CALIFORNIA ENERGY COMMISSION

California Energy Commission

Clean Transportation Program

FINAL PROJECT REPORT

Scaling Up the True Zero Network

Hydrogen Station – 605 Contra Costa Boulevard, Concord, CA 94523

Prepared for: California Energy Commission

Prepared by: FirstElement Fuel, Inc.

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California Energy Commission

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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 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 on November 8, 2017, and the agreement was executed as ARV-17-017 on March 20, 2018.

ABSTRACT

Per funding agreement ARV-17-017 between the California Energy Commission (CEC) and FirstElement Fuel, Inc. (FEF), FEF designed, engineered, permitted, constructed, and commissioned a hydrogen refueling station at 605 Contra Costa, Concord, CA 94523. FEF plans to own and operate the hydrogen refueling station until at least 2025. The hydrogen refueling 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, and a customer payment interface.

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. The Governor's *Zero Emission Vehicle Action Plan* specifies actions to bring FCEVs to California markets.

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 three to four minutes the way gasoline passenger vehicles are fueled. FCEVs 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 sport utility vehicles, 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 FCEV 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. As a result, the auto industry and station development industry have had to co-develop two new technologies in parallel: hydrogen fuel cell electric vehicles and hydrogen refueling infrastructure. The auto industry cannot market and sell FCEVs widely 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 (CEC) 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 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 FCEVs. In response to GFO-15-605, FirstElement Fuel, Inc. submitted an application for a number of stations, including one to be located at 605 Contra Costa, Concord, CA 94523, which was proposed for funding in the CEC's Notice of Proposed Awards on November 8, 2017.

Note: If needed, insert a blank page so that Chapter 1 begins on the left side in two-page electronic view (same side as the cover page).

CHAPTER 1: Purpose

As fuel cell electric vehicle (FCEVs) are deployed in greater quantities, a network of refueling stations is needed to provide fueling coverage which takes advantage of the range of the vehicle. This agreement provides a hydrogen refueling station at 605 Contra Costa, Concord, CA 94523. The station equipment stores liquid hydrogen and dispenses gaseous hydrogen.

This project helps 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 that can provide up to 606 kilogram (kg) of hydrogen in 12 hours, or over 1212 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 zero emission vehicle (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.

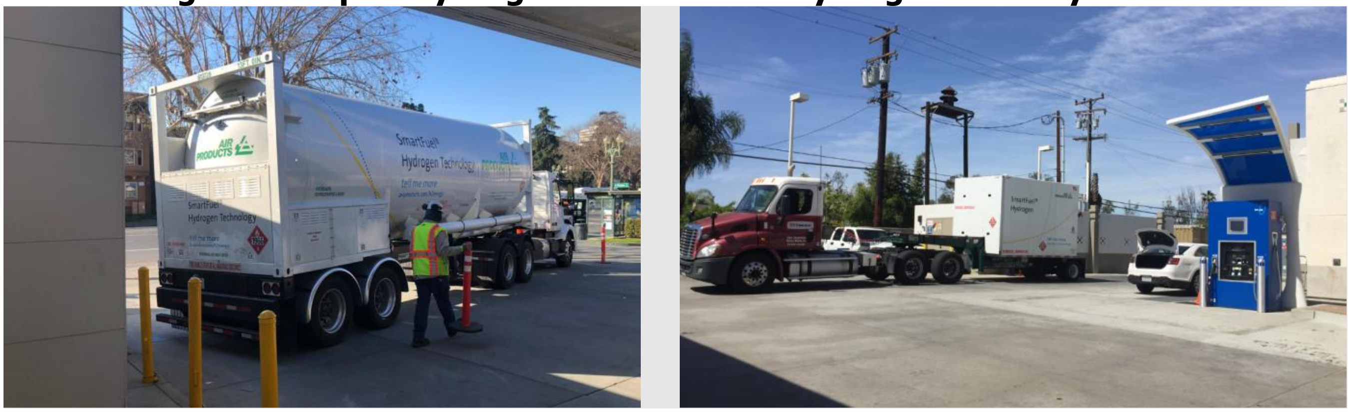
Inherent Efficiency of Liquid Hydrogen

Liquid hydrogen, as used at the Concord station, has storage, transportation, and pumping efficiencies compared to gaseous hydrogen in refueling infrastructure scenarios. For example, compression of gaseous hydrogen at refueling stations to fill FCEVs fully requires 3-5 kilowatt hour per kilogram (kWh/kg) of electricity. On the other hand, liquid pump stations use less than 1 kWh/kg to accomplish the same task. Because less electricity is needed, pumping liquid hydrogen is more efficient than compressing gaseous hydrogen. This is important to highlight because electricity at hydrogen stations can be expensive and is generally hard to make renewable.

Because of the extremely cold temperature of liquid hydrogen (-416°F), no additional refrigeration system is required to meet fueling protocol in the SAE J2601 standard 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 in the industrial gas sector. This means that the safety, costs, and operational experience of using liquid hydrogen are well understood. Liquid hydrogen delivery trucks can carry 10 or more times the deliverable hydrogen as equivalently sized gaseous hydrogen trucks (Figure 1). This higher capacity enables multiple stops and 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 kg (left) compared to 120 kg for gaseous hydrogen truck (right).
Source: FirstElement Fuel, Inc.

Higher Capacity Results in Lower Price at the Pump

Because of the FEF's dedicated hydrogen supply, volume equipment purchasing, CEC grant funding, and California Air Resources Board's hydrogen refueling infrastructure (HRI) credit value, FEF was able to lower the hydrogen price at the pump to $13.00 per kg (approximating $5.20 of comparative gasoline) significantly decreasing the current price at the pump.

With the Concord station capacity of 1,212 kg/day:

- Installed two dual sided dispenser, one with 2 H70 hoses and 1 H35 hose and the other with 2 H70 hoses. This configuration allows for four fueling positions (any three can be used simultaneously) to improve customer experience and reduce wait times
- Have over 900 kg of storage to mitigate potential supply disruptions better
- Reduce retail hydrogen price in comparison with gasoline and bringing price parity

These leaps in performance and price are made possible by moving to liquid hydrogen production, distribution, storage, and pumping. Producing liquid hydrogen generally takes more energy compared to gaseous 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, and optimized facility can be used to serve the entire network. This efficiency results in lower cost hydrogen supply. In addition, pumping liquid hydrogen is inherently more efficient than compressing gaseous hydrogen. Therefore, the pumps used at the Concord station is considerably smaller, more efficient, with 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, historically, there has been enough excess gaseous hydrogen from existing industrial 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 a substantial reduction in the price of hydrogen at the pump.

Sustainability and Environmental Impacts

FEF notes that hydrogen and FCEVs are among the most effective means to achieve sustainable transportation in California. As part of FEF's motivation in starting the company and mission statement, FEF aims to improve the economics of driving and reduce its footprint on our planet. FEF aims to grow the proportion of FCEVs on the road as quickly as possible so that California, and the world, can capitalize fully 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
- Reducing dependency on petroleum

Part of the FEF core business strategy is to accelerate the adoption of FCEVs and maximize their potential environmental benefits. FEF plans on simultaneously executing this strategy through a conscientious approach to the fuel supply chain, the operation of hydrogen station projects, and throughout the hydrogen station development and construction process for the hydrogen station in Concord, CA.

CHAPTER 2: Approach

FEF is proud to recognize many of its accomplishments including its team of dedicated and knowledgeable members that has contributed towards so many retail openings and operations of hydrogen refueling stations. FEF has successfully created the largest and most reliable hydrogen refueling network in the world and has provided original equipment manufacturers (OEMs) the confidence to release FCEVs on a large scale into the California market. FEF stations have the best up-time performance in California. FEF's culture focuses most on the customer experience and on the safety and security of its team and stations. To that end, FEF has developed and continues to refine rigorous technical and safety training procedures for 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 knowledge in a specific field of work. The four major competence categories include:

- Observer: personnel can only assist in a task
- Supervised: personnel can perform the task only if supervised
- Independent: personnel can perform the work unsupervised
- Trainer: 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. A 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, all pertinent employees are 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 the most qualified contractors to do the work, have a similar vision for safety, and have a proven track record. FEF reviews these records through contractor's U.S Occupational Safety and Health Administration Form 300A for the past three years. If there are any major injuries in the records, FEF investigates further 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 Concord station that mandates monthly, quarterly, semi-annual, and annual scheduled maintenance activities. Each week, the team manager reviews the preventive maintenance schedule for FEF's stations, opens work orders for each station 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 maintenance plan 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 uses 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, employee vacations, etc.

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

CHAPTER 3: Activities Performed

FEF took many steps to bring the Concord 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 install hydrogen fueling equipment safely
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 fueling equipment, 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, OEMs, and the CEC's Station Location Areas specified in the solicitation 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. FEF executed a 10-year lease with the property owner of 337 605 Contra Costa, Concord, CA 95008 on April 20, 2016.

Figure 2: Property View During Acquisition Phase

View of the property where the station is located, looking east of Contra Costa Blvd.

Source: FirstElement Fuel, Inc.

Equipment Procurement

The equipment packages installed at the Concord Hydrogen Refueling Station is comprised of 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 development, evaluating and visiting various component and part suppliers. As a hydrogen station integrator, FEF assessed and helped design an equipment package utilizing leaders in the industry to assemble an equipment package that exceeded the minimum technical requirements in the solicitation.

As a result of efficiencies of liquid hydrogen listed in chapter 1, FEF decided to upgrade the throughput and capacity of the Concord station bringing the station dispensing capacity per day to 1,212 kg of hydrogen. This decision to upgrade the station capacity resulted in a delay in the approval and engineering design process and more expenditures by FEF, but the added benefits (improved customer experience, storage to weather supply disruptions and lower price at pump) of the increased capacity far outweighed the delay and the additional cost to FEF.

Figure 3: Installed Linde Equipment – Concord

Source: FirstElement Fuel, Inc.

Site Design and Engineering

The site design for the Concord station on September 2, 2019 where FEF engaged internal permitting and engineering teams to proceed with design scope. As a result of upgrading equipment package, additional time was spent some time modifying the equipment footprint with the equipment supplier and engineering team, with site design drawings released on September 4, 2019, allowing the project to proceed with entitlement approval process.

Entitlement

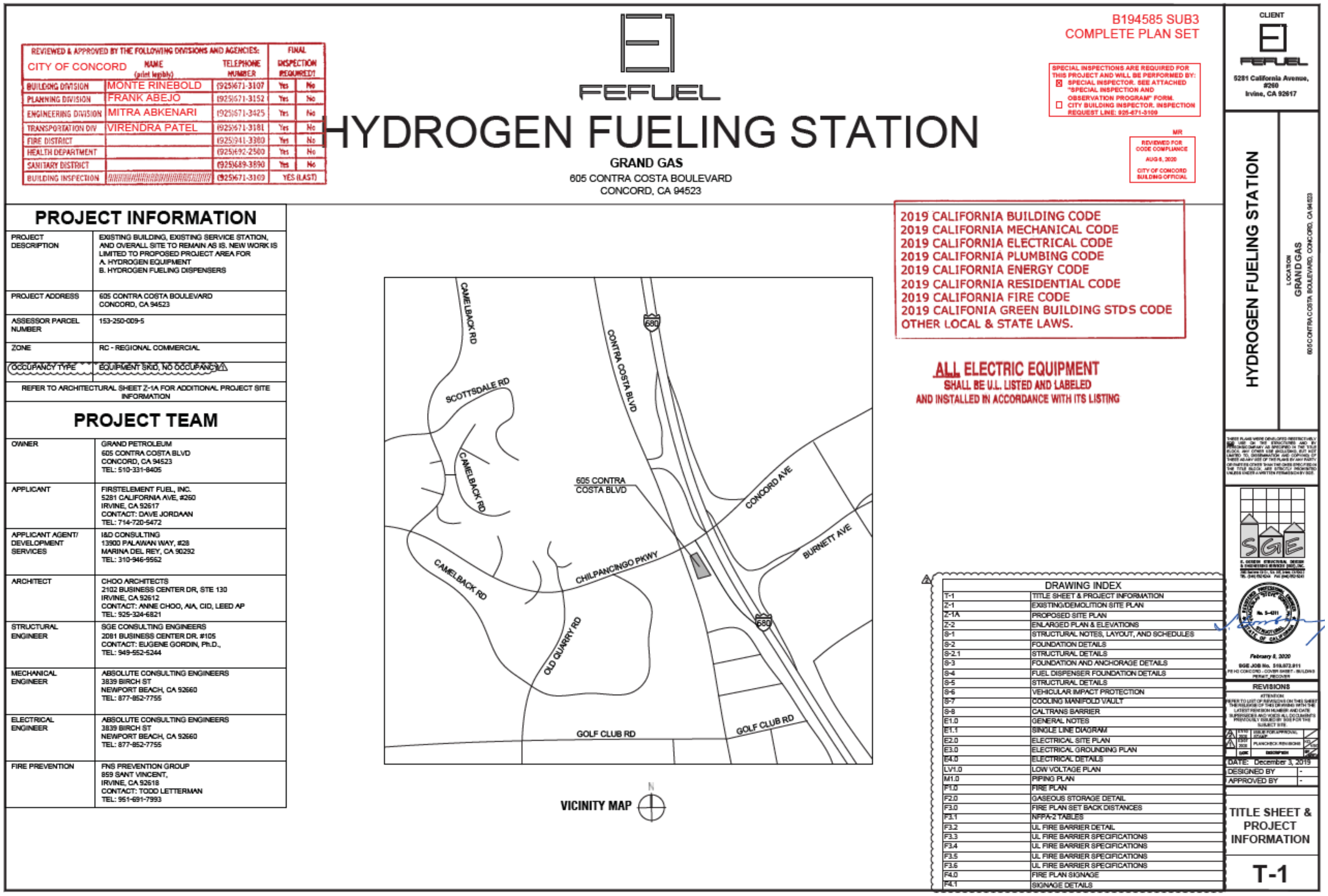
The local planning department typically verifies that the project meets the zoning requirements of the proposed location, and approve any aesthetic, landscaping or other details that are important to the community.

FEF submitted an entitlement package to the City of Concord in September 2, 2019, which the city approved following review and corrections on October 15, 2019.

Building Plan Check

Upon completion of the construction/engineering drawings, FEF submitted the initial building permit application on October 23, 2019. Following review and corrections with the various building departments at the City of Concord, FEF received the final clearances and the building permit on July 7, 2020.

Figure 4: Approved Building Plans



Source: FirstElement Fuel, Inc.

Site Preparation and Construction

On August 3, 2020, after receiving the approval to build, the construction team broke ground and started work addressing existing site conditions and relocating equipment necessary for gas station operations. Shortly thereafter, the construction team proceeded with demolition, formwork laying initial conduit connections, and pouring concrete for our equipment pads that serve as the base of our Linde compressing and FIBA storage units.

Figure 5: Form Work at the Concord Station

Source: FirstElement Fuel, Inc.

Equipment Installation

On September 23, 2020, logistic coordinators and crane operators helped ensure that equipment was delivered to this site and subsequently installed.

Figure 6: Linde Equipment Installation at the Concord Station

Source: FirstElement Fuel, Inc.

Figure 7: Tatsuno Dispenser Installation Progress at the Concord Station

Source: FirstElement Fuel, Inc.

Energization and Mechanical Connections

Following equipment installation, contractors completed scope to make sure that both mechanical and electrical connections were property terminated and ready for energization.

At this point, FEF noted a slight delay for utility inspections needed to energize site. Specifically, electrical inspections resulted in a critical path delay as FEF was unable to bring power to the site until these inspections had occurred.

To proceed with the commissioning scope and to continue progress, FEF used generator power to complete the next phase. The permanent utility connection was approved on April 30, 2021.

Commissioning

On January 11, 2021 FEF started the commissioning phase where the equipment is tested to verify that the station is ready dispense hydrogen. Table 1 summarizes tasks performed to commission the station.

Table 1: Commissioning Checklist

Commissioning Tasks		FE1028 605 Contra Costa Blvd Concord CA 94523
Date: 05/27/2021		FE FUEL
Operator: Edgard Curiel		
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.

Station 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 May 27, 2021 where inspection report results are summarized in Figure 9.

Figure 8: Particulate Testing Report

SAE J2719-202003			Concord_Dispenser_1_Side_2	Concord_Dispenser_2_Side_2
SUMMARY	SAE J2719 Limits: µmol/mol	Smart Chemistry Limits: µmol/mol	Concentration (µmol/mol)	Concentration (µmol/mol)
H_2O (ASTM D7649)	5	0.5	1.7	1.9
Total hydrocarbons except methane (C_1 equivalent) (ASTM D7892)	2	0.01	< 0.01	0.036
Acetone				0.036
O_2 (ASTM D7649)	5	0.2	3.5	3.7
CH_4 (ASTM D5466)	100	0.001	0.025	0.0099
He (ASTM D1946)	300	10	< 10	< 10
N_2 (ASTM D7649)	300	2	15	16
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	0.0001	0.0019	0.0017
Total S (ASTM D7652)	0.004	0.00004	0.000019	0.000012
Hydrogen Sulfide		0.000002	0.0000036	0.0000024
Carbonyl Sulfide		0.000001	0.000009	0.0000061
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	0.0000065	0.0000037
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	0.001	< 0.001	< 0.001
Formic Acid (ASTM D5466)	0.2	0.002	< 0.002	< 0.002
Ammonia (ASTM D5466)	0.1	0.009	< 0.009	< 0.009
Halogenated Compounds (halogen ion equivalent)	0.05		< 0.001	< 0.001
Cl_2 (ASTM D5466)		0.0001	< 0.0001	< 0.0001
HCl (ASTM D5466)		0.0006	< 0.0006	< 0.0006
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 bold red in Non-Methane Hydrocarbons report	0.001	< 0.001	< 0.001
Particulate Concentration (SAE J2719 Limit: 1 mg/kg)(ASTM D7651)	Dispenser 1 Side 2: 29 Particulate in the filter center and one 0.01mm particulate at filter edge		Dispenser 1 Side 1: 0.088 mg/kg Dispenser 1 Side 2: 0.072 mg/kg	Dispenser 2 Side 1: 0.070 mg/kg Dispenser 2 Side 2: 0.060 mg/kg
Particulates Found & Size (ASTM D7634)	Dispenser 1 Side 1: Grease found in the filter center		Dispenser 2 Side 1: 2 Particulates	Dispenser 2 Side 2: A 200 µm particulate found in the filter center along with some oil stains
Hydrogen Fuel Index	99.97%		99.997992%	99.997874%
Total Non-Hydrogen Gases	300		20.1	21.3
CO + HCHO + HCOOH	0.2	0.00005	0.0019	0.0017

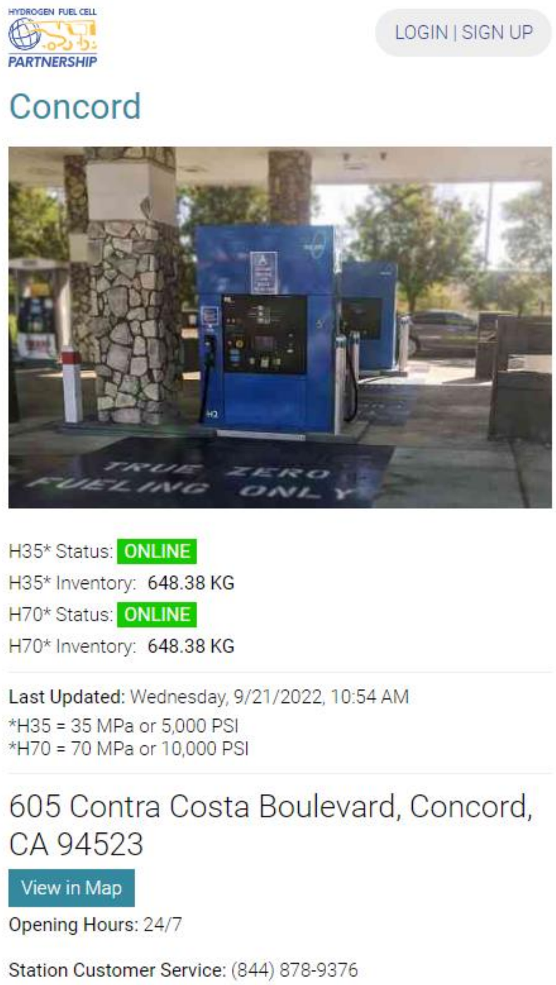
Source: Smart Chemistry Corporation

Hydrogen fueling station performance validation is accomplished through the Hydrogen Station Equipment Performance (HyStEP) testing device. California Air Resources Board performed the HyStEP testing on May 18th, 2021 to validate that the station is able to meet the fueling protocol standards. The OEM manufacturers reviewed the results and approved for station opening on May 28, 2021.

Operational and Open Retail

The California Fuel Cell Partnership Station Operational Status System (SOSS) provides regularly updated station status information to FCEV drivers. FEF developed software to serve updates to SOSS about the amount of hydrogen available at the Concord station. The Concord station began sending regular status updates to SOSS on May 28, 2021.

Figure 9: SOSS – Concord



Source: California Fuel Cell Partnership

The Concord station met the requirements for open retail status specified in the solicitation, GFO-15-605, on May 28, 2021.

Figure 10: Customer Fueling at the Concord Station

Source: FirstElement Fuel, Inc.

CHAPTER 4: Results

Concord Hydrogen Station Open

The Concord hydrogen station has a fueling capacity of more than 1,200 kilograms per day, which plays a pivotal role in the infrastructure needs of today, serving the greater number of FCEVs on the road. Additionally, with four fueling positions that allows three cars to fill simultaneously, FEF can improve the customer experience and reduce the amount of time customers have to wait for an open pump.

Figure 11: Completed Concord Hydrogen Station

Source: FirstElement Fuel, Inc.

Data Collection and Energy Analysis

Since the first fill that occurred at the Concord station on May 28, 2021, the station has dispensed just over 30,000 kg in its first year of usage and recorded just over 15,000 fills. The table below summarizes the data collected during the first year.

Table 2: Data Collection During First Year

Month	KGs Dispensed	Count of Fills	Avg Kgs Dispensed
Jun-21	1,008.44	977.00	1.03
Jul-21	1,227.80	829.00	1.48
Aug-21	208.36	338.00	0.62
Sep-21	-	-	-
Oct-21	1,879.80	980.00	1.92
Nov-21	3,187.23	2,561.00	1.24
Dec-21	4,152.29	1,641.00	2.53
Jan-22	4,113.17	1,799.00	2.29
Feb-22	4,114.72	1,594.00	2.58
Mar-22	2,147.57	928.00	2.31
Apr-22	3,909.12	1,664.00	2.35
May-22	4,511.22	1,753.00	2.57
Total	**30,459.71**	**15,064.00**	**2.02**

Source: FirstElement Fuel, Inc.

The Concord 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 Concord hydrogen refueling station. These attributes have been procured directly by FEF through a third party to increase the renewable supply.

Hydrogen is supplied to the hydrogen refueling stations from Praxair (Linde) hydrogen production facilities in Ontario, CA

Subcontractors and Budgets

Table 3 summarizes a detailed view of the budget to construct the Concord hydrogen station.

Table 3: Agreement Budget – Concord

Category	Agreement Reimbursable Budget	Agreement Match Budget	Total Project Budget
Compressing and Bulk Storage Equipmer	$ 1,452,986	$ 103,740	**$ 1,556,726**
Ground Storage	$ 154,314	$ 117,028	**$ 271,342**
Dispenser	$ 262,700	$ 236,000	**$ 498,700**
Equipment	*$ 1,870,000*	*$ 456,768*	***$ 2,326,768***
Materials/Misc.	*$ -*	*$ 149,332*	***$ 149,332***
I&D Consulting PM	$ -	$ 2,500	**$ 2,500**
SGE Consulting Engineers	$ -	$ 77,672	**$ 77,672**
I&D Consulting Permitting	$ -	$ 32,940	**$ 32,940**
Site Construction	$ -	$ 476,488	**$ 476,488**
Fire Permit Consulting	$ -	$ 11,900	**$ 11,900**
Subcontractors	*$ -*	*$ 601,500*	***$ 601,500***
Indirect Costs	*$ -*	*$ -*	***$ -***
Total	**$ 1,870,000**	**$ 1,207,600**	**$ 3,077,600**

Source: FirstElement Fuel, Inc.

Statement of Future Intent

FEF intends to own and operate the refueling station at 605 Contra Costa, Concord CA 94323 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, FEF has implemented a comprehensive data collection and monitoring system. 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. These systems will generate, complete, and log work orders for all maintenance and repair activities. These systems will help maximize station up-time and enable tracking of key performance indicators.

Findings, Conclusions, and Recommendations

The following findings from the Concord hydrogen station project:

- Because the Concord station represents one of early stations constructed that incorporate our next generation liquid hydrogen storage, FEF learned substantially in the design, permitting, and construction phases that will carry forward in FEF's future station builds.

- Considerable learnings in process and procedures for decommissioning existing gas pump and replacing with hydrogen dispenser.

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 CEC'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.
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.

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

HYDROGEN (H_2) - A colorless, odorless, highly flammable gas, the chemical element of atomic number 1.

METHANE (CH_4) - 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 CH_4.

WATER (H_2O) - 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°C.