CALIFORNIA ENERGY COMMISSION

California Energy Commission

Clean Transportation Program

FINAL PROJECT REPORT

Solar PV Hydrogen Production Plant in Central California

H2B2 USA, LLC SoHyCal Renewable Hydrogen Production Plant

Prepared for: California Energy Commission

Prepared by: H2B2 USA, LLC

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California Energy Commission

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Finally, H2B2 would like to acknowledge the tremendous commitment of the Fresno Economic Development Corporation (EDC) in the establishment of a new hydrogen production plant in the region. Their assistance in navigating the complex permitting process and in complying with all regulatory requirements was invaluable. In addition, they assisted H2B2 in securing various incentives and tax credits, which ultimately helped to make the project more financially viable. The Fresno EDC also provided relevant economic and demographic data essential in strategic planning and decision-making. Through their extensive network, they were able to connect project developers with key stakeholders (including government agencies, potential investors, and industry experts), thereby fostering collaboration and ensuring the success of the hydrogen plant.

PREFACE

Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007) created the Clean Transportation Program. The statute authorizes the California Energy Commission (CEC) to develop and deploy alternative and renewable fuels and advanced transportation technologies to help attain the state's climate change policies. Assembly Bill 8 (Perea, Chapter 401, Statutes of 2013) reauthorizes the Clean Transportation Program through January 1, 2024, and specifies that the CEC allocate up to $20 million per year (or up to 20 percent of each fiscal year's funds) in funding for hydrogen station development until at least 100 stations are operational.

The Clean Transportation Program has an annual budget of about $100 million and provides financial support for projects that:

- Reduce California's use and dependence on petroleum transportation fuels and increase the use of alternative and renewable fuels and advanced vehicle technologies.
- Produce sustainable alternative and renewable low-carbon fuels in California.
- Expand alternative fueling infrastructure and fueling stations.
- Improve the efficiency, performance and market viability of alternative light-, medium-, and heavy-duty vehicle technologies.
- Expand the alternative fueling infrastructure available to existing fleets, public transit, and transportation corridors.
- Establish workforce-training programs and conduct public outreach on the benefits of alternative transportation fuels and vehicle technologies.

To be eligible for funding under the Clean Transportation Program, a project must be consistent with the CEC's annual Clean Transportation Program Investment Plan Update. The CEC issued Grant Funding Opportunity GFO-17-602 – Renewable Hydrogen Transportation Fuel Production Facilities and Systems (renewable hydrogen plants) to create renewable hydrogen generation facilities in California. In response to GFO-17-602, H2B2 USA, LLC submitted an application which was proposed for funding in the CEC's Notice of Proposed Awards on October 8, 2018 (proposal number 8) and the agreement was executed as ARV-21-029 on September 9, 2021.

ABSTRACT

H2B2 USA, LLC designed, engineered, manufactured, constructed and commissioned a hydrogen production facility located at 24205 W. Whitesbridge Avenue, Kerman, CA 93630 under their grant funding agreement, ARV-21-029, with the California Energy Commission (CEC). H2B2's plant is expected to generate up to 1,000 kg/day of 100% emission-free hydrogen which will serve the Hydrogen Refueling Stations (HRS) of the San Joaquin Valley and the San Francisco Bay Area. The green hydrogen produced at the SoHyCal facility creates noteworthy progress towards the fulfillment of the goal of a zero emissions future. With the ability to add to the supply of renewable hydrogen in this growing market, confidence in this innovative technology will grow as well. The SoHyCal project covers all facets of the value chain, from manufacturing the electrolyzers to the dispensing, transportation and distribution of hydrogen. The project received an award of $3,965,000 in grant funding from the CEC to support the construction of the facility.

Keywords: California Energy Commission, H2B2 USA, LLC, hydrogen production facility, electrolyzers, 100% emission-free hydrogen

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EXECUTIVE SUMMARY

H2B2 USA, LLC is a technology company established as a California Limited Liability Company in 2016. It is a subsidiary of H2B2 Electrolysis Technologies Inc ("H2B2 Inc."), a Delaware corporation. H2B2 Inc. is a global, vertically integrated provider of hydrogen energy systems, services and equipment, including electrolyzers which are manufactured using proprietary in-house technology. The company's highly qualified and experienced engineers have been working on hydrogen related projects for over 30 years. The company's suite of products and services span the production and transport of hydrogen, from design through operation. H2B2 Inc., through H2B2 USA, LLC, develops renewable hydrogen production projects in California, with a focus on reducing carbon emissions and accelerating clean energy adoption.

The California Energy Commission (CEC) issued a solicitation, GFO-17-602 – Renewable Hydrogen Transportation Fuel Production Facilities and Systems (Renewable Hydrogen Generation Plants) to create renewable hydrogen generation facilities in California. In 2018, H2B2 USA, LLC was awarded a grant through GFO-17-602 by the CEC to develop and construct a 1,000 kg/day plant located in Fresno County – SoHyCal (Phase 1). Construction of Phase 1 of our project is complete and is currently in operation, with the ability to produce up to one ton per day of green hydrogen. We are working to boost our renewable sources of power, as limitations by the utility are restricting our ability to accomplish this.

Construction phase started with the Kickoff Meeting in September 2021, immediately after the engineering group of H2B2 started with the design of the plant supported by local engineering and consultant firms. Orders for the main equipment were placed in the 4th quarter of 2021.

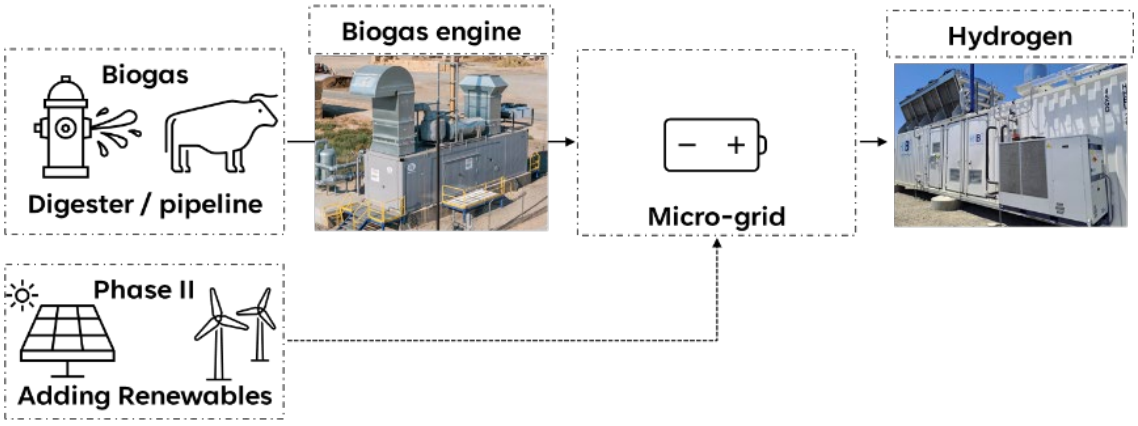
After receiving the first materials and the container, in January 2022 the manufacturing of the electrolyzer started. Ultimately it was shipped to the project site in December 2022. In June 2022 the contract with the local general contractor performing grading, civil works and electrical and mechanical erection was signed and work at the site began immediately after (July 2022). Construction delays slowed progress on the installation of the electrolyzer and completion of the plant, but ultimately the commissioning phase began in April 2023, culminating in the Commencement Operation date in September 2023.

This first-of-its-kind project is the largest operational green hydrogen production plant powered entirely by renewable energy in North America to date. Being able to utilize the biogas from the neighboring dairy Bar 20, we are then fueling our biogas engine, manufactured by 2G. This 1 megawatt (MW) genset unit provides less than one-third of the power needed for our 3MW Proton Exchange Membrane (PEM)[1] electrolyzer. The energy is then sent to our internal grid on a system set on island mode and converted from alternating current (AC) to direct current (DC) in the rectifier to be able to feed the electrolyzer. At this point, the entire train of our system is powered by the biogas engine, thus, producing renewable hydrogen. As part of the plan, the first phase was designed to receive power that

[1]. https://www.plugpower.com/blog/pem-fuel-cells-101-how-they-work-and-why-they-matter/

can be utilized at all hours of the day from energy deriving from biogas, then later supplement the remaining energy from photovoltaic (PV)[2] that will be built apart of phase two.

Figure 1: Pathway of dairy biogas to energy production then hydrogen production



Source: *H2B2 USA*

To complete the full project, H2B2 plans to expand production capacity to approximately of 3,000 kg/day at the same location, as well as add a 15MW PV farm and an HRS to commercialize the hydrogen (Phase 2) covering the full value chain. The goal is to accomplish this by Q2 2026. This amount of hydrogen has the potential to fuel up to 210,000 cars per year or 30,000 city buses. Fresno County Department of Public Works and Planning, the Lead Agency, has already permitted the expansion. The permit includes the completion of the full and final phase of the SoHyCal project, which includes 9MW of renewable hydrogen production through electrolysis. Additionally, permits have been obtained for completion of a 15MW PV farm on land adjacent to the production plant, which is ready for installation.

H2B2 is excited to be on the forefront of the initiative in California to transition to lower-carbon and zero-emission vehicles. The SoHyCal project is at the forefront, from both a technical and commercial perspective, including construction, financing and operation of a 100% renewable hydrogen production plant with PEM technology and with a targeted capacity of up to three tons per day, which will then allow us to be able to use renewable energy derived from our PV plant. Per the Governor's "Zero Emission Vehicle Action Plan" (Governor Gavin Newsom 2022) and specifically the mandate regarding fuel cell electric vehicles in California, H2B2 intends to play a key role in hydrogen fuel cell utilization in transit buses as well as light and heavy-duty truck fleets.

[2] https://www.energy.gov/eere/solar/photovoltaics

CHAPTER 1: Introduction

Problem Statement

Challenges are particularly relevant to the production of green hydrogen through electrolysis in California. One of the most significant barriers is access to capital, as these systems, along with the renewable energy infrastructure needed to power them, require substantial upfront investment. Despite the potential benefits of the federal 45V tax credit[3], there is no assurance from Congress that this incentive will be available in the long term. As a result, investors are hesitant to commit to the substantial initial costs uncertainty around the long-term viability of green hydrogen production.

Regulatory ambiguity and evolving policies often delay electrolyzer permitting and compliance, complicating green hydrogen production. The immature market and lack of long-term offtake agreements further hinder access to financing for large-scale projects. High capital costs, unclear regulations, and uncertain incentives create significant barriers, including for H2B2. Support from the California Energy Commission was vital, but the project required substantial internal investment, reflecting H2B2's commitment to green hydrogen's future.

Who We Are

H2B2's SoHyCal project is a cornerstone of California's clean energy transition, advancing sustainable hydrogen fuel technologies to meet growing demand, reduce emissions, and decarbonize mobility. Its primary goal is to produce and distribute green hydrogen, positioning it as a critical element in the state's energy landscape while encouraging further projects.

This scalable and sustainable facility, H2B2's first in California, marks the beginning of a broader vision for renewable hydrogen production statewide and beyond. The project provides insights into the challenges and opportunities of green hydrogen production, laying the foundation for future developments.

Led by H2B2, the SoHyCal project is supported by a multidisciplinary team. Morris General Construction oversees plant design and construction, Dirk Poeschel Land Development ensures permitting and regulatory compliance, and Calvert Advisors manages finances and reporting to the CEC. Together, this team ensures efficient, responsible execution aligned with state objectives.

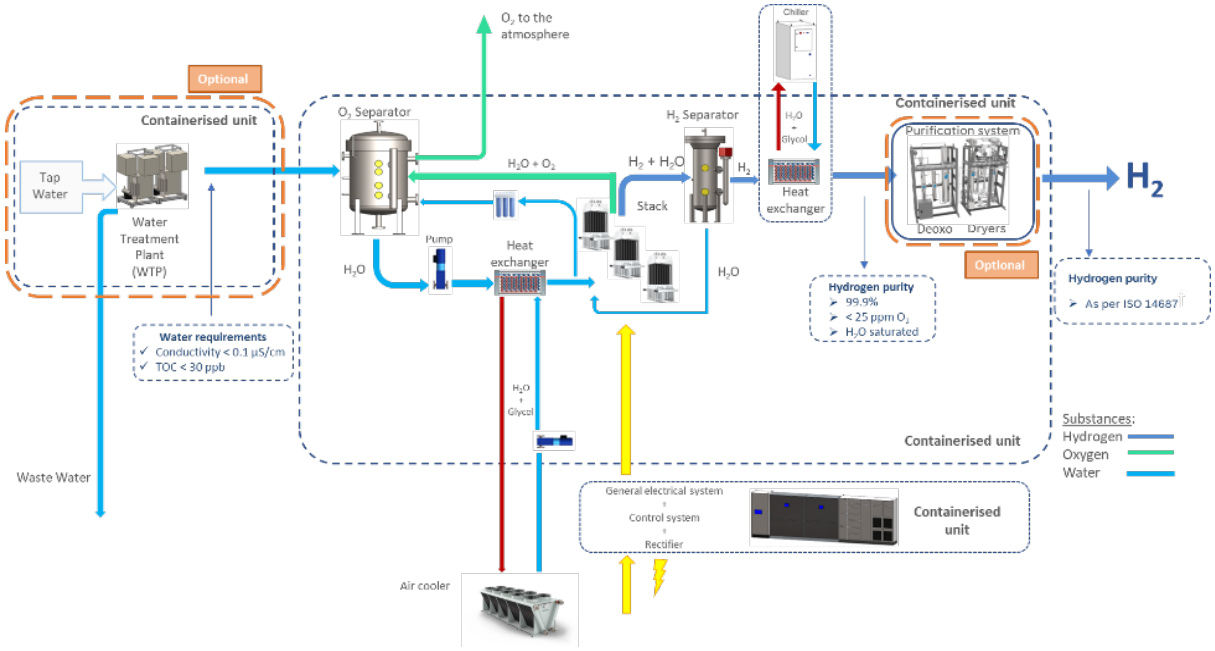
The Technology

H2B2 integrates highly advanced hydrogen production technologies that will propel the quick realization of California's clean energy objectives. The SoHyCal project uses a proton exchange membrane (PEM) electrolyzer to provide a high purity hydrogen to multiple applications by making the energy transformation to a sustainable, low-carbon energy foundation a reality. The PEM electrolyzer produces up to 600 Nm^3/h of hydrogen, with a purity of 99.999 %. The

[3] https://www.energy.gov/articles/clean-hydrogen-production-tax-credit-45v-resources#:~:text=The%20Clean%20Hydrogen%20Production%20Tax%20Credit%20creates%20a%20new%2010,per%20kilogram%20of%20H2 .

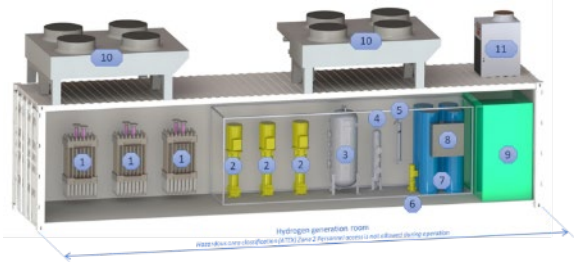
electrolyzer, which is considered a hydrogen equipment enclosure (HEE)[4], is located inside a 40ft container. It is divided into two zones: Hydrogen Generation Room (HGR)[5], and Support Equipment Room (SER)[6], as shown in Figures 2 and 3 on the following page.

Figure 2: Electrolyzer Technology Process



Source: *H2B2 USA*

Figure 3: Electrolyzer Equipment Layout

H2B2 EL600N PEM Electrolyzer (outside view)	H2B2 EL600N Electrolyzer (inside view)
	

Source: *H2B2 USA*

Support Equipment Room (SER)

[4] https://www.h2b2.es/electrolyzers/?_gl=1*i1nc61*_up*MQ..*_ga*MjkzODIxMDQzLjE3MzU2NzM0MTI.*_ga_9LR8MCBSP6*MTczNTY3MzQxMC4xLjEuMTczNTY3NjEzMy4wLjAuMA

[5] https://www.h2b2.es/electrolyzers/?_gl=1*i1nc61*_up*MQ..*_ga*MjkzODIxMDQzLjE3MzU2NzM0MTI.*_ga_9LR8MCBSP6*MTczNTY3MzQxMC4xLjEuMTczNTY3NjEzMy4wLjAuMA

[6] https://en.itpedia.nl/2019/05/15/de-it-equipment-room-mer-ser-en-der/

This unclassified area contains the control equipment and water processing necessary to support hydrogen generation in the HGR. The control panel located in this area includes a fully automated Programmable Logic Controller (PLC)[7] to operate the electrolyzer continuously.

The Control system monitors variables, analyzes the different states, and actuates valves and other control elements, among other tasks. The control system is connected to an uninterrupted power supply (UPS)[8] to guarantee a controlled and safe shut down.

The water processing system includes the complete water circuit (except for the stack):

- Oxygen separator: This equipment is required to separate oxygen from water dragged from the stack. Also, the oxygen separator is used as a water storage tank to ensure the continuous supply of water to the stack. A single separator for the three stacks is included within the system. This equipment recovers liquid water, recirculating it into the stacks.
- Pumps: To bring deionized water into the stacks and to recirculate water into the deionization resins, guaranteeing the water quality needed for the stacks.
- Deionization system: It is composed of Deionized-resin bottle/s to maintain water quality required by the stack.

Hydrogen Generation Room (HGR)

The hydrogen separation room in an electrolysis plant contains essential components, including electrolyzer stacks that drive the process of water splitting. These stacks, made up of multiple cells, work simultaneously to boost hydrogen production. Once the electrolysis is complete, hydrogen and oxygen are separated through advanced systems designed to achieve high purity. The room is also outfitted with important safety measures like ventilation, gas detection, and insulation, all ensuring the secure handling of hydrogen. Continuous monitoring of the equipment ensures smooth operation and helps maintain safety and efficiency throughout the process.

- Stacks. Three stacks, manufactured by Plug Power[9], based on PEM technology. Electricity and water enter the system, splitting water into hydrogen and oxygen molecules. The maximum production of hydrogen combining the two stacks will be 600 Nm^3/h.
- Hydrogen separator. This equipment is needed to separate hydrogen from water dragged by the flow from the stack. We include a single separator for the three stacks within the system.
- Hydrogen purification system: this system has the responsibility to guarantee hydrogen purity (99.999%), achieving the requirement of Society of Automotive Engineers (SAE) J2719 which outlines the quality specifications for hydrogen fuel utilized within fuel cell vehicles. It details the purity standards and contaminant thresholds that define the

[7] https://csrc.nist.gov/glossary/term/programmable_logic_controller

[8] https://www.usaid.gov/energy/powering-health/system-components/uninterruptible-power-supplies

[9] https://www.plugpower.com/about-us/

acceptable allowances of impurities within the hydrogen. Meeting the requirements of SAE J2719 is fundamental in ensuring the fuel cell vehicles are operating with safe hydrogen of high purity, which in turn diminishes the likelihood of impurities trapping together to prematurely damage the fuel system. Equipment included is:

- Catalytic re-combiner - deoxo: some oxygen traces can be found in the hydrogen stream at the stack outlet, which is removed in this catalytic recombiner. The process is remarkably simple: the catalyst inside the recombiner initiates the reaction between oxygen and hydrogen producing water. The outlet stream is sent to the dryer.
- Dryer: downstream of the deoxo, there is a dryer in line to remove the moisture of the hydrogen stream. This system catches the moisture, and it is regenerated when the absorbent is saturated. There are two dryers available to allow continuous operation of the electrolyzer, one is working while the other hone is in regeneration (no need for maintenance stop).

Environmental Impacts

Fuel Cell Electric Vehicles (FCEVs) offer major benefits compared to traditional gasoline cars, especially when it comes to tackling California's environmental and public health issues. Transportation alone is responsible for about half of the state's greenhouse gas (GHG) emissions, along with nearly 80% of nitrogen oxide (NOx) pollution and 90% of harmful diesel particulate matter. Gasoline vehicles release carbon dioxide, NOx, and particulate matter, which all contribute to poor air quality and climate change. In contrast, FCEVs produce zero tailpipe emissions—just water vapor and heat—making them a cleaner alternative that can significantly cut air pollution, particularly in cities. When FCEVs are powered by green hydrogen from renewable sources, they can almost eliminate carbon emissions, helping California meet its goal of becoming carbon neutral.

The SoHyCal project addresses the growing need for hydrogen production and thus the opportunity to help meet the goal of putting more FCEVs on the road in mind. California has established aggressive targets to reduce greenhouse gas emissions and shift towards zero-emission transportation. The state plans to achieve carbon neutrality by 2045, which means that all emissions will be offset by carbon removal efforts. Additionally, California aims for a 40% decrease in greenhouse gas emissions from 1990 levels by 2030, as outlined in the California Global Warming Solutions Act and Senate Bill 32. As part of its Zero Emission Vehicle (ZEV) initiative, California mandates that all new passenger vehicles sold in the state must be zero-emission by 2035, specifically battery-electric, plug-in hybrid, and hydrogen fuel cell vehicles. The Advanced Clean Trucks (ACT) Rule also requires that by 2045, all new trucks sold in California must be zero-emission, with specific requirements for segments such as drayage trucks to transition by 2035. Under this regulation, by 2035, 75% of Class 4-8 trucks and 40% of all trucks sold in the state must meet zero-emission standards.

CHAPTER 2: Approach

On-Site Operations

The SoHyCal project, managed by H2B2, utilizes electrolysis to produce green hydrogen from water using renewable electricity. Daily operations include water purification, running electrolyzers to separate hydrogen and oxygen, and storing the hydrogen under high pressure. The facility employs advanced monitoring and control systems to optimize performance, making minor adjustments such as fine-tuning electrolyzer settings and enhancing water purification processes to ensure efficient production.

The hydrogen produced by SoHyCal is dedicated to transportation, specifically fueling the City of Fresno's hydrogen buses operated by Fresno Area Express (FAX)[10]. The project aims to expand its capacity to support a growing fleet of hydrogen-powered vehicles, reinforcing Fresno's commitment to sustainable transportation solutions.

Figure 4: Hydrogen Refueling Trailer

Source:: *H2B2 USA*

In the image above, a GTM 1500 trailer, the smaller enclosed tube trailer, is shown alongside a 500-bar stanchion. Utilizing the GTM 1500 trailer, we can conduct cascade fills and are able to provide directly to off takers with minimal equipment. This provides a reliable, temporary solution to direct refueling for the FAX.

[10] https://www.fresno.gov/transportation/fax/

Figure 5: Plant Location

Source: *H2B2 USA*

Training

Training is conducted internally for all newly hired employees. With an emphasis on hiring knowledgeable and skilled staff, we were able to tap into a pool of local job seekers that possessed the necessary experience for understanding the operational duties.

Operators at the hydrogen production facility have received essential training to ensure safety and efficiency, especially in the context of hydrogen production through electrolysis. This includes Occupational Safety and Health Administration (OSHA)[11] 30 certifications for safety compliance, medium and high voltage power systems training, and expertise in handling high-pressure gas lines—all critical for managing the electrical and gas systems involved in electrolysis. A basic understanding of gaseous hydrogen is vital for safely controlling hydrogen production, while knowledge of reverse osmosis ensures the purity of water used in the process. Additionally, Microsoft Office skills streamline data management and reporting. This specialized training is crucial for maintaining safety and operational reliability in electrolysis-based hydrogen production. H2B2 is committed to equitable hiring by promoting the open positions in nearby areas. All Plant Operators currently handling the hydrogen production are locals from the surrounding areas and have been trained in cutting edge technologies like the one used in this renewable hydrogen plant. Once the project is complete, there will be a total of seven operators and H2B2 will do all the efforts to have them hired from the vicinity of the plant and using them as basis for the future expansion of H2B2 in other areas, giving them the responsibility to teach and training others to be hired.

Safety Plan

Safety is a critical aspect of any energy or fuel project, particularly in the realm of hydrogen facilities where the risks associated with hydrogen use and handling are substantial. For

[11] https://www.dir.ca.gov/dosh/

projects like those managed by H2B2, the role of safety extends beyond mere compliance; it is a core operational priority.

H2B2, as both the owner and operator of hydrogen facilities, is responsible for adhering to rigorous safety standards. To ensure that CEC funded hydrogen gas production projects meet the highest safety standards, the CEC's Hydrogen Safety Panel (HSP)[12] is tasked with evaluating and enforcing safety measures. This involves rigorous scrutiny of safety plans, adherence to best practices, and proactive measures to prevent incidents.

When H2B2 was awarded a grant by the CEC, a preliminary safety plan was submitted. At that stage, the plan was not a detailed document but rather a framework—a table of contents and a declaration of intent. This initial submission was a starting point, signaling H2B2's commitment to safety and its intention to develop a thorough safety plan in accordance with CEC guidelines and HSP requirements. As a result of the efforts of the H2B2 team, along with specialized consultants, and thanks to the incredible support of HSP members, together we were able to create a Safety Plan which was ultimately praised due to the attention to detail and the level of accuracy in addressing each and every comment from panel members.

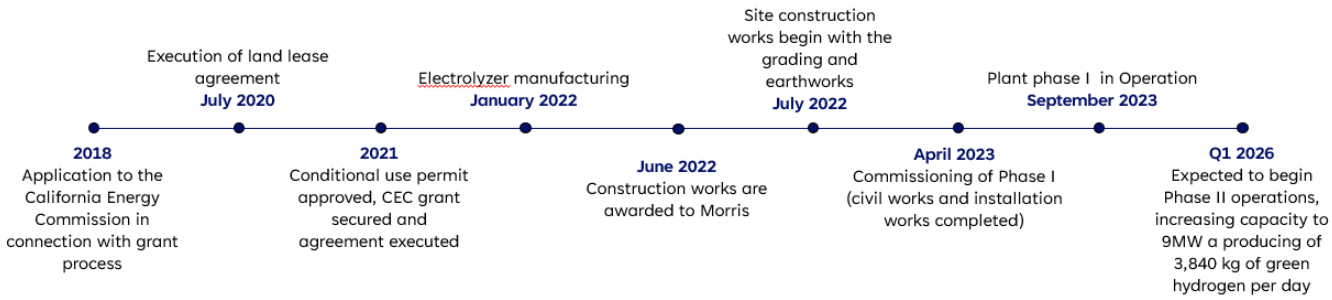
[12] https://www.energy.gov/eere/fuelcells/articles/safety-planning-guidance-hydrogen-and-fuel-cell-projects?utm_source=chatgpt.com

CHAPTER 3: Activities Performed

Site Acquisition

The importance of the SoHyCal project in Kerman lies in its ability to serve various local industries, including agriculture, transportation, and energy. The central location provides access to California's transportation networks and key markets, facilitating the distribution of green hydrogen to support decarbonization efforts across the state. By establishing SoHyCal in Kerman, H2B2 is contributing to the region's economic growth and helping meet California's ambitious climate goals by promoting the adoption of hydrogen as a clean and sustainable energy source.

Figure 6: SoHyCal Timeline from Start to end of Phase 1



Source: *H2B2 USA*

Phase two of the project has not started, but soon we will integrate a neighboring PV farm. Transitioning from alfalfa cultivation to a solar farm offers significant water conservation benefits. Alfalfa requires substantial irrigation, while solar energy and hydrogen electrolysis use minimal water. By placing a PV farm on land previously used for alfalfa, irrigation water demand is reduced, offsetting the water needed for hydrogen production. This approach promotes sustainable agriculture and energy practices, conserving water and ensuring resource stewardship.

Equipment Procurement

Two main components set the SoHyCal project apart from the rest, playing a crucial role in making green hydrogen possible. Although every piece of equipment plays an important role, two specific units make this a unique approach to green hydrogen.

Electrolyzer – Installed is a 3MW PEM electrolyzer. This unit comes equipped with 3, 1MW Plug Power stacks along with a hydrogen purification system to reach the SAE J2719 standard.

2G Energy Inc., Biogas Engine – Installed is a 1MW biogas engine that provides 100% of the energy to produce hydrogen. The biogas engine comes equipped with a Selective Catalytic Reduction (SCR) to reduce the emissions coming from this engine, to ensure that emission emitted are in compliance with the San Joaquin Valley Air Pollution Control District (SJVAPCD)[13] air quality standards. The source test has been conducted showing positive reading and pending the approval from SJVAPCD. Confirmation of final approval have not been

[13] https://www.valleyair.org/

granted but are expected to be done before 2025. The source test conducted on July 3rd of 2024 shows conditions are met.

The remaining units include a switchgear, UPS, rectifier, and a compressor/chiller. To meet the market needs, the compressor can reach up to 517 bar, allowing for high compression hydrogen. There are multiple stanchions installed that allow operations to implement a drop-and-swap fuel trailer process. The goal is to not have drivers waiting to be loaded and rather for customers to drop off their empty fuel trailer and take a pre-filled fuel trailer that has been filled before their arrival to the SoHyCal facility.

Project Team

The SoHyCal Green Hydrogen Plant project team comprises a diverse group of experts dedicated to advancing green hydrogen production in Fresno County, California. Each member brings specialized knowledge and experience to ensure the successful development and operation of the facility. Below is a list of project team members and their roles:

Bar 20 – Property Owner and Project Supporter: Bar 20 is the owner of the property on which the SoHyCal Green Hydrogen Plant is located. As a forward-thinking organization, Bar 20 is acutely aware of the environmental challenges posed by traditional dairy operations, particularly in terms of greenhouse gas emissions. Their commitment to sustainability and innovation has positioned them as staunch supporters of the SoHyCal project, recognizing the transformative potential of green hydrogen in reducing emissions and promoting renewable energy solutions.

Their collaborative spirit and commitment to enhancing the local ecosystem through innovative solutions make them an invaluable partner in the SoHyCal initiative. We extend our heartfelt gratitude to Bar 20 for their unwavering support and vision for a more sustainable future. Their leadership in promoting renewable energy not only benefits the SoHyCal project but also sets a benchmark for other agricultural enterprises in the region, paving the way for a greener, cleaner future. Thank you, Bar 20, for your commitment to innovation and sustainability!

Agilitech – Electrical Construction: Agilitech specializes in electrical construction and automation, playing a critical role in the installation of the electrical systems at the SoHyCal plant. With a strong track record in renewable energy projects, Agilitech ensures that the plant's electrical infrastructure is robust, reliable, and compliant with all safety regulations. Their expertise encompasses the design and implementation of advanced electrical systems crucial for efficient hydrogen production.

Morris General Construction – General Contractor: Morris General Construction is a full-service general contractor with extensive experience in large-scale construction projects. They are tasked with overseeing all construction activities for the SoHyCal plant, ensuring that the facility is built to the highest standards of quality and efficiency. Their skilled team is dedicated to completing all phases of construction on schedule, contributing to the project's overall success.

Dirk Poeschel Land Development Services, Inc.– Permitting Assistance: Dirk Poeschel Land Development Services, Inc.'s office specializes in navigating the complex permitting processes required for renewable energy projects. They provide essential support to the SoHyCal project,

ensuring that all necessary permits are obtained in a timely manner. Their expertise in local and state regulations facilitates a smooth project timeline and helps avoid potential delays.

Fresno County Economic Development Corporation – Project Support: The Fresno County EDC is dedicated to fostering economic growth and sustainability in the region. They play a pivotal role in supporting the SoHyCal project through permitting assistance, network extensions, and various resources that facilitate the project's success. Their commitment to collaboration and local development enhances the project's viability and aligns with community goals.

Calvert Advisors – Grant Documentation and Budgeting: Calvert Advisors specializes in securing funding for renewable energy projects through grant documentation and budgeting. Their expertise ensures that the SoHyCal project obtains the necessary financial resources to support its development and operations. By providing strategic financial guidance, Calvert Advisors helps optimize the project's budget and resource allocation, ensuring long-term viability and success.

Consultants for safety plan: the following entities collaborated with H2B2 on the development and approval of H2B2 safety plan submitted to the HSP.

- Bluefield Process Safety, LLC: Hazard and Operability Study (HAZOP)[14] and Layers of Protection Analysis (LOPA) [15]analysis.
- Dynamic 3D Solutions: as third-party process engineering advisor.
- M&I Consulting, LLC: Management consultants in charge of organizing the external and internal efforts to complete the plan, as well as being the contact point for the HSP and CEC.

Site Design and Engineering

H2B2 spearheaded the development, design, and engineering of SoHyCal, showcasing its expertise in hydrogen technology and infrastructure. The project involved site planning, system integration, and optimizing hydrogen production and distribution to meet California's clean energy standards.

Fresno County staff expedited construction, while H2B2 ensured detailed documentation for necessary permits. Collaboration with the SJVAPCD was vital for biogas engine approvals, with Dirk Poeschel Land Development Services and Fresno EDC providing critical support during the permitting process, including engagement with the Fresno County Planning Commission.

In December 2021, the initial documentation, including the Project Initiation Document (PID)[16], was completed, followed by a Hazop study. In January 2022, the Safety Plan Report was finalized. By February 2022, the Site Plan was approved by Fresno County. In March 2022, process engineering was nearly complete, with I&C and Electrical systems at 60%.

In May 2022, a revised Site Plan was approved, and most engineering, including grading and main equipment foundations, was completed. By September 2022, all civil designs were ready, and most engineering tasks were finished, except for plant control documents.

[14] https://safetyculture.com/topics/hazop/

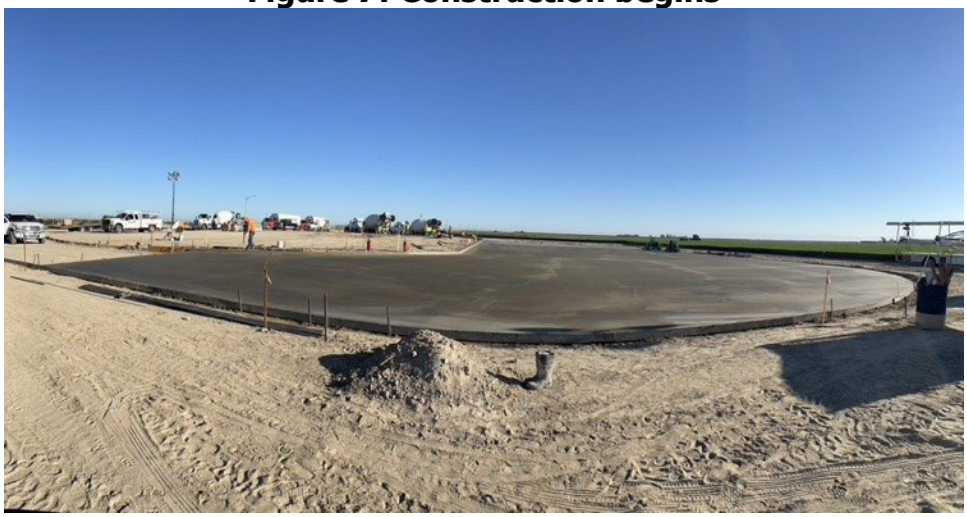
[15] https://saltegra.com/lopa/layer-of-protection-analysis-lopa-california-usa/

[16] https://www.gre.ac.uk/docs/rep/information-and-library-services/project-initiation-document-pid

Site Preparation and Construction

After receiving all the necessary permits and approval to build, H2B2 selected local general contractor Morris General Contracting as their general contractors in June 2022. In July 2022, the construction team broke ground and preparation of the site began. Utilizing local construction gave the opportunity to indirect jobs to a company that is in an underserved community. The advantage of using a local construction company means the transportation to their warehouse was a ten-minute trip and had local stores to purchase materials. The stores vary from nearby hardware stores to lumber yards, and other miscellaneous items.

Figure 7: Construction begins



The start of the east side concrete road commenced as the outline Starting with the east side driveway, concrete was poured. This outlines the plant with the most significant open area of the plant.

Source: *H2B2 USA* Date: 8/2022

Figure 8: Electrical Room and Rectifier

The remainder of the driving path has been poured. Shortly following were the foundations for the water treatment plant, the rectifier and the electrical room.

Source: *H2B2 USA* Date: 10/2022

Figure 9: Water Treatment Plant Installation

The installation of the water treatment began while finishing the electrical and control building.

Source: *H2B2 USA* Date: 11/2022

Figure 10: Electrolyzer, Compressor and Chiller Foundations

General view. Foundations completed for the electrolyzers, cable trays, air compressor room, chiller and compressor. These are the remaining foundations to install equipment to complete the full train.

Source: *H2B2 USA* Date: 12/2022

Figure 11: Electrolyzer Container Installation

Monumental day for H2B2 as our electrolyzer arrives onsite. Also slightly seen in the picture is the chiller to the left, cable tray poles in the center, and the compressor to the right in light blue.

Source: *H2B2 USA* Date: 01/2023

Figure 12: Biogas Unit Installation

Biogas engine arrives on site. Although not complete, this progress was important to outline the gas lines correctly.

Source: *H2B2 USA* Date: 05/2023

Commissioning

In April 2023, H2B2 began the commissioning phase with cold commissioning, followed by hot commissioning using biogas to operate the biogas engine and the full production train. Cold commissioning checked mechanical, electrical, and control systems without fluid flow, while hot commissioning involved energizing systems with circulating fluids. Key equipment, including the rectifier and electrolyzer, were commissioned, with the compressor tested last. Initial testing at 198 bar focused on hydrogen production and dispensing. The process faced challenges, requiring collaboration between H2B2 staff and the equipment manufacturer's team. Early issues with the biogas engine and rectifier inverter were resolved through continuous testing and remote support from Spain. Despite these difficulties, successful integration of the rectifier ensured plant readiness.

During this period, H2B2 needed to hire three operators to manage the plant and oversee upgrades. Support from our team in Spain, both remotely and in person, was essential. Furthermore, a total of four local hires were engaged to coordinate efforts and manage administrative tasks.

With the electrolyzer now fine-tuned, the insights gained during commissioning have informed the manufacturing and testing of future electrolyzers. Similarly, the 2G unit has benefited from these lessons, serving as a critical test ground for future projects.

Figure 13: Biogas Engine Testing

Using a natural gas trailer, the biogas engine was commissioned in island mode. The thought behind this was being able to commission the electrolyzer using the biogas engine while the biogas lines continue to progress.

Source: *H2B2 USA* Date: 06/2023

Testing

As part of the Air Districts' requirements, a source test is necessary for commissioning the biogas engine, which has been approved under an Authority to Construct (ATC) permit. The SJVAPCD enforces strict emission standards for biogas engines to minimize air pollution, setting low limits for pollutants like NOx, CO, VOCs, and PM. NOx emissions are capped at 11-

25 parts per million (ppm)[17], with similar limits for CO and VOCs. Facilities must utilize advanced pollution control technologies, such as SCR for NOx and oxidation catalysts for CO and VOC reduction, to meet these standard.

To ensure compliance, facilities must regularly monitor emissions, and some may require Continuous Emission Monitoring Systems (CEMS). In addition to adhering to emission limits, companies must obtain an ATC and a Permit to Operate (PTO) before any installation or modifications. These measures aim to help the San Joaquin Valley, which struggles with air quality, move towards cleaner energy using renewable biogas resources (SJVAPCD Rule 4702).[18]

On July 3rd, 2024, we conducted a source test with AirX Testing who is a certified third-party vendor. During the test, the SJVAPCD was onsite to witness the test and verify the test. There, data was reviewed for a six-hour period to ensure all emissions comply to meet the PTO requirements. The source test results were submitted to SJVAPCD for review. The PTO will then be granted but the process typically takes several months to complete which leaves this still pending. The next source test needed will be before our anniversary date which is July 3rd of 2025. After that, the source test will need to be completed biyearly, and all data must be collected and submitted to the SJVAPCD on a regular basis. All plant Operators have been trained to collect the data and adhere to any visits from the SJVAPCD.

Production

The SoHyCal project successfully commenced commercial operations on September 7, 2023, following the completion of its commissioning phase. Despite several challenges during the integration of various systems required to complete the process, the team's collaborative approach enabled them to fine-tune the electrolysis process effectively. A key component of production was the biogas engine supplied by 2G Energy Inc, which was still optimizing its operation in island mode.

Currently, SoHyCal operates a three-MW electrolyzer, which has the potential to produce over 1,000 kilograms of hydrogen per day. However, the electrolyzer is only receiving one MW of power from the biogas engine, which limits its production to between 200 and 250 kilograms of hydrogen per day. This reduced output is influenced by various factors, including ambient temperatures that affect the biogas skid performance, supplied by BAR 20 and monitored by California Bioenergy (CalBio)[19]. These conditions necessitate careful monitoring and adjustment to maintain optimal production levels. Although these factors impact the energy powering our plant, they do not cause any severe hurdles reducing our production. The power being received from the grid provided by PG&E is not used for hydrogen production given that there is not renewable energy available.

[17] https://www3.epa.gov/ceampubl/learn2model/part-two/onsite/doc/Indoor%20Air%20Unit%20Conversions.pdf

[18] https://ww2.valleyair.org/search-results?q=rule+4702

[19] https://calbioenergy.com/

CHAPTER 4: Results

Data Collection & Analysis

H2B2 submitted to California Air Resources Board a joint application with CalBio Biogas for the Low Carbon Fuel Standard Carbon Intensity (CI) score for the produced green hydrogen, the data being collected includes biogas production metrics, such as feedstock types, volumes, and methane content, along with energy generation data from the biogas engine, including electricity output, efficiency, and emissions. Additionally, information on hydrogen production through electrolysis will be gathered, focusing on energy consumption, hydrogen yield, and purity. Comprehensive greenhouse gas emissions data, covering biogas capture, energy conversion, and hydrogen production, will also be included to quantify lifecycle emissions reductions.

Table 1: SoHyCal Operational Data

Monthly values	
date	**Hydrogen production [kg/month]**
Aug-23	30.50
Sep-23	168.12
Oct-23	52.21
Nov-23	95.02
Feb-24	434.47
Mar-24	7.77
Apr-24	No production
May-24	No production
Jun-24	245.849
Jul-24	337.89
Aug-24	318.4
Sep-24	96.63
Oct-24	344.48
Total	**2,131.34**

Source: *H2B2 USA*

A few notes from the table above are that the hydrogen being produced is based on the requirements of our clients.

While SoHyCal phase 1 is set for a nameplate capacity for 1,281.6 kilograms renewable hydrogen per day, production is currently limited to approximately 300 kilograms per day due energy availability. The biogas being derived from the dairy has had to make modifications to their skids, limiting the amount of biogas being delivered for renewable energy production. Thus, the limitation of energy and the demands from our clients are reflected in the data above. Without a doubt, the restrictions are being resolved and the client demand is increasing. FAX for instance, has begun to utilize their FCEB on a daily basis. Additionally, given that there is no storage on site, production is done for the demand of client needs.

During phase two, onsite storage will be implemented along with a hydrogen refueling station. Both of which will allow for more steady production. In regard to limitations from renewable energy the solar farm that will be used to power the plant will allow us to maximize the hydrogen production and produce the full 9 megawatts through electrolysis. Currently we are working on closing out additional agreements with off takers to be able to bring more renewable hydrogen to the California market. But what we have at the current production capacity has and extremely low carbon intensity score. The score based on the biogas pathway with Calbio and the hydrogen production through electrolysis, bringing our hydrogen produced in the -1262 range, still to be confirmed by CARB.

Table 2: Data collection and proposed Carbon Intensity score

	HYF Lookup Table Pathway	HYEG Lookup Table Pathway	Calbio Pathway	This Tier 2 Pathway
Process Description	**NG to Gaseous H2 from SMR**	**Gaseous H2 from electrolysis (grid**	**Dairy/Swine manure to Biogas to Electricity**	**Dairy/Swine manure to Biogas to Electricity to H2**
NG Recovery	6.07			
NG Processing	3.31			
NG or RNG Transport	5.5			
LFG Recovery				
LFG Processing				
RNG CI entering the SMR				
H2 Production	20.46			
H2 Production Non-combustion	64.09	153.95		-1282.87
Liquefaction				
H2 Transport (Gaseous H2): 100 miles	7.21			7.21
H2 Transport (Gaseous H2): Additional 40 miles				2.88
Gaseous H2 Compression and Precoolir	11.04	10.51		10.51
Electricity CI			-763.33	
Total CI	**117.67**	**164.46**	**-763.33**	**-1262.26**

Source: *H2B2 USA*

The expected CI score, according to our calculations listed below should be approximately -1262.The collected data will be used to calculate the overall CI score of the hydrogen produced, reflecting the environmental benefits of this biogas-to-hydrogen pathway. The provisional pathway to get the approved CI score from California Air Resource Board (CARB) is expected to be determined during Q1 of 2025.

Subcontractors and Budgets

Table 3: Agreement Budget and Total Expenditures

.	Budget		Cumulative Approved Invoices		Remaining Balance		% of Agreement Funding Invoiced	
Cost Category	**CEC Share**	**Match Share**	**CEC Share**	**Match Share**	**CEC Share**	**Match Share**	**CEC Share**	**Match Share**
Direct Labor	$121,512	$75,529	$121,512.46	$74,492.18	$0.00	$1,036.82	100.00%	98.63%
Fringe Benefits	$0	$0	$0.00	$0.00	$0.00	$0.00	0.0%	0.0%
Travel	$0	$0	$0.00	$0.00	$0.00	$0.00	0.0%	0.0%
Equipment	$693,617	$338,468	$693,616.15	$667,304.98	$0.00	$(328,836.98)	100.00%	197.15%

Materials/ Miscellaneous	$172,462	$149,538	$172,462.00	$461,621.25	$0.00	$(312,083.25)	100.00%	308.70%
Subrecipients/ Vendors	$2,977,409	$1,537,307	$2,977,408.84	$2,674,666.25	$0.00	$(1,137,359.25)	100.00%	173.98%
Indirect Costs	$0	$99,616	$0.00	$0.00	$0.00	$99,616.00	0.0%	0.0%
Profit (not allowed for grant recipients)	$0	$0	$0.00	$0.00	$0.00	$0.00	0.0%	0.0%
Grand Totals	***$3,965,000***	***$2,200,458***	***$3,964,999.45***	***$4,188,759.53***	***$0.55***	***$(1,988,301.53)***	***100.00%***	***176.24%***
Retention Amount Withheld:			***$396,499.95***					
Total Paid:			***$3,568,499.04***		***$396,499.95***		***90.00%***	

Source: *H2B2 USA*

The nearly $4 million grant received from the CEC in support of the SoHyCal project helped turn vision into reality. H2B2 believed from the outset in the viability of hydrogen as a critical component in California's plan to reduce emissions and power the transportation sector with renewable fuels. As such, their investment in this project has also been substantial. H2B2 significantly exceeded the match funds requirement early in the project as the CEC funds primarily supported the project site, equipment, and materials necessary to build a hydrogen generation plant of this capacity.

Statement of Future Intent

The SoHyCal project serves as a strong foundation for H2B2 as we advance to future phases. Lessons from the first phase are being incorporated into the second, such as expediting permitting, collaborating with local engineering firms, and ensuring high performance from local contractors and entities. The innovative design of electrolyzers maximizes space for operators, enhancing efficiency.

Looking ahead, H2B2 aims to replicate this model across California, the U.S., and globally, partnering with dairy farms to drive hydrogen production and reduce emissions. The scalable design and forward-thinking approach position us for a zero-emissions future.

The agreement between FAX and H2B2 marks a significant step toward sustainable public transportation. With a three-year commitment and two, one-year options, for locally produced green hydrogen, the partnership ensures FAX has a reliable source of clean hydrogen to support its transition to hydrogen-powered buses. As FAX looks to expand its fleet, H2B2 is prepared to meet their growing demand for zero-emission fuel.

This collaboration offers a true path to zero emissions, as hydrogen fuel cells produce only water vapor. It comes at a crucial time for FAX, following difficulties with their electric buses, which have all been taken out of service due to complication to the electric buses, that include weight issues and repairs needed without availability to received replacement parts. By switching to hydrogen, FAX can overcome these setbacks and achieve its sustainability goals, contributing to California's clean transportation and air quality objectives.

Figure 14: H2B2 H2 trailer refueling City of Fresno FCEV Bus

A FAX bus is being refueled using the GTL Leasing gaseous hydrogen trailer.

Source: *H2B2 USA* Date: 06/2024

Findings, Conclusions and Recommendations

The SoHyCal project, based in Kerman, California, represents a pioneering effort in the production of green hydrogen utilizing biogas from dairy operations in the Central Valley. As the first initiative of its kind, SoHyCal integrates agricultural waste management with renewable energy technology to advance hydrogen production through electrolysis.

Key Findings

- Green Hydrogen Production: The project effectively converts dairy biogas, primarily methane, into energy to use as power to produce green hydrogen and feedstock to fuel cells. This process captures methane emissions, turning them into a renewable energy source.
- Electrolysis Production with Renewable Energy: Using biogas-derived electricity, the electrolysis process splits water into hydrogen and oxygen, ensuring emission-free hydrogen production.
- Environmental Impact: The project has achieved a preliminary carbon intensity (CI) score of approximately -1262, pending confirmation by the CARB. A negative CI score indicates a net reduction in greenhouse gases, demonstrating the project's significant climate benefits.
- Economic and Scalability Benefits: SoHyCal provides a scalable model of being able to take something that was once a contributor to emissions, to now being able to divert emissions and promote a renewable fuel. Using a similar approach, SoHyCal shows that it can be replicated in other regions with similar agricultural profiles.

Conclusion

The SoHyCal project exemplifies innovation and sustainability, offering a scalable green hydrogen production solution. Its projected negative carbon intensity score underscores its significant climate impact potential and aligns with California's energy policy goals. This project has demonstrated the promising potential of dairy farm biogas collection as a viable pathway for hydrogen production via electrolysis. The partnership with Bar 20 has been instrumental, positioning them as forward-thinking sustainability leaders and playing a crucial role in advancing hydrogen production for California and beyond.

We also extend our sincere gratitude to the California Energy Commission for their invaluable support in enabling H2B2 to move this project forward. Their assistance has been essential to overcoming potential delays and ensuring continued progress in renewable hydrogen production in California. Together, we have brought this project to a point that serves as a replicable model for large-scale application

Recommendations

Using dairy biogas for hydrogen production through electrolysis offers a sustainable, low-carbon solution aligned with California’s climate and energy goals. This approach reduces greenhouse gas emissions and utilizes waste products to generate clean energy, supporting a closed-loop, resource-efficient model.

To maintain consistent hydrogen production, a combination of renewable energy sources such as solar, wind, and grid-tied electricity is essential. This diversified approach ensures steady output by mitigating risks associated with biogas availability fluctuations, providing a resilient and adaptable energy system.

Replicating the dairy biogas-to-hydrogen model across California offers a scalable solution for expanding renewable hydrogen infrastructure. By collaborating with local dairy farms, regions throughout the state can harness local resources to generate hydrogen, contributing to decentralized production and distribution networks. Involving public agencies, such as the California Energy Commission and regional transit authorities, is essential for sharing resources, securing permits, and building hydrogen infrastructure efficiently. These partnerships would streamline the permitting process, provide financial and logistical support, and ensure hydrogen fuel is accessible to public fleets and transit systems. Coordinated resource-sharing between agencies and producers can significantly enhance the impact and reach of renewable hydrogen, benefiting both local economies and state-wide sustainability initiatives.

GLOSSARY

ALTERNATING CURRENT (AC)—Flow of electricity that constantly changes direction between positive and negative sides. Almost all power produced by electric utilities in the United States moves in current that shifts direction at a rate of 60 times per second.

AUTHORITY TO CONSTRUCT (A/C) - A pre-construction permit issued by an air district.

BATTERY ELECTRIC VEHICLE (BEV)—Also known as an "All-electric" vehicle (AEV), BEVs utilize energy that is stored in rechargeable battery packs. BEVs sustain their power through the batteries and therefore must be plugged into an external electricity source in order to recharge.

BIOGAS[20] – The mixture of methane, carbon dioxide, and other minor gases formed from the decomposition of organic materials.

CALIFORNIA BIOENERGY (CALBIO) – a company working with the dairies we capture methane, a potent greenhouse gas, that currently is released into the atmosphere and use it beneficially.

CALIFORNIA DEPARTMENT OF TRANSPORTATION (Caltrans)— Is responsible for the design, construction, maintenance, and operation of the California State Highway System, as well as that portion of the Interstate Highway System within the state's boundaries.

CALIFORNIA ENERGY COMMISSION (CEC)—The state agency established by the Warren-Alquist State Energy Resources Conservation and Development Act in 1974 (Public Resources Code, Sections 25000 et seq.) responsible for energy policy. The Energy Commission's five major areas of responsibilities are:

1. Forecasting future statewide energy needs
2. Licensing power plants sufficient to meet those needs
3. Promoting energy conservation and efficiency measures
4. Developing renewable and alternative energy resources, including providing assistance to develop clean transportation fuels
5. Planning for and directing state response to energy emergencies.

CARBON INTENSITY (CI) - The amount of carbon by weight emitted per unit of energy consumed. A common measure of carbon intensity is weight of carbon per British thermal unit (Btu) of energy. When there is only one fossil fuel under consideration, the carbon intensity and the emissions coefficient are identical. When there are several fuels, carbon intensity is based on their combined emissions coefficients weighted by their energy consumption levels.

[20] https://afdc.energy.gov/fuels/natural-gas-renewable

COMPRESSED NATURAL GAS (CNG)—Natural gas that has been compressed under high pressure, typically between 2,000 and 3,600 pounds per square inch, held in a container. The gas expands when released for use as a fuel.

CONTINUOUS EMISSION MONITORING (CEM) - CEM involves determining compliance of stationary sources with their emission limitations on a continuous basis by installing a system to operate continuously inside of the smokestack or other emission source. CEM are also used for process control and to monitor the operations of the control equipment.

DIRECT CURRENT (DC)— Electricity that flows continuously in the same direction.

FRESNO AREA EXPRESS (FAX) - a public transportation system in Fresno, California, operated by the City of Fresno.

FUEL CELL ELECTRIC VEHICLE (FCEV) - A zero-emission vehicle that runs on compressed hydrogen fed into a fuel cell "stack" that produces electricity to power the vehicle.

GRANT FUNDING OPPORTUNITY (GFO) – meaning it is a solicitation for grant applications where organizations can apply for funding to support projects related to energy efficiency, clean transportation, or other relevant initiatives within California energy policy.

GREENHOUSE GAS (GHG) - Any gas that absorbs infra-red radiation in the atmosphere. Greenhouse gases include water vapor, carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), halogenated fluorocarbons (HCFCs), ozone (O3), perfluorinated carbons (PFCs), and hydrofluorocarbons (HFCs). (EPA).

HAZARD AND OPERABILITY STUDY (HAZOP) - which is a systematic process for identifying and evaluating potential problems in a system.

HYDROGEN EQUIPMENT ENCLOSURE (HEE) - a specially designed, secure area or container used to house and protect hydrogen storage and delivery equipment, like tanks, piping, and control systems, from environmental factors while mitigating potential hazards associated with the flammable nature of hydrogen gas.

HYDROGEN GENERATION ROOM (HGR) - a designated area specifically designed to house the equipment and processes necessary to produce hydrogen gas, typically through electrolysis, where water is split into hydrogen and oxygen using electricity.

HYDROGEN SAFETY PLAN (HSP) - a comprehensive document outlining procedures and protocols to ensure the safe production, storage, handling, and use of hydrogen gas, by identifying potential hazards associated with hydrogen operations, evaluating their risks, and implementing preventative measures to minimize the likelihood of accidents and injuries, including proper equipment design, personnel training, leak detection systems, and emergency response procedures.

LAYER OF PROTECTION ANALYSIS (LOPA) - which is a risk assessment technique used to evaluate the likelihood of a harmful event occurring.

LOW CARBON FUEL STANDARD (LCFS) A set of standards designed to encourage the use of cleaner low-carbon fuels in California, encourage the production of those fuels, and therefore, reduce greenhouse gas (GHG) emissions. The LCFS standards are expressed in terms of the "carbon intensity" (CI) for gasoline and diesel fuel and their respective substitutes. The LCFS is a key part of a comprehensive set of programs in California to cut greenhouse gas emission

and other smog-forming and toxic air pollutants by improving vehicle technology, reducing fuel consumption, and increasing transportation mobility options.

OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) - a federal agency that works to ensure safe and healthy working conditions for employees.

PACIFIC GAS AND ELECTRIC (PG&E) - a utility company that provides natural gas and electricity to California.

PROGRAMMABNLE LOGIC CONTROLLER (PLC) - an instrument that receives input data from sensors, calculates the difference between the actual value and the desired setpoint, and adjusts outputs to control variables such as temperature, flow rate, speed, pressure, and voltage.

PROJECT INITIATION DOCUMENT (PID) - a document created at the start of a project that outlines the key details, goals, scope, and objectives of the project, providing a comprehensive overview for all stakeholders involved to understand the project's purpose, approach, and success criteria; essentially serving as a foundational document to guide the project team throughout its lifecycle.

PROTON EXCHANGE MEMBRANE (PEM) ELECTROLYSIS – The electrolysis of water for the production of hydrogen in a cell equipped with a solid polymer electrolyte that is responsible for the conduction of protons, separation of product gases, and electrical insulation of the electrodes.

PHOTOVOLTAIC (PV) POWER STATION – is a large-scale grid-connected power system which uses solar generated power to provide merchant power.

PERMIT TO OPERATE (PTO) - a legal document that allows the operator of a piece of equipment to begin operating it after all construction and installation is complete.

SAN JOAQUIN AIR POLLUTION CONTROL DISTRICT (SJVAPCD) - a public health agency whose mission is to improve the health and quality of life for all Valley residents through efficient, effective and entrepreneurial air quality management strategies.

SELECTIVE CATALYTIC REDUCTION (SCR) SYSTEM- An emission control system that reduces Nox emissions through the catalytic reduction of Nox in diesel exhaust to N2 and H2O by injecting nitrogen-containing compounds into the exhaust stream, such as ammonia or urea.

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE) - SAE International, formerly the Society of Automotive Engineers, is a U.S.-based, globally active processional association and standards organization for engineering professionals in various industries.

SUPPORT EQUIPMENT ROOM (SER) - a space that houses equipment that is used by a company or department and is often located near that department.

UNINTERRUPTED POWER SUPPLY (UPS) - is a device that allows a computer to keep running for at least a short time when incoming power is interrupted. Provided utility power is flowing, it also replenishes and maintains energy storage.

ZERO EMISSION VEHICLES (ZEV) - a vehicle that does not produce tailpipe emissions of greenhouse gases or criteria pollutants. ZEVs can be battery-electric, hydrogen fuel cell, or plug-in hybrid electric.