

## Hydrogen Blending at UCSD Plan Workpaper Supporting Chapter 3

### Joint IOU Hydrogen Blending Demonstration Application

#### **Explanation of Work Paper**

This work paper (WP-2) includes all Level 5 cost estimates to support the SDG&E Hydrogen Blending Demonstration Project (Project) at the University of California, San Diego (UCSD). For information on Loaded Costs and revenue requirements, see Chapter 6 testimony.

Table 1 summarizes the Capital and O&M costs related to the project. Tables 2 to 5 reflect the costs by Project Phase, as laid out in Chapter 3 testimony. Detailed cost estimates and assumptions to support the work paper are provided in WP-2 Appendix A and WP-2 Appendix B.

**Table 1: Project Cost Estimates, (\$M)**

Table 1: 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

#### **Cost Mechanism Justification**

The Project at UCSD is designed to be a temporary project. Once the Project is planned, designed, constructed and commissioned, SDG&E will test various hydrogen blends over the course of approximately 18 months on UCSD's campus. At the conclusion of the testing, the majority of the equipment will be removed. The short-term nature of the Project planned at UCSD makes it unusual compared to most utility activities and is closer to a Research and Development (R&D) program than a typical capital project. For this reason, the majority of the equipment costs and related direct labor are being treated as O&M. Equipment and labor associated with installation of polyethylene (PE) pipe and an SDG&E meter is treated as capital cost to remain in use after the Project period.

#### **Project Description**

The Project has been designed to be located at the One Miramar Graduate and Family Housing Complex at UCSD's main campus in La Jolla, California, and to blend hydrogen into an isolated section of the medium pressure<sup>4</sup> natural gas distribution pipeline system. The pipe will be new, state of the art PE pipe and all hydrogen related equipment will be procured and deployed on site. 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% H<sub>2</sub> by volume<sup>5</sup> 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, and unmodified common appliances that will receive the blended gas, such as residential building equipment comprising hydronic heating boilers, domestic water heaters, outdoor gas grills, and dryers. There are no gas stoves on this distribution system. 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 the site shall be restored. Only the polyethylene pipe and upgraded meter on

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the distribution pipeline will remain on campus. Periodic progress reports will be provided to the Commission. A final report will be prepared and publicly disseminated to share the results and findings of the study.

#### ***Project Plan***

PHASE & ACTIVITY	DESCRIPTION	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

#### **Forecast Methodology (Construction Costs and Labor)**

SDG&E's methodology for forecasting costs is discussed in the Direct Testimony of Melanie Davidson and Pooyan Kabir (Chapter 3). SDG&E used a Level 5 Estimate for Total Installed Cost (TIC) estimate to implement the scope of work in Phases 1 & 3. The TIC Estimate includes direct costs associated with project management, engineering and design, environmental permitting, land acquisition, material and equipment procurement, and construction. For programmatic and RD&D related expenses in Phases 2 & 4, the forecast method developed for this cost category is zero-based. This method is most appropriate because RD&D needs and activities will evolve with the project and this is a new type of project with new technologies.

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At the time of cost estimate preparation, this project stage was in preliminary site layout design level and scope. Further development of this project could reveal new information requiring some adjustments to the project plan in the areas such as engineering, materials, permitting, environmental and land, staffing, and customer engagement, all of which could impact actual costs compared this cost estimate. An average 25% contingency has been placed on all costs.

### Schedule

Implementation of this project is proposed to be completed consistent with the overall prioritization and timing described in Chapter 3 testimony. The key project deliverables were identified and incorporated into a work breakdown structure. This work breakdown structure was then sequenced, and predecessor and successor tasks were linked to each task. Durations were added to each task to provide a total project duration.

### PHASE 1 COSTS

Table 2: Phase 1 Capital and O&M (\$M)				
Phase 1	2023	2024	2025-2027	Total
Capital	0.05	0.26	0.01	0.32
O&M	2.87	6.58	0.08	9.52
Total	2.92	6.84	0.09	9.84

### Phase 1 Assumptions

Refer to WP-2 Appendix A for detailed list of assumptions used to develop Phase 1 estimates.

### PHASE 2 COSTS

Table 3: Phase 2 Capital and O&M (\$M)				
Phase 2	2023	2024	2025-2027	Total
Capital	0.00	0.00	0.00	0.00
O&M	0.00	0.17	0.52	0.69
Total	0.00	0.17	0.52	0.69

### Phase 2 Assumptions

The following assumptions were made to develop this cost estimate:

- Class 5 Estimate (- 50% / +100%)

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- Monthly odorant sampling and analysis
- Monthly leak surveys and leak detection equipment evaluation
- Monthly customer equipment checks
- Quarterly maintenance of major equipment (blending skid and electrolyzer)
- Pre-hydrogen blend exposure and post-hydrogen blend exposure pipeline sampling and analysis
- Customer Field Service (Customer Equipment Checks, Leak Surveys, Odorant Sampling and Data Analysis)
- Program management
- 25% contingency in alignment with Class 5 estimates is included

### PHASE 3 COSTS

Phase 3	2023	2024	2025-2027	Total
Capital	0.0	0.0	0.0	0.0
O&M	0.0	0.0	1.26	1.26
Total	0.0	0.0	1.26	1.26

### Phase 3 Assumptions

Refer to WP-2 Appendix A for detailed list of assumptions used to develop Phase 3 estimates.

### PHASE 4 COSTS

Phase 4	2023	2024	2025-2027	Total
Capital	0.0	0.0	0.0	0.0
O&M	0.0	0.0	0.39	0.39
Total	0.0	0.0	0.39	0.39

### Phase 4 Assumptions

The following assumptions were made to develop this cost estimate:

- Class 5 Estimate (- 50% / +100%)
- An engineering and data team of 6, each employee working 15 hours per week for 27 weeks
- A management team of 2, each employee working 10 hours per week for 27 weeks
- 25% contingency in alignment with Class 5 estimates is included

**Workpaper Supporting  
Direct Testimony of Melanie Davidson and Pooyan Kabir  
(WP-2)**

**Appendix A**

WDA Estimate Sheet  
 ODC 1  
 ODC 1E  
 OM 3  
 OM 4  
 OM 5  
 PM 6  
 CL 2M  
 CL 2U  
 CL 2PA  
 S 6D  
 S 6P  
 S 6CM  
 S 6S  
 S 6E  
 S 6H  
 S 19W  
 S 6X  
 S 6LS  
 S 6C  
 S 6C  
 S 6M  
 S 6PA  
 Perm 7  
 ODC 8

UCSD Hydrogen Blending Installation Phase 1									
Class 5 - Estimate									
Accuracy Range: - 50% / +100%									
PROJECT SUMMARY									
Construction Summary Description	Bare Total		Contingency	Total Cost	Basis	% of Direct Costs			
Mechanical Contractor	\$ 2,178,292		25%	\$ 544,573	\$ 2,722,864	See "Estimate" Tab	28%		
Electrical Contractor	\$ 500,000		25%	\$ 125,000	\$ 625,000	Historical	6%		
Material- Pipe & Fittings	\$ 13,713		25%	\$ 3,428	\$ 17,142	See "Estimate" Tab	0%		
Material- Valves	\$ 40,430		25%	\$ 10,108	\$ 50,538	See "Estimate" Tab	1%		
Material- Other	\$ 2,152,411		25%	\$ 538,103	\$ 2,690,514	See "Estimate" Tab	27%		
Pipeline & Meter Install (CAP EX)	\$ 166,676		25%	\$ 41,669	\$ 208,345	See "Estimate" Tab	2%		
<b>Sub-Total Construction and Materials</b>	<b>\$ 5,051,522</b>			<b>\$ 1,262,880</b>	<b>\$ 6,314,402</b>		<b>64%</b>		
Planning Summary Description	Bare Total	% Factor	Override	Contingency	Total Cost	Basis	% of DC - Hydrogen Supply		
SCG Labor - Mgmt & Non Labor	\$ 202,061	4.0%		25%	\$ 50,515	\$ 252,576	Historical %	3%	
SCG Labor - Union T/H	\$ 101,030	2.0%		25%	\$ 25,258	\$ 126,288	Historical %	1%	
SCG Labor - Outreach & Public Affairs	\$ 95,000	5.0%	\$ 95,000	20%	\$ 19,000	\$ 114,000	Less complexity factored based off project of similar size and scope	1%	
Engineering / Design Services	\$ 1,467,000	0.0%	\$ 1,467,000	25%	\$ 366,750	\$ 1,833,750	Based off project of similar scope	19%	
PM / Project Services	\$ 202,061	4.0%		25%	\$ 50,515	\$ 252,576	Historical %	3%	
Construction Management / Inspection	\$ 353,607	7.0%		25%	\$ 88,402	\$ 442,009	Historical %	4%	
Surveying / As-builts	\$ 101,030	2.0%		25%	\$ 25,258	\$ 126,288	Historical %	1%	
Environmental Services	\$ 25,258	0.5%		25%	\$ 6,314	\$ 31,572	Historical %	0%	
Pressure Test Certification Services	\$ 50,515	1.0%		25%	\$ 12,629	\$ 63,144	Historical %	1%	
Water Storage	\$ -	0.0%		25%	\$ -	\$ -	Historical %	0%	
Weld X-Ray / NDE	\$ 50,515	1.0%		25%	\$ 12,629	\$ 63,144	Historical %	1%	
Land Services	\$ 56,666	1.0%	\$ 56,666	15%	\$ 8,500	\$ 65,166	Based off project of similar scope	1%	
ONG / LNG	\$ -	0.0%		25%	\$ -	\$ -	Historical %	0%	
Gas Capture / Cross Compression	\$ -	0.0%		25%	\$ -	\$ -	Historical %	0%	
Miscellaneous Services	\$ 25,258	0.5%		25%	\$ 6,314	\$ 31,572	Historical %	0%	
Outreach & Public Affairs	\$ 60,000	0.0%	\$ 60,000	20%	\$ 12,000	\$ 72,000	Less complexity factored based off project of similar size and scope	1%	
Permits	\$ 25,258	0.5%		25%	\$ 6,314	\$ 31,572	Historical %	0%	
Other Non-Labor Costs	\$ 19,905	5.0%	\$ 19,905	25%	\$ 4,976	\$ 24,881	5% of SCG labor	0%	
<b>Total Direct Estimated Cost (No Loaders)</b>	<b>\$ 7,866,684</b>			<b>24.83%</b>	<b>\$ 1,958,295</b>	<b>\$ 9,844,959</b>			

UCSD Hydrogen Blending Decommission Phase 3									
Class 5 - Estimate									
Accuracy Range: - 50% / +100%									
PROJECT SUMMARY									
Construction Summary Description	Bare Total		Contingency	Total Cost	Basis	% of Direct Costs			
Mechanical Contractor	\$ 648,085		25%	\$ 162,021	\$ 810,107	See "Estimate" Tab	64%		
Electrical Contractor	\$ 31,200		25%	\$ 7,800	\$ 39,000	See "Estimate" Tab	3%		
Material- Pipe & Fittings	\$ 10,189		25%	\$ 2,547	\$ 12,736	See "Estimate" Tab	1%		
Material- Valves	\$ -		0%	\$ -	\$ -	N/A	0%		
Material- Other	\$ 1,375		25%	\$ 344	\$ 1,719	See "Estimate" Tab	0%		
Pipeline & Meter Install (CAP EX)	\$ -		0%	\$ -	\$ -	N/A	0%		
<b>Sub-Total Construction and Materials</b>	<b>\$ 690,850</b>			<b>\$ 172,712</b>	<b>\$ 863,562</b>		<b>69%</b>		
Planning Summary Description	Bare Total	% Factor	Override	Contingency	Total Cost	Basis	% of DC - Hydrogen Supply		
SCG Labor - Mgmt & Non Labor	\$ 69,085	10.0%		25%	\$ 17,271	\$ 86,356	% of Subtotal Construction and Materials	7%	
SCG Labor - Union T/H	\$ 13,817	2.0%		25%	\$ 3,454	\$ 17,271	% of Subtotal Construction and Materials	1%	
SCG Labor - Outreach & Public Affairs	\$ 20,725	3.0%		25%	\$ 5,181	\$ 25,907	% of Subtotal Construction and Materials	2%	
Engineering / Design Services	\$ 34,542	5.0%		25%	\$ 8,636	\$ 43,178	% of Subtotal Construction and Materials	3%	
PM / Project Services	\$ 27,634	4.0%		25%	\$ 6,908	\$ 34,542	% of Subtotal Construction and Materials	3%	
Construction Management / Inspection	\$ 20,725	3.0%		25%	\$ 5,181	\$ 25,907	% of Subtotal Construction and Materials	2%	
Surveying / As-builts	\$ 13,817	2.0%		25%	\$ 3,454	\$ 17,271	% of Subtotal Construction and Materials	1%	
Environmental Services	\$ 6,908	1.0%		25%	\$ 1,727	\$ 8,636	% of Subtotal Construction and Materials	1%	
Pressure Test Certification Services	\$ -	0.0%		25%	\$ -	\$ -	N/A	0%	
Water Storage	\$ -	0.0%		25%	\$ -	\$ -	N/A	0%	
Weld X-Ray / NDE	\$ -	0.0%		25%	\$ -	\$ -	N/A	0%	
Land Services	\$ 62,176	9.0%		25%	\$ 15,544	\$ 77,721	Assumed Storage fee for one year	6%	
ONG / LNG	\$ -	0.0%		25%	\$ -	\$ -	N/A	0%	
Gas Capture / Cross Compression	\$ 13,817	2.0%		25%	\$ 3,454	\$ 17,271	Assumed Isolation	1%	
Miscellaneous Services	\$ 3,454	0.5%		25%	\$ 864	\$ 4,318	% of Subtotal Construction and Materials	0%	
Outreach & Public Affairs	\$ 20,725	3.0%		25%	\$ 5,181	\$ 25,907	% of Subtotal Construction and Materials	2%	
Permits	\$ 3,454	0.5%		25%	\$ 864	\$ 4,318	% of Subtotal Construction and Materials	0%	
Other Non-Labor Costs	\$ 5,181	5.0%	\$ 5,181	25%	\$ 1,295	\$ 6,477	5% of SCG labor	1%	
<b>Total Direct Estimated Cost (No Loaders)</b>	<b>\$ 1,006,913</b>			<b>25.00%</b>	<b>\$ 251,728</b>	<b>\$ 1,258,642</b>			

UCSD Hydrogen Blending Installation Phase 1

WO#  
WR#

Total Sheet

ELEMENTS OF ESTIMATED COSTS	TOTAL PLANT	TOTAL ABD.	TOTAL O&M	TOTAL EST. COSTS
Miles	0.00	0.00	0.00	
LENGTH OF PIPE (in feet)	-			
CONTRACT COSTS	\$ -	\$ -	\$ 3,347,864	\$ 3,347,864
COMPANY LABOR	\$ 16,262	\$ -	\$ 476,602	\$ 492,864
<b>TOTAL COMPANY LABOR &amp; CONTRACT COST</b>	<b>\$ 16,262</b>	<b>\$ -</b>	<b>\$ 3,824,466</b>	<b>\$ 3,840,729</b>
PIPE COSTS				
OTHER STORES MATERIAL				
PURCHASED MATERIAL	\$ 208,345	\$ -	\$ 2,758,193	\$ 2,966,538
PURCHASED SERVICES	\$ 98,366	\$ -	\$ 2,882,854	\$ 2,981,220
PAVING	\$ -	\$ -	\$ -	\$ -
PERMITS	\$ 1,042	\$ -	\$ 30,530	\$ 31,572
OTHER DIRECT COSTS	\$ 821	\$ -	\$ 24,060	\$ 24,881
<b>TOTAL DIRECT COSTS</b>	<b>\$ 324,835</b>	<b>\$ -</b>	<b>\$ 9,520,104</b>	<b>\$ 9,844,939</b>
<b>% of TOTAL</b>	<b>3.30%</b>	<b>0.00%</b>	<b>96.70%</b>	<b>100.00%</b>

	TOTAL PLANT	TOTAL ABD.	TOTAL O&M	
CONTRACT AND MATERIAL COSTS	\$ 208,345	\$ -	\$ 6,106,057	\$ 6,314,402
<b>% of Total</b>	<b>3.30%</b>	<b>0.00%</b>	<b>96.70%</b>	<b>100.00%</b>

	TOTAL PLANT	TOTAL ABD.	TOTAL O&M	
CONTRACT COSTS	PCC	ACC	OCC	
COMPANY LABOR	CL	CL	CL	
<b>TOTAL COMPANY LABOR &amp; CONTRACT COST</b>				
PIPE COSTS				
OTHER STORES MATERIAL				
PURCHASED MATERIAL	PM	AM	OM	
PURCHASED SERVICES	S	S	S	
PAVING	Pav	Pav	Pav	
PERMITS	Perm	Perm	Perm	
OTHER DIRECT COSTS	ODC	ODC	ODC	
<b>TOTAL DIRECT COSTS</b>				

UCSD Hydrogen Blending Decommission Phase 3

WO#  
WR#

Total Sheet

ELEMENTS OF ESTIMATED COSTS	TOTAL PLANT	TOTAL ABD.	TOTAL O&M	TOTAL EST. COSTS
Miles	0.00	0.00	0.00	
LENGTH OF PIPE (in feet)	-			
CONTRACT COSTS	\$ -	\$ -	\$ 849,107	\$ 849,107
COMPANY LABOR	\$ -	\$ -	\$ 129,534	\$ 129,534
<b>TOTAL COMPANY LABOR &amp; CONTRACT COST</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ 978,641</b>	<b>\$ 978,641</b>
PIPE COSTS				
OTHER STORES MATERIAL				
PURCHASED MATERIAL	\$ -	\$ -	\$ 14,455	\$ 14,455
PURCHASED SERVICES	\$ -	\$ -	\$ 254,751	\$ 254,751
PAVING	\$ -	\$ -	\$ -	\$ -
PERMITS	\$ -	\$ -	\$ 4,318	\$ 4,318
OTHER DIRECT COSTS	\$ -	\$ -	\$ 6,477	\$ 6,477
<b>TOTAL DIRECT COSTS</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ 1,258,642</b>	<b>\$ 1,258,642</b>
<b>% of TOTAL</b>	<b>0.00%</b>	<b>0.00%</b>	<b>100.00%</b>	<b>100.00%</b>

	TOTAL PLANT	TOTAL ABD.	TOTAL O&M	
CONTRACT AND MATERIAL COSTS	\$ -	\$ -	\$ 863,562	\$ 863,562
<b>% of Total</b>	<b>0.00%</b>	<b>0.00%</b>	<b>100.00%</b>	<b>100.00%</b>

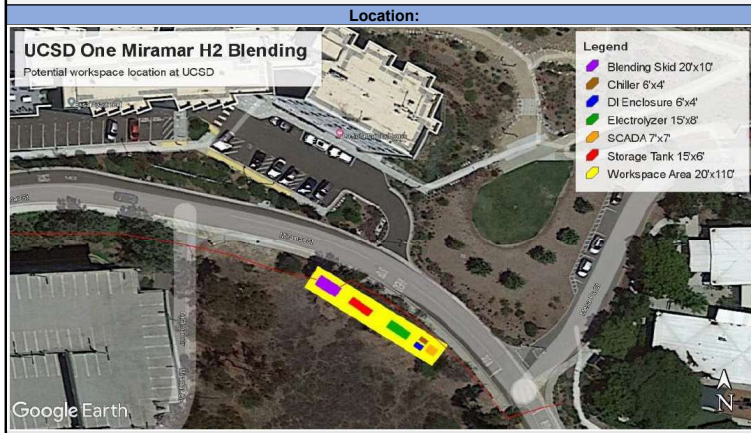
	TOTAL PLANT	TOTAL ABD.	TOTAL O&M	
CONTRACT COSTS	PCC	ACC	OCC	
COMPANY LABOR	CL	CL	CL	
<b>TOTAL COMPANY LABOR &amp; CONTRACT COST</b>				
PIPE COSTS				
OTHER STORES MATERIAL				
PURCHASED MATERIAL	PM	AM	OM	
PURCHASED SERVICES	S	S	S	
PAVING	Pav	Pav	Pav	
PERMITS	Perm	Perm	Perm	
OTHER DIRECT COSTS	ODC	ODC	ODC	
<b>TOTAL DIRECT COSTS</b>				

<b>Basis Of Estimate</b>	
<b>Project Details:</b>	
Project Location: Miramar Street on UCSD campus (32.873706937181446, -117.22421886469735)	
Purpose: The UCSD Hydrogen Blending project will investigate the potential role of hydrogen in the future of energy mix by utilizing a single-fed isolated distribution system to test the effect of having a 5% to 20% hydrogen to natural gas blend by volume in part of SDG&E's distribution pipeline, as well as a customer (UCSD) owned distribution pipeline.	
High Level Construction Schedule: 4 month Installation	
Equipment: Electrolyzer, C30 (NEL Electrolyzer) DI Enclosure, Chiller Compressed hydrogen in a pressure vessel (10 ft by ft 4ft Vessel, Non-Bulk Hydrogen Storage). Blending skid Pressure regulators (5) Temperature transmitters (1) Gas Chromatograph Gas detector/leak detectors (2) Fire detectors (2) Control valves (2) Relief valves (2) Vessel inlet valve (1) Vessel outlet valve (1) Blending skid inlet valve (1) Blending skid outlet valve (1) Pressure transmitters (3) Communications Utility systems Supervisory Control and Data Acquisition (SCADA) RTU Human Machine Interface (HMI) 260 ft PE pipe between blending skid and UCSD meter. Miscellaneous valves, fittings, and common gas line equipment installed for testing purposes 240 ft PE pipe between the existing 2" SDG&E plastic pipe and the blending skid. Sub-meter (8) SDGE Meter (1) Bollards and/or vehicle barrier Fence Driveway (2) Gas Source: Hydrogen to be generated by electrolyzer	
<b>Scope Of Work:</b>	

The project will install a PEM electrolyzer on the UCSD campus close to One Miramar Graduate Housing with a hydrogen storage vessel on site to store up to estimated 11 kg H2 to feed into the natural gas system by the blending skid. The water to the electrolyzer will be supplied from the water line at the facility site. The maximum water flow for the electrolyzer is 4.7 gal/hr. The blending skid will mix the natural gas from the SDG&E owned 2-inch plastic medium pressure gas main on Miramar Street (32°52'26.4"N 117°13'26.4"W) and blend with the onsite produced hydrogen. The maximum allowable operating pressure of the medium pressure line that the project taps into is 60 psig. The minimum expected operating pressure based on a heating degree day of 24 (worst case winter) is 49 psig. The recommended minimum operating pressure for the UCSD medium pressure piping system is 25 psig. A hydrogen blending skid will take natural gas from the existing SDG&E 2 inch medium pressure plastic main (240 ft) and use regulators to inject hydrogen into the natural gas stream to create a hydrogen natural gas blend. The composition of hydrogen will be increased incrementally from 5% to 20%. A composition of up to 20% hydrogen will need to be considered to test the limits of the end user equipment. SDG&E will build a 260 ft state-of-the-art PE pipe to deliver the blended gas from the new blending skid to the UCSD meter at the site. A third party will be hired to design and build the blending skid with Company oversight, including its control systems. The mixed gas composition will be tested downstream of the blending skid to ensure that composition limits aren't surpassed. This blended gas will then be injected downstream of the blending skid natural gas inlet, into the distribution system where it will be used by approximately 806 apartments (4 Units). SDG&E will install two individual meters for each unit (one for boiler room and one for laundry room) to test the integrity of the meter and verify volume measurement of blended gas to the One Miramar graduate housing. One additional meter needs to be installed before the UCSD meter (along the 260 ft run) to measure the flow of blended gas. The hydrogen blending skid will be controlled by a remote terminal unit (RTU) which will monitor and regulate line pressures, temperatures, flow rates, valve statuses and gas composition. Power will need to be brought into the site for the blending skid, electrolyzer, and SCADA. The one Miramar graduate housing can be isolated from the UCSD piping running North along Miramar Street at the UCSD meter to prevent bleeding of blended gas into the rest of the system via cut and cap. In addition, SDG&E pipe will be extended to the blending skid to deliver natural gas (240 ft). The 260 feet PE pipe that delivers blended gas from the blending skid to the UCSD meter 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.

<b>Assumptions:</b>
The following assumptions and clarifications were used in the creation of this estimate based on feedback from the project team: - Crews will mobilize to construction yard and job site - Compressed hydrogen to be produced by electrolyzer - Company purchase of Blending Skid - Foundations will required to be reinforced for hill stability or set back to be determined - 8 sub-Meter Replacements and 1 new SDGE meter - Cut & cap the 2" plastic mainline to prevent issues with H2 bleeding into the system - Material, excavation, installation, and backfill costs exclusive to new Piping and one newly installed SDG&E meter are counted as capital cost. - Pressure vessel and blending skid will have its own press and temp transmitters - Mechanical contractor duration anticipated at approximately 4 months for site facilities and field supervision - Assumes UCSD will provide laydown yard at no cost - Additional site excavation included 2" bypass, CMU Wall Footer, Foundations pads, blending skid pad, and water/sewer trench - Install C30 Electrolyzer, Chiller, and Deionizer cost at 25% factored off Equipment Cost. Includes: equipment install, foundations, E&I bulks, piping to tie-in - Install Blending Skid at 30% factored off Equipment Cost. Includes: equipment install, foundations, E&I bulks, piping to tie-in - Installation of 200 LF of electrical Ductbank - Assuming 667 CY of Coat Welds & Backfill Excavations - Restoration includes repavement of concrete, 260 LF of chain link fence and associated fence, man gates, and shelter foundation. - Assumes 6 production hours during 8 hour work day - Assuming 10 days of commissioning support - Class 5 Estimate - 50% / +100% - Assumes 5% freight cost - Assumes 8% sales tax - Construction Estimate is calculated using parametric values and historical crew rates. Does not include escalation. - Additional contingency for material due to current material market volatility - Maximum 10-day daily gas consumption is 67 MSCF (equivalent of 2795 SCF Natural gas/hr). This is the maximum 10-day average consumption of natural gas based on the years 2016, 2017, and 2018. To blend up to 20% of hydrogen, 41.60 kg of H2 per day should be produced. - Electrical scope includes; install SCADA/RTU, Cost for power drop from Edison, install switchgear and install of transformer
<b>Stakeholder Estimate Assumptions:</b>
*Non-construction and non-material costs are based on top-down estimating approach consistent with an AACE Class 5 estimate. Cost ranges development are based on considerations of historical cost estimate ranges and/or similar size and scope projects.

<b>Exclusions:</b>
- Estimate excludes any maintenance and utility costs that would be incurred after site is operational - Excludes ongoing electrical costs once site is operational





## Basis Of Estimate

### Project Details:

Project Location: Miramar Street on UCSD campus (32.873706937181446, -117.22421886469735)

Purpose: The UCSD Hydrogen Blending project will investigate the potential role of hydrogen in the future of energy mix by utilizing a single-fed isolated distribution system to test the effect of having a 5% to 20% hydrogen to natural gas blend by volume in part of SDG&E's distribution pipeline, as well as a customer (UCSD) owned distribution pipeline.

High Level Construction Schedule: 1 Month for Decommissioning Scope

### Decommission the following above ground equipment:

Equipment:  
Electrolyzer, C30 (NEL Electrolyzer)  
DI Enclosure, Chiller  
Compressed hydrogen in a pressure vessel (10 ft by ft 4ft Vessel, Non-Bulk Hydrogen Storage).  
Blending skid  
Pressure regulators (5)  
Temperature transmitters (1)  
Gas Chromatograph  
Gas detectors/leak detectors (2)  
Fire detectors (2)  
Control valves (2)  
Relief valves (2)  
Pressure transmitters (3)  
Vessel inlet valve (1)  
Vessel outlet valve (1)  
Blending skid inlet valve (1)  
Blending skid outlet valve (1)  
Communications  
Supervisory Control and Data Acquisition (SCADA) RTU  
Human Machine Interface (HMI)

Gas Source: Hydrogen to be generated by electrolyzer

### Scope Of Work:

The decommissioning of the project will remove the electrolyzer, hydrogen storage vessel, DI enclosure, blending skid, chiller, and SCADA unit. The water line connection will be capped. The cut and cap between the meter and UCSD piping running North along Miramar Street will be removed. The hydrogen blending skid will be removed from the site and repurposed for another project. The pipeline between the blending skid and the UCSD meter at One Miramar housing and between 2" SDG&E plastic pipe and blending skid will remain in place. Removal of equipment from site will need mobilization of a crane that can handle up to 7,000 lbs. The site of the project will need to be restored to its original state, green landscaping with trees. The fencing and vehicle barrier needs to be removed from the site. The power line needs to be disconnected. The foundation for the equipment and driveways needs to be demolished and debris will be removed and disposed of according to the city codes. Construction and demolition debris needs to be removed from the site and either recycled or disposed of according to the city of San Diego.

### Assumptions:

The following assumptions and clarifications were used in the creation of this estimate based on feedback from the project team:

- This Estimate is for a Class 5 TIC To Decommission / Remove H2 UCSD Facility
- Assumption is to remove all above ground equipment, structures, and piping. Unless specifically called out later in assumptions like water and sewer pipe.
- No hazardous materials assumed
- Assumes UCSD will provide laydown yard at no cost
- Estimate includes decommissioning, removal, hauling, and storage of: Electrolyzer, Blending Skid, Storage Tank, Deionizer, Chiller, and SCADA
- Construction Estimate is calculated using parametric values and historical crew rates. Does not include escalation.
- Crew rate includes trucking/hauling equipment needed to lift and transport skids and equipment
- Estimate includes replacement of 5 LF of plastic pipe. The miscellaneous valves, fittings, and common gas line equipment installed for testing purposes will be removed only for testing and the line will be restored. All sub-meters will be removed only and sent out for mechanical integrity testing (total of 8).
- Estimate includes removal of buried water and sewer pipe
- Crews will mobilize to construction yard and job site
- Mechanical contractor duration anticipated at approximately 1 month for site facilities and field supervision
- Assumes 5.5% freight cost
- Assumes 8% sales tax
- Class 5 Estimate (-50%, +100% accuracy)

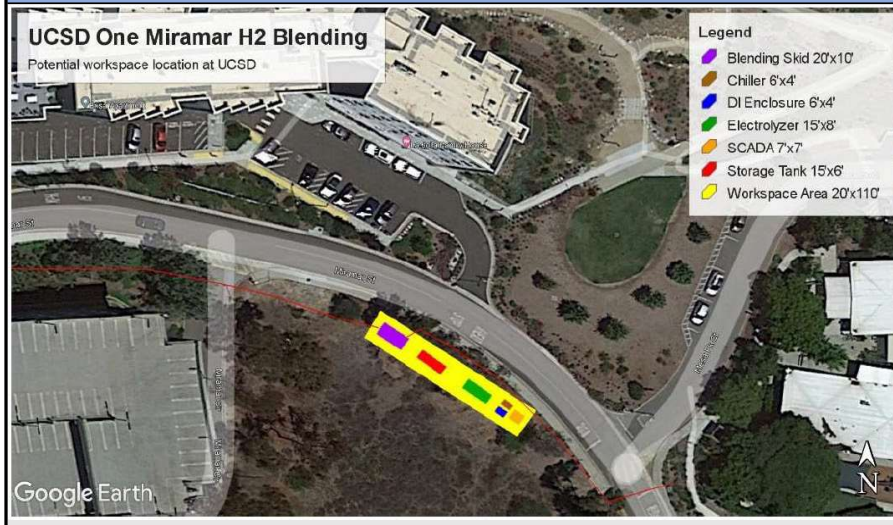
### Stakeholder Estimate Assumptions:

\*Non-construction and non-material costs are based on top-down estimating approach consistent with an AACE Class 5 estimate. Cost ranges development are based on considerations of historical cost estimate ranges and/or similar size and scope projects.

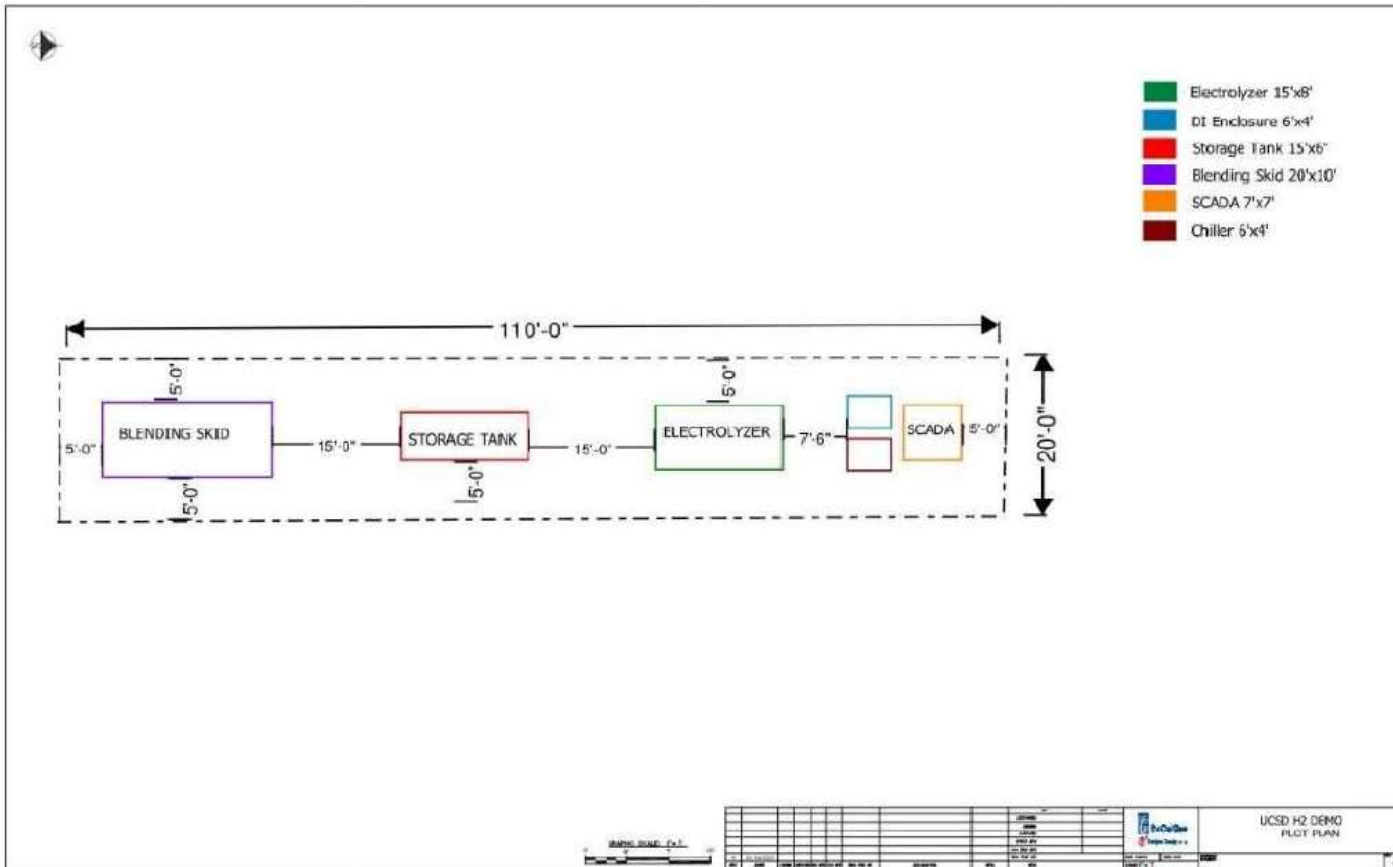
### Exclusions:

- Estimate excludes any maintenance and utility costs that would be incurred after site is Decommissioned

### Location:



### Site Mockup (Draft) - 3.14.2022



**Workpaper Supporting  
Direct Testimony of Melanie Davidson and Pooyan Kabir  
(WP-2)**

**Appendix B**

**WP-2 APPENDIX B**

**PHASE 2**

Description	Occurrence	# Staff	Hours per Staff	Rate	Estimate	Total w/ 25% Cont.	Union	Management	3rd Party
Oderant Sampling and Analysis	18	1	13	\$59.86	\$14,007.24	\$17,509.05	\$17,509.05	\$-	\$-
Leak Surveys and Equipment	18	2	13	\$55.00	\$25,740.00	\$32,175.00	\$16,087.50	\$16,087.50	\$-
Pipe Sampling (Excavation - Plastic)	1				\$25,000.00	\$31,250.00			\$31,250.00
Pipe Sample Prep & Analysis (Plastic)	1	2			\$2,882.00	\$3,602.50			\$3,602.50
Customer Feedback	18	1	2	\$50.00	\$1,800.00	\$2,250.00		\$2,250.00	
Blending Skid Operations, Gas Usage, Customer Meters Comparison	18	1	8	\$50.00	\$7,200.00	\$9,000.00		\$9,000.00	
Customer Equipment Checks	18	1	8	\$59.86	\$8,619.84	\$10,774.80	\$10,774.80		
Water (non-labor)	18				\$480.00	\$600.00			\$600.00
Electricity (non-labor)	18				\$137,687.00	\$172,108.75			\$172,108.75
Vehicle Utilization					\$37,586.12	\$46,982.65	\$46,982.65		
Services Agreement for Major Equipment					\$40,000.00	\$50,000.00			\$50,000.00
Program Management (50% FTE 4 years @125K)					\$250,000.00	\$312,500.00		\$312,500.00	
<b>TOTAL PHASE 2</b>					<b>\$551,002.20</b>	<b>\$688,752.75</b>	<b>\$91,354.00</b>	<b>\$339,837.50</b>	<b>\$257,561.25</b>

	2024	2025	2026	2027	TOTAL
Union	\$22,838.50	\$45,677.00	\$22,838.50	\$-	\$91,354.00
Management	\$84,959.38	\$169,918.75	\$84,959.38	\$-	\$339,837.50
3rd Party	\$64,390.31	\$128,780.63	\$64,390.31	\$-	\$257,561.25
<b>TOTAL Phase 2</b>	<b>\$172,188.19</b>	<b>\$344,376.38</b>	<b>\$172,188.19</b>	<b>\$-</b>	<b>\$688,752.75</b>

**PHASE 4**

Description	Occurrence	Staff	Hours per Staff	Rate	Total	Total w/ 25% Cont.	Union	Management	3rd Party
Hydrogen Engineering and Data Team	27	6	15	\$69.35	\$168,522.84	\$210,653.55		\$210,653.55	
Management	27	2	10	\$78.37	\$42,317.31	\$52,896.63		\$52,896.63	
Reporting (3rd Party)					\$100,000.00	\$125,000.00			\$125,000.00
<b>TOTAL PHASE 4</b>					\$310,840.14	<b>\$388,550.18</b>	\$-	\$263,550.18	\$125,000.00

	2024	2025	2026	2027	TOTAL
Union	\$-	\$-	\$-	\$-	\$-
Management	\$-	\$-	\$197,662.64	\$65,887.55	\$263,550.18
3rd Party	\$-	\$-	\$93,750.00	\$31,250.00	\$125,000.00
<b>TOTAL Phase 4</b>	<b>\$-</b>	<b>\$-</b>	<b>\$291,412.64</b>	<b>\$97,137.55</b>	<b>\$388,550.18</b>