CALIFORNIA ENERGY COMMISSION

California Energy Commission

Clean Transportation Program

FINAL PROJECT REPORT

Scaling Up the True Zero Network

Hydrogen Station – 15544 San Fernando Mission Blvd, Los Angeles, CA 91345

Prepared for: California Energy Commission

Prepared by: FirstElement Fuel, Inc.

Gavin Newsom, Governor

MARCH **2024 | CEC-600-2024-019**

California Energy Commission

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The construction of the Mission Hills hydrogen refueling station has only been possible because of the substantial efforts and funds provided by a number of stakeholders.

FirstElement Fuel graciously thanks Toyota for their vision and fortitude, Honda for their innovation and environmental commitment, Linde for their partnership in advancing sustainable hydrogen infrastructure, Tatsuno for their dedication to innovation and reliability, and of course, Jean Baronas, Mark Johnson, Kevyn Piper, and many others at the California Energy Commission for tremendous, sustained confidence in clean, alternative transportation.

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.
- Retrofit medium- and heavy-duty on-road and nonroad vehicle fleets to alternative technologies or fuel use.
- 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 solicitation Grant Funding Opportunity (GFO)-15-605, Light Duty Vehicle Hydrogen Refueling Infrastructure to provide grant funds to expand the network of publicly accessible hydrogen refueling stations that serve California's light duty fuel cell electric vehicles (FCEVs). In response to GFO-15-605, FirstElement Fuel submitted an application which was proposed for funding in the CEC's notice of proposed awards November 8, 2017, and the agreement was executed as ARV-17-018 on March 11, 2018.

ABSTRACT

Per the terms of funding agreement ARV-17-018 between the California Energy Commission (Energy Commission) and FirstElement Fuel, Inc. (FEF), FEF designed, engineered, permitted, constructed, and commissioned a hydrogen refueling station located at 15544 San Fernando Mission Blvd, Los Angeles, CA 91345. FEF plans to own and operate the hydrogen refueling station until at least 2025. The station consists of an enclosed compound, or building, that houses compressing and dispensing equipment, high pressure storage tubes, two dispensers each with two fueling positions, a customer payment interface, and canopies for each dispenser.

Keywords: California Energy Commission, FirstElement Fuel, Inc., hydrogen refueling station, hydrogen infrastructure, fuel cell vehicles

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EXECUTIVE SUMMARY

Hydrogen fuel cell electric vehicles (FCEVs) and hydrogen refueling stations are expected to play key roles in California as the state transitions to lower-carbon and zero-emission vehicle (ZEV) technologies for light-duty passenger vehicles, transit buses, and truck transport fleets. Numerous government regulations and policy actions identify FCEVs as a vehicle technology that will be available to meet the California Air Resources Board Zero Emission Vehicle Regulation and the Governor's Zero Emission Vehicle Mandate. More specific actions to bring FCEVs to California markets are specified in the Governor's *Zero Emission Vehicle Action Plan*.

Hydrogen fuel cell electric drive technology offers tremendous potential for the light-duty passenger vehicle market and medium- and heavy-duty truck and bus markets. FCEV passenger vehicles can drive more than 300 miles on a tank of hydrogen and can be refueled in 3 to 4 minutes the way gasoline passenger vehicles are fueled. They have zero tailpipe emissions, while the carbon footprint of these vehicles is nearly the same as plug-in electric vehicles. The technology can be readily scaled up for SUVs, family passenger vans, pick-up trucks, urban package and beverage delivery trucks, and heavy-duty trucks and buses. Most auto industry analysts and agencies view fuel cell electric drive technology as a complement to battery electric drive technologies, rather than as a competing technology. Both battery and fuel cell electric vehicle technologies will be needed in California to achieve the ZEV deployment goals.

In contrast to battery electric and plug-in hybrid electric vehicles that can be charged in home settings, FCEVs require a new network of refueling stations that dispense pressurized hydrogen for consumer use. This has meant that the auto industry and station development industry have had to co-develop two new technologies in parallel: hydrogen refueling infrastructure and hydrogen fuel cell electric vehicles. FCEVs cannot be widely marketed and sold to consumers without a minimum network of refueling stations available.

Assembly Bill (AB) 118 (Núñez, Chapter 750, Statutes of 2007), created the Clean Transportation Program. The statute authorizes the California Energy Commission (Energy Commission) to develop and deploy alternative and renewable fuels and advanced transportation technologies to help attain the state's climate change, clean air, and alternative energy policies. AB 8 (Perea, Chapter 401, Statutes of 2013) re-authorizes the Clean Transportation Program through January 1, 2024. The Clean Transportation Program has an annual budget of approximately $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.
- Retrofit medium-and heavy-duty on-road and non-road vehicle fleets to alternative technologies or fuel use.

- 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.

The Energy Commission issued solicitation Grant Funding Opportunity (GFO)-15-605, Light Duty Vehicle Hydrogen Refueling Infrastructure, to provide grant funds to expand the network of publicly accessible hydrogen refueling stations that serve California's light duty fuel cell electric vehicles (FCEVs). To be eligible for funding under GFO-15-605, the projects must also be consistent with the Energy Commission's Clean Transportation Program Investment Plan updated annually.

In response to GFO-15-605, FirstElement Fuel, Inc. submitted an application for a number of stations, including one to be located at 15544 San Fernando Mission Blvd, Los Angeles, CA 91345, which was proposed for funding in the Energy Commission's Notice of Proposed Awards on November 8, 2017.

The California Energy Commission contributed $1,870,000 of the total $3,162,008 cost to design, engineer, permit, construct, and commission the station.

CHAPTER 1:
Purpose

Hydrogen distribution and dispensing infrastructure is not readily available to meet projected commercial targets for the deployment of FCEVs. As FCEVs are deployed in greater quantities, a network of refueling stations is needed to provide coverage which takes advantage of the range of the vehicle, and provides a means to transport, store, and dispense hydrogen. The purpose of this agreement is to provide a hydrogen refueling station at 15544 San Fernando Mission Blvd, Los Angeles, CA 91345. The station equipment stores liquid hydrogen and dispenses gaseous hydrogen.

This project will help address scientific and technical barriers to the build out of hydrogen refueling infrastructure, including addressing the limited availability of hydrogen refueling infrastructure performance data by delivering station performance data for larger capacity stations, namely those which can provide up to 310 kg of hydrogen in 12 hours, or over 1,200 kg in 24 hours.

Improvements to the network of hydrogen refueling stations and an expected corresponding increase in FCEVs will support the carbon reduction and air quality improvement goals of the State of California, such as the ZEV Mandate, which calls for sufficient alternative refueling infrastructure to support up to 1 million ZEVs by 2020, reaching 1.5 million ZEVs on the road in California by 2025. Hydrogen FCEVs are expected to play a critical role in meeting the ZEV Mandate targets.

Inherent Efficiency of Liquid Hydrogen

Liquid hydrogen, as used in the Mission Hills station, has storage, transportation, and pumping efficiencies compared to gaseous hydrogen in hydrogen infrastructure scenarios. Compression of gaseous hydrogen at fueling stations up to the pressures required to fully fill FCEVs requires 3-5 kWh/kg of electricity. Because pumping a liquid is much more efficient than compressing a gas, liquid pump stations use less than 1 kWh/kg to accomplish the same task. This is important because electricity at individual hydrogen stations sites can be expensive and is generally hard to make renewable.

Because of the already extremely cold temperature of liquid hydrogen (-416°F), no additional refrigeration system is required to meet fueling protocol in the SAE J2601 cold fill requirements. This saves capital costs, reduces electricity consumption, and in FirstElement Fuel's (FEF) experience, improves reliability.

Delivery of liquid hydrogen is common practice in the industrial gas industry. This means that the safety, costs, and operational experience of using liquid hydrogen are well understood. Liquid hydrogen delivery trucks can easily carry 10 or more times the deliverable hydrogen as equivalently sized gaseous hydrogen trucks (see Figure 1 below). This enables multiple stops and "short, milk runs" without constantly returning to the plant to get a new load and substantially reduces emissions and carbon associated with trucking hydrogen.

Figure 1: Liquid Hydrogen and Gaseous Hydrogen Delivery Trucks

Liquid hydrogen truck can deliver 2,400 kgs (left) compared to 120 kgs for gaseous H2 truck (right). Source: FirstElement Fuel, Inc.

Higher Capacity Results in Lower Price at the Pump

Because of the FEF dedicated hydrogen supply, volume equipment purchasing, CEC grant funding, and HRI credit value, FEF will be able to lower the hydrogen price at the pump to be competitive with gasoline immediately.

With the Mission Hills station capacity of 1,200 kg/day:

- 4 fueling positions (any 3 simultaneous) to improve customer experience and reduce wait times
- Have over 900 kgs of storage to better mitigate potential supply disruptions
- Have a retail hydrogen price competitive with gasoline on a per mile basis

These leaps in performance and price are made possible by moving to liquid hydrogen production, distribution, storage, and pumping. It generally takes more energy to produce liquid hydrogen, compared with liquid hydrogen, but the storage costs and energy densities exceed those of gaseous hydrogen. Like most industrial processes, scale is an important factor in both cost and efficiency for hydrogen production. Because liquid hydrogen is relatively inexpensive to store and transport, a single large, efficient, optimized facility can be used to serve the entire network. This results in lower cost hydrogen supply. In addition, pumping a liquid is inherently more efficient than compressing a gas. Therefore, the pumps used in this generation of the stations are considerably smaller, more efficient, have higher throughput, and lower cost than comparable compressor systems.

The advantages of liquid hydrogen production, delivery, and storage are common knowledge in the hydrogen industry. But most stations rely on gaseous hydrogen because there has historically been enough excess gaseous hydrogen from existing industry applications for the insignificant amount needed for FCEVs, and because new liquid hydrogen production requires substantial capital investment. FEF is fortunate to have developed a secure source for liquid hydrogen for the current batch of stations that will enable substantially reducing the price of this fuel.

Sustainability and Environmental Impacts

FEF notes that hydrogen and FCEVs are among the most effective means to achieve sustainable transportation in the State of California. That is part of FEF's mission statement and the motivation for starting this company in the first place. FEF aims to grow the proportion of FCEVs on the road as quickly as possible so that California, and the world, can fully capitalize on the environmental benefits of electric propulsion. FEF understands that, based on years of analysis and research, FCEVs can change the world in a positive way by:

- Reducing criteria pollutant emissions
- Improving urban air quality
- Reducing greenhouse gas emissions, and
- Reducing dependency on petroleum

Part of the FEF core business strategy is to simultaneously accelerate the adoption of FCEVs and to maximize the potential environmental benefits through a conscientious approach to the fuel supply chain, the operation of hydrogen station projects, and even the hydrogen development process for the hydrogen station in Mission Hills.

CHAPTER 2:
Approach

FEF has worked hard and considers itself to have built the largest, most experienced and dedicated team for retail opening and operation of hydrogen refueling stations. FEF has successfully created the largest and most reliable hydrogen refueling network in the world and has provided OEMs the confidence to release FCEVs on a large scale into the California market. FEF stations have the best up-time performance in the state of California. Primary in the FEF culture is a focus on the customer experience and a focus on the safety and security of the FEF team and stations. To that end, FEF has developed, and continue to refine, rigorous technical and safety training procedures for the service and maintenance personnel.

Field Service Operations Technical Training

FEF Technical Training policies are intended to ensure that personnel have the right tools and experience required for the job. No employee is put in a situation where their safety is compromised. For that reason, FEF has implemented a competence tracking system where employees are graded based on their competence in a specific field of work. The four major competence categories include:

- Observer: where the personnel can only assist in a task
- Supervised: where the personnel can perform the task only if supervised
- Independent: where the personnel can perform the work unsupervised
- Trainer: where the personnel can train others on the task

For an employee to be qualified to work independently in the field, they must meet the competence criteria after working with a Trainer for enough time. Typical supervised training period is one to two months or more.

Field Service Safety Training

In addition to hands-on Station Operational Technical training, FEF personnel are constantly discussing, learning, and reviewing general safety procedures and operations.

Communication

The Field Service Team meets three times per week to discuss operational status and safety procedures. A new safety topic is introduced at every meeting and is discussed during at least three meetings. Additionally, prior to beginning every operational meeting a moment is taken to discuss a "Safety Moment".

Training Methods

The safety training program uses some or all of the following communication methods: video instruction, group discussion, homework, quick phone quizzes and when possible, practical hands-on practice. Attendance is tracked to ensure that, at a minimum, each employee

attends two of these safety sessions. At these meetings, all new policies and procedures are introduced, and the employee is told where this information resides within the company.

Special Work

When a new task is being conducted or the task does not have established procedures, pertinent employees are all trained on performing a Job Hazard Analysis prior to beginning the work.

Contractors

In some cases, where FEF requires the help of a contractor, for example in construction, refrigeration, or crane operation, FEF only employs contractors who are qualified to do the work, have a similar vision for safety and have a proven track record. These records are viewed through their U.S Occupational Safety and Health Administration Form 300A for the past three years. If there are any major injuries in the records, these are investigated to ensure that the contractor has the right culture and policies in place.

Station Operation and Maintenance

FEF has established a Preventive Maintenance Plan for the station in Mission Hills that mandates Monthly, Quarterly, Semi-Annual, and Annual scheduled maintenance activities. Each week the Team Manager reviews the preventive maintenance schedule, opens work orders for each site with the tasks to be completed by the Technicians on duty, and verifies completion of the prior week's work orders. As a routine part of the scheduling, the Team Managers arrange the planned maintenance activities to avoid cluster shutdowns of adjacent stations in the network that would otherwise create area-wide unavailability.

Far too often a robust service machine falters due to lack of communication. Therefore, simply relying on a chart of maintenance activities on a map is not sufficient. FEF goes a few steps further. The FEF Hydrogen Engineers are in constant contact with each other, literally 24 hours a day, seven days a week. The team also meets three times a week for operational meetings with Management, Schedulers and Service Technicians. FEF utilizes internal social media apps and cloud-based documentation for companywide communication at all times. The entire team knows the status of all activities at each station from any connected computer, tablet or smart phone. This communication serves greatly in the coordination of planned maintenance, emergency maintenance, stress testing, press events, vacations, etc.

Additionally, FEF coordinates its planned maintenance activities at the Mission Hills station such that all technicians are instructed to plan work such that the outage time is minimized and can return the station to working conditions with limited down time. Each technician has a personalized sign to let arriving customers at a station know that maintenance is being done, but the station is still open.

CHAPTER 3:
Activities Performed

There were many steps required to bring the Mission Hills hydrogen refueling station project to completion. The following synopsis highlights the most critical items, provides detail on each one, and states the timing required for each step for this project.

Site Acquisition

Three independent objectives must be achieved to develop a successful hydrogen station project:

1) The location must meet the needs of customers
2) The parcel must have sufficient space to safely install hydrogen fueling equipment
3) The landowner and/or business operator must be willing to participate

FEF searches for sites by first selecting specific geographic areas, then narrowing down to only those sites that have room for hydrogen, and finally, negotiating with landowners.

In early 2016, FEF took steps to identify and acquire appropriate sites for the station. FEF worked with historic vehicle sales data, academic publications, automakers, and the Energy Commission's Station Location Areas to select desired market locations. FEF then analyzed specific properties within the target locations to find sites that could meet the space requirements for hydrogen fueling equipment.

After selecting general locations and specific sites, FEF contacted station owners and operators to negotiate lease opportunities. A 10-year lease was executed with the property owner of 15544 San Fernando Mission Blvd, Los Angeles, CA 91345 on April 13, 2016.

Figure 2: Property View During Acquisition Phase

View of the property where the station is located, looking from San Fernando Mission Blvd.

Source: FirstElement Fuel, Inc.

Equipment Procurement

The equipment packages installed at the Mission Hills Hydrogen Refueling Station is comprised or three main components: Compressing and Dispensing Equipment manufactured by Linde, LLC; Ground Storage Unit manufactured by FIBA; and Point of Sale (Dispenser) manufactured by Tatsuno. The FEF team started the equipment procurement process early on in the station's development, evaluating and visiting various component and part suppliers. As hydrogen station integrators, FEF assessed and helped design an equipment package utilizing leaders in the industry to assemble an equipment package that exceeded the minimum technical required by the solicitation.

As noted in the previous chapter, FEF decided to upgrade the throughput and capacity of the Mission Hills station bringing the station dispensing capacity per day to 1,200 kgs of hydrogen. This decision resulted in a delay in the approval and engineering design process, more expenditures by FEF, but the added benefits of the increased capacity far outweighed the delay and the additional cost to FEF.

Figure 3: Installed Tatsuno Dispensers With Four Fueling Positions

Source: FirstElement Fuel, Inc.

Figure 4: Linde Unit (Compressing and Dispensing Equipment)

Source: FirstElement Fuel, Inc.

Site Design and Engineering

FEF started the site design for the Mission Hills station on January 30, 2018, where FEF engaged internal permitting and engineering teams to proceed with design scope. Due to equipment package upgrade process, where time was spent finalizing the equipment footprint with the equipment supplier, the engineering drawings were released on June 6, 2018, allowing the project to proceed with entitlement approval process.

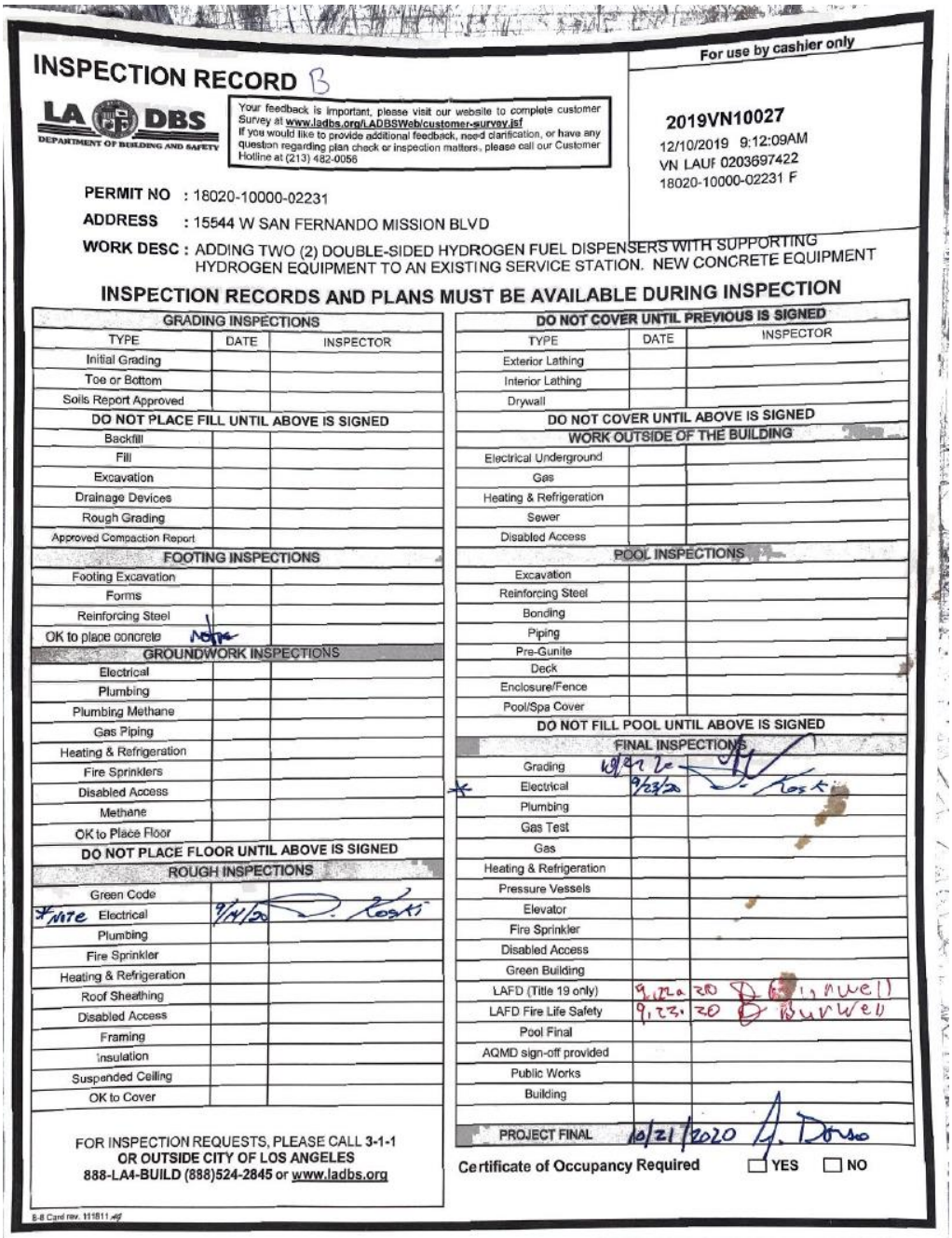
Entitlement

The local planning department typically verifies that the project meets the zoning requirements of the proposed location, and approve any aesthetic, landscaping or other details that are important to the community. The City of Mission Hills does not have a separate entitlement/permitting process. The City confirmed the overall zoning requirements concurrently with building plan check process for the Mission Hills station.

Building Plan Check

Upon completion of the construction drawings, FEF submitted the initial building permit application on July 30, 2018. Following review and corrections with the various building departments at the City of Mission Hills, FEF received the final clearances and the building permit on August 19, 2019.

Figure 5: Approved Building Permit



INSPECTION RECORD B

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12/10/2019 9:12:09AM
VN LAUF 0203697422
18020-10000-02231 F

PERMIT NO : 18020-10000-02231
ADDRESS : 15544 W SAN FERNANDO MISSION BLVD
WORK DESC : ADDING TWO (2) DOUBLE-SIDED HYDROGEN FUEL DISPENSERS WITH SUPPORTING HYDROGEN EQUIPMENT TO AN EXISTING SERVICE STATION. NEW CONCRETE EQUIPMENT

INSPECTION RECORDS AND PLANS MUST BE AVAILABLE DURING INSPECTION

GRADING INSPECTIONS		
TYPE	DATE	INSPECTOR
Initial Grading		
Toe or Bottom		
Soils Report Approved		
DO NOT PLACE FILL UNTIL ABOVE IS SIGNED		
Backfill		
Fill		
Excavation		
Drainage Devices		
Rough Grading		
Approved Compaction Report		
FOOTING INSPECTIONS		
Footing Excavation		
Forms		
Reinforcing Steel		
OK to place concrete	NOTE	
GROUNDWORK INSPECTIONS		
Electrical		
Plumbing		
Plumbing Methane		
Gas Piping		
Heating & Refrigeration		
Fire Sprinklers		
Disabled Access		
Methane		
OK to Place Floor		
DO NOT PLACE FLOOR UNTIL ABOVE IS SIGNED		
ROUGH INSPECTIONS		
Green Code		
NOTE Electrical	9/4/20	D. Kosti
Plumbing		
Fire Sprinkler		
Heating & Refrigeration		
Roof Sheathing		
Disabled Access		
Framing		
Insulation		
Suspended Ceiling		
OK to Cover		

DO NOT COVER UNTIL PREVIOUS IS SIGNED		
TYPE	DATE	INSPECTOR
Exterior Lathing		
Interior Lathing		
Drywall		
DO NOT COVER UNTIL ABOVE IS SIGNED		
WORK OUTSIDE OF THE BUILDING		
Electrical Underground		
Gas		
Heating & Refrigeration		
Sewer		
Disabled Access		
POOL INSPECTIONS		
Excavation		
Reinforcing Steel		
Bonding		
Piping		
Pre-Gunite		
Deck		
Enclosure/Fence		
Pool/Spa Cover		
DO NOT FILL POOL UNTIL ABOVE IS SIGNED		
FINAL INSPECTIONS		
Grading	9/22/20	J. Kosti
* Electrical	9/23/20	D. Kosti
Plumbing		
Gas Test		
Gas		
Heating & Refrigeration		
Pressure Vessels		
Elevator		
Fire Sprinkler		
Disabled Access		
Green Building		
LAFD (Title 19 only)	9,22,20	D Burwell
LAFD Fire Life Safety	9,23,20	D Burwell
Pool Final		
AQMD sign-off provided		
Public Works		
Building		
PROJECT FINAL	10/21/2020	J. Dorso

Certificate of Occupancy Required ☐ YES ☐ NO

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Source: FirstElement Fuel, Inc.

Site Preparation and Construction

After receiving the approval to build, FEF selected Black & Veatch, as the General Contractor to perform construction work for the Mission Hills Hydrogen Station.

On November 25, 2019; the construction team broke ground and started work addressing existing site conditions, relocating equipment necessary for gas station operations. Shortly thereafter the construction team proceeded with demolition, formwork laying initial conduit connections and pouring concrete four our equipment pads that serve as the base of our Linde Compressing and FIBA storage units.

Figure 6: Completed Equipment Pad at the Mission Hills Station

Source: FirstElement Fuel, Inc.

Equipment Installation

The equipment install occurred on February 10, 2020, with careful coordination with crane operators as well as the logistic coordinators to ensure that equipment was delivered on site and ready for install.

Figure 7: Linde Equipment Installation at the Mission Hills Station

Source: FirstElement Fuel, Inc.

Shortly after the Linde unit installation, COVID-19 lockdown orders were issued as a result of the COVID-19 pandemic. The FEF team responded immediately with implementing and following the proper health and safety protocols to ensure that construction could proceed.

As a result of the COVID-19 lockdown orders, the FEF team encountered the first delay in securing the appropriate approvals needed to proceed with the installation of the dispensers and the associated canopies. Historically, the team has been successful in obtaining "over-the-counter" approvals from the Authority Having Jurisdiction for the canopy structural drawings. With the COVID-19 lockdown orders, the plan check counters for the city closed and as a result updated plans were required to be resubmitted through the plan check process. After a 2-month delay, FEF received the structural permitting approvals and remobilized the construction team. FEF completed building the foundation for the dispensers and the hydrogen dispensers and canopies were installed on June 8, 2020 and June 17, 2020, respectively.

Figure 8: Tatsuno Dispensers Progress at the Mission Hills Station

Source: FirstElement Fuel, Inc.

Energize and Mechanical Connections

Following equipment installation, Black & Veatch completed scope on make sure that both mechanical and electrical connections were property terminated and ready for energization.

At this point a slight delay was noted for city utility inspections. The Los Angeles Department of Water and Power (LADWP) was experiencing delays due to the COVID-19 pandemic lock down orders. Specifically, electrical inspections resulted in a critical path delay as FEF was unable to bring power to the site until these inspections had occurred.

In order to proceed with the commissioning scope and continue progress, the next phase was completed utilizing generator power, the permanent utility connection was approved on July 1, 2020.

Commissioning

On September 3, 2020, FEF started the commissioning phase where the equipment is tested to verify that the station is ready dispense hydrogen. See Table 1 for a summary of tasks performed to commission the station.

Table 1: Commissioning Checklist

Commissioning Tasks	FE1030 Mission Hills, 15544 San Fernando Mission Blvd., Mission Hills, CA 91345-1347
Date: 10/22/20	
Operator:	

No.	Complete If yes check box	Tasks
1	x	Cleaning Skid
2	x	Pressure Test
3	x	Electrical Startup
4	x	Mechanical Landing
5	x	PSV Check
6	x	Calibrate Gas Detectors
7	x	Safety Function Test
8	x	Vacuum H2 Storage
9	x	Purge GH2 Storage
10	x	Vacuum LH2 Tank
11	x	Purge LH2 Tank
12	x	FillFluids
13	x	Cooldown LH2 Tank and Fill
14	x	Remove and Pump Drive
15	x	Cleaning Pump Vessel
16	x	Install Pump Insert
17	x	Install Pump Coupling
18	x	Purge pump vessel and head room
19	x	Cooldown the pump
20	x	Recalibrate Pump Level Sensor
21	x	Power on Dispenser'
22	x	Pressure Test Dispenser

Source: FirstElement Fuel, Inc.

HySTEP and California Food and Agriculture Division of Measurement Standards (DMS) Testing

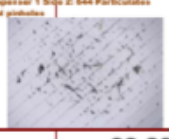
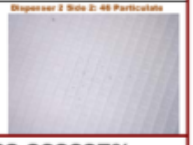
The California Department of Food and Agriculture Division of Measurement Standards (DMS) is responsible for enforcement of California weights and measures laws and regulations and must certify any device used for metering the sale of commercial items within California.

Acting as a Registered Service Agent and working with the local County Weights and Measures Officer as a witness, FEF successfully completed the DMS Testing on October 16, 2020.

As part of this process Fuel Quality Testing was performed, where results are summarized in Figure 9.

Figure 9: Hydrogen Fuel Quality Testing Report

SmartChemistry

MISSION HILLS	Sampled on 10/02/2020 & 10/10/2020		Dispenser 1	Dispenser 2
SAE J2719 202003	SAE J2719 Limits, µmol/mol	Smart Chemistry Limits, µmol/mol	Concentration (µmol/mol)	Concentration (µmol/mol)
H_2O (ASTM D7649)	5	2	< 2	4.6
Total hydrocarbons except methane (C_1 equivalent) (ASTM D7892) Benzene Methylene chloride	2	0.01	< 0.01	0.000
O_2 (ASTM D7649)	5	0.5	1.8	1.4
CH_4 (ASTM D5466)	100	0.001	0.016	0.0047
He (ASTM D1946)	300	10	< 10	< 10
N_2 (ASTM D7649)	300	2	3.4	3.0
Ar (ASTM D7649)	300	0.2	< 0.2	< 0.2
CO_2 (ASTM D7649)	2	0.03	< 0.03	< 0.03
CO (ASTM D5466)	0.2	0.00001	0.0012	0.00029
Total S (ASTM D7652)	0.004	0.00004	0.000020	0.000020
Hydrogen Sulfide		0.000002	0.0000061	0.0000065
Carbonyl Sulfide		0.000001	0.0000046	0.000006
Methyl Mercaptan (MTM)		0.000002	< 0.000002	< 0.000002
Ethyl Mercaptan (ETM)		0.000004	< 0.000004	< 0.000004
Dimethyl Sulfide (DMS)		0.000002	< 0.000002	< 0.000002
Carbon Disulfide		0.000001	0.0000088	0.0000073
Isopropyl Mercaptan (IPM)		0.000004	< 0.000004	< 0.000004
Tert-Butyl Mercaptan (TBM)		0.000004	< 0.000004	< 0.000004
n-Propyl Mercaptan		0.000004	< 0.000004	< 0.000004
Thiophene		0.000004	< 0.000004	< 0.000004
Diethyl Sulfide		0.000004	< 0.000004	< 0.000004
n-Butyl Mercaptan		0.000004	< 0.000004	< 0.000004
Dimethyl Disulfide (DMDS)		0.000004	< 0.000004	< 0.000004
Tetrahydrothiophene (THT)		0.000004	< 0.000004	< 0.000004
Formaldehyde (ASTM D7892)	0.2	0.002	< 0.002	< 0.002
Formic Acid (ASTM D5466)	0.2	0.001	< 0.001	< 0.001
Ammonia (ASTM D5466)	0.1	0.02	< 0.02	< 0.02
Halogenated Compounds (halogen ion equivalent)	0.05		< 0.001	< 0.001
Cl_2 (ASTM D5466)		0.0001	< 0.0001	< 0.0001
HCl (ASTM D5466)		0.0004	< 0.0004	< 0.0004
HBr (ASTM D5466)		0.0007	< 0.0007	< 0.0007
Organic Halides (R-XCl) (ASTM D7892, Smart Chemistry limit is for each individual organic halide)	32 compounds in hold out in Non-Methane Hydrocarbons report	0.001	< 0.001	< 0.001
Particulate Concentration (SAE J2719 Limit, 1 mg/kg(ASTM D7651))			Dispenser 1 Side 1: 0.518 mg/kg Dispenser 1 Side 2: 0.048 mg/kg	Dispenser 2 Side 1: 0.272 mg/kg Dispenser 2 Side 2: 0.186 mg/kg
Particulates Found & Size (ASTM D7834)			Dispenser 1 Side 1: A lot of grease 	Dispenser 1 Side 2: 644 Particulates and globules 
			Dispenser 2 Side 1: 522 Particulates 	Dispenser 2 Side 2: 46 Particulate 
Hydrogen Fuel Index	99.97%		**99.999476%**	**99.999097%**
Total Non-Hydrogen Gases	300		**5.2**	**9.0**
CO + HCHO + HCOOH	0.2	0.00005	**0.0012**	**0.00029**

Source: FirstElement Fuel, Inc.

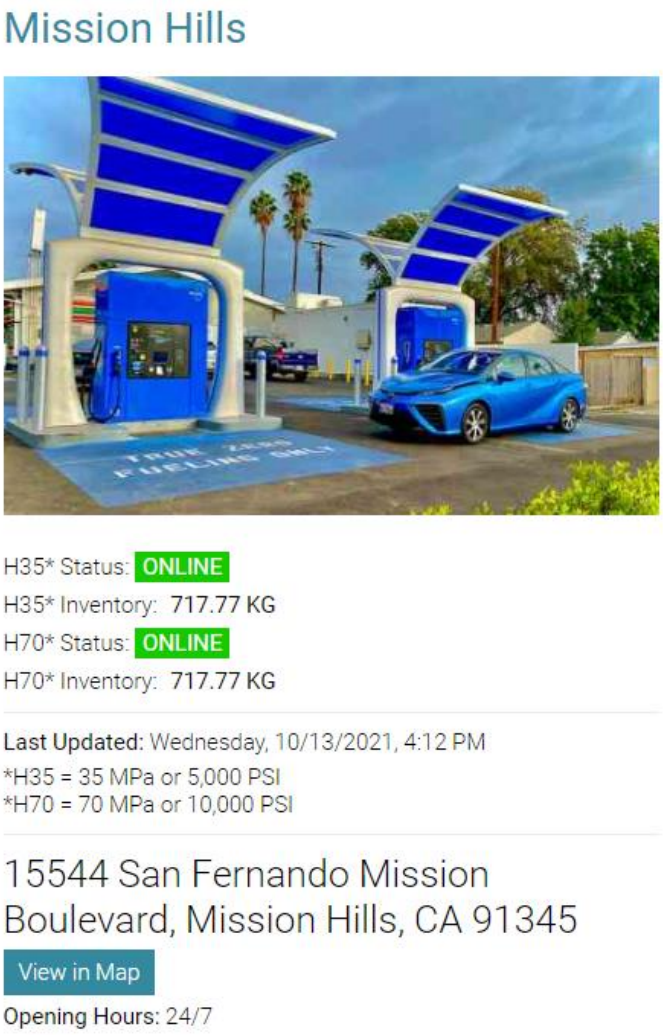
Hydrogen fueling station performance validation is accomplished through the Hydrogen Station Equipment Performance (HyStEP) testing device and was performed on September 29, 2020, to validate that the station is able to meet the fueling protocol standards. The results were reviewed by the OEM manufacturers and approved for station opening on October 19, 2020.

Operational and Open Retail

The California Fuel Cell Partnership Station Operational Status System (SOSS) provides regularly updated station status information to fuel cell vehicle drivers. FEF developed software to serve updates to the SOSS system about the amount of hydrogen available at the Mission Hills station. The Mission Hills hydrogen station began sending regular status updates to SOSS on October 26, 2020.

The Mission Hills station met requirements for open retail status on October 26, 2020.

Figure 10: Station Operation Status System - Mission Hills



Source: FirstElement Fuel, Inc.

Figure 11: Customer Fueling a Hyundai NEXO Vehicle at the Mission Hills Station

Source: FirstElement Fuel, Inc.

CHAPTER 4:
Results

Mission Hills Hydrogen Station Open

The Mission Hills hydrogen station is the second liquid hydrogen station that FEF has opened which has a capacity of more than 1,200 kilograms per day. This larger capacity plays a pivotal role in the infrastructure needs of today serving the greater number of FCEV on the road today. Additionally, with four fueling positions that allows three cars to fill simultaneously at this station, FEF is able improve the customer experience and reduce that amount of time waiting for an open pump.

Figure 12: Completed Mission Hills Hydrogen Station

Source: FirstElement Fuel, Inc.

Data Collection and Energy Analysis

Since the first fill that occurred at the Mission Hills station on October 26, 2020, the station has dispensed over 26,000 kgs in its first year of usage and recorded just under 18,600 fills. The table below summaries our data collection during this first year.

Table 2: Data Collection During First Year

Month	KGs Dispensed	Count of Fills	Avg Kgs Dispensed
October-20	205	87	2.36
November-20	1,471	1,328	1.11
December-20	141	112	1.26
January-21	1,234	1,245	0.99
February-21	477	437	1.09
March-21	503	329	1.53
April-21	2,338	1,996	1.17
May-21	2,868	1,713	1.67
June-21	2,758	2,306	1.20
July-21	2,654	1,703	1.56
August-21	4,006	1,963	2.04
September-21	2,681	2,044	1.31
October-21	5,122	3,263	1.57
Total	**26,456**	**18,526**	**1.45**

Source: FirstElement Fuel, Inc.

The Mission Hills hydrogen refueling station is supplied by hydrogen generated via the Steam Methane Reformation that converts methane (CH4) and water (H2O) to hydrogen (H2) and carbon dioxide (CO2):

$$CH_4 + 2H_2O \rightarrow 4H_2 + CO_2$$

Per California Senate Bill 1505 (Lowenthal, Chapter 877, Statutes of 2006), Environmental Standards for Hydrogen Production, at least one-third of the hydrogen sold by FirstElement Fuel, Inc.'s state funded hydrogen refueling stations will be produced from renewable sources.

During the first year of operation, FEF has been able to procure environmental attributes necessary to achieve 100% renewable hydrogen for the hydrogen dispensed at the Mission Hills hydrogen refueling station. These attributes have been procured directly by FEF through a third party in order to increase the renewable supply.

Hydrogen is supplied to the hydrogen fueling stations from Air Products' hydrogen production facilities in Wilmington, CA.

Subcontractors and Budgets

A detailed view of the budget to construct the Mission Hills hydrogen station has been summarized in Table 3 below.

Table 3: Agreement Budget - Mission Hills

Category	Agreement Reimbursable Budget	Agreement Match Budget	Total Project Budget
Compressing and Bulk Storage Equipment	$ 1,452,986	$ 104,419	**$ 1,557,405**
Ground Storage	$ 154,314	$ 88,403	**$ 242,717**
Dispenser	$ 262,700	$ 236,000	**$ 498,700**
Equipment	*$ 1,870,000*	*$ 428,822*	***$ 2,298,822***
Materials/Misc.	*$ -*	*$ 156,011*	***$ 156,011***
I&D Consulting PM	$ -	$ 41,993	**$ 41,993**
SGE Consulting Engineers	$ -	$ 77,390	**$ 77,390**
I&D Consulting Permitting	$ -	$ 47,241	**$ 47,241**
Site Construction	$ -	$ 540,551	**$ 540,551**
Subcontractors	*$ -*	*$ 707,176*	***$ 707,176***
Indirect Costs	*$ -*	*$ -*	***$ -***
Total	**$ 1,870,000**	**$ 1,292,008**	**$ 3,162,008**

Source: FirstElement Fuel, Inc.

Statement of Future Intent

FEF intends to own and operate the refueling station at 15544 San Fernando Mission Blvd, Los Angeles, CA 91345 for at least 10 years. FEF has invested capital to build the station and will require many years of operation to recoup the costs. FEF has executed an initial 10-year lease with the landowner with the possibility for extension.

In addition, FEF built a maintenance team with the personnel, equipment, and resources to maintain and repair the station as quickly as possible.

To augment onsite personnel across the FEF network, a comprehensive data collection and monitoring system has been implemented. FEF maintenance personal can access a breadth of real-time performance and sensor data, live video feeds, and historic usage data, and can control some features of the station remotely, 24 hours a day.

In addition to remote monitoring, FEF implemented a Computerized Maintenance Management Systems and an Enterprise Asset Management systems to schedule and track maintenance, repairs, and inventory. Work orders will be generated, completed, and logged for all maintenance and repair activities. This will help to maximize station up-time and enable tracking of key performance indicators.

Findings, Conclusions and Recommendations

The following and three findings from the Mission Hills hydrogen station project:

- Because the Mission Hills station represents one of early stations constructed that incorporates next generation liquid hydrogen storage, substantial learnings were

made in the design, permitting, and construction phases that were carried forward in future station builds.

- Major delays in commissioning the Mission Hills hydrogen station resulted from the delays due to the COVID-19 pandemic and the lock down orders, utility design, inspection and install process with LADWP.

GLOSSARY

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.

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.

CALIFORNIA FUEL CELL PARTNERSHIP (CaFCP) -- The California Fuel Cell Partnership is an industry/government collaboration aimed at expanding the market for fuel cell electric vehicles powered by hydrogen to help create a cleaner, more energy-diverse future with no-compromises to zero emission vehicles.

CARBON DIOXIDE (CO2) - A colorless, odorless, non-poisonous gas that is a normal part of the air. Carbon dioxide is exhaled by humans and animals and is absorbed by green growing things and by the sea. CO2 is the greenhouse gas whose concentration is being most affected directly by human activities. CO2 also serves as the reference to compare all other greenhouse gases (see carbon dioxide equivalent). The major source of CO2 emissions is fossil fuel combustion. CO2 emissions are also a product of forest clearing, biomass burning, and nonenergy production processes such as cement production. Atmospheric concentrations of CO2 have been increasing at a rate of about 0.5 percent per year and are now about 30 percent above preindustrial levels. (EPA)

DIVISION OF MEASUREMENT STANDARDS (DMS) – a Division of the California Department of Food and Agriculture who's responsibilities include Enforcement of California weights and measures laws and regulations. The Division's activities are designed to:[1]

1. Ensure the accuracy of commercial weighing and measuring devices.
2. Verify the quantity of both bulk and packaged commodities.

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1 https://www.cdfa.ca.gov/dms/

3. Enforce the quality, advertising and labeling standards for most petroleum products.

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.

HYDROGEN (H2) - A colorless, odorless, highly flammable gas, the chemical element of atomic number 1.

METHANE (CH4) - A light hydrocarbon that is the main component of natural gas and marsh gas. It is the product of the anaerobic decomposition of organic matter, enteric fermentation in animals and is one of the greenhouse gases. Chemical formula is CH4.

WATER (H2O) - A colorless, transparent, odorless, tasteless liquid compound of hydrogen and oxygen. The liquid form of steam and ice. Fresh water at atmospheric pressure is used as a standard for describing the relative density of liquids, the standard for liquid capacity, and the standard for fluid flow. The melting and boiling points of water are the basis for the Celsius temperature system. Water is the only byproduct of the combination of hydrogen and oxygen and is produced during the burning of any hydrocarbon. Water is the only substance that expands on freezing as well as by heating and has a maximum density at 4°