CALIFORNIA ENERGY COMMISSION

California Energy Commission

Clean Transportation Program

FINAL PROJECT REPORT

DC FAST CHARGING INFRASTRUCTURE ON INTERSTATE-5 AND STATE ROUTE-99 FROM THE BAY AREA TO OCEANSIDE

Prepared for: California Energy Commission

Prepared by: US Green Vehicle Council

January 2022 | CEC-600-2022-026

California Energy Commission

Lloyd L. Tran
Primary Author(s)

US Green Vehicle Council
NASA Ames Research Center
P.O. Box 58
Moffett Field, CA 94035
(408) 280-6222
Green Vehicle Council (http://www.usgvc.com)

Agreement Number: ARV-14-002

Shaun Ransom
Commission Agreement Manager

Mark Wenzel
Office Manager
ADVANCED VEHICLE INFRASTRUCTURE

Hannon Rasool
Deputy Director
FUELS AND TRANSPORTATION

Drew Bohan
Executive Director

ACKNOWLEDGEMENTS

US Green Vehicle Council[1] would like to thank the following individuals and organizations for their contributions to the success of this project:

- Mr. Phil Dyer and Ms. Leslie Baroody, Mr. Sam Lerman, Mr. Brad Worster, Mr. Shaun Ransom, Kathleen Jones and other staff from the CEC
- Ms. Fern Vu and Ms. Stephanie Neave from Cleantech Institute
- Mr. Lawrence Rhodes and Mr. Peter Tran from EVRUS[2], Limited Liability Corporation (LLC).
- Mr. Samir Sheikh of San Joaquin Air Pollution Control District
- Mr. Hasan Ikhrata, of Southern California Association of Government
- Econolodge, Stockton
- Holiday Inn Express and Suites-Merced
- La Quinta- Riverpark, Fresno
- Quality Inn & Suites-Tulare
- Best Western Andersen's Inn-Santa Nella
- Best Western Big Country Inn-Coalinga
- Days Inn-Lost Hills
- Studio 6-Gorman
- Castaic Recreation Vehicle Park-Castaic Lakes
- Holiday Inn & Suites-Oceanside
- The staff of US Green Vehicles for all of their hard work and dedication

[1] US Green Vehicle Council http://usgvc.com/

[2] EVRUS LLC https://www.evrus.net/

PREFACE

Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007) created the Clean Transportation Program. The statute authorizes the 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:

1. Reduce California's use and dependence on petroleum transportation fuels and increase the use of alternative and renewable fuels and advanced vehicle technologies.
2. Produce sustainable alternative and renewable low-carbon fuels in California.
3. Expand alternative fueling infrastructure and fueling stations.
4. Improve the efficiency, performance and market viability of alternative light-, medium-, and heavy-duty vehicle technologies.
5. Retrofit medium- and heavy-duty on-road and nonroad vehicle fleets to alternative technologies or fuel use.
6. Expand the alternative fueling infrastructure available to existing fleets, public transit, and transportation corridors.
7. 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 PON-13-606 to provide funding opportunities for Electric Vehicle Charging Infrastructure In response to PON-13-606, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards April 4, 2014 and the agreement was executed as ARV-14-002 on August 19, 2014.

ABSTRACT

This report entitled "Direct Current Fast Charging Infrastructure on Interstate-5 and State Route 99 Connecting the Bay Area to Oceanside" is the final project report from US Green Vehicle Council for the California Energy Commission, under grant number ARV-14-002. The project was undertaken in cooperation with Cleantech Institute and EVRUS, LLC.
The primary objectives of the project were:

- To design and install 10 Direct Current fast charging stations at 10 cities along freeway corridors of Interstate-5 and State Route 99: Stockton, Santa Nella, Coalinga, Lost Hills, Merced, Fresno, Tulare, Lebec, Castaic and Oceanside
- To enable electric vehicles to travel from the Bay Area to Southern California through the Central Valley
- To accelerate plug-in electric vehicle adoption
- To promote green zero emission transportation

Key results:

- The project resulted in more than 681 charge sessions over a six-month period,
- This project reduced 6,794 kilogram of greenhouse gas emissions, and saved 765 gallons of gasoline, and
- This project provided insight of usage of fast charging stations along the freeway corridors of Interstate-5 from Stockton to Oceanside and State Route 99 from Merced to Tulare.

Keywords: Los Angeles County, Greenhouse Gas (GHG), Zero-Emission Vehicles (ZEVs), Electric Vehicle Service Equipment (EVSE), Kilowatt-Hour (kWh), Plug-In Electric Vehicle (PEV).

Please use the following citation for this report:

Lloyd L. Tran (US Green Vehicle Council), and Fern D. Vu (Cleantech Institute). 2022. *DC Fast Charging Infrastructure on Interstate-5 and State Route-99 Connecting the Bay Area to Oceanside*. California Energy Commission. Publication number: CEC-600-2022-026.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Page

EXECUTIVE SUMMARY

The primary objectives of the project were:

- To design and install 10 direct current fast charging stations at 10 cities along freeway corridors of Interstate-5 and State Route-99: Stockton, Santa Nella, Coalinga, Lost Hills, Merced, Fresno, Tulare, Lebec, Castaic and Oceanside
- To enable electric vehicles to travel from the Bay Area to Southern California through the Central Valley
- To accelerate plug-in electric vehicle adoption
- To promote green zero emission transportation

At each of these 10 locations, a direct current fast charging station, known as Electric Vehicle Express, was installed and commissioned. The deployments included the hardware provided by the Environmental Vapor Recovery Unit, limited liability company and the software provided by Cleantech Institute, using Open Charge Point Protocol communication standard. The network enabled remote monitoring and management of the charging stations.

After six months of usage and data collection, U.S. Green Vehicle Council and the team have achieved the following:

- The project resulted in more than 681 charge sessions over a six-month period
- This project reduced greenhouse gas emissions by 6,793 kilogram and saved 795 gallons of gasoline
- This project provided measurements of usage at fast charging stations along freeway corridor settings

CHAPTER 1:
Project Description

Objectives

In October 2013, the governments of California, Washington, Oregon and British Columbia signed an agreement called the "Pacific Coast Action Plan on Climate and Energy"[3] which includes a commitment to transition the West Coast to clean modes of transportation. One action is to expand the use of ZEVs, aiming for 10 percent of new vehicle purchases in public and private fleets to be ZEVs by 2016.

The State of California has the ZEV goals of having sufficient ZEV infrastructure that is able to support up to 1.5 million vehicles by 2025. However, one of the major barriers for the acceptance and deployment of electric vehicle (EV) in California is a lack of charging infrastructure, especially that connects major highway corridors. Electric vehicle drivers are not able to travel from Northern California to the Central Valley or Southern California due to the lack of fast charging stations along Interstate-5 and State Route-99. Corridor charging also gives existing and prospective electric vehicle owners the assurance that they can recharge when driving long distances along a freeway or highway. Establishing an adequate charging infrastructure network will help to address range anxiety.

According to the "*Bay Area and Monterey Bay Area Plug-In Electric Vehicle Readiness Plan*"[4] along the corridor Interstate-5 from Stockton to Los Angeles, there are no fast chargers available for EV (except 2 sites only for Tesla located in Coalinga and Lebec). The "*San Joaquin Valley Regional Charging Siting Analysis- December 2013*" has identified a lack of EV charging infrastructure in the Central Valley. With reference to the "*Southern California Plug-in Electric Vehicle Readiness Plan*"[5], there is an urgent need to have fast chargers along the corridor connecting Los Angeles to San Diego regions. The main objective of this Agreement is to design and install a direct current (DC) fast charger at 10 sites along the Interstate-5 and State Route-99 corridors in the following cities: Stockton, Merced, Fresno, Tulare, Santa Nella, Coalinga, Lost Hills, Lebec, Castaic, and Oceanside.

Overview

For this project, we have designed and installed a DC fast charging station at 10 sites primarily at hotels and recreation vehicle park at the following cities along Interstate-5 and State Route-99 from Stockton to Oceanside, and the map of these locations can be seen below in Figure 1. All the sites are conveniently located within less than 1 mile to the Interstate-5 or State Route-99:

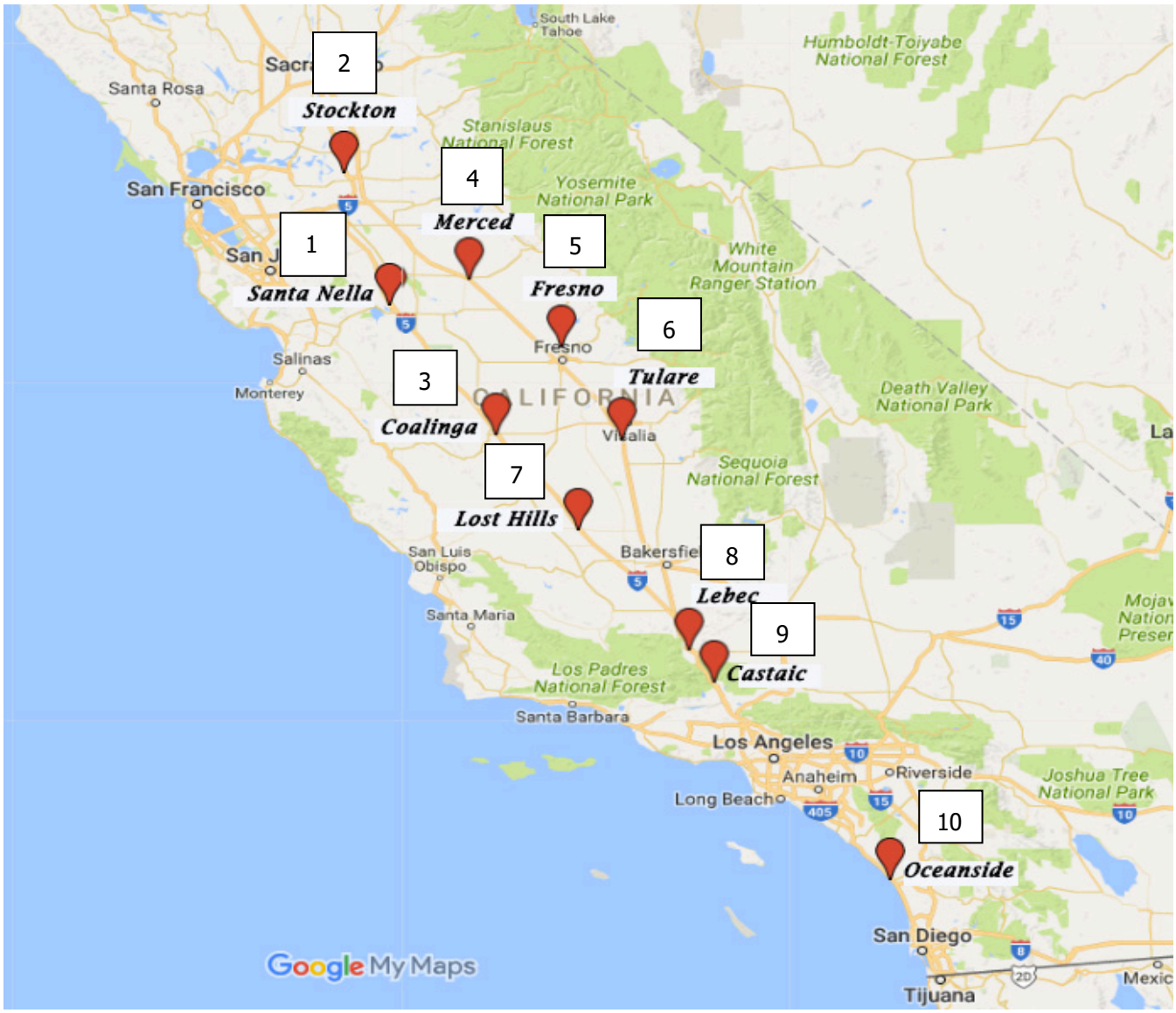
---

[3] Pacific Coast Action Plan on Climate and Energy https://www.energy.ca.gov/sites/default/files/2019-12/pacific_coast_ada.pdf

[4] Bay Area and Monterey Bay Area Plug-In Electric Vehicle Readiness Plan https://www.baaqmd.gov/plans-and-climate/bay-area-pev-program/bay-area-pev-ready

[5] Southern California Plug-in Electric Vehicle Readiness Plan https://energycenter.org/sites/default/files/docs/nav/programs/pev-planning

Figure 1: Locations of DC fast charging stations in Southern California



(1) Best Western Andersen's Inn 12367 South Highway 33, Santa Nella, CA. 95322

(2) Econolodge- Stockton 2654 W March Ln, Stockton, CA 95207

(3) Best Western Big Country Inn 25020 W. Dorris Ave, Coalinga, CA 93210

(4) Holiday Inn Express & Suites 151 S Parson Ave Merced, CA 95341

(5) La Quinta Inn & Suites 330 E. Fir Ave, Fresno CA 93720

(6) Quality Inn & Suites 1010 E. Prosperity Ave Tulare, CA 93274

(7) Days Inn 14684 Aloma St, Lost Hills, CA 93249

(8) Studio 6 49713 Gorman Post Rd Lebec, CA 93242

(9) Castaic Lake Recreation Vehicle Park 31540 Ridge Route Rd Castaic, CA 91384

(10) Holiday Inn-Marina 1401 Carmelo Drive Oceanside, CA

Source: Google Maps

CHAPTER 2:
Project Execution

The project execution included planning, equipment purchases and testing, installation, and commissioning.

Planning included the following:

- Review and approval of site plans
- Preparation of construction drawings and documents
- Permit application
- EVSE equipment specification approval and ordering
- EVSE testing and approval
- Installation contractor's approval
- Project schedule review and approval
- Payment system set-up and field testing
- Signage Plan review and approval, and
- Maintenance & Inspection Plan review and approval
- Installation & Commissioning

Equipment purchase and testing

We have evaluated a number of DC fast charging equipment and have chosen the EV Express fast charging station, manufactured and serviced by EVRS, LLC. of San Jose, California

EV Express is a DC fast charger, powered by 208 Volt alternate current input, 3-phase, with operating current of up to 65 amps. Depending on the battery condition, it normally takes about 30 minutes to charge a Nissan Leaf from 20 percent to 80 percent State of Charge. The EV Express is equipped with a CHAdeMO connector[6]. It has a second slot for future retrofit with a Society of Automotive Engineers Combined Charging System Connector[7]. It was designed to charge all EV that are compatible with a CHAdeMo connector including Nissan Leaf, Kia Soul Electric, Mitsubishi i-MiEV, and RAV4- electric.

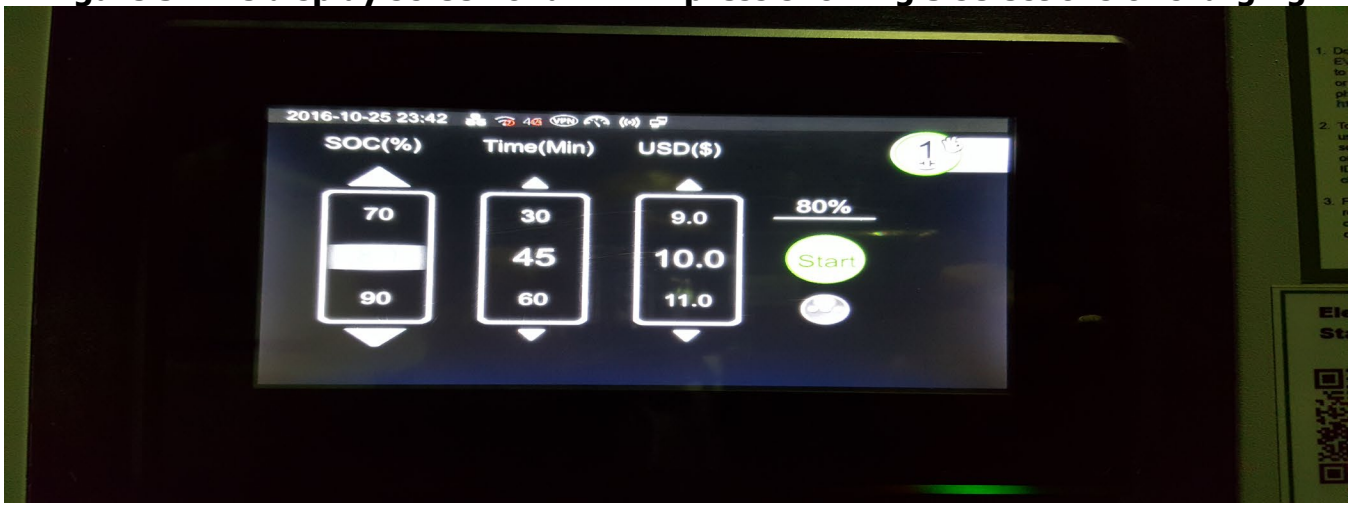
[6] CHAdeMO Connector https://www.chademo.com/products/connectors/

[7] SAE Combined Charging System Connector https://en.wikipedia.org/wiki/Combined_Charging_System

Figure 2: EV Express DC fast charging station- Best Western Inn- Coalinga

Source: US Green Vehicle Council

Figure 3: The display screen of an EV Express showing 3 selections of charging

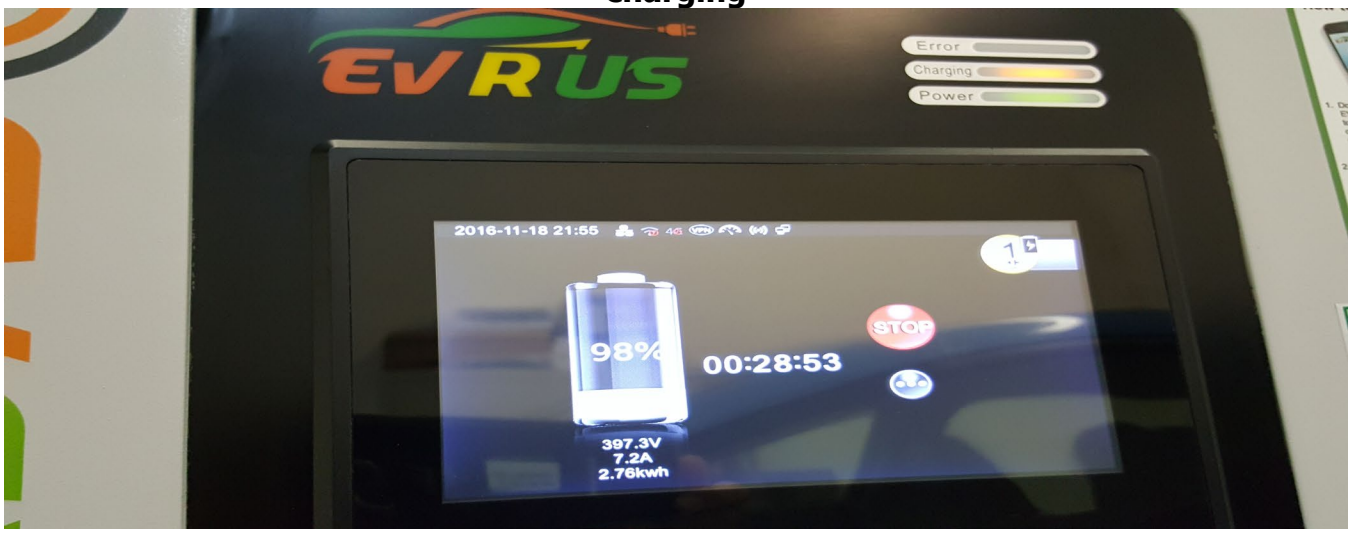


Source: EVRUS, LLC.

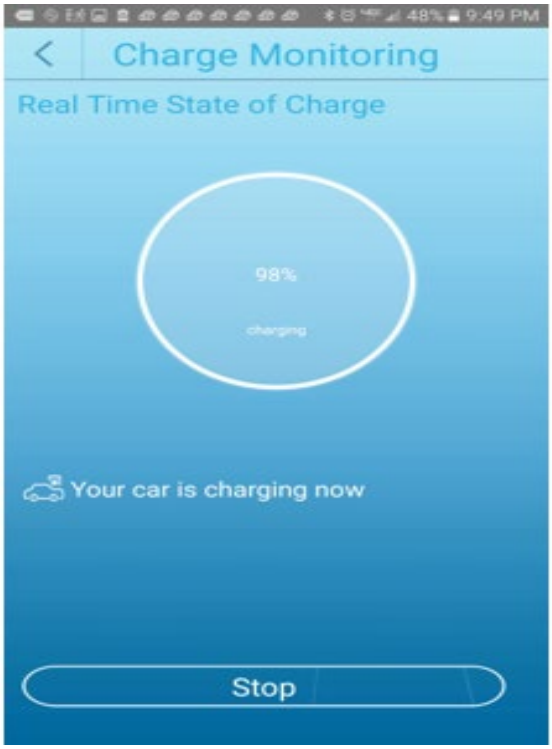
The EV Express allows the user to choose one of three options for charging:

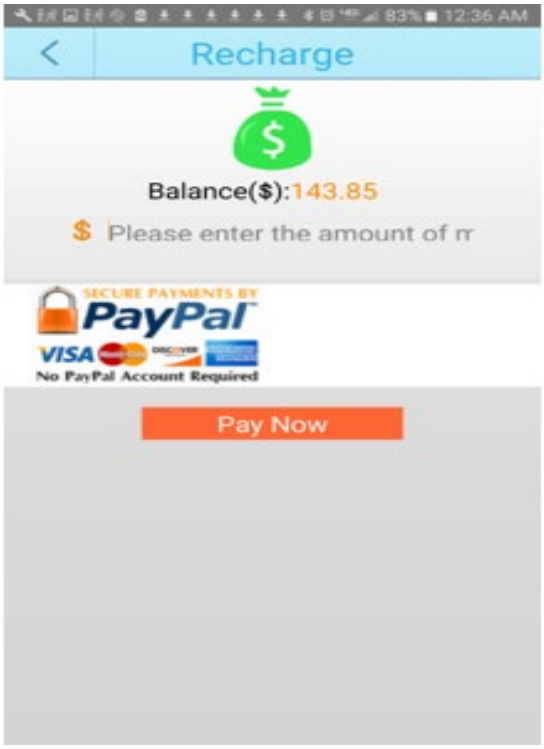
- State of charge, i.e. selecting 90 percent means the EV Express will charge the electric vehicle up to 90 percent of the capacity of the battery.
- Charging time: can be selected from 10 minutes to 60 minutes
- Dollar amount: a user can select the limit of the charging costs from $5 to $15. An average cost to charge an EV such as a Nissan Leaf from 20 percent to 80 percent is about $10.00

Figure 4: Display screen of the EV Express showing 98 percent after 28 minutes of charging



Source: EVRUS, LLC.





Source: EVRUS, LLC.

- Obtaining city permit
- Hiring installation subcontractors
- Site preparation including concrete cutting and trenching
- Running the electrical and communication conduit
- Concrete pouring
- Forming and pouring of reinforced concrete foundations for the sites
- Pre-installation inspection of cement
- Electric service upgrades including circuit breakers, panels, and safety disconnect and transformers
- EVSE installation
- Signage installation
- Final inspection and approval
- Network commissioning
- Final testing with a Nissan Leaf

Final commissioning meeting included the following:

- Check and validate radio frequency identification cards
- Check the internet communication between a charging station and the central server
- Turn on and charge a test vehicle (Nissan Leaf)
- Check the app. Validate the sign-up and login as a new customer
- Test the automatic switch-off in response to a major fault

- Test the charging session in the case of a minor fault
- Test the remote system control and monitoring system
- Test the charging session and display of state of charge on a test EV (Nissan Leaf)

Operating Costs of Managing DC Fast Charging Stations

The on-going operation costs (shown in Table 1 on the next page) of a DC fast charging station include the costs of electricity, utility fees, city utility user taxes, insurance, internet communication network, customer services and technical support. While the costs are variable based on charges imposed by each utility and city and county in California, following is an average costs of on-going operation costs of one of our 10 EV Express DC fast charging stations, based on a usage of 500kWh per month, as an example:

Table 1: On-going operating costs of an EV Express based on 500 kilowatt per month

Electric Usage: $0.25/kWh	$125.00
Customer Service Charge by Utility	$10.00
Mandated Franchise Charge: 2.50 percent	$12.00
Public Benefits Charge: 2.85 percent	$14.25
Power Cost Adjustment: 2.75 percent	$13.75
Environmental Charges: 3.75 percent	$18.75
California Commission Tax: 1.5 percent	$7.50
City Utility Users' Tax (5- 7 percent, depending of the city):	$30.00
Insurance (based on the replacement costs of a direct current fast charging system)	$78.35
Central Server, Internet for intercommunication	$100.00
Customer Service Call Center (24/7 services)	$67.00
Technical Support per site per month	$95.00
Average Demand Charge from Utility (Pacific Gas & Electric, Southern California Edison and San Diego Gas & Electric)	$115.00
Total Monthly Costs	**$686.60**

Source: US Green Vehicle Council

Based on an example of 500kWh usage per month at one of the charging stations, the average cost is $1.37 per kWh.

This excludes the administrative costs of managing the operation including credit card billings, accounting, report and coordination with hosts and technical support staff.

To help promoting the DC fast charging services along the freeway corridors on Interstate-5 and SR-99, we offer a charging service based on $0.59/kWh plus a service fee of $2.95 per charging session. A typical charging session for a Nissan Leaf from 25 percent to 80 percent will consume 13.2 kWh over about 30 minutes and will cost approximately $10.73, which is within the expectation and affordability of EV drivers.

With a projected usage of 500kWh per month, which is equivalent to 37 charging sessions at 13.2 kWh each, the projected revenue would be $506/month, while the operating expenses of $687.10. The net loss is $$181.10 per month per station.

The projected operating loss is $1,811 per month for 10 DC fast charging stations.

U.S. Green Vehicle Council and partners are contributing funds to cover the operating loss to maintain the on-going operation of DC fast charging infrastructure project.

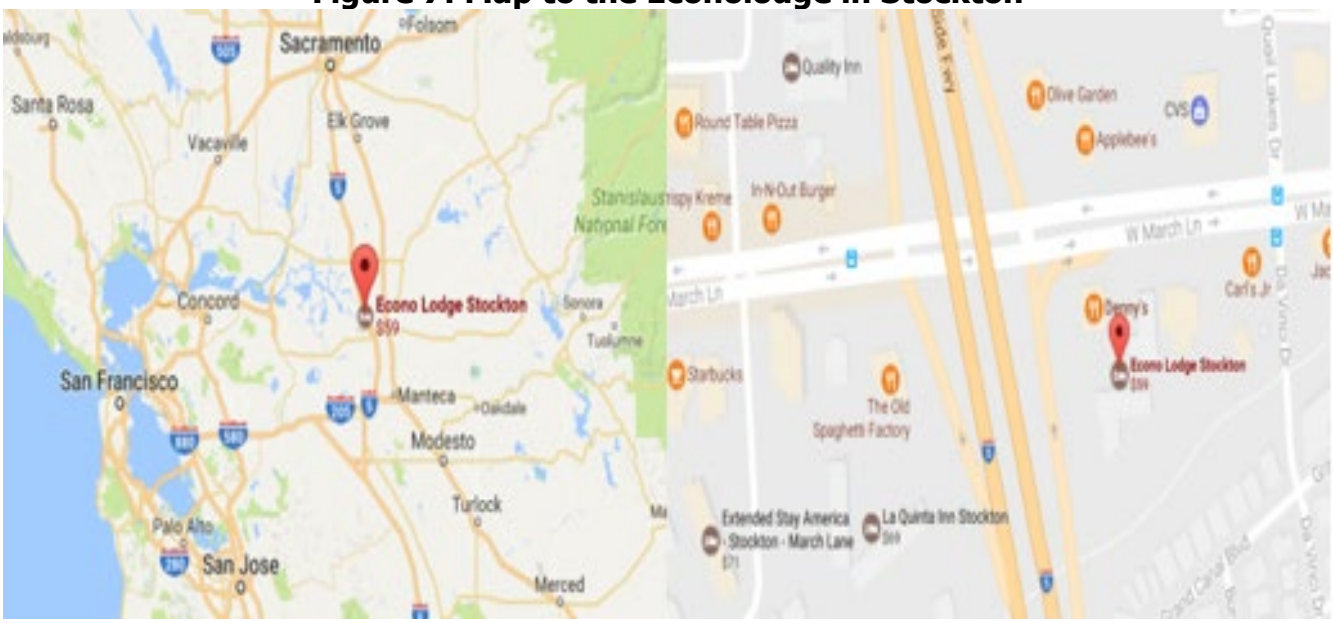
Installation Projects

Figures 6-35 provide a detailed description of each of the EV Express Charging Station installation projects mentioned in this plan.

Figure 6: The Econolodge in Stockton

Source: Cleantech Institute

Figure 7: Map to the Econolodge in Stockton



Source: Cleantech Institute

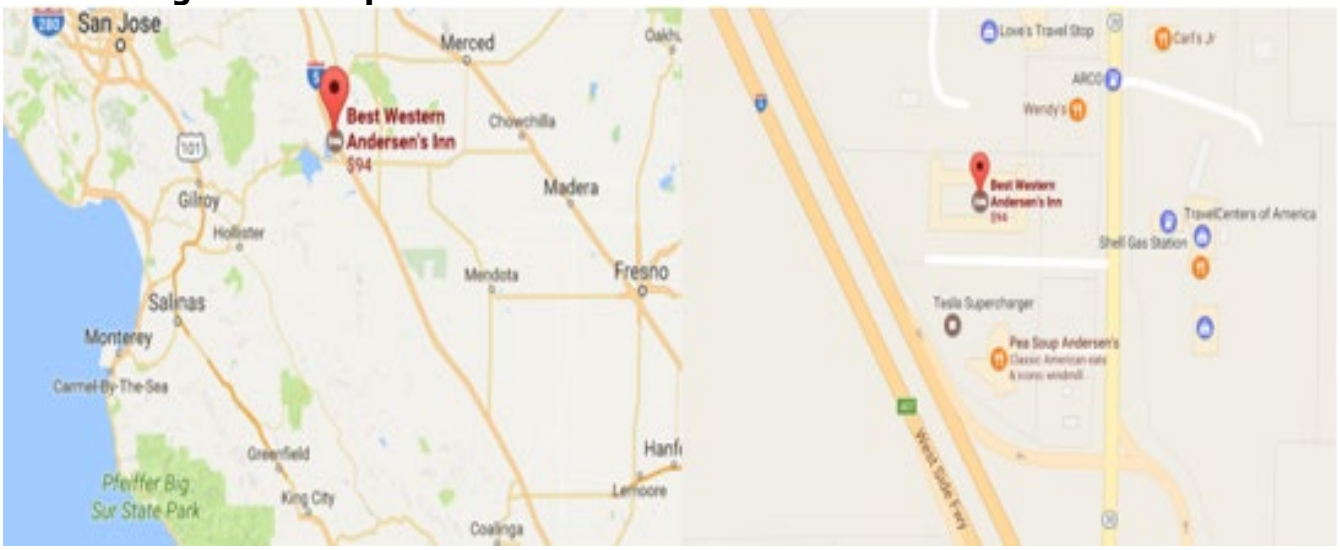
Figure 8: EV Express Charging Station

Source: Cleantech Institute

Figure 9: The Santa Nella Best Western Andersen

Source: Cleantech Institute

Figure 10: Map to the Best Western Andersen's Inn in Santa Nella



Source: Cleantech Institute

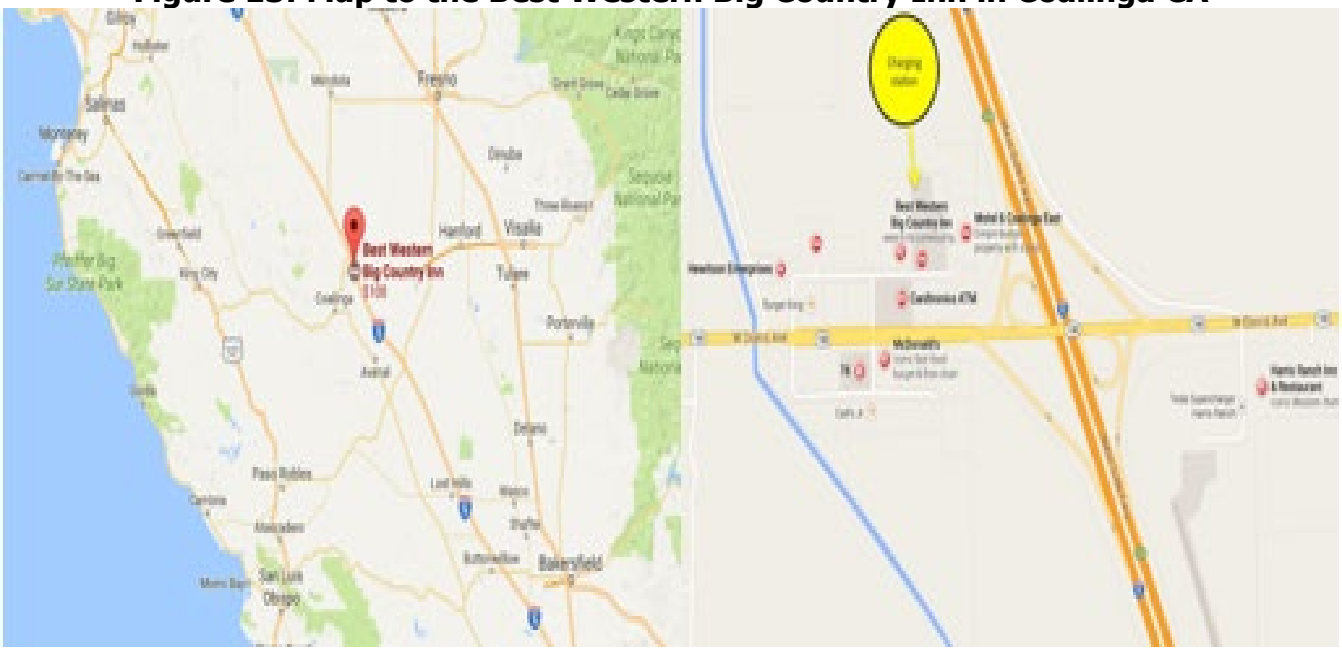
Figure 11: EV Express Charging Station

Source: Cleantech Institute

Figure 12: Coalinga Best Western Big Country Inn

Source: Cleantech Institute

Figure 13: Map to the Best Western Big Country Inn in Coalinga CA



Source: Cleantech Institute

Figure 14: EV Express Charging Station

Source: Cleantech Institute

Figure 15: Lost Hills Days Inn in CA

Source: Cleantech Institute

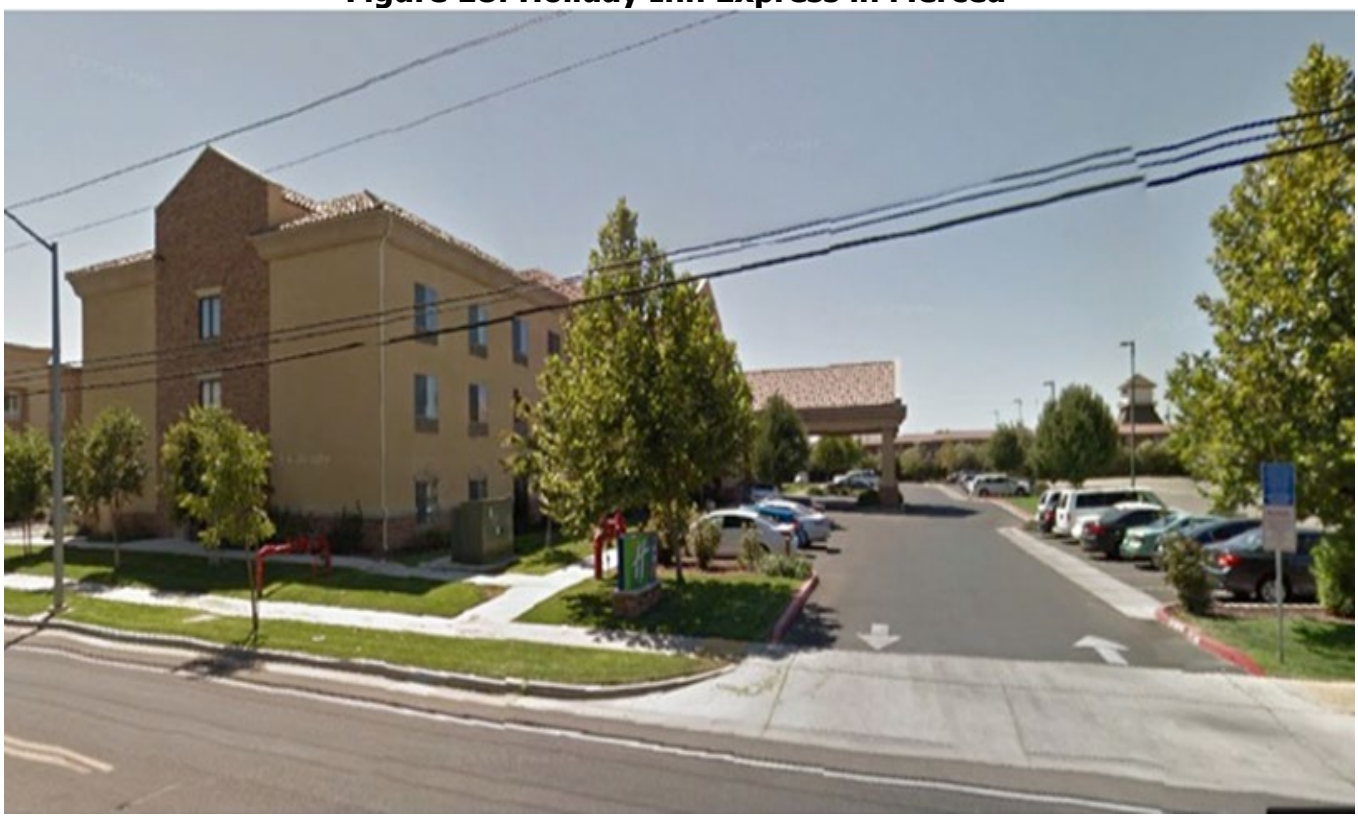
Figure 16: Map to the Days Inn in Lost Hills CA

Source: Cleantech Institute

Figure 17: EV Express Charging Station

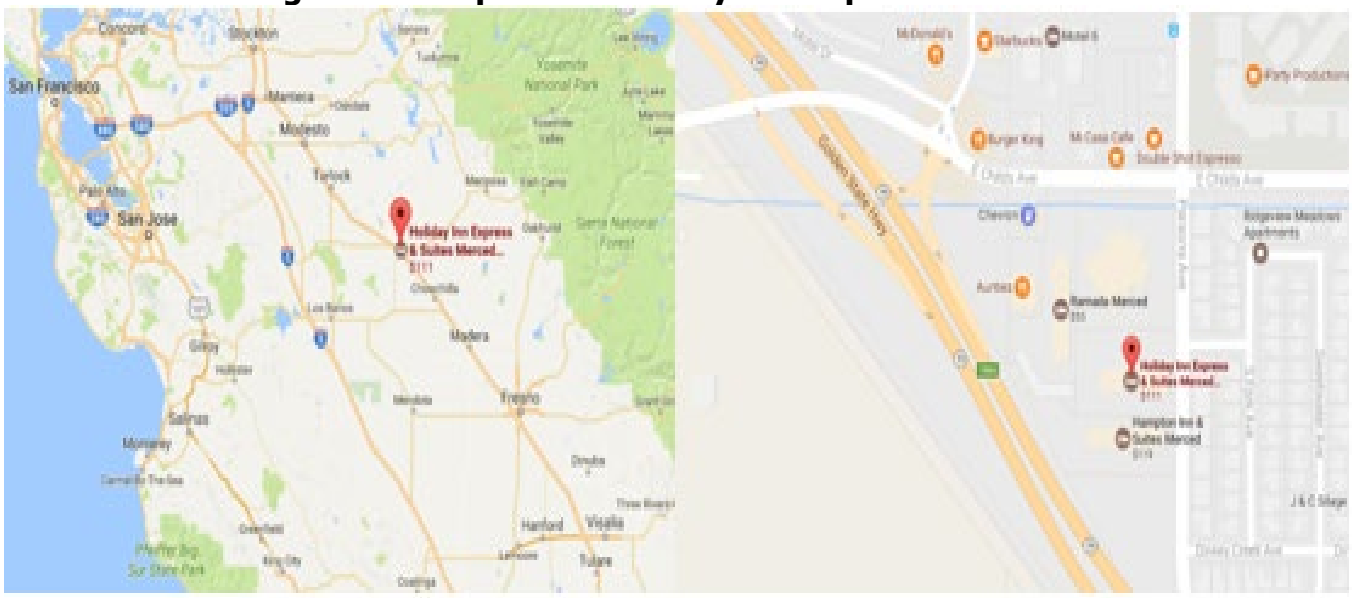
Source: Cleantech Institute

Figure 18: Holiday Inn Express in Merced



Source: Cleantech Institute

Figure 19: Map to the Holiday Inn Express in Merced



Source: Cleantech Institute

Figure 20: EV Express Charging Station

Source: Cleantech Institute

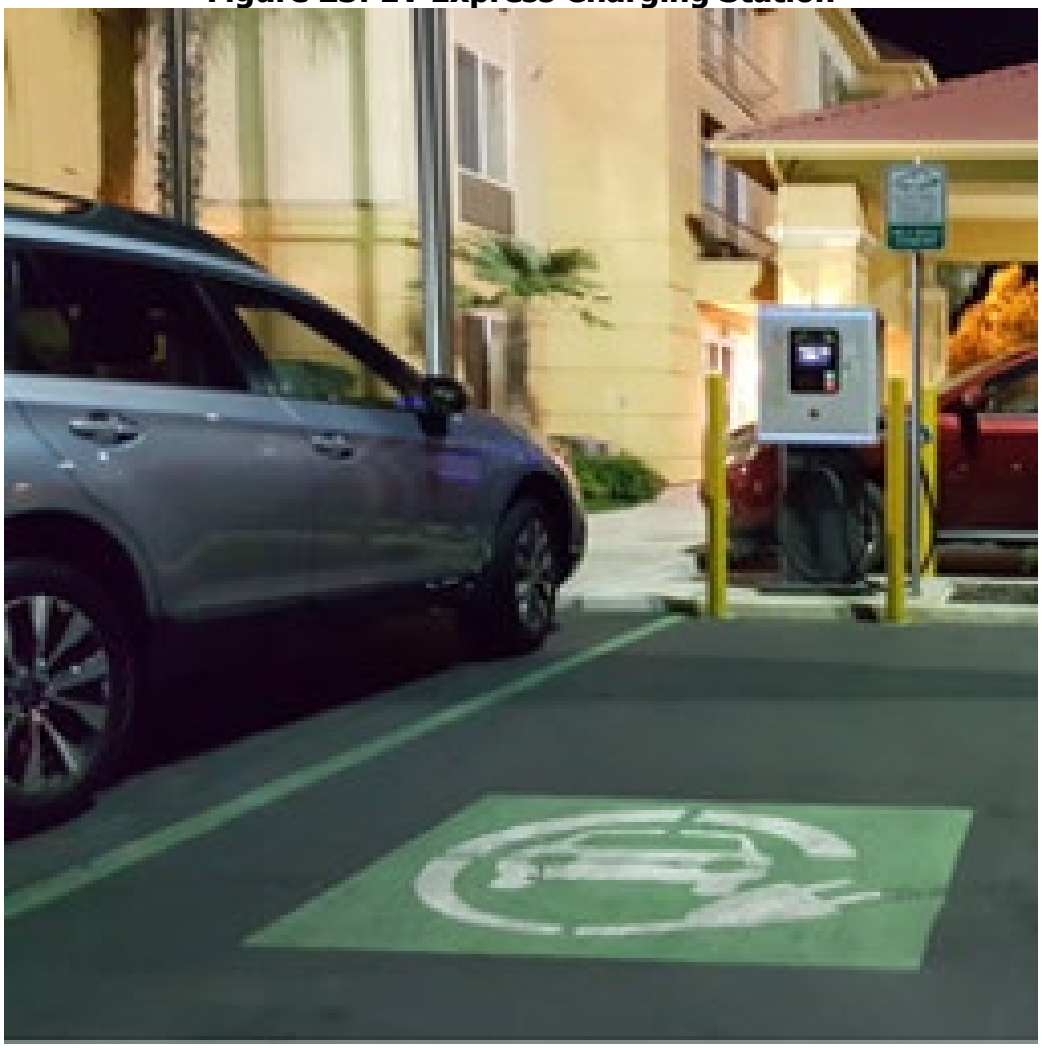
Figure 21: La Quinta Riverpark in Fresno

Source: Cleantech Institute

Figure 22: Map to the La Quinta Riverpark in Fresno

Source: Cleantech Institute

Figure 23: EV Express Charging Station



Source: Cleantech Institute

Figure 24: Quality Inn Suites in Tulare

Source: Cleantech Institute

Figure 25: Map to the Quality Inn Suites in Tulare

Source: Cleantech Institute

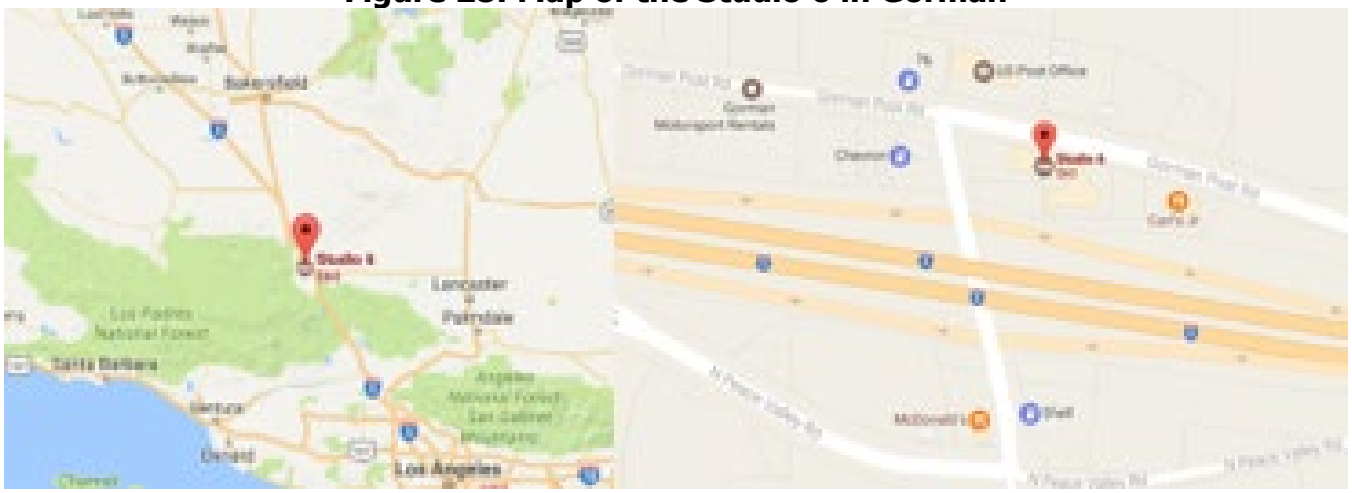
Figure 26: EV Express Charging Station

Source: Cleantech Institute

Figure 27: The Studio 6 in Gorman

Source: Cleantech Institute

Figure 28: Map of the Studio 6 in Gorman



Source: Cleantech Institute

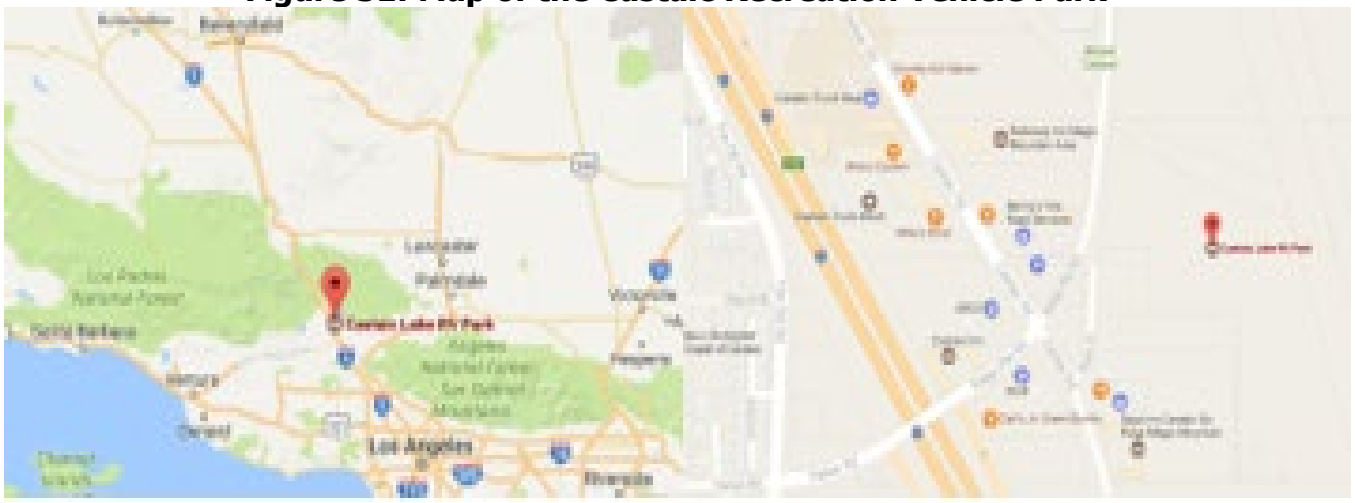
Figure 29: EV Express Charging Station

Source: Cleantech Institute

Figure 30: Castaic Recreation Vehicle Park

Source: Cleantech Institute

Figure 31: Map of the Castaic Recreation Vehicle Park



Source: Cleantech Institute

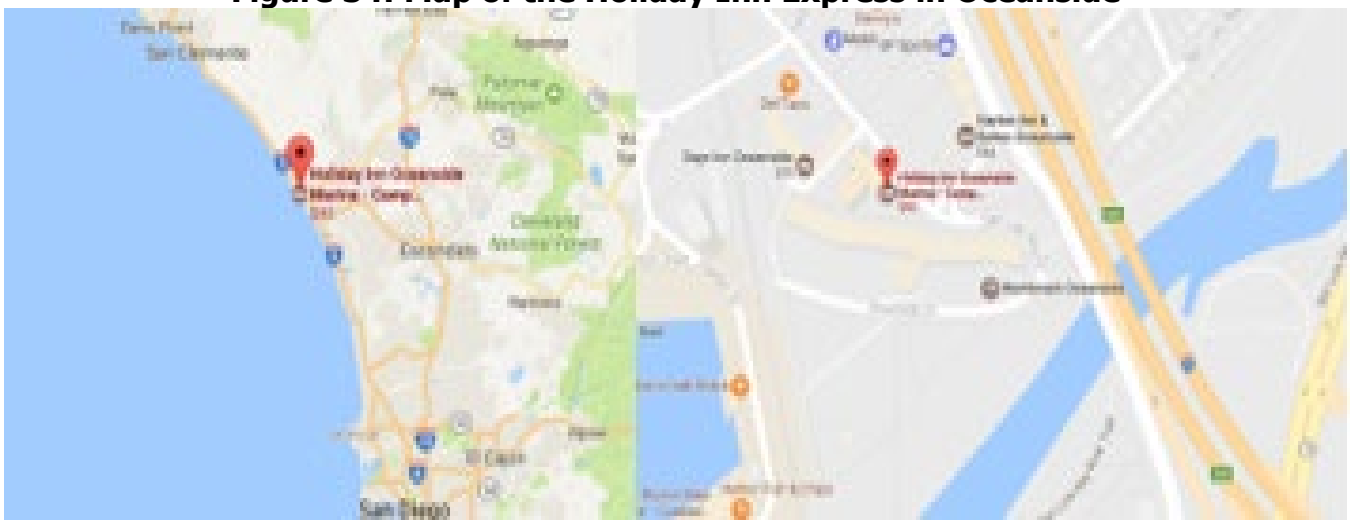
Figure 32: EV Express Charging Station

Source: Cleantech Institute

Figure 33: Holiday Inn Express- Oceanside

Source: Cleantech Institute

Figure 34: Map of the Holiday Inn Express in Oceanside



Source: Cleantech Institute

Figure 35: EV Express Charging Station

Source: Cleantech Institute

CHAPTER 3:
Data and Analysis

A total of 10 DC fast charging stations were deployed at 10 cities along the freeway corridors of State Route-99 and Interstate-5 from Stockton to Oceanside. After deployment and commissioning and in conformance with the terms of the grant, the charge stations were monitored continuously for a period of six months from June 2016 to November 2016.

This section details the technical findings from the project. It includes site specific as well as aggregate information. The results provided below include:

- Number of charging sessions per station per month
- The total time of usage at each station per month
- The total kWh of electrical energy usage at each station per month
- GHG savings
- Estimated gallons of gasoline displaced

Overview

Table 2 below provides a summary of the aggregated data collected during the recording period.

Table 2: Summary Project Data (June-October 2016)

Dates	Jun-16	Jul-16	Aug-16	Sept-16	Oct-16	Nov-16	TOTAL
Number of Charging Sessions	**55**	**88**	**104**	**124**	**145**	**165**	**681**
Total Charging Times (minutes)	**1750**	**2769**	**3409**	**3722**	**4961**	**5913**	**22524**
Total Consumed Energy (kWh)	**701.2**	**1120.2**	**1243.4**	**1417**	**1913.2**	**2134.6**	**8529.6**
Estimated Greenhouse Gas Reduction (kg)	**558.51**	**892.24**	**990.37**	**1128.64**	**1523.86**	**1700.21**	**6793.83**
Estimated Number Gallons of Gasoline Displaced	**62.89**	**100.48**	**111.53**	**127.10**	**171.61**	**191.46**	**765.07**

Source: Source: US Green Vehicle Council

Greenhouse Gas Reduction

The GHG reductions are calculated using information given below. The calculation method is to convert the kWh consumed by the EVSE in the project to the equivalent number of gallons of gasoline saved and number of tons of carbon dioxide (CO_2) reduced.

- First, we calculate the miles/kWh for a representative electric vehicle. For this project, the most common EV is Nissan Leaf
- Calculating electric miles range per kWh for the Leaf is accomplished by 85-mile range powered by 24 kWh. This results in a value of 3.54 miles per kWh for the Leaf.
- The Leaf data is from Nissan's websites at http://www.nissanusa.com/electric-cars/leaf/charging-range/ and http://www.nissanusa.com/electric-cars/leaf/versions-specs/)
- The average CO_2 emissions for an internal combustion engine vehicle is 450 g/mile. Likewise, the average CO_2 emissions for a plug-in EV is 225 g/mile assuming power is generated using an efficient mix of fossil and renewable power generation. (Reference EPRI; NRDC and Charles Clark Group: Nationwide Greenhouse Gas Emissions 2007)
- The difference in CO_2 (or CO_2 savings using an EV) between an internal combustion engine and an EV is (450 – 225) =225 g/mile CO_2 reduced.
- Therefore, the GHG reduction calculation is as follows:

(kwh consumed x miles/kwh) x 225gallons per mile = Grams of CO_2 reduced by using EVs

For the entire project, the calculation shows

(8529.6 x 3.54) x 225g/mile = **6,793 kg of CO_2 reduced by using EVs charged by the project.**

Gallons of gasoline consumed

To obtain the number of grams of CO_2 emitted per gallon of gasoline combusted, the heat content of the fuel per gallon is multiplied by the kg CO_2 per heat content of the fuel. In the preamble to the joint Environmental Protection Agency/Department of Transportation rulemaking on May 7, 2010 that established the initial National Program fuel economy standards for model years 2012-2016, the agencies stated that they had agreed to use a common conversion factor of 8,887 grams of CO_2 emissions per gallon of gasoline consumed (Federal Register 2010). This value assumes that all the carbon in the gasoline is converted to CO_2 (IPCC 2006).

In our calculation, 8,887 grams of CO_2 **is equivalent to 1** gallon of gasoline

Therefore, the entire project, over 6 months, has saved: 676 gallons of gasoline.

Summary of EV charging station data for each of these 10 sites

EV charging station data for each of the 10 fast charging stations are given below in Tables 3-12:

Table 3: Summary of EV charging data at the Stockton Econolodge

Dates	June-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	TOTAL
Number of Charging Sessions	10	12	13	15	18	20	88
Total Charging Times in minutes	476	497	416	495	558	684	3126
Total Consumed Energy kWh	190.5	152.4	156.6	162.6	225	248.7	1135.8
Estimated Greenhouse Gas Reduction (kg)	151.73	121.39	124.73	129.51	179.21	198.09	904.66
Estimated No. Gallons of Gasoline Displaced	17.09	13.67	14.05	14.58	20.18	22.31	101.88

Source: Source: US Green Vehicle Council

Table 4: Summary of EV charging data at the Santa Nella Best Western Andersen's Inn

Dates	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	TOTAL
Number of Charging Sessions	12	15	17	16	17	19	96
Total Charging Times (minutes)	476	497	544	528	578	665	3288
Total Consumed Energy kWh	190.5	192.7	197.2	179.2	214.2	241.3	1215.1
Estimated Greenhouse Gas Reduction (kg)	151.73	153.49	157.07	142.73	170.61	192.20	967.83
Estimated No. Gallons of Gasoline Displaced	17.09	17.28	17.69	16.07	19.21	21.64	108.99

Source: US Green Vehicle Council

Table 5: Summary of EV charging data at the Coalinga Best Western Big Country Inn

DATES	June-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	TOTAL
Number of Charging Sessions	6	8	9	11	13	14	61
Total Charging Times (minutes)	186	264	306	385	416	490	2047
Total Consumed Energy (kWh)	74.2	96.8	108.7	119.9	162.5	180.6	742.7
Estimated Greenhouse Gas Reduction (kg)	57.79	75.39	84.66	93.38	126.56	140.65	578.41
Estimated No. Gallons of Gasoline Displaced	6.51	8.49	9.53	10.52	14.25	15.84	65.14

Source: US Green Vehicle Council

Table 6: Summary of EV charging data at the Lost Hills Days Inn

Dates	June-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	TOTAL
Number of Charging Sessions	N/A	N/A	2	5	7	11	25
Total Charging Times (minutes)	N/A	N/A	67	175	238	418	898
Total Consumed Energy (kWh)	N/A	N/A	24.2	56.4	101.5	143	325.1
Estimated Greenhouse Gas Reduction (kg)	N/A	N/A	19.28	44.92	80.84	113.90	258.94
Estimated No. Gallons of Gasoline Displaced	N/A	N/A	2.17	5.06	9.10	12.83	29.16

Source: US Green Vehicle Council

Table 7: Summary of EV charging data at the Merced Holiday Inn Express & Suites

Dates	June-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	TOTAL
Number of Charging Sessions	7	12	12	12	11	12	66
Total Charging Times (minutes)	198	384	387	386	383	408	2146
Total Consumed Energy (kWh)	79.6	154.8	154.8	154.8	148.5	156.3	848.8
Estimated Greenhouse Gas Reduction (kg)	63.40	123.30	123.30	123.30	118.28	124.49	676.07
Estimated No. Gallons of Gasoline Displaced	7.14	13.88	13.88	13.88	13.32	14.02	76.13

Source: US Green Vehicle Council

Table 8: Summary of EV charging data at Fresno La Quinta Riverpark

Dates	June-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	TOTAL
Number of Charging Sessions	9	10	11	10	8	9	57
Total Charging Times (minutes)	262	313	376	293	281	315	1840
Total Consumed Energy (kWh)	104.8	129.3	129.3	105.7	107.2	112.5	688.8
Estimated Greenhouse Gas Reduction (kg)	83.47	102.99	102.99	84.19	85.38	89.61	548.63
Estimated No. Gallons of Gasoline Displaced	9.40	11.60	11.60	9.48	9.62	10.09	61.78

Source: US Green Vehicle Council

Table 9: Summary of EV charging data at the Tulare Quality Inn & Suites

Dates	June-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	TOTAL
Number of Charging Sessions	N/A	11	13	13	16	18	71
Total Charging Times (minutes)	N/A	327	426	442	544	648	2387
Total Consumed Energy (kWh)	N/A	139.7	139.7	154.7	224	237.6	895.7
Estimated Greenhouse Gas Reduction (kg)	N/A	111.27	111.27	123.22	178.42	189.25	713.43
Estimated No. Gallons of Gasoline Displaced	N/A	12.53	12.53	13.88	20.09	21.31	80.34

Source: US Green Vehicle Council

Table 10: Summary of EV charging data at the Lebec- Studio 6

Dates	June-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	TOTAL
Number of Charging Sessions	N/A	N/A	2	13	22	24	61
Total Charging Times (minutes)	N/A	N/A	71	455	792	889	2207
Total Consumed Energy (kWh)	N/A	N/A	27.2	149.5	297.4	316.8	790.9
Estimated Greenhouse Gas Reduction (kg)	N/A	N/A	21.66	119.08	236.88	252.33	629.95
Estimated No. Gallons of Gasoline Displaced	N/A	N/A	2.44	13.41	26.68	28.42	70.94

Source: US Green Vehicle Council

Table 11: Summary of EV charging data at the Castaic- RV Park

Dates	June-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	TOTAL
Number of Charging Sessions	N/A	7	10	13	15	19	64
Total Charging Times (minutes)	N/A	220	347	429	540	731	2267
Total Consumed Energy (kWh)	N/A	86.8	138	143.8	202.5	256.5	827.6
Estimated Greenhouse Gas Reduction (kg)	N/A	69.14	109.92	114.54	161.29	204.30	659.18
Estimated No. Gallons of Gasoline Displaced	N/A	7.79	12.38	12.90	18.16	23.01	74.23

Source: US Green Vehicle Council

Table 12: Summary of EV charging data at the Oceanside- Holiday Inn

Dates	June-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	TOTAL
Number of Charging Sessions	11	13	15	16	18	9	82
Total Charging Times (minutes)	341	413	490	544	631	315	2734
Total Consumed Energy (kWh)	136.8	167.7	167.7	190.4	230.4	112.5	1005.5
Estimated Greenhouse Gas Reduction (kg)	108.96	133.57	133.57	151.65	183.51	89.61	800.88
Estimated No. Gallons of Gasoline Displaced	12.27	15.04	15.04	17.08	20.67	10.09	90.19

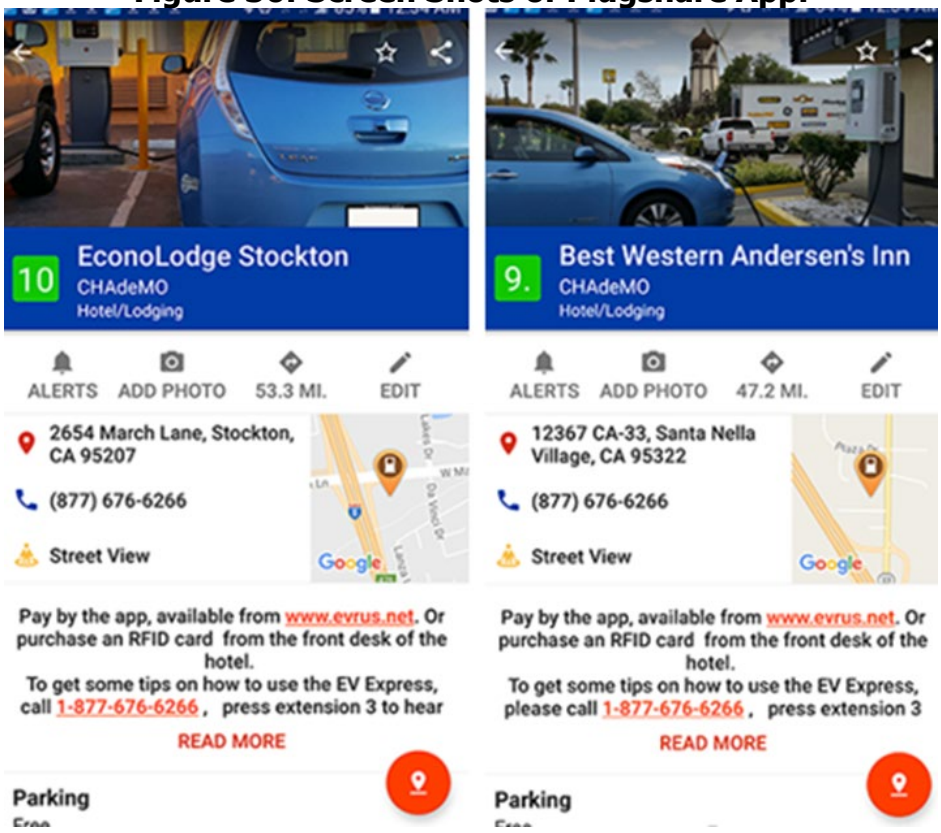
Source: US Green Vehicle Council

Customer Review on Plugshare

Below in Figures 36-40 are the scores (the scores are located in the green box next to the name of the charging station location) of customer satisfaction as given on the Plugshare App over 6-month period from June 1 to November 30, 2016. Plugshare one of the most popular reviewers of the charging stations in the United States.

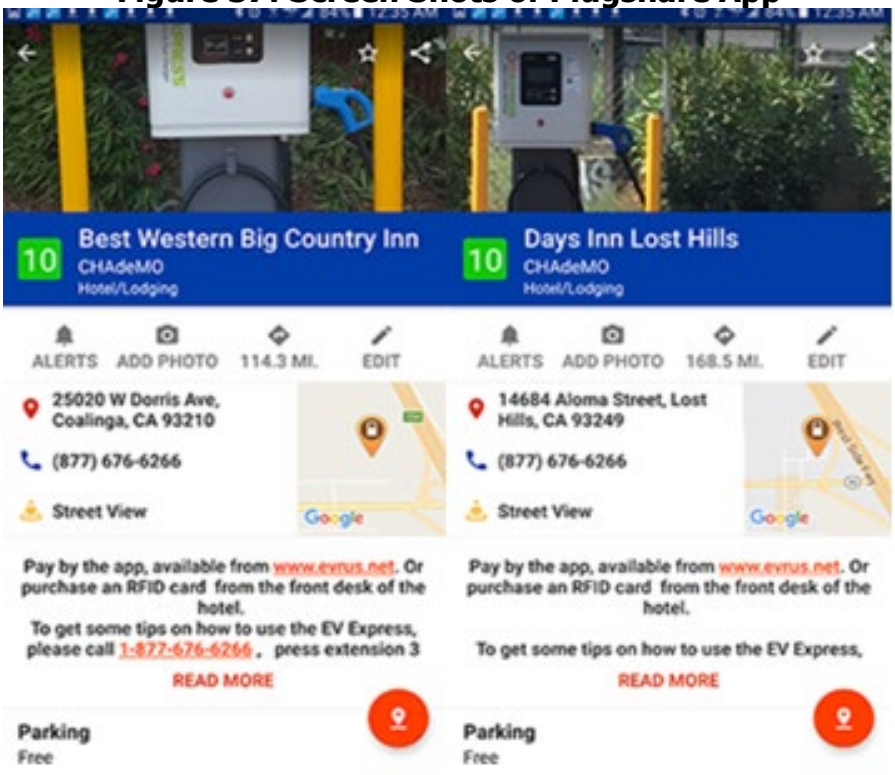
Eight of ten stations are scored 10/10 with 10 is the highest customer satisfaction. Two stations are scored 9/10. The overall average of customer satisfaction is 98 percent.

Figure 36: Screen Shots of Plugshare App.



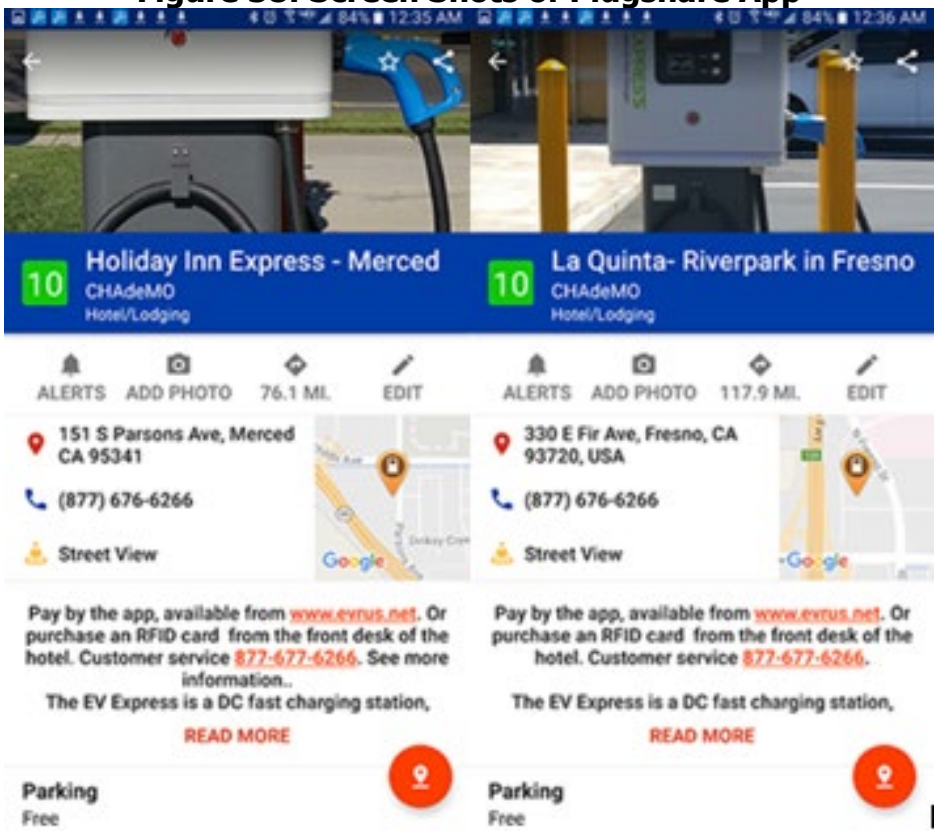
Source: Cleantech Institute DONE

Figure 37: Screen Shots of Plugshare App



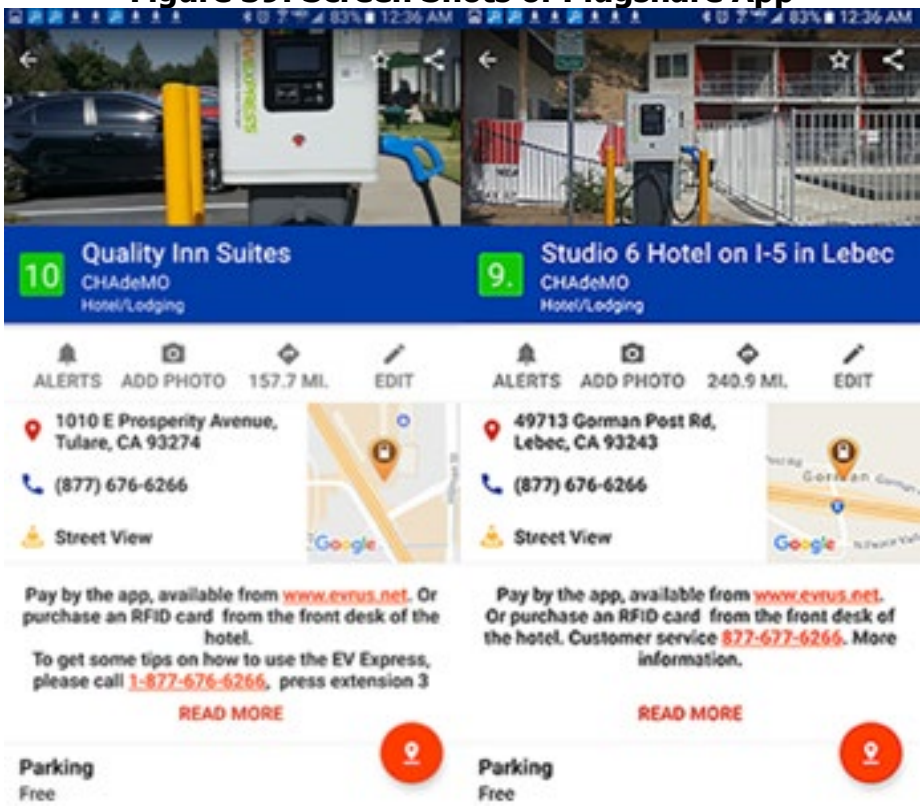
Source: Cleantech Institute DONE

Figure 38: Screen Shots of Plugshare App



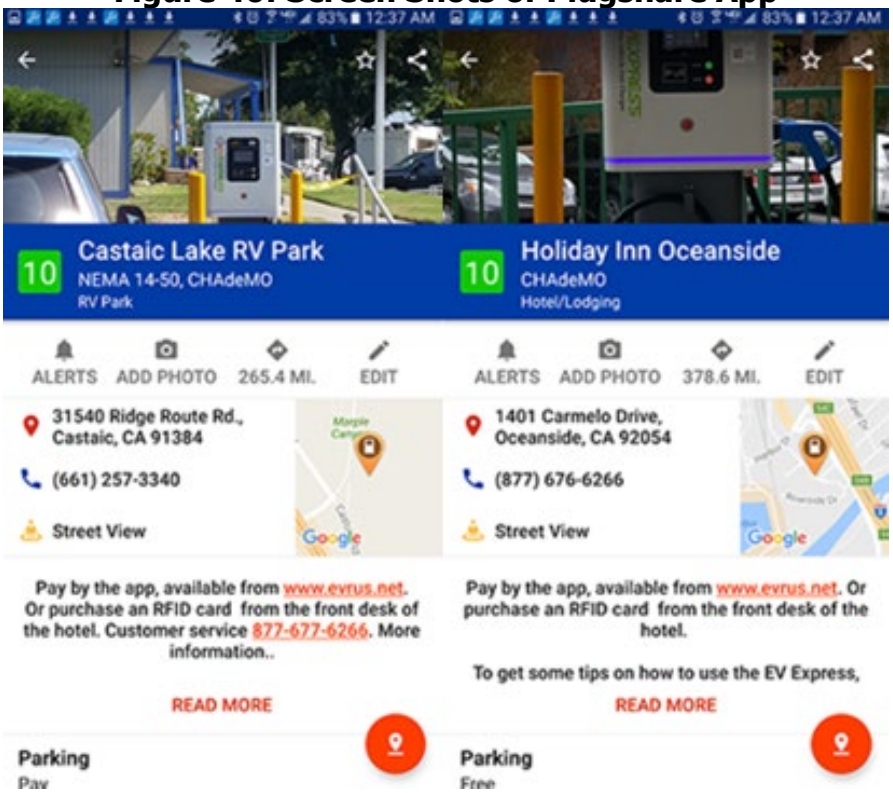
Source: Cleantech Institute

Figure 39: Screen Shots of Plugshare App



Source: Cleantech Institute

Figure 40: Screen Shots of Plugshare App



Source: Cleantech Institute

CHAPTER 4:
Summary and Conclusion

The project concluded with the following results:

- The project resulted in more than 681 charge sessions over a six-month period.
- The total charging time: 22,534 minutes or about 375 hours
- The total consumed energy: 8.529.6 kWh
- The estimated greenhouse gas reduction: 6,793 kg
- The estimated number of gallons of gasoline displaced: 765 gallons
- It delivered the expected results on budget and within schedules.
- All 10 stations have received positive customer satisfaction of an average of 98 percent

In addition, during the course of this project, US Green Vehicle Council had phone conversations and interacted directly with a goon number of the EV drivers. These conversations allowed us to gain a series of insights into EV drivers, their motivations and hot-button issues. Specifically, we have found the following:

a. Most EV drivers value charging convenience and are not averse to paying to charge their vehicles if the costs are reasonable and known in advance.

b. Many EV drivers are willing to drive long distance goes well beyond the comfort short distance from their home, with the availability of DC fast charging stations,

c. We have observed the increased adoption of the EV thanks to the availability of DC fast charging stations.

d. The business model of installing and managing DC fast charging stations still remains a challenge with expensive capital investment and high operating costs.

e. Public investment is needed to fund the building of infrastructure of DC fast charging stations to enable the deployment of EV to meet the State of California's goal of reaching $1.5 million zero emission vehicles by 2025.

GLOSSARY

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.

CARBON DIOXIDE (CO2)—A colorless, odorless, nonpoisonous 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).

DIRECT CURRENT (DC)—A charge of electricity that flows in one direction and is the type of power that comes from a battery.

GREENHOUSE GAS (GHG)—Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include water vapor, carbon dioxide (CO2), methane (CH4), nitrous oxide (NOx), halogenated fluorocarbons (HCFCs), ozone (O3), per fluorinated carbons (PFCs), and hydrofluorocarbons (HFCs).

KILOGRAM (kg)—The base unit of mass in the International System of Units that is equal to the mass of a prototype agreed upon by international convention and that is nearly equal to the mass of 1,000 cubic centimeters of water at the temperature of its maximum density.

KILOWATT-HOUR (kWh)—The most commonly used unit of measure telling the amount of electricity consumed over time, means one kilowatt of electricity supplied for one hour. In 1989, a typical California household consumed 534 kWh in an average month.

LIMITED LIABILITY CORPORATION (LLC)—is the US-specific form of a private limited company. It is a business structure that can combine the pass-through taxation of a partnership or sole proprietorship with the limited liability of a corporation.[8]

PLUG-IN ELECTRIC VEHICLE (PEV)—A general term for any car that runs at least partially on battery power and is recharged from the electricity grid. There are two different types of PEVs to choose from—pure battery electric and plug-in hybrid vehicles.

[8] Limited Liability Corporation https://en.wikipedia.org/wiki/Limited_liability_company

ZERO EMISSION VEHICLE (ZEV)—Vehicles that produce no emissions from the on-board source of power (e.g., an electric vehicle).