiality, export control, indemnity, liability and other matters relevant to the Project.
5. Working with and providing relevant information to all UCI administrative committees established to support the Project.

IV. SUBJECT TO TERMS AND CONDITIONS IN FUTURE AGREEMENT, SOCALGAS SHALL INVESTIGATE:

1. A cut and cap of one pipeline location to isolate SoCalGas' gas system and to continue providing gas to UCI and non-UCI customers in the area;
2. Managing the design, permitting, construction, procurement and temporary siting on campus of related hydrogen equipment, including fencing, an electrolyzer and blending skid;
3. Testing hydrogen injection and blending on the system in increments from 5% to 20% by volume over the course of the Project;
4. Performing inspections and maintenance of the hydrogen blending facility over the course of the Project;
5. Following the end of the Project, reconnecting the demonstration pipeline system to the main distribution system and removing hydrogen blending equipment;
6. Providing facilitation services to support the UCI community throughout the duration of the Project;
7. Seeking full rate recovery for the Project from the CPUC; and
8. Obtaining all required licenses and/or easements from UCI prior to performing any such work, which licenses and/or easements shall be subject to Future Agreement.

V. SUBJECT TO TERMS AND CONDITIONS IN FUTURE AGREEMENT, UCI SHALL INVESTIGATE:

1. Providing easements (and/or temporary license) and site access sufficient to install, operate, maintain and remove the Project equipment;
2. Providing facility access to test end use equipment as necessary; and
3. Providing faculty and student engagement to further the achievement of Project goals, for example in the areas of environmental engineering, behavioral sciences, and environmental education, among others.
4. Providing our faculty, students and our broader research community the opportunity to contribute data, information and knowledge on the use of natural gas pipelines for hydrogen transport. The outcomes are expected to contribute significantly to the development of California's hydrogen blending regulations and support the state's climate and energy goals.

VI. MISCELLANEOUS:

This non-binding Amended MOU is not a contract, nor an agreement for a contract, but an expression of the intention of the parties to negotiate toward a binding and definitive Future Agreement and such other transaction documents as necessary based on the understandings contained herein and such additional or different terms as may be mutually acceptable to the parties. Neither party shall have any obligation to commence or continue negotiations for Future Agreement and may terminate negotiations for Future Agreement at any time for any reason or no reason whatsoever. Neither of the parties shall be bound with respect to any of the matters set forth in this Amended MOU, except to the extent such matters are contained in binding and definitive transaction documents executed by both parties. Any such definitive transaction documents will contain usual and customary provisions for transactions of the types contemplated therein with due regard for applicable tax, financial, indemnity, liability, and regulatory requirements.

IN WITNESS WHEREOF, the parties hereto have executed this Memorandum of Understanding as of the last date written below:

<p>UNIVERSITY OF CALIFORNIA IRVINE</p> <p>By: Errol Arkilic, Chief Innovation Officer</p> <p><i>Arkilic Errol</i> <small>Arkilic Errol (May 14, 2025 10:36 PDT)</small></p> <hr/> <p>Signature</p> <p>Date: <u>05/14/2025</u></p>	<p>SOUTHERN CALIFORNIA GAS COMPANY</p> <p>By: Neil Navin, Senior Vice President, Chief Infrastructure Officer</p> <p><i>Neil Navin</i> <small>Neil Navin (May 14, 2025 09:32 PDT)</small></p> <hr/> <p>Signature</p> <p>Date: 05/14/2025</p> <p>Approved as to legal form: <i>ASC</i> <small>ASC (May 13, 2025 10:08 PDT)</small></p>
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05/13/2025

EXHIBIT A

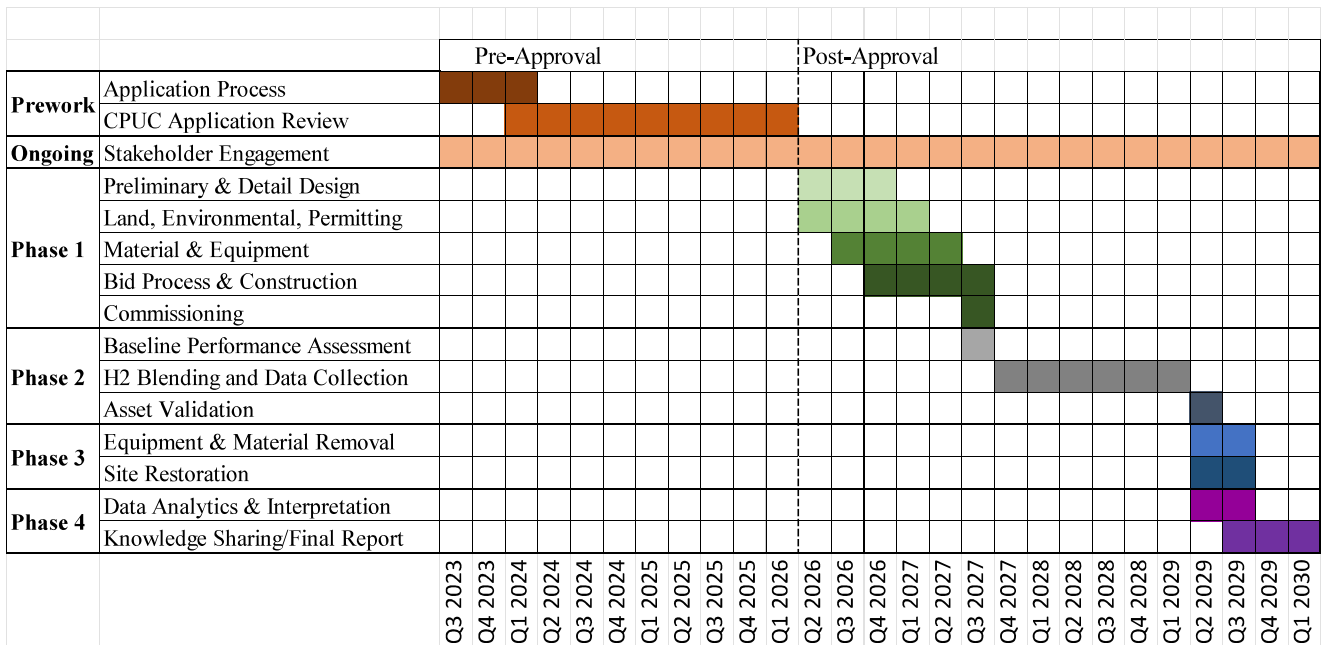
The purpose of the Project on the UCI campus is to specifically provide operational, live blending data for blending from 5% up to 20% hydrogen by volume in an isolated portion of a medium pressure steel and plastic distribution natural gas system. The Project will inform the feasibility of developing a state-wide hydrogen blending standard for steel and plastic pipe gas distribution systems that serve existing customers and equipment in the State of California.

The hydrogen production, storage, and blending equipment will be installed on a site east of California Avenue, just south of the service road behind UCI's Anteater Recreation Center (ARC), adjacent to the former farm school complex. The Project will ultimately serve blended fuel to UCI's ARC. The Project goal is to safely blend hydrogen into an isolated section of the medium pressure natural gas distribution pipeline system. The Project will begin by observing 100% natural gas in the pipeline system. Once that baseline is established, SoCalGas plans to blend and inject hydrogen into the system, starting at 5% hydrogen by volume and up to 20% hydrogen by volume over time. The blend volume will be gradually increased based on safety and technical feasibility validated with testing throughout the project duration, including evaluating key impacts on safety, odorant, pipes, valves, meters, and unmodified common appliances that will receive the blended gas.

The Project will be divided into four chronological phases ("Phases"). The Phases are briefly summarized in the table below; timing and duration of the Phases are estimated and subject to change. Phases have some overlap. See Estimated Project Schedule for details.

Phase & Activity	Description	Estimated Duration
0. Pre-development	All efforts supporting this Amended Application submittal are considered "Pre-development." Upon Commission approval, the project will move on to subsequent phases	Pre-application submittal
1. Design, Construction, and Commissioning	Hydrogen production and blending equipment is designed; detailed safety and feasibility analyses are performed. Stakeholder engagement will be conducted throughout the project's lifespan. Following design and feasibility, equipment is procured, constructed, and commissioned on campus; pre-demo equipment and pipeline system inspections and any necessary remediation are conducted	18 months
2. Demonstration and Data Collection	Hydrogen is blended in system on a data analysis schedule; data is collected; periodic inspection of equipment and pipelines; test	24 months (18 months live blending and 6 months asset)

	pipelines and components pre-, during, and post-hydrogen blend exposure	inspection and validation)
3. Decommissioning, Equipment Removal, and System Restoration	Hydrogen equipment is removed from campus, unless otherwise agreed upon with UC Irvine	6 months
4. Data Analysis and Dissemination	Data from pilot is analyzed and a public report will be released	9 months



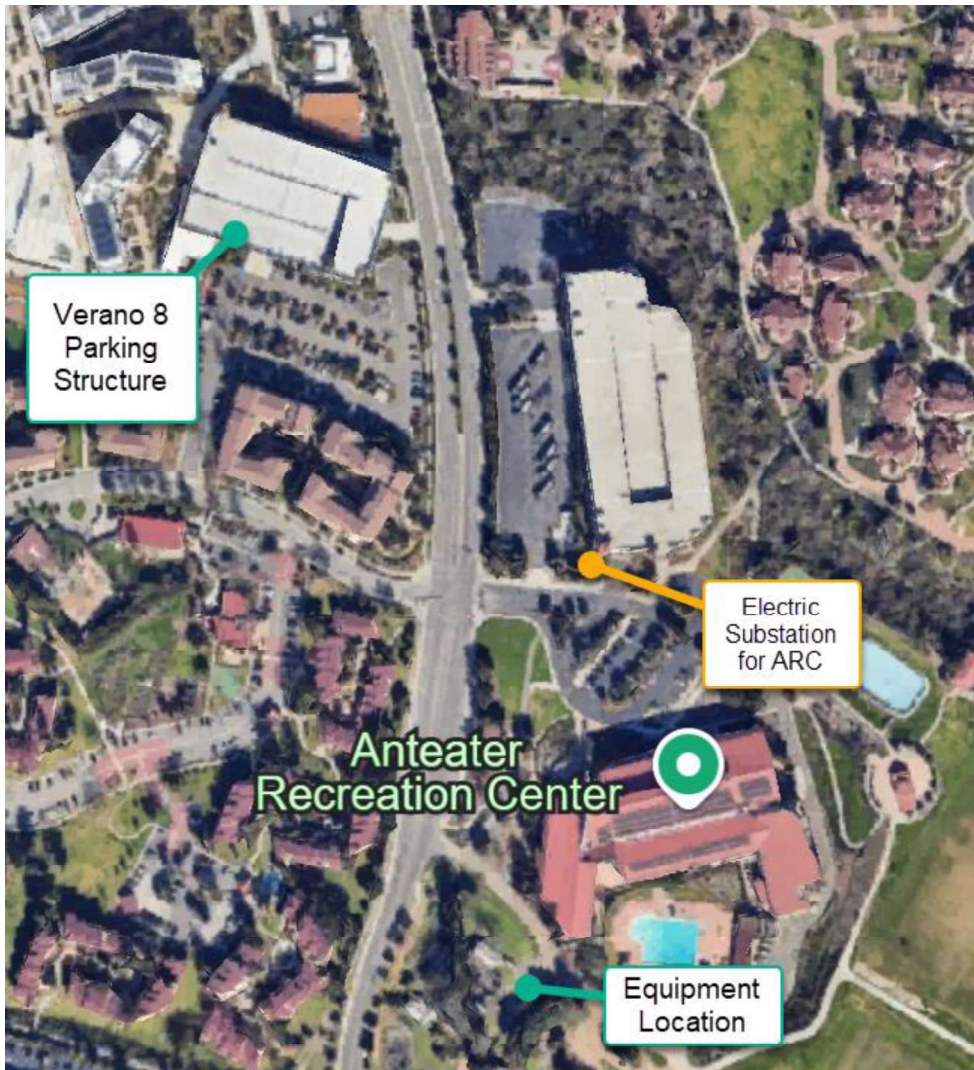
Figures 1 to 3 show the potential Project site layout, plot plan, and pipeline locations on the UCI campus.

Figure 1: Potential SoCalGas Hydrogen Blending Demonstration Site Layout on UCI campus



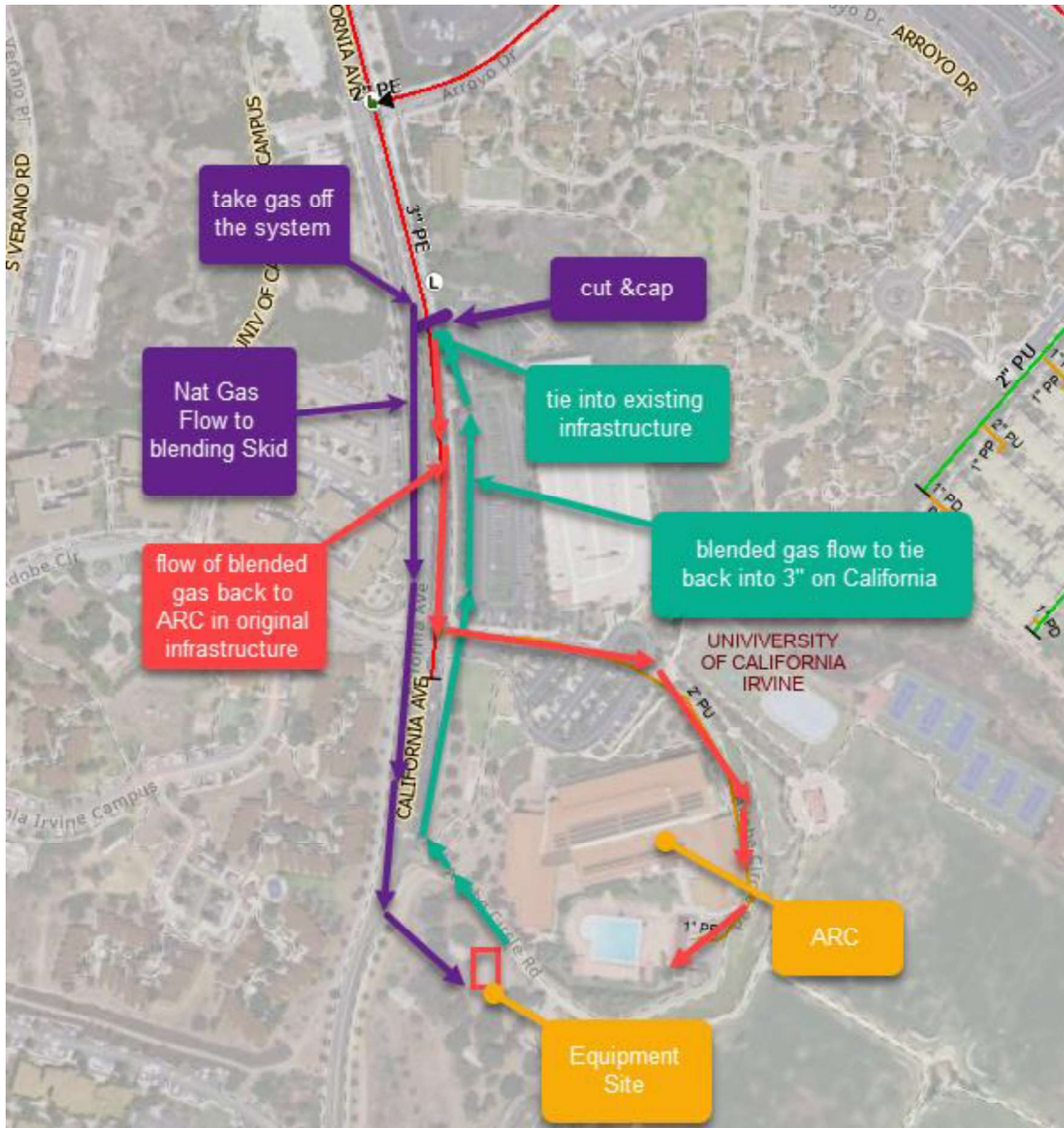
Equipment Type	Color
Electrolyzer	Green
SCADA Building	Orange
Storage Shed	Yellow
Bulk Hydrogen Storage (~ 150 kg)	Red
Chiller Unit	Purple
Gas Composition Analyzer	Brown
Blending Skid	Black
Hydrogen Compressor	Pink

Figure 2: Preliminary Solar Siting Proposal



An exact solar location is still being finalized; however, preliminary review indicates the Verano 8 parking structure as a suitable area for the solar installation. Approximately 150 kW of solar is being proposed to offset the energy needs of the electrolyzer to produce clean renewable hydrogen. Initial analysis indicates that there is adequate space to install a 150 kW solar array needed for hydrogen production from the proposed electrolyzer. Any solar installation will be connected to UCI's microgrid with the intended purpose of serving the electrolyzer, also to be located on UCI's microgrid.

Figure 3: Location of Pipelines Performing the Demonstration



One cut and cap location is on California Avenue, south of Arroyo Drive to isolate the line on California Avenue and ensure hydrogen blends only flow to UCI's ARC. While there is only one cut location, each side of the pipe will need a cap.