Application: A.25-12-XXX
Exhibit No.: SDGE-02
Witness: P. Kabir and K. Counts

PREPARED DIRECT TESTIMONY OF

POOYAN KABIR AND KEVIN COUNTS

ON BEHALF OF SAN DIEGO GAS & ELECTRIC COMPANY

CHAPTER 2 - OPERATIONS

**BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA**

SDGE™

DECEMBER 16, 2025

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I. INTRODUCTION

The purpose of this chapter is to provide technical and operating details related to the San Diego Gas and Electric Company ("SDG&E") Palomar Decarbonization Demonstration Project ("Project"). The Project refers to SDG&E's integrated hydrogen system at Palomar Energy Center ("PEC"), including onsite hydrogen production, storage, blending into turbines, and fueling of hydrogen vehicles. The Project does not include vehicle procurement or broader hydrogen distribution infrastructure. This chapter includes discussion of: (1) PEC and its operations, (2) system design and its equipment, (3) the Project testing plan (verification and validation plan), (4) safety and environmental issues, and (5) Direct Costs.

A. Palomar Energy Center – Detailed Description

PEC is home to a 588 megawatt ("MW") (nominal) combined cycle gas turbine power generation plant and a 230-kilovolt switchyard. SDG&E placed the plant into service in 2006 in Escondido, California, San Diego County. PEC is the largest power plant in the SDG&E Generation fleet.

The PEC power plant is a 2x1 configuration comprised of two General Electric ("GE") Frame 7FA combustion turbine generators ("CTG"), each with a nominal rating of 176 MW, and a steam turbine generator ("STG") with a nominal rating of 236 MW. Each CTG is equipped with a Dry Low NOx burner system, a heat recovery steam generator, auxiliary duct burners, an oxidation catalyst, and a selective catalytic reduction ("SCR") unit to control atmospheric emissions.

PEC serves as the operations hub for SDG&E's electric generation and reliability assets deployed across our service territory. Approximately 45 full-time employees report to this location. PEC staff oversee, maintain, dispatch, and operate three SDG&E-owned gas power plants: PEC, Cuyamaca Peak Energy Plant, and Miramar Energy Facility. Additionally, PEC staff monitor and control nearly 500 MW of SDG&E-owned battery energy storage systems ("BESS") and microgrids across 19 unique sites. The staff use SDG&E fleet vehicles to travel to the sites they oversee to perform site checks, inspections, and maintenance. Decision ("D.") 24-12-074 ("2024 GRC Decision"), approved SDG&E to procure up to three hydrogen fuel cell electric vehicles ("HFCEVs") for light-duty use and up to three medium-duty HFCEVs.[1] Currently, SDG&E operates two Toyota Mirai (passenger sedans) stationed out of PEC. There are currently no commercially available medium-duty HFCEVs in the market, however SDG&E will attempt to procure medium-duty HFCEVs when they become available.

Figure 1 illustrates BESS and microgrid sites in SDG&E's service territory, many of which are managed out of PEC.

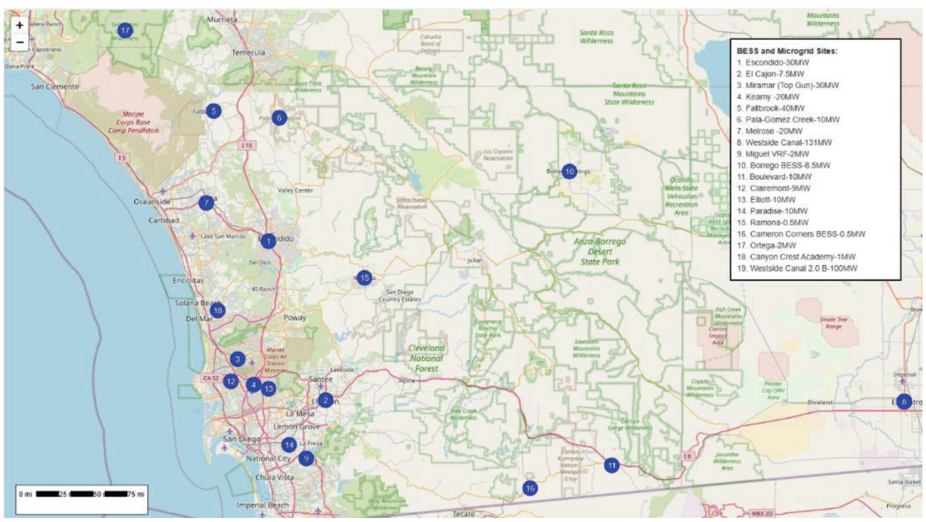

Figure 1: SDG&E BESS and Microgrid Sites Managed by PEC Staff[2]

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[1] D.24-12-074 at 591, available at https://docs.cpuc.ca.gov/SearchRes.aspx?DocFormat=ALL&DocID=550485071.

[2] SDG&E, Local utility-owned energy storage and microgrids, available at https://www.sdge.com/sites/default/files/S2550013-EnergyStorageMap_FLY_Update.pdf.

Table 1 contains the plant's annual operating net generation from 2020-2024. Major equipment, such as CTG and STG, requires periodic service to maintain peak performance. Annually, PEC undergoes maintenance that typically lasts for one month, during which the plant is not dispatched to the grid.

Table 1: Palomar Energy Center Power Plant Yearly Net Generation Data[3]

Year	Capacity Factor[4]	Service Factor[5]	Net Generation (MWh)
2024	18%	24%	925,649
2023	25%	33%	1,279,412
2022	46%	61%	2,381,530
2021	36%	49%	1,835,521
2020	39%	57%	2,029,259

B. PEC Has Always Required Hydrogen for Generator Cooling

Since its original construction, PEC has always relied on hydrogen gas to cool the CTGs and the STG. SDG&E identified PEC as a candidate for the demonstration with co-located hydrogen production and storage in part because the plant staff already had experience working with hydrogen and the facility has an established operational need. The plant cannot operate without a reliable supply of hydrogen. Prior to this Project, SDG&E trucked-in "gray" hydrogen produced by steam methane reforming from a third party.

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3 Data is available at U.S. Energy Information Administration, Form EIA-923 detailed data with previous form data (EIA-906/920) - U.S. Energy Information Administration (EIA), available at https://www.eia.gov/electricity/data/eia923/.

4 Capacity factor represents the ratio of actual electricity output to the theoretical maximum output of a power plant over a specific period. Capacity Factor= Net Generation divided by (period hours times max capacity).

5 The service factor measures the ratio of actual electricity output to the actual load demand of a power plant.

II. TECHNICAL SYSTEM DESIGN AND EQUIPMENT DETAILS

The Project is comprised of the following key elements:

Hydrogen Production

- Dedicated 274-kilowatt ("Kw") photovoltaic ("PV") system.
- 1.25 MW electrolyzer capable of generating up to 500 kilograms (kg)/day of hydrogen.
- De-ionized water sourced from the existing PEC water supply.
- Electrical equipment includes a transformer, utility interconnection, switchgear, motor control centers, and ancillary equipment.

Hydrogen Storage

- Hydrogen compression.
- 250 kg gaseous hydrogen storage.
- Integrated controls.

Hydrogen Use:

- Replacing gray hydrogen for generator cooling.
- Blending skid to support the use of up to 2% hydrogen by volume in one CTG.
- Fueling station module with second-stage compression and cooling.
- Single-position 70-bar[6] hydrogen dispensing station for HFCEV.
- Hydrogen export panel which dispenses lower pressure hydrogen to standard tanks to support local decarbonization-focused research, development, and demonstration ("RD&D") projects.

Figure 2 illustrates the major components of the project on the eastern side of PEC.

[6] Bar – unit of pressure (1 bar ≈ atmospheric pressure at sea level).

Figure 2: Major Equipment at Palomar Energy Center

A. Equipment Details

1. PV System

PV systems convert sunlight into electrical energy. The Project includes the placement of new, dedicated solar PV modules at the plant to provide renewable power for hydrogen production. The solar output is grid-connected. The nameplate capacity of the solar system is 274 kW. The annual total output of the solar system is estimated at 410 megawatt hours ("MWh"). The system can offset the electricity draw of the electrolyzer in terms of total MWh/year, depending on how frequently the electrolyzer is operated.

SDG&E initially considered a larger solar system that included solar panels on buildings and pole-mounted parking canopy. However, due to concerns regarding roof integrity, SDG&E decided to limit the solar deployments to the carports. Ground-mounted solar installations were also considered, however the available land at PEC for a ground-mounted system was insufficient to generate the amount of renewable power needed to support electrolyzer operations. Therefore, SDG&E deployed solar-integrated parking canopy structures at this site.

The PV at PEC is registered as a generating unit within the Western Renewable Energy Generation Information System ("WREGIS"). The Renewable Energy Certificates ("RECs") generated are tracked in WREGIS and logged monthly. A REC is a market-based instrument that certifies one MWh of electricity generated from a renewable energy source and delivered to the grid. RECs represent the environmental attributes of renewable electricity and are used to verify claims of clean energy use. SDG&E balances the RECs produced via the solar array at PEC with the power consumption of the electrolyzer. Should there not be enough RECs to offset electrolyzer power use, SDG&E would make up the difference by purchasing RECs that meet the Internal Revenue Service ("IRS") requirements for the hydrogen production tax credit.[7]

2. Electrolyzer

Figure 3: Electrolyzer at PEC

[7] Department of the Treasury, Internal Revenue Service, Credit for Production of Clean Hydrogen and Energy Credit; Final Rule, 90 Fed. Reg. 2224 (January 10, 2025), available at https://www.federalregister.gov/documents/2025/01/10/2024-31513/credit-for-production-of-clean-hydrogen-and-energy-credit.

The Project uses a proton exchange membrane ("PEM") electrolyzer to produce hydrogen onsite. An electrolyzer is a system that uses electricity to split water into hydrogen and oxygen through a process called electrolysis. SDG&E selected a PEM electrolyzer due to its flexible operations—it can easily ramp on and off. Alternatives to PEM systems perform better with constant operations that produce hydrogen 24/7, which would not have been feasible due to site constraints and hydrogen storage capacity.

The electrolysis of water occurs through an electrochemical reaction between de-ionized (DI) water and electricity. The reaction splits water molecules (H_2O) into gaseous hydrogen (H_2) and oxygen (O_2). The hydrogen is stored as an energy source/fuel for later use, and the oxygen is vented to the atmosphere. Hydrogen generated via electrolysis does not produce greenhouse gas ("GHG") emissions when the process is powered by a renewable electricity source, such as solar energy, and the resultant hydrogen gas is carbon-free.

The electrolyzer specifications used for the Project are included in Table 1 below:

Table 2: Electrolyzer Specifications for PEC

Electrolyzer Type	Rated Power	Rated Hydrogen Production	Delivery pressure	Average power consumption at stack	Water Flow Rate
PEM	1.25 MW	22.1 kilogram per hour (kg/hr)	30 bar	50.4 Kilowatt-hours per kilogram (kWh/kg)	6 gallons per minute (gal/min)

3. Compressor

Figure 4: Hydrogen Compressor at PEC

A single two-stage, diaphragm compressor is used to pressurize the hydrogen produced in the electrolyzer and transfer it to the storage tanks. This compressor takes hydrogen at a minimum pressure of 30 bar and discharges it to hydrogen storage at a pressure of 450 bar.

4. Gaseous Hydrogen Storage

Figure 5: Hydrogen Storage at PEC

All hydrogen produced on-site is stored in ASME-Certified pressure vessels. There are ten pressure vessel cylinders in total, connected using a valve panel. Hydrogen storage is sufficient to maintain a minimum of 6 hours of operation for 2% by volume blending in the fuel gas into one CTG, which is approximately 272 kg.

5. Hydrogen for Generator Cooling

As stated previously, PEC was designed to use hydrogen gas to cool the CTGs and the STG; this is a common practice for power plants. Hydrogen for generator cooling at the plant is supplied to Unit 1 and Unit 2 CTGs at 5 bar and regulated to 2 bar downstream of the existing pressure regulating valves. Hydrogen is supplied to the STG at 8.6 bar and regulated to 3 bar downstream of the existing pressure regulating valves. The estimated total hydrogen demand for CTGs and STG cooling is around 1.8 kg per day for daily operation. Moreover, after plant shutdown or maintenance, hydrogen is required to refill the generator cooling lines and ensure proper system readiness before restart. The estimated demand to refill the cooling lines after a power plant outage and/or line maintenance is around 60 kg of hydrogen in total.

6. Blending Skid for Power Generation

Hydrogen passes from the hydrogen storage through dedicated pipes into the blending skid before reaching one CTG to generate electricity. A blending skid is a modular system designed to safely and precisely mix hydrogen gas with natural gas before combustion or pipeline injection. It includes flow controllers, analyzers, and safety systems to ensure an accurate blend ratio. The purpose of the blending skid is to ensure safe, accurate, and consistent mixing of hydrogen and natural gas before combustion in the turbine. Hydrogen and natural gas have different combustion properties. It is important to control the gas composition for a specialized combustor such as a gas turbine; even minor unplanned deviations in the blend ratio can lead to unstable combustion, flashback, or equipment malfunction. To control the blend ratio in the CTG, the blending skid utilizes mass flow controllers, analyzers, and automated control systems to maintain the desired hydrogen-to-natural gas ratio and achieve a consistent flow. In the case of the Project, this ratio is up to 2% by volume.

While the control blend ratio for the Project is currently up to 2%, blending up to five percent into GE Frame 7 GTC, which is the same model for PEC, is technically sound and operationally safe based on the previous feasibility testing and project results in the literature on the same unit.[8,9,10] Consistent with a small-scale demonstration, SDG&E elected to limit the maximum hydrogen blend by volume in natural gas up to 2% as a balance of collecting relevant operational data against the additional cost for expanded hydrogen storage enabling higher blending percentage. Using the existing demonstration, it would be possible to increase the blend percentage, however it would add cost, including additional storage and potentially turbine retrofits. Should the Commission desire to fund an expansion of the demonstration to test higher blends and review and share the related data, SDG&E would be supportive.

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8 Ohio Capital Journal, World science community watching as natural gas-hydrogen power plant comes to Hannibal, Ohio (August 27, 2021) available at https://ohiocapitaljournal.com/2021/08/27/world-science-community-watching-as-natural-gas-hydrogen-power-plant-comes-to-hannibal-ohio/.

9 The Intelligencer, Cleaner Future in Sight: Long Ridge Energy Terminal in Monroe County Begins Blending Hydrogen (April 25, 2022), available at https://www.theintelligencer.net/news/community/2022/04/cleaner-future-in-sight-long-ridge-energy-terminal-in-monroe-county-begins-blending-hydrogen/.

10 U.S. Environmental Protection Agency, Hydrogen in Combustion Turbine Electric Generating Units Technical Support Document (May 23, 2023) available at https://www.epa.gov/system/files/documents/2023-05/TSD%20-%20Hydrogen%20in%20Combustion%20Turbine%20EGUs.pdf.

7. Hydrogen Fueling Module & Dispensing Station

Figure 6: Hydrogen Dispensing Station at PEC

The purpose of the fueling module and dispensing station is to fuel HFCEVs. The module supports the station by supplying the discharge pressure and temperature required for vehicle fueling. It achieves this via a set of integral compressors and a chiller. During HFCEV fueling, hydrogen flows from storage at 450 bar and enters the module, where it is compressed further to 700 bar, chilled to -40º Celsius (C), and delivered to the dispenser. The fueling dispenser can only dispense at high pressures (700 bar) with a specific fuel flow rate and pressure increase rate, to specialized tanks that use a two-way infrared communication protocol (such as the ones found in HFCEVs).[11]

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[11] SAE International, Fueling Protocols for Ligh Dusty Gaseous Hydrogen Surface Vehicles (May 28, 2020) available at https://saemobilus.sae.org/standards/j2601_202005-fueling-protocols-light-duty-gaseous-hydrogen-surface-vehicles.

The station module contains sophisticated safety systems, as well as monitoring and data collection systems for metrics such as dispensing pressure and temperature, fill time, and flow rate. Together, these systems ensure safety and reliability and optimize the performance of hydrogen fueling. At 700 bar, a typical HFCEV passenger vehicle can be fueled in approximately five minutes, delivering 5-7 kg of hydrogen, enough for 300-400 miles of driving range.

Two Toyota Mirai FCEVs currently fuel at PEC. The vehicles were authorized in the 2024 GRC Decision, and are not included as a cost for this Project – See Chapter 1 Sec VI for details.[12] In the future, should SDG&E acquire additional light-duty HFCEV, they could also fuel at PEC. The range of light-duty HFCEV are enough to cover normal operations and emergency response to all the microgrid sites shown in Figure 1.

8. Export Panel

SDG&E added an export panel to the Project because the fueling dispenser is not compatible with filling conventional hydrogen storage tanks. The export panel enables hydrogen produced at PEC to be dispensed into standard pressure vessels (tanks) at pressures ranging from 200-350 bar. The export panel is equipped with a check valve, pressure transducer, relief valve, nozzle hose for dispensing hydrogen, and a flow meter.

The export panel was added as part of SDG&E's Electric Program Investment Charge ("EPIC") 4 project, the "Renewable Mobile Nanogrid for Climate Resiliency" ("Nanogrid"). The Nanogrid and the related export panel are funded through EPIC by California utility customers

[12] D.24-12-074 at 591, available at https://docs.cpuc.ca.gov/SearchRes.aspx?DocFormat=ALL&DocID=550485071.

under the auspices of the Commission.[13] SDG&E's EPIC 4 test plan includes operating the Nanogrid in island mode for long durations using an external clean hydrogen source for power, which SDG&E can now produce locally. See Chapter 1, Sec VII for more details. The export panel is not included as a cost on this application.

9. Auxiliary

The auxiliary equipment for the hydrogen production facility encompasses a set of systems designed to support safe, efficient, and reliable operations. This includes advanced control systems for process automation and monitoring, electrical equipment such as transformers, switchgear, and motor control centers to ensure stable power distribution, and networking infrastructure to enable seamless communication between field devices, control rooms, and remote monitoring platforms. These components are integrated to facilitate real-time data acquisition, diagnostics, and operational flexibility.

B. System Integration

1. Hydrogen Integration

The use of hydrogen will be prioritized as follows: a) hydrogen as a cooling gas, b) hydrogen for blending into natural gas, c) hydrogen for transportation, and d) hydrogen export to support RD&D. Hydrogen for CTG and STG cooling is prioritized due to its impact on plant reliability, uptime and performance. Hydrogen for generator cooling system existed and was operational at PEC prior to the Project. The Project includes the integration of onsite hydrogen production, hydrogen storage, hydrogen fuel dispensing, and hydrogen blending into CTG with the existing generator cooling hydrogen system. SDG&E made no physical changes to the power

[13] CA.Gov, EPIC Database, SDG&E EPIC-4 Project 5 - Renewable Mobile Nanogrid for Climate Resiliency (October 21, 2025), available at https://database.epicpartnership.org/project/135075.

generation equipment at PEC, including the CTGs, dry low-NOx combustors, heat recovery stream generator ("HRSG") duct burners, or emissions control systems.

2. Water Integration

PEC utilizes water for various processes within the power plant. The Project is integrated into the existing system, where condensate from the compressor knockout drums and intermittent wastewater discharged from the electrolyzer will be gravity-drained to an underground sump and transferred to the existing HRSG blowdown sump. While this wastewater is not suitable for reuse within the electrolyzer, it is high-quality, oil-free wastewater that is suitable for discharge to the cooling tower via the HRSG blowdown sump.

3. Electrical Integration

SDG&E integrated the Project into the electric system at PEC. Both the PV system and the power plant at PEC feed electricity onto the grid. Neither generation source continuously produces energy. The PV system provides electricity to the grid during solar production hours, and the PEC power plant generates electricity when dispatched by the California Independent System Operator.

All loads at PEC (such as offices, auxiliaries, and the electrolyzer) are grid-tied and receive power from the grid, delivered by SDG&E. This ensures reliable operations twenty-four hours a day, seven days a week. The most important use case for the electrolyzer at PEC is to generate hydrogen to support plant-critical CTG and STG cooling operations. Therefore, the electrolyzer requires full reliability guaranteed by a grid connection. SDG&E offsets grid electricity pulled by the electrolyzer with RECs it generates through the dedicated PEC PV system.

III. SAFETY AND ENVIRONMENTAL

A. Safety

Safety is foundational to the design, implementation, and operation of the hydrogen systems at PEC. From project inception, SDG&E has prioritized a rigorous safety practice rooted in proactive risk identification, engineering controls, and operational direction. SDG&E conducted comprehensive Hazard Identification ("HAZID") and Hazard and Operability ("HAZOP") studies to systematically assess potential risks and ensure mitigations were integrated into the project's design. Safety protocols were incorporated into the project's commissioning, encompassing material selection, site design, and training for employees and first responders. SDG&E is committed to industry best practices, ensuring that hydrogen technologies are deployed responsibly to protect personnel, infrastructure, and the surrounding community. Demonstrations like this one provide critical operational insights into hydrogen behavior and equipment performance, while also providing the time to refine safety protocols before implementing large-scale projects.

B. Hydrogen Leakage

The system was designed to be leak-tight. Preventing hydrogen leakage is essential to ensuring safety and efficiency in hydrogen systems. SDG&E employed design strategies including the use of high-integrity seals and gaskets, particularly those made from materials resistant to hydrogen embrittlement. Welded connections are preferred over threaded or flanged joints to minimize potential leak paths. The system incorporates pressure monitoring to quickly identify and isolate leaks. Additionally, the electrolyzer and hydrogen fueling station have a safety design to avoid hazardous situations. The equipment is designed with safety components and functions, including proper selection of components regarding process parameters, electrical design, and classified location, and specific automatic control process parameters such as pressure and temperatures, additional automatic control and supervision of the operation by a programmable logic controller, and lowering the likelihood of sparks through adherence to hazardous area specifications.

Moreover, there are warning and safety signs on each component that communicates critical information to the operators and authorities having system jurisdiction. Emergency shutdowns exist outside of the electrolyzer, inside the electrolyzer cabinet, inside of the fueling station module, and in front of the hydrogen dispenser.

During Commissioning, SDG&E performed a pressure test of the system, where all joints, welds and bonds were left uninsulated and exposed for examination during leak testing. The fueling system is designed to operate and be leak tight at 700 bar. The pressure test employed 1050 bar over 15 minutes and observed no pressure drop and hence no leak.

C. Water Usage

PEC is required to use reclaimed water for all non-potable uses. Reclaimed water for PEC is obtained from the Hale Avenue Resource Recovery Facility.

Reclaimed water used in the hydrogen production process is demineralized. The DI water system at PEC consists of a 200,000-gallon de-mineralized water storage tank and two de-mineralized water pumps rated for 500 gallons per minute. The existing demineralized water storage will be used to meet the demands of the hydrogen production system.

D. Environmental Discussion

1. Carbon Dioxide Reductions

This Project will reduce emissions of carbon dioxide, a greenhouse gas, in the following ways: 1) by replacing trucked-in gray hydrogen with clean hydrogen generated onsite; 2) by replacing natural gas in one of the turbines with up to 2% hydrogen by volume; 3) by fueling hydrogen fuel cell vehicles that replaced gasoline-powered vehicles.

Historically, plant records show that PEC relied on approximately 800 kg of hydrogen per year of delivered gray hydrogen for generator cooling. The average carbon intensity of gray hydrogen is 11-12 $KgCO_2/Kg\ H_2$.[14] The hydrogen was delivered via an internal combustion engine truck.[15] Replacing the previous system of receiving gray hydrogen with green hydrogen produced on site therefore reduces emissions by 12 tons CO_2/year.[16]

The Project displaces some natural gas in the turbine. Blending up to 2% hydrogen by volume into one of PEC's gas turbines could reduce carbon dioxide emissions by approximately 0.67%. Hydrogen blending into CTG will displace natural gas with hydrogen and will reduce emission by 12 tones CO_2/year.[17]

Two Toyota Mirai FCEVs fuel at PEC. The vehicles are authorized in GRC 2024, and they are not accounted for in this project.[18] Toyota Mirai are light duty sedans that support plant operations. They are powered by hydrogen with zero carbon intensity instead of a fossil fuel car. Toyota Mirai FCEV sedan drives an average of 15,000 miles per year. The use of each zero-

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[14] International Energy Agency, Towards hydrogen definitions based on their emissions intensity (2023) at 40, available at https://iea.blob.core.windows.net/assets/acc7a642-e42b-4972-8893-2f03bf0bfa03/Towardshydrogendefinitionsbasedontheiremissionsintensity.pdf.

[15] Assume 200 miles between gray hydrogen production site and Palomar Energy Center for CO2 calculations.

[16] Replacement of hydrogen with renewable hydrogen: 800 Kg/year x12 Kg Co2/KgH2= 9600 Kg CO2/Year. Replacement of hydrogen delivery by truck: (200 miles per delivery x 12 delivery per year/10 MPG)= 240 Gallon of Disel/year x 10.19 Kg CO2/Gallon= 2450Kg CO2/Year.

[17] Calculation: 400 Kg H2/month*87.66Kg H2/hr (hydrogen need for 2% blend) =4.56 hr/month. Natural gas displaced at 2% blend with hydrogen= 4.56 hr/month*4095.6 cubic ft per hour= 18,688 cubic ft/month. Monthly CO2 reduction= 18,688*0.05481 (kg CO2/cubic feet of natural gas) = 1024 Kg/month. Carbon Dioxide Emissions Coefficients. *See* U.S. Energy Information Administration, Today in Energy (December 12, 2025), available at https://www.eia.gov/.

[18] D.24-12-074 at 591, available at https://docs.cpuc.ca.gov/SearchRes.aspx?DocFormat=ALL&DocID=550485071.

emission FCEV, results in an estimated reduction of 6 metric tons of CO_2 annually.[19] In total, the demonstration project reduces emission by 36 metric tons of CO_2 annually.

2. NOx

The Project did not require any modifications to the existing emissions or operating limits in the Permits to Operate, including related to NOx. At a 2% blend, hydrogen has a negligible effect on the NOx produced in combustion.[20] Additionally, the existing SCR units and oxidation catalysts maintain compliance with the current emissions limits even with the use of a 2% hydrogen blend.

E. Permitting

The Project required permits from two California agencies: the California Energy Commission ("CEC"), and the San Diego Air Pollution Control District ("SDAPCD"). The CEC permit was required for proposed changes to the power plant and SDAPCD permitting was required for blending hydrogen in the CTGs. A discussion of each permit is presented below:

1. CEC Permit

The CEC is responsible for licensing thermal power plants with a capacity of 50 MW or more. In August 2021, SDG&E filed a petition for post-certification change (TNs 239299 and 239330) with the CEC for PEC. This petition requested to add hydrogen generation and storage at PEC. CEC approved the hydrogen generation and energy storage project, serving as a regulatory determination that the proposed project complies with applicable laws, ordinances,

[19] This calculation assumes the average fossil fuel car emits about 400 grams of CO_2 per mile. *See* EPA, Greenhouse Gas Emissions from a Typical Passenger Vehicle, available at https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle.

[20] LCRI, Hydrogen Cofiring Demonstration at New York Power Authority's Brentwood Site: GE LM6000 Gas Turbine, Executive Summary at 6-7, available at https://www.epri.com/research/products/000000003002025166.

regulations, and standards, poses no significant environmental impacts, and does not require supplemental review under California Environmental Quality Act. The approval included a determination that the modifiers would not increase any daily, quarterly, annual, or other emission limits.

2. San Diego Air Pollution Control District Permit

A Minor Permit Modification Application was submitted to the San Diego Air Pollution Control District ("SDAPCD") on December 16, 2021, subsequent to and in concert with the request to modify the CEC license. Although the SDAPCD does not regulate the creation or combustion of hydrogen, it was determined that two permit conditions needed to be modified in order to proceed; condition 2 only allowed the combustion of pipeline quality natural gas and condition 37, which added hydrogen as one of the components of fuel input in the determination of mass emissions. Once the project was complete, modification of condition 37 meant that the Continuous Emissions Monitoring System ("CEMS") programming had to be revised to incorporate a percentage based total fuel flow using the proportions of natural gas and hydrogen. This change required Environmental Protection Agency ("EPA") authorization due to the fact that the heat input would not match what was calculated in the EPA quarterly reporting system Emissions Collection and Monitoring Plan System ("ECMPS"). The EPA approved the addition of hydrogen fuel in early 2025 and later altered the ECMPS programming to allow for multiple fuel use at the same time. In doing so, the EPA directed SDG&E to utilize the hydrogen fuel constant of 5970 dry standard cubic feet per million British thermal units (dscf/mmBtu) (PNG is 8710). Once the EPA approval was in place, the CEMS Quality Assurance Manual was modified to incorporate the revised fuel calculation and approved by the SDAPCD Source Test Division.

IV. TECHNICAL PROJECT LEARNINGS

A. Technical Experience

This Project allows SDG&E to gain experience and understanding on a fuel that many consider critical to decarbonizing dispatchable, firm power generation: clean hydrogen. The learnings from the Project that SDG&E has gained and will continue to gain over time include but are not limited to: (1) hydrogen generation, including the design, operation, and maintenance requirements for local production of hydrogen collocated with end use; (2) hydrogen use, including monitoring and measuring hydrogen's behavior and impact on turbines and emissions; the design, operation and maintenance of hydrogen equipment such as blending skids, compressors and storage systems; how to integrate hydrogen into various use cases to replace fossil fuels; and (3) how to scale the use of hydrogen in the future to support the broader generation fleet.

Below is a summary of the specific areas of learning supported by the Project:

- **Engineering**: SDG&E gained practical experience integrating hydrogen systems into an existing combined-cycle power plant, including adapting infrastructure for hydrogen production, compression, and multi-use deployment.
- **System design**: The Project provided insights into designing a modular hydrogen system that supports generator cooling, turbine blending, vehicle fueling, and RD&D, while maintaining operational flexibility and safety.
- **Codes and standards**: The project applied hydrogen-specific codes and standards, including National Fire Protection Association, American Society of Mechanical Engineers, Society of Automotive Engineers, UL certifications governing hydrogen production, storage, compression, fueling protocols and blending into CTG as well as

identifying hazardous locations, safe distances, ensuring regulatory compliance and safe operations.

- **Controls Integration**: SDG&E implemented advanced control systems integration to manage electrolyzer operations, compressor, monitor hydrogen storage and fueling station performance through a centralized control system in PEC, gaining experience in automation and system data collection and reliability.
- **Valves**: The Project involved selecting and testing valves suitable for hydrogen service, including those resistant to hydrogen embrittlement and capable of maintaining leak-tight performance under high pressure.
- **Piping**: SDG&E evaluated piping materials and configurations for various hydrogen use cases, ensuring compatibility with hydrogen's unique properties and minimizing leak risks.
- **Venting**: The project required careful design of venting systems to safely release hydrogen during maintenance or emergencies, incorporating best practices for dispersion and detection. The venting system is deployed for several parts of the system, including but not limited to the electrolyzer, fueling station module, storage tanks, and export panel.
- **Safety requirements**: Comprehensive HAZID and HAZOP studies informed the safety safeguards, including emergency shutdowns, leak detection, and pressure testing protocols that exceeded 700 bar.
- **Material specifications**: The Project provided real-world data on material performance under hydrogen exposure, guiding future selection of components for durability and safety.

- **Metering**: SDG&E implemented metering systems to track hydrogen production, flow rates, and hydrogen dispensing, supporting performance validation and regulatory compliance.
- **Performance Data**: The Project generates operational data on several parts of the system. Data verification and validation for the hydrogen system is discussed below.
- **Best practices**: SDG&E documented best practices for hydrogen system deployment, including commissioning procedures, leak testing, and integration with existing plant operations.

B. Data Verification and Validation

The objective of the test plan is to assess and understand the operational performance of the systems that comprise the Project. The SDG&E test plan includes assessing and validating the performance of hydrogen blending in a gas turbine at low percentages, evaluating the impact on plant emissions at the flue, monitoring hydrogen system reliability, safety, and integration with other infrastructure, and understanding the performance of hydrogen generation and compression equipment. SDG&E is collaborating with faculty at the University of California Irvine Combustion Laboratory to develop a data collection framework.

The scope of the testing plan will focus on hydrogen blending in one turbine unit, monitoring power output while monitoring emissions including carbon dioxide and NOx at stack and generator level, PV system monitoring under varying weather and over time, safety performance of the system (leak detection, pressure, temperature drops). In addition, SDG&E will monitor electrolytic hydrogen production performance over time.

V. DIRECT COSTS

A. Capital Costs

The Project is fully constructed and the capital budget was closed in September 2025. Table 3 below describes actual direct unloaded capital costs for the project:

Table 3: Capital Cost- Actual Direct (in Millions of Dollars)

Direct Costs	2021	2022	2023	2024	2025	Total
Direct Capital Cost	$1.2	$6.2	$9.2	$0.7	$0.1	$17.4

SDG&E's actual Direct Capital spend is 0.1% higher than the 2024 GRC Application ("A.") 22-05-016 Capital forecast.[21,22]

Further details on the capital costs can be found in other areas of the Application. Details on direct capital costs are included in Workpaper 1 (WP-1), provided herewith as Attachment A. Details on loaded direct and indirect capital costs and revenue requirements are described in Chapter 3, Prepared Direct Testimony of Michael Woodruff.

B. Operations and Maintenance ("O&M") Costs

The solar, electrolyzer, and hydrogen storage were placed "in service" by the end of 2023 and thus began to incur O&M costs beginning in 2024. Other capital aspects of the project continued through 2025; see Workpaper 2 (WP-2), provided herewith as Attachment B, for details. SDG&E provides the actual direct O&M costs recorded for 2024 in Table 4. O&M forecasts are included for 2025 through 2036, the final year of the book life of PEC.

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[21] Capital cost spend was $25,067 higher than GRC 2024 Estimate based on WP-1.

[22] A.22-05-016, Exhibit (Ex.) SDG&E-14-CWP, Capital Workpapers to Prepared Direct Testimony of Daniel S. Baerman (May 2022) (Ex. SDG&E-14-CWP (Baerman)) at 52-57 available at https://www.sdge.com/sites/default/files/regulatory/SDGE-14-CWP%20Daniel%20S%20Baerman%20-%20Electric%20Generation_0.pdf.

Table 4: Direct O&M Costs (Unloaded) (in Millions of Dollars)

	Actual O&M	Forecasted O&M				
Year	2024	2025	2026	2027	2028	2029-2036
Total	$0.2	$0.2	$0.2	$0.2	$0.2	$0.2

SDG&E's actual O&M spend in 2024 is 14% lower than the 2024 GRC Application O&M forecast.[23,24]

Further details on O&M can be found in other areas of the Application. Details on O&M costs are included in WP-2. Details on actual loaded direct and forecasted O&M costs and revenue requirements are described in Chapter 3, Prepared Direct Testimony of Michael Woodruff.

VI. CONCLUSION AND SUMMARY

This concludes our prepared direct testimony.

23 Saved $38,633/year (-14%).

24 Ex. SDG&E-14-CWP (Baerman) at 52-57 available at https://www.sdge.com/sites/default/files/regulatory/SDGE-14-CWP%20Daniel%20S%20Baerman%20-%20Electric%20Generation_0.pdf.

VII. STATEMENT OF QUALIFICATIONS

A. Pooyan Kabir

My name is Pooyan Kabir. I am the Principal Engineer for hydrogen at SDG&E. I have been with SDG&E since August 2021. My business address is 8306 Century Park Ct. San Diego, CA 92123. Before joining SDG&E, I was 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.

I hold a Bachelor of Science in Structural Engineering from the University of Tehran, a Master of Science in Materials from Texas A&M University, and a Doctorate in Structural Mechanics from the University of Illinois at Urbana-Champaign. I am a licensed Professional Engineer in the States of Texas and California.

I have previously testified before the Commission.

B. Kevin Counts

My name is Kevin M. Counts. My business address is 2300 Harveson Place, Escondido, CA 92029. I am currently employed by SDG&E as Plant Manager for Palomar Energy Center, Miramar Energy Facility and Cuyamaca Peak Energy Plant. My responsibilities include overseeing a staff that operates these power plants.

I began employment at SDG&E in 2005 as an Operations Technician for Palomar Energy Center and Miramar Energy. My experience prior to employment at SDG&E (approximately 8 years) includes various positions in the US Nuclear Navy and with Reliant Energy at the Bighorn Generating Station. I hold a Bachelor of Science degree in Business from the University of Phoenix.

I have previously testified before the Commission.

ATTACHMENT A
Workpaper 1 – Direct Capital Cost Details

Workpaper 1 – Direct Capital Cost Details

This document provides detail on the actual direct capital costs of the Palomar Decarbonization Demonstration Project by year, explains and categorizes the actual direct costs, and compares them to the forecast from the SDG&E 2024 General Rate Case application.

Project Activity Chronology

The capital project began in 2021 and was completed in September 2025. Certain key equipment, including the electrolyzer, was placed into service at the end of 2023. Other equipment was not placed into service until later. Table WP1-A describes project capital activity by year.

Table WP1-A: Project Capital Activity by Year

Year	Capital Activities
2021	• Pilot design, preliminary engineering, and solar equipment procurement
2022	• Project detailed design, equipment procurement, construction
2023	• Project detailed design, equipment procurement, construction continues • Electrolyzer commissioning completed • Solar, electrolyzer, and storage placed "in service" by year end
2024	• Blending skid installed and commissioned • Fueling station placed into service
2025	• Meters installed to support third party verification and test plan

Table WP1-B is repeated from Chapter 2.

Table WP1-B: Capital Cost- Actual Direct (in Millions of Dollars)

Direct Costs	2021	2022	2023	2024	2025	Total
Direct Capital Cost	$1.22	$6.24	$9.19	$0.71	$0.13	$17.49

Table WP1-C provides cost details on actual direct costs by category and item detail.

Table WP1-C: Capital Cost Details (Unloaded) (in Millions of Dollars)

Category	Item	Cost	Total Cost By Category
Major Equipment	Solar System Package	$1.63	$9.06
	H2 Vendor Package: Electrolyzer, Storage, Fueling Station, and Compressor	$6.14	
	Blending Skid and Analyzer	$1.10	

	Switchgear	$0.18	
Other Services and Materials	Government Payments and Permits	$0.01	$8.24
	Service Vehicle & Equipment Rental	$0.02	
	Services- Engineering	$1.40	
	Services-Construction	$2.64	
	Services- Contractors	$2.00	
	Services-Consultants	$0.79	
	Services- Other	$0.31	
	Materials	$1.07	
Management and Non-Union Labor	Management and Non-Union Labor	$0.25	$0.25
Miscellaneous & Adjustments	Accounting Adjustment, Discounts, etc.	$(0.06)	$(0.06)
Total		$17.49	$17.49

There are non-direct incremental costs and Allowable Funds Used During Construction for this project.

GRC Capital Cost Comparison

The figure below presents the estimated capital costs submitted as part of SDG&E's Test Year 2024 General Rate Case (GRC), Application No. 22-05-016. These estimates were documented in Exhibit SDG&E-14CWP-E and reflect projected costs for Group 210390. These represent the original project budget forecast.

Figure 1: GRC Supplemental Workpapers for Group 210390.[1]

			Notes	Estimate (2021 - July 2023)	2021	2022 (1.02)	2023
CPUC	Mgmt & Non-Union Labor		Internal Labor - $1500 in directs per month for entire project	$ 42,997	$ 12,456	$ 19,838	$ 10,703
	Union Labor				$ -	$ -	$ -
	Material Issuances				$ -	$ -	$ -
		Nel Contract	Nel Hydrogen - Compensation Schedule, freight included in the Feb 2023 amount ($:	$ 4,995,000	$ -	$ 3,496,500	$ 1,498,500
		PSM Hydrogen Gas Train	PSM - Blending Skid Proposal	$ 610,000	$ -	$ 183,000	$ 427,000
		Remaining Materials	B&V Cost Estimate - Materials	$ 4,079,080	$ -	$ 1,000,000	$ 3,079,080
	Material Other Total		B&V Cost Estimate - Mechanical Equiopment, Piping, Electrical	$ 9,684,080	$ -	$ 4,679,500	$ 5,004,580
		Services - Baker	Baker Electric Estimate - PEC PV System Project	$ 1,488,639	$ 595,456	$ 893,183	$ -
		Services B&V	B&V Cost Esimate - Services Engineering	$ 1,348,000	$ 303,308	$ 807,691	$ 237,001
		Services - Burns & McDonnell	B&M forecast based on project 3-month burn rate	$ 30,898	$ 11,699	$ 12,066	$ 7,133
		Pride Resource	Pride forecast based on project 3-month burn rate	$ 94,037	$ 16,920	$ 48,585	$ 28,533
		Estimate Services	B&V Cost Estimate - Total Union Labor directs, subcontractor indirects, and CM/CI total	$ 3,834,000	$ -	$ 1,643,143	$ 2,190,857
		Additional Construction Services	B&V Cost Estimate - additional services using total union labor as estimate	$ 657,000	$ -	$ 292,000	$ 365,000
		No Vendor	Additional vendors not included in above services	$ 30,212	$ 22,730	$ 7,482	$ -
	Services Total			$ 7,743,157	$ 1,210,484	$ 3,704,150	$ 2,828,524
	CIAC				$ -	$ -	$ -
	All Other			$ (812)	$ (770)	$ (42)	$ -
	Adjustments				$ -	$ -	$ -
	Vehicle Utilization				$ -	$ -	$ -
	All Direct Costs			$ 17,469,422	$ 1,222,170	$ 8,403,446	$ 7,843,807

	$ 9,684,080	Materials - includes $1.3M in contingency & $277k in freight
	$ 1,348,000	Services Engineering
	$ 2,520,000	Services / Construction
	$ 1,508,000	Services
	$ 1,289,000	Contingency Services - built into services forecast
Cost Estimate Total	$ 16,349,080	$ -
Internal Labor	$ 42,997	Labor
	$ 16,392,077	
Additional Contingency	$ 1,077,345.00	built into Services forecast
Directs Total	$ 17,469,422	

Total Directs

2021	$ 1,222,170
2022	$ 8,403,446
2023	$ 7,843,807
	$ 17,469,422

[1] Capital Workpaper to Application No. 22-05-016, Exhibit No: SDG&E-14CWP-E, available at: SDGE-14-CWP-E_Daniel S Baerman_EGEN.pdf

ATTACHMENT B
Workpaper 2 – Operations and Maintenance Cost Summary

Workpaper 2 – Operations & Maintenance (O&M) Cost Summary

This document provides detail on the actual and forecasted O&M costs of the Palomar Decarbonization Demonstration Project by year, explains and categorizes the costs, and compares them to the forecast from the SDG&E 2024 General Rate Case application.

Project Activity Chronology

The capital project began in 2021 and was completed in September 2025. Certain key equipment, including the electrolyzer, solar, and hydrogen storage was placed into service by the end of 2023. Other equipment was not placed into service until later. O&M for the electrolyzer, solar, and hydrogen storage, and fueling system began in 2024. Actual O&M costs are reported for 2024, and O&M forecasts are provided for 2025 through 2036, which is the end of the book life of the plant.

Table WP2-A: Project Capital and O&M Activity by Year

Year	Capital Activities	O&M
2021	• Pilot design, preliminary engineering, and solar equipment procurement	N/A
2022	• Project detailed design, equipment procurement, construction	N/A
2023	• Project detailed design, equipment procurement, construction continues • Electrolyzer Commissioning completed • Solar, electrolyzer, and storage placed "in service" by year end	N/A
2024	• Blending skid installed and commissioned • Fueling station placed into service	• Maintenance and operations of electrolyzer, compressor, storage, and fueling • Third party tax credit verification
2025 (Jan – Sept)	• Meters installed to support third party verification and test plan	• Maintenance and operations of electrolyzer, compressor, storage, fueling and blending • Third party tax credit verification
Oct 2025-2027		• Maintenance and operations of electrolyzer, compressor, storage, fueling and blending • Third party tax credit verification (through 2028 only).

Table WP2-B is repeated from Chapter 2:

Table WP2-B: Direct O&M Costs (Unloaded) (in Millions of Dollars)

	Actual O&M	Forecasted O&M				
Year	2024	2025	2026	2027	2028	2029-2036
Total	$0.23	$0.22	$0.22	$0.18	$0.18	$0.19

Table WP2-C provides cost details on O&M by category and item detail.

Table WP2-C: O&M Cost Details (Unloaded) (in Thousands of Dollars)

	Actual	Forecast				
Item	**2024**	**2025**	**2026**	**2027**	**2028**	**2029 -2036 (per year)**
Equipment Service	$198	$159	$159	$122	$122	$163
Tax Credit Verification	$30	$30	$30	$30	$30	0
Materials	$3	$10	$10	$10	$10	$10
Internal Labor	-	$10	$10	$10	$10	$10
Indirect Labor	-	$10	$10	$10	$10	$10
Annual Total:	$231	$219	$219	$182	$182	$193

Equipment Service: Equipment service contracts cover long-term service agreements for the electrolyzer, storage tanks, the fueling station module, and the fueling dispenser. These agreements enable the equipment to be properly maintained by their vendors. Covered activities include scheduled maintenance, repairs, remote monitoring and support services for the equipment. Maintenance and service costs from 2024-2028 are contracted on a graduated payment schedule with SDG&E frontloading payments in 2024 and with lower payments in the following four years and are valid through 2028. For the years 2029 and beyond, SDG&E is using the average annual cost of current agreements in today's dollars to support its forecast.

Tax Credit Verification: The third-party verification for the income tax election on the federal hydrogen production tax credit (45V) is required by the US Department of Treasury for the first five years the hydrogen production system is in service. The verification payments lag the tax credit by one year. Therefore, SDG&E paid for verification services starting in 2024 for the 2023 tax year. SDG&E's final verification payment will take place in 2028 and is not applicable for 2029-2036.

Materials: Equipment not covered under service contracts includes the compressor, blending skid, export panel, pipes, valves, and control systems. The "materials" category is a zero-based forecast for the annual cost for the parts needed to maintain the system over its useful life. Over time, more materials will need to be repaired and replaced. In 2024, SDG&E spent $3000 on tools and tool storage compartment. In the future, SDG&E assumed material costs would increase and that $10,000/year was a reasonable estimate.

Labor- Internal: Labor includes zero based estimate for direct costs for SDG&E staff time for operating the system, managing contractors, and maintenance performed on the system.

Labor- Non-Direct: Labor includes zero based estimate for direct costs for contractor labor and services to perform maintenance on equipment not covered under service contracts.

GRC O&M Forecast

In 2024, SDG&E adjusted its non-labor forecast to include maintenance and service costs for the Palomar Hydrogen Project. Figure 1 illustrates this adjustment as submitted in the Test Year 2024 General Rate Case.

Figure 1. O&M Cost Forecast Associated with the PEC Hydrogen Project[1]

San Diego Gas & Electric Company
2024 GRC - APP
Non-Shared Service Workpapers

Area:	ELECTRIC GENERATION
Witness:	Daniel S. Baerman
Category:	A. Generation Plant
Category-Sub:	1. Generation Plant Palomar
Workpaper:	1EG003.000 - Generation Plant Palomar

Year	Labor	NLbr	NSE	Total	FTE	Adj_Type
2024	0	270	0	270	0.0	1-Sided Adj

Explanation: Increased forecast to include Long Term Service Agreement (LTSA) costs associated with the Palomar Hydrogen Project.

[1] SDG&E 2024 General Rate Case, Exhibit SDG&E-14-WP, Workpapers to Direct Testimony of Daniel Baerman – Electric Generation, p. 8. Available at: https://www.sdge.com/sdge-2024-general-rate-case