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PREPARED DIRECT TESTIMONY OF

MELANIE DAVIDSON AND POOYAN KABIR

ON BEHALF OF SAN DIEGO GAS AND ELECTRIC

(SDG&E'S HYDROGEN BLENDING DEMONSTRATION PROJECT)

BEFORE THE PUBLIC UTILITIES COMMISSION

OF THE STATE OF CALIFORNIA

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PREPARED DIRECT TESTIMONY OF MELANIE DAVIDSON AND POOYAN KABIR (SDG&E'S HYDROGEN BLENDING DEMONSTRATION PROJECT)

I. PURPOSE

The purpose of this chapter's testimony on behalf of San Diego Gas & Electric Company (SDG&E) is to provide the technical objectives, need, project implantation detail, and costs for the proposed SDG&E Hydrogen Blending Demonstration Project (Project). Testimony will focus on a description of the Project and how it will help inform a future statewide hydrogen injection standard and support Southern California Gas Company's (SoCalGas), SDG&E, and Southwest Gas Corporation's (Southwest Gas) (collectively, the Applicants) focus on safety, system integrity, and reliability. The Testimony will discuss (1) the Project's purpose, (2) how live blending operations and data collection plan will provide key technical, operational, and safety information to support a future hydrogen injection standard, (3) how SDG&E will collaborate with the University of California, San Diego (UCSD), the other investor-owned utilities (IOUs), and other relevant stakeholders to integrate data collected from the demonstration projects and prevent duplicative efforts, and (4) provide Project cost estimates.

The purpose of the Project is to provide operational as well as live blending and system performance data for blending up to 20% hydrogen gas by volume[1] in an isolated portion of a medium pressure[2] polyethylene (PE) distribution pipeline system in SDG&E's service territory. Project data will inform the feasibility of developing a hydrogen injection standard for newer gas PE pipe distribution systems that serve existing natural-gas powered appliances found in residential buildings and smaller commercial facilities common in our region and environment.[3]

Testing on the plastic pipeline system in SDG&E territory is necessary as this is the most common distribution piping material in SDG&E's system. At the end of 2021, SDG&E managed 3,520 miles of plastic distribution mains of 2" or less, which made up 57.5% of all

[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.
[3] *See* Weather Spark, *Climate and Average Weather Year Round in La Jolla*, *available at:* https://weatherspark.com/y/1809/Average-Weather-in-La-Jolla-California-United-States-Year-Round.

installed mains and 59.8% of all services of 2" or less. Of the plastic pipe in the system, 70% is State of the Art[4] PE and 30% Aldyl-A plastic.[5] The remainder of the system is steel.[6]

SDG&E is pleased to collaborate with UCSD, a leading university in the field of clean energy research and demonstration to conduct a hydrogen blending demonstration on campus.[7] The campus is the size of a small- to mid-sized city, with complex energy needs. In parallel to renewable electrification efforts, UCSD is exploring the potential of supplying all or most of the campus's electricity needs with renewable energy, such as renewable hydrogen. UCSD is a committed project host and one of the world's leading public research universities, whose campus already supports numerous clean energy projects and demonstrations as part of its commitment to being a "living lab."

The project will provide validation on a local system utilizing a strong base of previous analysis, testing, and field demonstration including comparable field testing performed in the United Kingdom.[8] Located on UCSD's campus, the Project will begin with an initial hydrogen blend level of 5% and increase to 20% through the testing period. The blend volume will be gradually increased based on safety and technical feasibility validated with testing throughout the project duration. This demonstration will provide valuable operational data that will support the development of a hydrogen injection standard for gas distribution systems and potentially for transmission systems.

II. BACKGROUND

In November 2020, the Joint Utilities filed Application (A.) 20-11-004 where they proposed a Hydrogen Blending Demonstration Program to be conducted by SoCalGas and SDG&E, consisting of three hydrogen blending projects on gas distribution and transmission pipeline systems. In July 2021, the Application was dismissed without prejudice due to the

[4] State of the Art PE pipe is plastic pipe that meets current industry standard and specification, ASTM D3350-21.
[5] Internal SDG&E GIS data, May 2022.
[6] U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration, Annual Report for Calendar Year 2021, Gas Distribution System; Prepared by James Dewberry for San Diego Gas and Electric. https://www.phmsa.dot.gov/data-and-statistics/pipeline/gas-distribution-gas-gathering-gas-transmission-hazardous-liquids
[7] Refer to Exhibit C for Memorandum of Understanding with UCSD.
[8] Pipeline Research Council International, *PR-720-20603-R01 Emerging Fuels - Hydrogen SOTA Gap Analysis and Future Project Roadmap, available at:* https://www.prci.org/Research/Measurement/MEASProjects/MEAS-15-02/178529/202786.aspx.

California Public Utilities Commission's (Commission or CPUC) concerns about, inter alia, duplicative efforts undertaken by the California Energy Commission's (CEC) funding solicitations and a blending study conducted by UC Riverside (UCR).

With this Application refiling, SDG&E proposes to conduct a "real world" demonstration project which will 1) implement demonstration recommendations set forth in the recently-published UCR study,[9] 2) model the United Kingdom's successful hydrogen blending trial at Keele University.[10] 3) demonstrate the integrity, durability, and safety of hydrogen integration into the distribution gas infrastructure in support of a hydrogen injection standard, and 4) guide the design of experiment for potential transmission scale demonstration.

A. UCR Hydrogen Blending Impacts Study

In July 2022, the CPUC published a study it sponsored titled "Hydrogen Blending Impacts Study"[11] that UCR prepared in collaboration with GTI Energy. The goal of the study was to determine the viability of blending hydrogen with natural gas in California's existing natural gas infrastructure based on existing information and targeted experimental and modeling work. Specific areas of investigation were maximum hydrogen blending percentage at which no or minor modification are required for existing natural gas infrastructure and end-use systems, potential modifications required at higher blending percentages, impact and safety aspects related to end-use appliances, degradation and durability of the existing pipeline system components (e.g., valves, fittings), leakage rates, natural gas storage, and cathodically protected pipelines. As an outcome of their findings, UCR recognized that a single, systemwide injection would have to consider the most susceptible conditions observed through all infrastructure components as well as end-uses, appliances, and industrial processes. The study further highlights "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". UCR also recommended that the utilities:

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[9] Miroslav Penchev, Taehoon Lim, Michael Todd, Oren Lever, Ernest Lever, Suveen Mathaudhu, Alfredo Martinez-Morales, and Arun S.K. Raju*. 2022. Hydrogen Blending Impacts Study Final Report. Agreement Number: 19NS1662.

[10] 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/.

[11] UCR, *Hydrogen Blending Impacts Study* (July 2022); *available at* https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M493/K760/493760600.PDF.

> Conduct demonstration of hydrogen blending in a section of the infrastructure that is isolated or is custom-built to include the commonly present materials, vintages, facilities, and equipment of the generic California natural gas infrastructure with appropriate maintenance, monitoring and safety protocols over extended periods. The recommended hydrogen percentages for this demonstration are 5 to 20%. Such demonstration projects will allow critical knowledge gaps to be filled, including the effect of parameters such as weather induced temperature changes, pressure cycling, length of exposure, effect of natural gas components and contaminants, and potential mitigation techniques.[12]

Additionally, these demonstration projects support the development of necessary policies and procedures towards adoption of a hydrogen injection standard.

Per these recommendations, the proposed Project will demonstrate hydrogen blends in the 5-20% range considering this is the range at which no major modifications are required to end-use equipment and not impacting safety and operation of end-use appliances.[13] Further, the Project will utilize state-of-the-art PE plastic pipeline commonly present within SDG&E natural gas infrastructure, monitor operations, conduct safety and leak surveys, and assess hydrogen tolerance levels and impact through sampling and analysis.

The UC Riverside study also recommends the following key activities in parallel:

- R&D (R&D Organizations Lead): address knowledge gaps and assess higher hydrogen percentages blending, mitigation strategies, support demonstration activity
- Planning (State Agencies Lead): develop inventories, update and develop specifications, safety/maintenance protocols, workforce development
- Engagement (State Agencies/Community Organizations Lead): understand priorities and concerns, outreach and consensus building

The Projects proposed by the Applicants will inform stakeholders of the critical technical and operational data that will support these parallel efforts. The Applicants also intend to collaborate with stakeholders on these recommended parallel efforts given the opportunity.

[12] *Id.* at 5

[13] 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/.

B. United Kingdom's HyDeploy University Hydrogen Blending Trial

A similar study has proven successful in the United Kingdom with The HyDeploy Keele University project that trialed blending up to 20% hydrogen in a private distribution gas system and fed 100 homes and 30 university buildings for 18 months. The project was completed in March 2021 and 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. The United Kingdom is planning a phase 2 that will blend hydrogen into a public distribution gas system.

Building on the success of the United Kingdom's HyDeploy hydrogen blending strategy and the knowledge gained, SDG&E proposes to conduct a similar pilot where hydrogen blends are introduced to an isolated portion of the medium pressure distribution gas system the UCSD campus. It is important to emphasize that although SDG&E can learn from the successful HyDeploy Keele University project, there is still a need to conduct a California-specific hydrogen blending pilot at a "typical" California location due to various regional and national differences in design, materials, and tolerances in pipeline systems and end-use equipment.[14] The operational data that will be collected and analyzed for the gas system and end use equipment in the proposed Project will help validate past hydrogen blending research, expand the body of knowledge, and ultimately inform and facilitate future hydrogen blending in California's wider distribution gas system and potentially the gas transmission system. SDG&E potentially anticipates a second demonstration phase to study the transmission gas system, leveraging lessons learned during this distribution system study.

III. PROJECT DESCRIPTION

The proposed Project location and design basis is identified in a Memorandum of Understanding (MOU) signed by UCSD and SDG&E as the One Miramar Street Graduate and Family Housing Apartments at UCSD's main campus in La Jolla, California. SDG&E will work with the campus to blend hydrogen into an isolated section of the medium pressure natural gas distribution pipeline system. Service is provided to four buildings with eight meters, comprising a total of 403 units. Only the meters on this isolated system will receive the 5% up to 20% hydrogen blend. The housing units are at full capacity year-round, and total gas demand for this

[14] For example, in the UK 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.

location has a seasonal fluctuation of less than 1.5 MSCFH per year between winter and summer demand. The pipe under investigation will be new, State of the Art PE pipe, which most accurately reflects the installed material currently approved for use in the SDG&E territory.

The Project will begin by observing 100% natural gas in the new pipeline system. Once that baseline is established, SDG&E plans to blend and inject electrolytic hydrogen produced onsite into the system, starting at 5% hydrogen by volume and up to 20% 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 pipes, valves, meters, as well as residential building equipment comprising hydronic heating boilers, domestic water heaters, outdoor gas grills, and dryers. Upon conclusion of the estimated 18-month testing period, all hydrogen-related equipment deployed for the testing program will be removed from the site and then the site will be restored. Only the upgraded PE pipe and one SDG&E meter will remain on campus.

The Project will be divided into four chronological phases with defined budgets for each phase. The Phases are briefly summarized in Table 1 and defined in detail in subsequent testimony.

Table 1. Summary of Project Phases*

PHASE & ACTIVITY	DESCRIPTION	ESTIMATED DURATION
1. Planning, Design, Construction and Commissioning	Hydrogen production and blending equipment is procured; system is designed, constructed, permitted, and commissioned on campus; PE pipe and meters are installed, inspections and any necessary remediation are conducted; stakeholder engagement commences.	18 months
2. Testing and Demonstration	Hydrogen is blended into the system on a testing schedule; data is collected; periodic inspection of equipment and pipelines; samples of pipelines and components are collected.	24 months (18 months live blending, + 6 months asset inspection & validation)

3. Decommissioning & Equipment Removal, and System Restoration	Hydrogen equipment is removed from campus and campus restored.	5 months
4. Knowledge Sharing	Data from pilot is interpreted and disseminated; a public report will be released.	9 months

*Project Phases have some overlap. See Estimated Project Schedule for Details.

Figure and 2 show the proposed Project site layout and plot plan on the UCSD campus. Refer to Exhibit D for additional Project details and visuals.

Figure 1: Proposed Blending Demonstration Site on UCSD's Campus

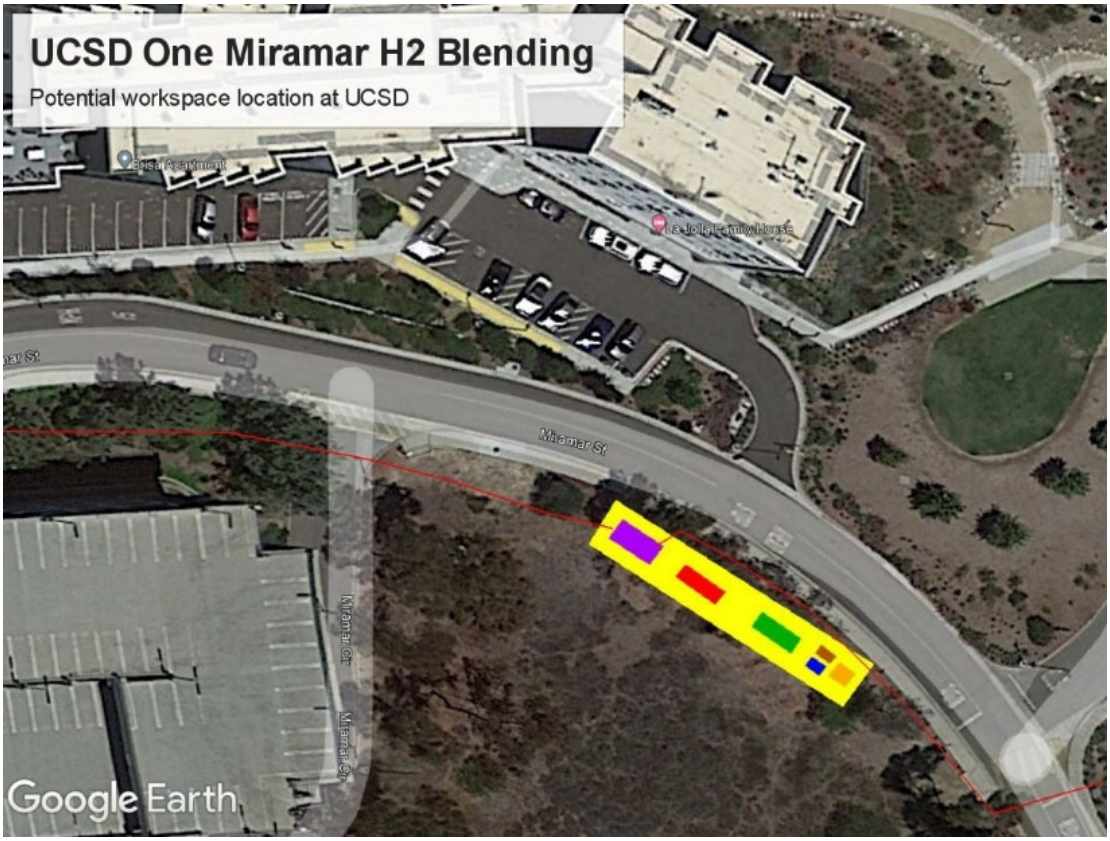
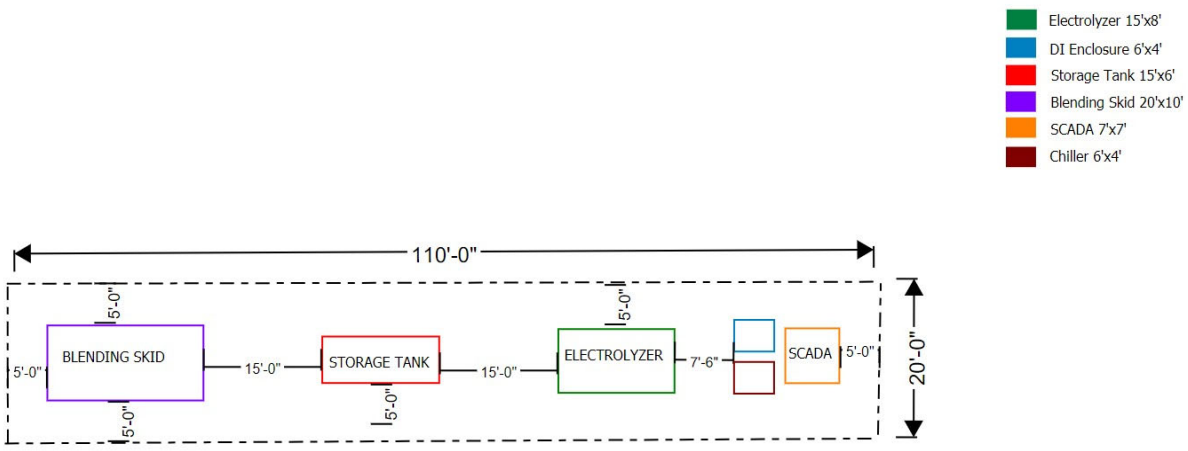


Figure 2: Preliminary Project Plot Plan



The Project aligns with recommendations from UCR's Hydrogen Blending Impacts Study. One of the key recommendations from the study is to "[conduct a demonstration] in a section of the infrastructure that is isolated or is custom-built to include the commonly present materials, vintages, facilities, and equipment of the generic California natural gas infrastructure with appropriate maintenance, monitoring and safety protocols over extended periods." The Project will follow UCR's recommendation and collect operational data utilizing commonly present PE that feeds typical residential and light commercial gas equipment found in California.

C. Phase 1: Planning, Design, Construction, and Commissioning

1. Planning

Site selection was made with input from UCSD Facilities and Real Estate personnel and considered the following:

- Pipe properties and operational history
- Ability to isolate from main network
- Constructability (adequate space)

- Time to survey pipeline system and load (pre-, during, and post-demonstration)
- Summer load and yearly load (sufficient flow to blend)
- Partner and local customer support
- Safety

A blending exception report under SoCalGas Rule No. 45[14] will accompany the Project. The report will follow the "Utility Evaluations" steps in the Renewable Gas Interconnection Tariff[15] and document the evaluation of the feasibility of blending and the safety assessment supporting blending percentages. The report will incorporate the following considerations:

- Flow rates and directional consistency of receiving pipeline(s), including daily and seasonal variations.
- Historical gas composition and gas quality specification at the chosen demonstration system and area of influence for purposes of determining impact on a British Thermal Unit (BTU) district.
- Current and expected future composition of natural gas in the pipeline system for the purpose of determining interchangeability on customers' end-use equipment and the pipeline system's future capability to accommodate supplies.
- Current and future customers in receiving pipeline flow rate, distance to these customers, time to first receiving customer, and anticipated downstream gas demand growth.
- Maximum time and distance required for complete mixing to occur under all pipeline flow conditions.
- The design, operation, and overall condition of the receiving pipeline(s), including any sensitivities to gas constituents.
- Additional monitoring, control, and/or mixing equipment that may be required to verify and ensure that adequate blending has occurred in the receiving pipeline system.

2. Design, Construction, and Commissioning

Phase 1 of the Project includes the overall design, procurement, construction and commissioning of key equipment. Most of the major related equipment is to be temporarily sited on campus, tested in Phase 2, and removed in Phase 3. Since the main purpose for the hydrogen

related equipment is to support a four-year research, development, and demonstration (RD&D) Project, much of the equipment is being treated as an Operations and Maintenance (O&M) expense. However, some of the major equipment in this study will have alternative use after Phase 2 and become a permanent part of the campus. Specifically, the installed PE pipe and main meter will be treated as capital expense. In the major equipment listed below, SDG&E indicates what shall be considered capital dollars versus O&M. The Project will include the following major equipment:

- **New PE Pipe (Capital):** The Project will entail installation of 500 ft of PE piping, between the blending skid and the UCSD meter, and between existing SDG&E PE pipe and the blending skid. SDG&E will begin the testing with brand new pipe. New, state-of-the-art PE meeting current industry standards and specifications (i.e., ASTM D3350-21) allows us to best observe and understand potential degradation issues. As PE is the preferred material for the future of the state's natural gas distribution systems and the system is already primed to transition to PE under the Commission's Gas Distribution Integrity Management Program (DIMP), it is sensible to test the effects of hydrogen on this material. Studies have indicated that for blending hydrogen up to 20% in a PE distribution system pipeline, the issues are well defined, understood, and the material is "capable of handling this blend."[15] Research to date indicates that hydrogen does not degrade PE pipes.[16, 17, 18]
- **New Meters (Capital and O&M):** The Project will collaborate with a yet-to-be-named meter manufacturer to design experiments to help understand the efficacy of existing versus new meters in accurately measuring gas usage with a hydrogen blend of up to

[15] Pipeline Research Council International (PRCI): "Emerging Fuels – Hydrogen SOTA, Gap Analysis, Future Project Roadmap." Catalog No. PR-720-20603-R01. November 9, 2020. Page 45.
[16] Daniel Krosch & Briony O'Shea, COAG Energy Council, Hydrogen in the Gas Distribution Networks: A kickstart project as an input into the development of a National Hydrogen Strategy for Australia (Jan. 11, 2019), available at: http://www.coagenergycouncil.gov.au/sites/prod.energycouncil/files/publications/documents/nhshydrogen-in-the-gas-distribution-networks-report-2019_0.pdf.
[17] Henrik Iskov & Stephan Kneck, Using the Natural Gas Network for Transporting Hydrogen – Ten Years of Experience, International Gas Union Research Conference (2017), available at https://www.dgc.dk/sites/default/files/filer/publikationer/C1703_IGRC2017_iskov.pdf.
[18] M.W. Melaina et al., National Renewable Energy Laboratory, Blending Hydrogen into Natural Gas Pipeline Networks: A Review of Key Issues (March 2013), available at https://www.nrel.gov/docs/fy13osti/51995.pdf.

20%. Meters use sensitive baffles to measure fluid flow, and there is a concern that baffles in older meters might not be sensitive enough to detect and respond to hydrogen molecules. One main meter will be installed servicing all buildings and remain in service after the project and treated as capital expense. Eight sub-meters will be installed, to be removed and evaluated after the project. These will be treated as O&M.

The rest of the equipment and expenses associated with the project will be treated as O&M because it is solely being utilized to support the short-term RD&D project. These materials may be warehoused and eventually repurposed to support other utility projects. However, given the time periods associated with the project and the fact that the equipment will not be available for other uses until 2026 or later, it is not feasible to determine their end use/alternative use at this time.

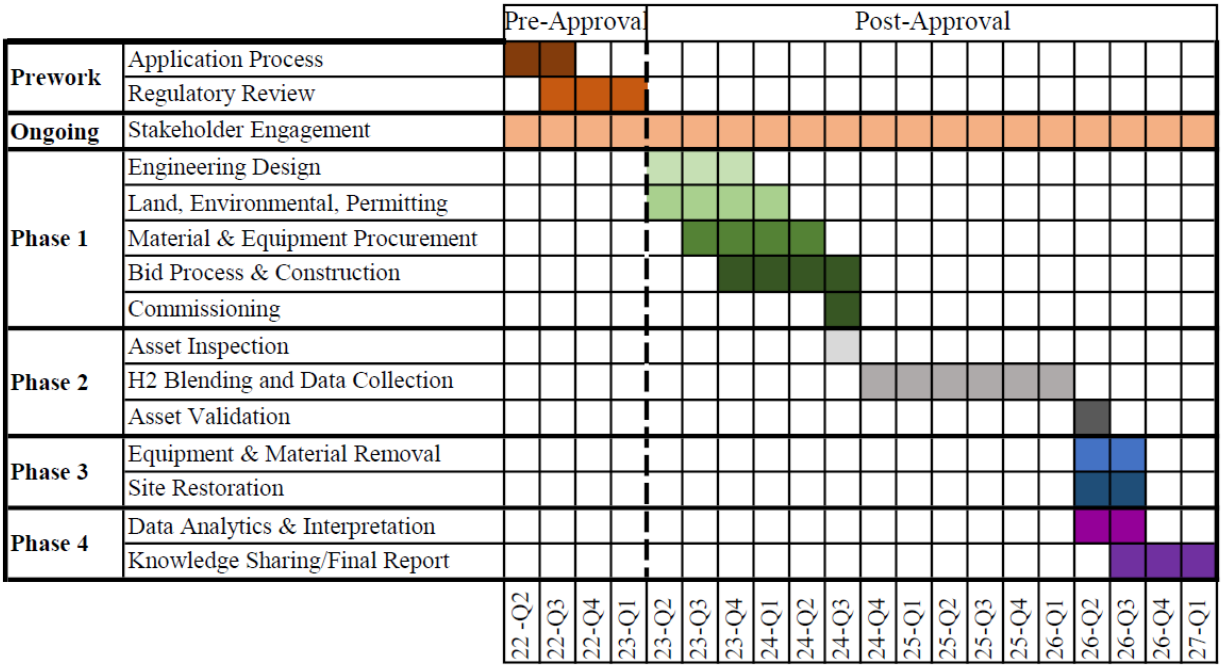
- **Electrolyzer (O&M):** Hydrogen used in this study will be produced onsite via a dedicated, grid-connected electrolyzer. Electrolyzers take inputs of water and electricity to create hydrogen gas. The electrolyzer will be sized for the purpose of blending up to 20% hydrogen gas in the isolated system. The electrolyzer will be utilized for the period of testing and demonstration. Estimated average daily electricity and water consumption is 963.9 kwh and 56.4 gallons, respectively. Additional equipment and instrumentation associated with the electrolyzer include the Supervisory Control and Data Acquisition (SCADA), chiller, de-ionizer (DI), gas analyzers, gas detectors, fire detectors, pressure transmitters, and temperature transmitters.
- **Hydrogen Blending Skid (O&M):** A hydrogen blending skid is required to blend natural gas with hydrogen. SDG&E is in dialogue with vendors who have built hydrogen blending injection skids. Commissioning blending skids for the demonstration projects will be key to learn about sizing and operation of these units that will likely be utilized for injection throughout the California system when a final hydrogen injection standard is created.
- **Storage Tank (O&M):** A compressed hydrogen pressure vessel will be on site to minimize target hydrogen blend level fluctuations over the duration of the demonstration.
- **Additional equipment (O&M):** Additional equipment may include pressure regulators, temperature transmitters, gas analyzers, gas detectors/leak detectors, fire detectors, control valves, relief valves, isolation valves, and pressure transmitters.

The project site will be isolated from the UCSD piping at the UCSD meter to prevent bleeding of blended gas into the rest of the system. SDG&E will install 240 ft. of new PE pipe to the blending skid to deliver natural gas, and an additional 260 ft. to deliver blended gas to UCSD meters. The blended gas pipe feeding into the UCSD meters will have valves, fittings, and common gas line equipment installed for testing purposes. The distribution system feeding the apartments owned by UCSD will be closely monitored by SDG&E during the time of operation.

3. Project Schedule

Table 2 provides an estimated project timeline; actual timeline and schedule will vary depending on the Applications regulatory process approval.

Table 2. Estimated Project Schedule



D. Phase 2: Testing and Demonstration

In Phase 2, equipment for blending will be in place and testing and demonstration of hydrogen from 5% blend up to 20% blend by volume will be tested and demonstrated. Phase 2 will be broken into three subphases: (a) Asset Inspection, (b) Live Hydrogen Blending, Data Collection, & Analysis, and once the test is complete, (c) Asset Validation.

1. Asset Inspection

SDG&E will conduct an asset inspection, which includes a tabletop review of all materials in the selected systems followed by detailed validation in the field. All customer appliances in common areas of the proposed location will be catalogued and inspected. In the unlikely event that modifications are required to be made to residential equipment, these will be completed prior to injecting hydrogen. Asset inspections will also include detailed surveys of the pipelines and appurtenances. Any pipeline related material repair or replacement needed will be completed prior to injecting hydrogen. Leak surveys will also be conducted prior to the demonstration and continue throughout the Project.

2. Live Hydrogen Blending, Data Collection, & Analysis

The project will follow the American Petroleum Institute's Recommended Practice 1173 (API RP 1173) Pipeline Safety Management System (PSMS) Plan-Do-Check-Act model. The PSMS system framework provides guidance to: (1) translate laboratory research and literature review into actual system operations and cover as many aspects of the technical considerations as possible; (2) confirm understanding of material response, end use/appliance response, load balancing and blend consistency; and (3) establish protocol for leak detection of the new gas composition (should it occur).The Project site will allow for these objectives to be achieved physically and operationally. More detail on this model can be found in the Project Guidance Section of this Chapter.

Operational needs include training, additional leak surveying, gas handling, customer service, routine service operations and customer interactions, proactive stakeholder engagement, and emergency response plans. Monitoring during demonstrations will include both system monitoring as well as collecting feedback from customers.

The PSMS "Check: Analysis of Data" step will analyze quantitative and qualitative data and will include an analysis of knowledge gained from any operational changes. Such analysis will inform SDG&E's recommendations for a statewide hydrogen injection standard. Many of the items below have been assessed through literature review, laboratory testing, and/or vendor surveying. The Project will allow for operational review and confirmation of the following within the limitations of the proposed Project site:

- Odorant compatibility
- Leak detection equipment compatibility

- Material compatibility (or determine need for material replacement)
- Component (e.g., fittings, valves) compatibility (or determine need for component replacement)
- Long-term integrity modeling
- Blend consistency (hydrogen blending injection skid)
- End use customer feedback
- End-use customer appliance compatibility
- Development of new Gas Standards for the construction, maintenance and operations of hydrogen blended natural gas system
- Effects on metering, and the effect on customers' energy use and billing
- Impact on emissions associated with hydrogen blending, including NO_x

Error! Reference source not found. provides an overview of the type of data that SDG&E will collect with the Project. Each data element serves to validate past hydrogen blending research. Data will be collected prior to, during, and after the Project. The data will be analyzed to provide insights to confirm hydrogen blending compatibility of the gas system and end-use equipment.

Table 2: Project 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	Validate performance of new leak survey equipment	Monthly, and as needed for customer service calls		✓	

Samples of pipe/pipeline components (Material Compatibility)	Verify if there are any material impacts (polyethylene piping, elastomers, rubbers, gaskets, valves, fittings, regulators) after exposure to hydrogen blends	Prior to demo and post-demo	✓		✓
Blending skid operation	Validate design, load balancing, and blend consistency	Continuous		✓	
Customer feedback	Validate customer equipment operation/response	Monthly		✓	✓
Gas usage	Monitor and analyze demand changes to forecast potential future supply needs	Monthly		✓	
Customer meters	Compare data from customer meters and blending skid data to confirm accuracy and performance of meters	Monthly		✓	✓
Customer equipment evaluation	Ensure equipment is working properly; validate gas interchangeability calculations and lab testing that has been done	Monthly, and as needed for customer service calls	✓	✓	✓
Customer equipment checks for emissions, including NO_x	Perform measurement on emissions from hot water and space heaters	To be determined	✓	✓	

Table 4 summarizes the incremental hydrogen blending level increase schedule. Please note that the actual blend percentage will depend on available hydrogen production and usage demand (i.e., if there is increased gas usage due to abnormally cold weather, the actual blend percentage may be lower than the target). This blending schedule aligns with recommendations from UCR's Hydrogen Blending Impacts Study. Per the study, "it is critical to conduct real world demonstration of hydrogen blending under safe and controlled conditions. The

recommended hydrogen percentages for this demonstration are 5 to 20%." Data collection will start with a target blend level of 5% and gradually go up to 20%. 6 months of data will be collected for the lower blends (up to 10%), and 12 months of data will be collected for the higher blends (10 to 20%).

Table 3: Estimated Blending Intervals by Increments

% Blending Level	Timeframe
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

3. Asset Validation

Asset validation includes the following post-hydrogen blending activities:

- Leak surveys of the pipeline system to verify no additional leaks have developed.
- Gathering of pipe and component samples to test and compare with pre-demo samples to evaluate if there are any material changes after exposure to hydrogen blends.
- End use equipment checks to ensure equipment continues to work properly.
- Minimum of two meters will be removed for mechanical integrity testing.

4. Billing Impacts

Since hydrogen will lower the heating value of the gas supplied to UCSD, SDG&E plans to apply retroactive volumetric adjustments to affected gas bills to ensure that ratepayers are being accurately charged based on them usage. SDG&E intends to address this directly with UCSD during project implementation.

5. Project Updates

While the demonstration is in progress, SDG&E will provide periodic status updates on the project. Depending on the data available, potentially enough information will be collected to support an interim preliminary hydrogen blending standard for the distribution system. The Applicants will share information on this potential interim standard with the CPUC as it becomes available.

E. Phase 3: Decommissioning, Equipment Removal, and Restoration

Phase 3 of the Project will commence at the conclusion of the Testing and Demonstration period. In Phase 3, all hydrogen-related equipment considered O&M will be removed from the site following completion of the Project. New PE pipe installed and one new main SDG&E site meter will be capitalized and remain onsite and in use for the respective lifetimes of that assets, considering they have alternative use in serving and metering 100% natural gas service to Miramar One Apartments.

Removed hydrogen-related equipment will be warehoused and efforts will be made to redeploy these assets for other RD&D utility purposes. Samples of pipelines and components will be collected during this period. SDG&E will also restore the pre-existing gas service to the effected buildings and will restore and remediate the site where the hydrogen equipment was temporarily located as per terms and conditions to be developed with UCSD.

F. Phase 4: Knowledge Sharing

After the completion of the demonstration, all the data collected will be analyzed to guide any operations and maintenance updates needed for hydrogen blending and to support a future hydrogen injection standard in the California gas system. A report will be published and made available to the general public. This report will be published in collaboration with the Applicants to integrate data collected from the demonstration projects to inform a future California hydrogen injection standard. A public workshop will be held to share project knowledge. As California is widely understood to be a leader in national energy policy, SDG&E anticipates significant and broad interest in the results of this pilot.

It is anticipated that the lessons learned from the Project will guide the development and execution of a potential transmission hydrogen blending demonstration project. Given that this is SDG&E's first distribution hydrogen blending demonstration project, the operational experience gained and processes established will facilitate the planning of a potential subsequent transmission system demonstration project and potentially expedite the project schedule.

IV. PROJECT GUIDANCE

A. API RP 1173 Pipeline Safety Management System

Safety is at the core of this overall Application, of paramount importance at SDG&E, and at the forefront of the Project. The Project utilizes the American Petroleum Institute's (API) 1173

Pipeline Safety Management System (PSMS) Plan-Do-Check-Act model.[19] SDG&E is currently in the "Plan" stage. The Project will move into the "Do" stage by initiating the controlled blending project that has been informed by the Plan stage. Leading up to and during this stage SDG&E will be establishing operational controls, training to operate with hydrogen blends, documenting and recording data from the demonstration, and engaging with stakeholders, including the communities and end users. The Project leads into the "Check" phase where SDG&E will learn from the data collected, including utilizing the data for an integrity/risk management analysis. The "Act" phase will be updating the hydrogen injection standard to allow for blended hydrogen in the distribution system more broadly, up to 20% hydrogen. SDG&E will translate the knowledge gained from the Project to safety policies and mitigations for the rest of our natural gas distribution system and customer installed equipment. Plan-Do-Check-Act is a continuous loop, and SDG&E intends to expand risk modeling, revise standards, policies, and procedures to safely blend hydrogen, and consider future larger scale demonstrations.

B. Overarching Safety Case

SDG&E's safety efforts to be taken before, during, and after the Project include, but are not limited to:

- Hydrogen Safety Training for SDG&E personnel and relevant USCD campus personnel
- Safety Assessment for hydrogen storage.
- Survey end use customer equipment to confirm behind-the-meter equipment present
- Conduct pre-, during, and post-implementation leak surveys.
- Create hydrogen blending specific customer protocols and emergency response plans.
- Conduct gas system operational and equipment tests (e.g., customer appliance leak, customer appliance flame-out, or pilot light failure), meter replacements, and other operational activities that occur in a natural gas distribution system.
- Test existing and new leak survey equipment.
- Conduct Asset (equipment) inspection pre- and during testing and validation at the conclusion of demonstration period

[19] https://flipflashpages.uniflip.com/3/94156/1106646/pub/html5.html#page/1

C. Stakeholder Engagement & Reporting

Education and outreach are critical, ongoing components of the Project and will affect a range of stakeholder groups from various internal organizations to external organizations, including the Commission, UCSD staff and students, campus residents, the cities of San Diego and La Jolla, San Diego County, various state agencies, and legislators. Hydrogen has the potential to play an important role in California's efforts to achieve carbon neutrality, and stakeholders, including utility personnel, customers, regulators and policymakers, and the community, need to understand how blended hydrogen can be utilized safely and reliably.

As such, SDG&E intends to work with UCSD, which can conduct publishable research to develop best practices for survey design and public outreach to understand how to best affect behavioral and attitudinal outcomes to changing energy technologies. Education, outreach, and survey materials will be coordinated in conjunction with the university throughout all Project Phases to ensure communications are timely, meaningful, and address concerns.

SDG&E and SoCalGas can partner on development of key educational resources to inform on the purpose and details of the blending project. These materials can include, for example, co-development materials featuring previous hydrogen blending research and demonstration to date, such as the SoCalGas hydrogen house and Situation City testing sites. Resources to be developed may include public webinars, public forums, short videos, and literature for communities affected by the pilot. Phase 4 of the project focuses on knowledge sharing the learnings and results of the Project and is described previously.

As part of the ongoing Project, periodic reports with status updates shall be provided to the Commission.

V. COST ESTIMATES

An Unloaded Direct Cost estimate is provided in Table 5. The unloaded direct cost includes all anticipated expenses, with contingency, for the entirety of the Project. The Project costs are based on a Level 5 estimate and shown in 2022 dollars. Please see WP-2 for the detailed breakdown of Project cost estimates by phase. Details on loaded direct costs and revenue requirements are described in Chapter 6, Direct Testimony of Eric Dalton, Jack M. Guidi, and Marjorie Schmidt-Pines.

Table 5: Project Cost Estimates, in US Dollars

Table 5: Total Capital and O&M ($M)				
	2023	2024	2025-2027	Total
Capital	0.05	0.26	0.01	0.32
O&M	2.87	6.75	2.24	11.86
Total	2.92	7.01	2.25	12.18

VI. CONCLUSION

This Project will inform the Joint Utilities and the State on the design, technical, material, training, maintenance, operational, and educational requirements needed to support a safe injection and blending standard up to 20% hydrogen for plastic distribution gas systems to transport natural gas/hydrogen blends. As a clean energy leader, California has an important role to play in validating all the tools in our decarbonization toolkit, including hydrogen for blending in the existing natural gas system. SDG&E is looking forward to partnering with UCSD and the Applicants to better understand hydrogen injection and blending, which we believe could play a key role in supporting California to achieve its decarbonization goals.

This concludes our prepared direct testimony.

VII. QUALIFICATIONS

Melanie Davidson

My name is Melanie Davidson and I have been the Hydrogen Commercial Development Manager at SDG&E since August 2021. I hold a Bachelor of Science degree in Mechanical Engineering from Rutgers University, a Bachelor of Arts degree in Political Science from Tulane University, and a Master of Business Administration from the University of California, Berkeley, Haas School of Business. Before joining SDG&E, I was employed as Senior Director by Strategen Consulting in April 2018, where I served clients such as the Green Hydrogen Coalition and the California Energy Storage Alliance. Prior to that, I have held commercial and engineering positions at Proterra, Commercial Energy of California, and five years with the former Clean Technologies business unit at DuPont, now Elessent Clean Technologies. This is my first time appearing before the Commission.

Pooyan Kabir

My name is Pooyan Kabir and I have been the Senior Hydrogen Engineer at SDG&E since August 2021. I hold a Bachelor of Science degree in Structural Engineering from the University of Tehran, a Master of Science in Materials from Texas A&M University, and a PhD from University of Illinois at Urbana-Champaign in Structural Mechanics. Before joining SDG&E, I was employed as an Engineer at McDermott International, a multinational Engineering Procurement Construction company, where I worked on storage vessels for different mediums, including hydrogen, LNG, and water. This is my first time appearing before the Commission.