UL Homer Grid Simulation of a DCFC Charging Station and Solar Plant in Yosemite National Park

Date: 2-12-24

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Figure 1: Ahwahnee Hotel in Yosemite National Park (NPS).

Contents

Task

Simulate a DCFC EV charging station and solar plant for Ahwahnee Hotel in Yosemite National Park using UL Homer Grid. Assume the park is piloting a system in which the price of DCFC is reduced for hotel guests and restaurant users between the hours of 10 a.m. and 4 p.m. but increases outside of this zone. The system should be able to service all the hotel guests in a single day in an emergency. The solar plant should be sized so that the system is estimated to require 0 net electricity from the grid in the first year. Also, provide background information on the site, rough estimated project costs, and rough estimates on a project timeline.

Executive Summary

The Ahwahnee Hotel is the luxury hotel for Yosemite National Park and its high-end clientele are likely to need electric vehicle infrastructure quickly. There are three parking lots on site where the EVSE equipment could be located. The local valet service can also help in the cycling of cars through the chargers to reduce charger standby time in peak sunlight hours. Two convenient areas for potential solar development are in the immediate vicinity and could allow the station to operate at net zero energy usage or better.

A system of 12 two-port EVSE charging stations can provide enough power to charge all of the hotel users vehicles with 50kWh of energy in a 6-hour time period. A 12-charger system can maintain this baseline even if 2 chargers are out of operation. 50kWh is enough to fully charge most vehicles and provide enough energy for all guests to reach other charging stations far out of the park.

The most convenient sites for solar are an unused field next to the hotel and a 27-acre picnic area just outside the hotel grounds. There is space for a 1,600kW system at both sites which is enough to provide 80% of the electricity between the hours of 10 a.m. to 4 p.m. while providing more net energy than the EVSE system requires on a yearly basis. The hotel is a National Historic Building, but protections associated with that do not extend to the hotel grounds.

The price for a 1,600kW solar plant with a system of 12 DCFC chargers is expected to cost around $2.5 – 2.8 million dollars. 1.6-1.7 million attributed to the solar aspects of the project and 0.8-1.1 million for the EVSE aspect. This is a cost of $36,000-$46,000 per DCFC port. O&M, network, and utility connection are expected to have a yearly cost of ~$90,000 a year ($0.042/kWh). One option for funding the project is to work with the National Park Foundation (NPF). A station to power 26 electric buses at Zion National Park was recently funded by the NPF.

After funding is secured, station developer selected, and an initial design is ready, the project has a timeline of 1-2 years. Variability in the time is related to unclear or variable timelines for construction, utility review/design, and variable shipping times for EVSE equipment purchased through government procurement channels.

Appendix A contains information on common problems associated with EVSE projects at National Parks. Appendix B has information regarding regulations, standards, permits and inspections for EVSE equipment.

Yosemite/Ahwahnee Background

Yosemite has 13 campgrounds (NPS, Yosemite Nation Park California - Camping Reservations) as well as lodges, hotels, and other housing options in and around the park. The park receives greater than 3.5 million visitors every year (NPS) with peak time in August reaching over 600,000 visitors a month. It is situated 170 miles due east from San Francisco (Maps). However, there are only 14 EV chargers in the park with another 20 planned at a raft rental site in the park (PlugShare).

The Ahwahnee Hotel is the luxury hotel for Yosemite and has 121 room available (NPS). It can be speculated that the clientele will be more likely to have newer cars, particularly EVs. In the future this will be one of the first places to see demand from customers to install EVSE. Currently the site only has two J-1772 chargers available (PlugShare). Parking is currently handled by valets who run a queue for the chargers and normally have a 3 hour charging limit. The 34 planned chargers in the park simply will not meet the needs and demands of visitors in the very near future.

Ahwahnee Site Map

Figure 2: Aerial view of the Ahwahnee hotel from Google Maps (Maps). The hotel has 3 parking lots, the main building, and cabins to the east. There is an unused space sparsely inhabited by trees to the immediate west and a large picnic area bordering the hotel grounds.

Weather Information

The Ahwahnee Hotel sits at an elevation of 3986 feet (WEMP)and is close to Yosemite Village which can drop to -5°F in the winter and have peaks around 105°F in the summer (WCG). In the coldest month, December, the average low temperature is 28°F and high of 46°F. In the hottest months (July/August), the average low is 57°F and high of 89°F. It has an annual precipitation (rain or snow) of 36.6 inches spread out over 67 days a year. The monthly rainfall peaks in January with an average of 6.9 inches received and tapers off to July/August with an average of 0.2 inches of precipitation.

On-Site Parking

There are 3 parking lots with approximately 120 spaces close to the hotel and each is surrounded by tall trees on all sides, especially the south. There is complimentary parking if you are a guest and parking fees if you are only a visitor. There is also a valet service which is complimentary for hotel guests and they cycle electric vehicles through the two chargers currently on site. Parking spots are shaded for most of the day.

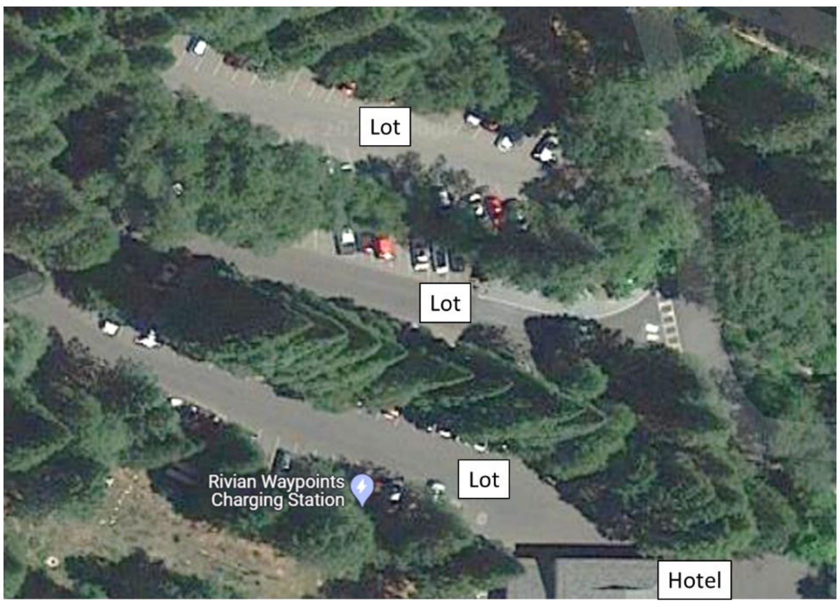


Figure 3: Parking lots for the hotel. There are 3 lots each with large trees directly to the south for each and the parking spaces are shaded for most of the day.

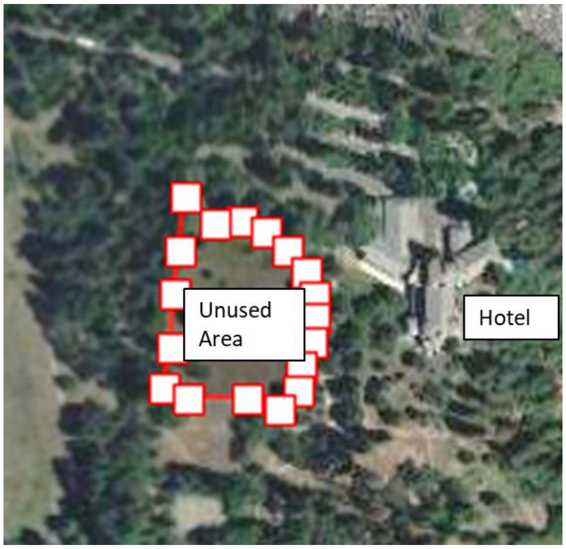
Solar Opportunity

Solar may be possible at an unused site abutting the west of the hotel as well as a large picnic area 1/4 of a mile to the west. It is unlikely that rooftop solar will be permitted doing to the historic nature of the hotel and the parking lot is a poor space for solar due to the large trees surrounding the space.

Using PVWatts' Rooftop Size estimator, the unused area without trails abutting the hotel to the west is 11191m^2 (2.7 acres) and a 1,678 kW system is suggested. Using default PVWatts information and sweeping various tilt angle options (standard modules, fixed array, 14.08% system losses, 30-

degree tilt, 180-degree azimuth), this space has the possibility for 2840 MWh of AC energy potential a year.

Similarly, the picnic area sits on 111553 m^2 (27 acres) and is recommended as a 16,733 kW system. There is a reported potential of 28,334 MWh of AC electricity generation a year.



RESULTS

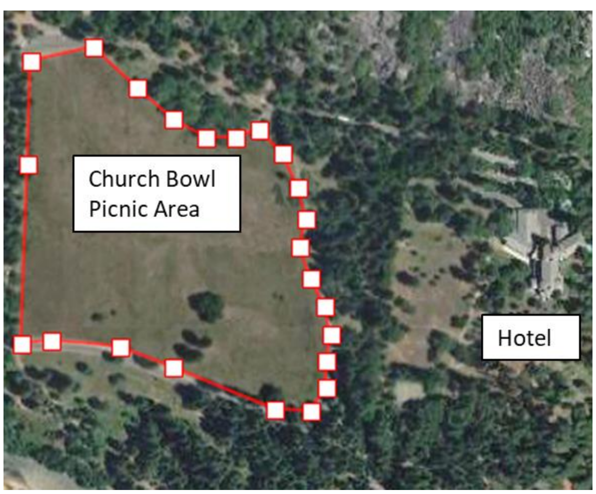
Print Results

2,842,507 kWh/Year*

System output may range from 2,699,813 to 2,905,610 kWh per year near this location. Click HERE for more information.

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)
January	4.25	178,889
February	5.02	185,815
March	6.49	259,861
April	6.55	246,938
May	6.80	260,178
June	7.62	277,504
July	7.78	283,385
August	7.73	284,037
September	7.38	267,843
October	6.17	240,312
November	4.88	190,570
December	4.02	167,174
Annual	6.22	2,842,506

Figure 4: PVWatts results for unused area directly west of the hotel. The site is an estimated 2.7 acres. An annual potential production of 2,842 MWh is projected with a peak of 284MWh in August and 167MWh in December.



RESULTS

Print Results

28,334,075 kWh/Year*

System output may range from 26,911,705 to 28,963,092 kWh per year near this location. Click HERE for more information.

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)
January	4.25	1,783,164
February	5.01	1,852,204
March	6.49	2,589,936
April	6.55	2,461,489
May	6.80	2,593,484
June	7.62	2,766,193
July	7.78	2,824,815
August	7.73	2,831,316
September	7.38	2,669,909
October	6.17	2,395,485
November	4.88	1,899,652
December	4.02	1,666,430
Annual	6.22	28,334,077

Figure 5: PVWatts results for the Church Bowl Picnic Area directly west of the hotel. The site is an estimated 27 acres. An annual potential production of 28,334 MWh is projected with a peak of 284MWh in August and 167MWh in December.

Park Decision Makers

Information on the decision makers for Yosemite National Park can be found in the Yosemite National Park Foundation Document (NPS). Relevant decision makers for the park include the

Facility Management Chief, Project Management Chief, Business and Revenue Management Chief, Strategic Planning Chief, Resources Management and Science Chief, and Branch Chief/Fee Revenue Manager, Business Revenue Management. To move forward with construction, park unit staff must review the scope of work and identify National Environmental Policy Act compliance requirements prior to installation.

Below is a list of further ways to contact the park for general inquiries.

- The Ahwahnee Front desk: 209-372-1407.
- NPS customer service emails: https://www.nps.gov/yose/contacts.htm
- Yosemite National Park General Questions: 209-372-0200 (then dial 3 then 5). Open 9 a.m. to 4 p.m. PST, closed for lunch (NPS, Yosemite - National Park California - Contact Us)decision)

Local Utility Contact

Yosemite is a large enough park that you may need to work with different utilities based on where a project is located. The Ahwahnee hotel is in the purview of PG&E based on the Electric Utility Service Areas Map from the California Energy Commission (CEC) and Google Maps (Maps). The Building and Renovation Service Center's phone number is 1-877-743-7782 (PG&E, Get started with electric vehicles). They should be contacted regarding the most recent process for installing EVSE as well as if there are any fees or costs that Rule 29 does not cover. It should additionally be noted that they have their own approved vendors for EVSE projects (PG&E).

Process for Installing EVSE with PG&E

The typical process for developing EVSE with PG&E takes 6-8 months on their end. The process is as follows (PG&E). An initial application will need to be sent to PG&E. A Pre-assessment is usually started within 10 days by PG&E regarding available circuit capacity, preliminary design options, and required equipment. This pre-assessment can take 30 days itself. If the customer approves, they will continue with designing the electrical distribution infrastructure, final design, and develop a contract over the period of 80 days. At this point a Pre-Contract meeting is set up with the inspector and the customer. After signing the contract, the customer proceeds with construction/electrical permits and constructs their portion of the infrastructure. Inspections will be conducted and may involve the following inspections: PG&E Trench, PG&E Cross Bore, PG&E Mandrel, PG&E Final, City/County Green Tag. At this point PG&E will schedule construction and the site needs to be ready 4-6 weeks before the construction date. 1.5-3 months of construction on their end can be expected. The project can be energized once new meters are installed and the utility infrastructure is in place.

Process for Installing Solar with PG&E

PG&E provides the steps for installing solar with them online for homeowners and they should be checked with to see what extra steps are necessary with larger PV systems. In addition to the steps that will be taken with the EVSE development, they may require an additional application to connect the system to the grid.

EVSE Tarriff with PG&E

Tariffs from PG&E for electric vehicles are Time-of-Use (TOU) rates (PG&E) and are different for residential and business customers. There are two potential EV tariffs based on size of the installation with the smaller rate for <100kW applications and larger rate for >100kW. This installation will be >100kW and fit in the BEV2 tariff.

Figure 6 :Identifying Pacific Gas & Electric Company as the electric utility for the Ahwahnee Hotel with the Electric Utility Service Areas Map from the California Energy Commission (CEC) and Google Maps (Maps).

Local Clean Cities Coalition

The NREL best practices recommends reaching out to the local Clean Cities Coalition leaders regarding the project. The U.S. Department of Energy's Clean Coalition Network tool identifies the San Joaquin Valley Clean Cities Coalition as the relevant entity for this geographical location (USDOE, U.S. Department of Energy Clean Cities Coalition Network - San Joaquin Valley Clean Cities).

Payment Options/Local Station Developers

Parks are encouraged to work with concessioners for EVSE projects. Potential concessioners with their charging network already in the area include ChargePoint, Electrify America, EVgo, Shell, and Tesla. These are also station developers. However, the infrastructure for the hotel and valet assistance could manage credit card readers at point of sale. Which option the park prefers to go with should be discussed with Ahwahnee staff, park leadership and the Nation Park Foundation further.

EVSE Selection

UL Homer Grid requires inputs related to the number of chargers and charger output power. The best way to select this information is to identify the desired EVSE and transfer information from the specification sheet into Homer. Below are the requirements for the EVSE and information on the selected EVSE equipment.

Equipment Procurement Process

It is anticipated that the project may need to use “GSAAdvantage!” for capital equipment purchases like most other government related projects. The General Services Administration (GSA) newly awarded Blanket Purchase Agreements (BPAs) provide a streamlined ordering process with reduced administrative burden for acquiring EVSE. These 60-month agreements include over 1,165 EVSE products across 30 EVSE brands. This project will be set up so equipment can be purchased through “GSAAdvantage!”. EVSE equipment will be approved by CALeVIP, certified to meet California’s weights and measures laws and regulations, and be an approved vendor of PG&E (PG&E).

DCFC EVSE Brands that fit this requirement include ABB, Blink, BTC Power, ChargePoint, Efacec, FreeWire, Noodoe EV, Siemens, and Tritium. Further requirements for

Equipment Requirements

(assembled with help from CALeVIP (CALeVIP))

- Operating High Temperature: 110ºF (max 105ºF + 5ºF)
- Operating Low Temperature: -10ºF (min -5ºF - ºF)
- Indoor/Outdoor rating: Outdoor
- GSA Advantage! Listing: Yes
- PG&E Approved Vendor: Yes
- CALeVIP Approved Vendor: Yes
- Certifications: Must be approved by a NRTL program for EVSE testing and certification.
- Charging Connector: DCFC dual standard chargers with both CHAdeMO and SAE CCS connector options.
- Minimum energy delivered to plug-in electric vehicle: 50 kW or greater.
- Network: Wi-Fi for tracking consumption and costs, monitor demands and trends, and better understand the usage profile. An open standard protocol should be used as a basic framework for network interoperability. The Wi-Fi for the hotel is reliable, cell service is unreliable.
- Networking agreement: Minimum of 5 years.

Equipment Selection

Deciding on the number of chargers to install and what charging capability to install is a difficult topic. Hotel guests, lunch visitors, and other EV users in the park will wish to have their cars charged up for their adventure and when they head out of the park. Additionally, the cars will arrive at the charging station with a wide range of charges. Discussion should be had with the hotel staff as to what they project the needs and the characteristics of their customers to be.

The current system will be sized so that 120 cars (the approximate number of hotel rooms) can receive at least 40kWh of energy between 10 a.m. and 4 p.m. on a single day. The hotel should then be to ensure that guests are either topped up when they leave or at least have sufficient charge to reach chargers outside the park. The site will also have 20% more chargers than this baseline to compensate for maintenance and repairs.

With the layout of the parking lots, it is expected that chargers with 2 ports can be used, but the layout of the site would not be convenient for 3 port systems or systems with separate towers and dispensers. Additionally, secondary power cabinets are not preferred.

Below is a list of the potential 2 port chargers and prices from GSAAdvantage!

Manufacturer	Part Number	Maximum Power Output (kW)	Temperature Range (°F)	Price	Price per kW	Time to Delivery (Days)	Warranty
ABB	Terra 124	120	-31 to 131	$ 74,259.02	$ 618.83	30	2 years
BTC Power	L3R-100-480-02-003	100	-22 to 122	$ 51,912.85	$ 519.13	120	2 years
FreeWire	BOOST 150 EVC	150	-4 to 131	$ 134,780.86	$ 898.54	120	3 or 5 year
Tritium	PKM150 (150KW)	150	-31 to 122	$ 94,296.02	$ 628.64	180	2 years

Table 1: List of relevant DCFC EVSE from GSAAdvantage!

Of the available options, further investigation into the options from ABB, BTC Power, and Tritium are worth further investigation. FreeWire is a more expensive option because they specifically include Li-ion battery storage in their products. That feature is not necessary in this project.

It should also be noted that the price advertised in the chart above does not include the full cost of a unit. Accessories may include card readers, hose management, warranties, network connection fees, different port connectors and more.

The BTC Power L3R-100-480-02-003 (L3R-100-480 family) will be used for this study. It currently is the lowest cost option, has the appropriate certifications, and is on all the appropriate supplier lists. The unit can provide 50kW to two different ports. 120 cars can be charged with 50kWh over the course of 6 hours with 10 units, so the installation will include 12 units for maintenance considerations. Cord retractors are built in and credit card readers are normally included should that park be interested in a different payment structure. Networking fees are expected to be $1000 per unit, roughly $12,000 a year total (USDOE).

100 kW DC Fast Charger

PARAMETERS	MODEL	
	L3R-100-480	
Power Rating	100 kW	
Dual Port Charging Topology	100 kW Single Output or 50 kW Parallel Output	
Connector	SAE J1772 Combo CCS1	CHAdeMO
Max Current	200 A	200 A
Max Voltage	50 - 920V	50 - 500V
Efficiency Rating	> 92%	
Network Compatibility	OCPP 1.5/1.6, BTCP Network	
Input Power	480VAC-3P@132A	
Input Power AC Current (FLA)	132 A	
Dimension	42" W x 86" H x 34" D	
Weight	1,350 lbs	

ENVIRONMENTAL AND COMPLIANCE	
Ambient Condition	-30 °C to +50 °C, 95% Humidity Non-Condensing, 6000 ft Altitude, NEMA 3R
Safety Compliance	ETL Listed for USA and Canada; Complies with UL 2202, UL 2231 UL50E, NEC Article 625, CSA STD C22.2 No. 107.1, FCC Part 15 Class A

STANDARD

- Integrated Cord Retractor (for CCS1)
- 15" Outdoor Color Display
- Connector Configuration:
  - CHAdeMO and SAE J1772 Combo CCS1
- Payment types: (OCPP Network Enabled)
  - Credit Card Reader
  - RFID

OPTIONAL

- ISO 15118:2014
- 4G Modem
- Connector Configuration:
  - Dual SAE J1772 Combo CCS1
  - Single CHAdeMO
  - Single SAE J1772 Combo CCS1

BTC POWER
1719 S Grand Ave, Santa Ana, CA 92705

www.btcpower.com
sales@btcpower.com

Figure 7: Specification sheet for the selected BTC Power DCFC charging equipment. The dual port option allows for charging of one car at 100kw or two cars at 50kW each.

UL Homer Grid Simulation

Setup

The geographical coordinates of the middle parking lot are 37.747006465851605, -119.57479730124143 and were used for relevant solar calculations in Homer.

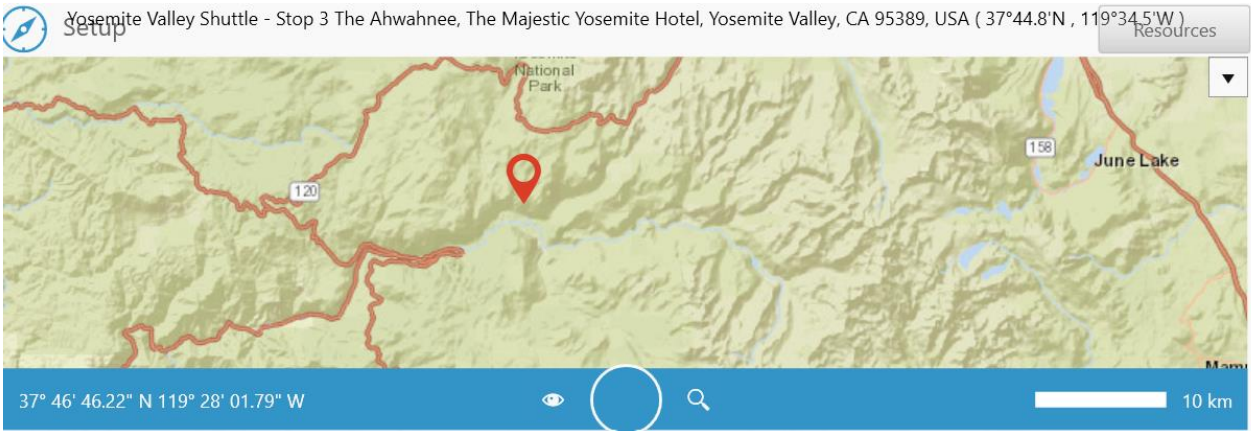


Figure 8: Ahwahnee site selection on the UL Homer Grid Map.

Electric Load

This project will be set up to only focus on the charging station and not consider the hotel's electricity usage itself. Thus, no information is added to this section. This can be a topic for discussion at a later point.

Utility

PG&E has rate plans for separately metered EV installations. This >100kW business installation fits into the new BEV-2-NEM2 tariff category.

Choose Utility

Select from North American Library | Select from User Library | Create Custom

United States | 95389 | Get Tariffs | The same company provides both generation and distribution ○ No ◉ Ye

Name	Code	Tariff Type	Utility	Demand Min (kW)	Demand Max (kW)
Business Electric Vehicles 2 (NEM 2)	BEV-2-NEM2	Dist+Gen	Pacific Gas & Electric Co	100	
Business Electric Vehicles 1 (NEM 2)	BEV-1-NEM2	Dist+Gen	Pacific Gas & Electric Co		100
Business Electric Vehicles 2 (NEM 1)	BEV-2-NEM1	Dist+Gen	Pacific Gas & Electric Co	100	
Business Electric Vehicles 1 (NEM 1)	BEV-1-NEM1	Dist+Gen	Pacific Gas & Electric Co		100

Table 2: Available EVSE tariffs installed in UL Homer Grid for PG&E.

Other Relevant Utility Information for Homer:

- Twelve 100kW fast chargers will be installed for an EV Subscription Block Size of 1200 kW
- The intention of the project is to have 0 net energy usage at true-up

- This will be the secondary connection for the site
- Being part of a federal agency, this site qualifies for an energy surcharge exemption
- As a secondary connection this site does not qualify for “In Grace Period”
- The project is not a Solar Choice Customer

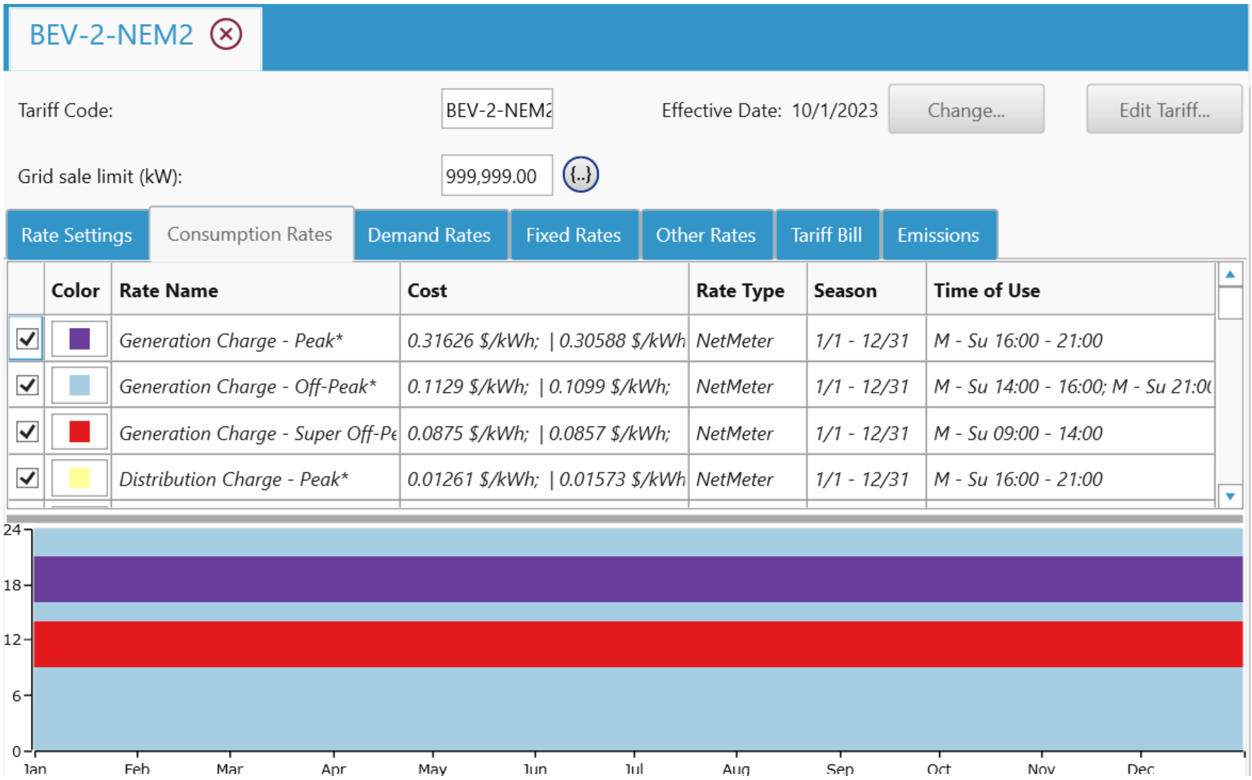


Figure 9: Breakdown of the EVSE tariff BEV-2-NEM2 from PG&E. The tariff is reported as constant throughout the year. Electricity is cheaper in the Off-Peak (blue) and Super Off-Peak (red) times. Charging during Peak times (purple, 16:00-21:00) should be avoided.

Components

PV

Generic components will be used for this project and more in-depth modelling with PVSyst and/or HelioScope will be pushed to a later project. Thus, a generic flat plate PV is selected for the site with a lifetime of 25 years.

- The default solar costs will be used in Homer as they were found to be close to data from NREL’s Solar Market Research and Analysis’ Solar Installed System Cost Analysis. Though Homer’s value of ~$1.60 per Watt for 1000kW is higher than NREL’s 2022 value for Utility-Scale PV (One-Axis Tracker) of $1.06/per Watt (NREL).
- The default derating factor of 0.8 will be used and it is assumed for now that the >92% charging efficiency of the DCFC chargers is factored into this value.
- System sizes of 100kW, 400kW, 800kW, 1600kW, 3,200kW, 8000kW, and 16,000kW systems will be investigated in Homer to consider different utilization of the different solar sites.

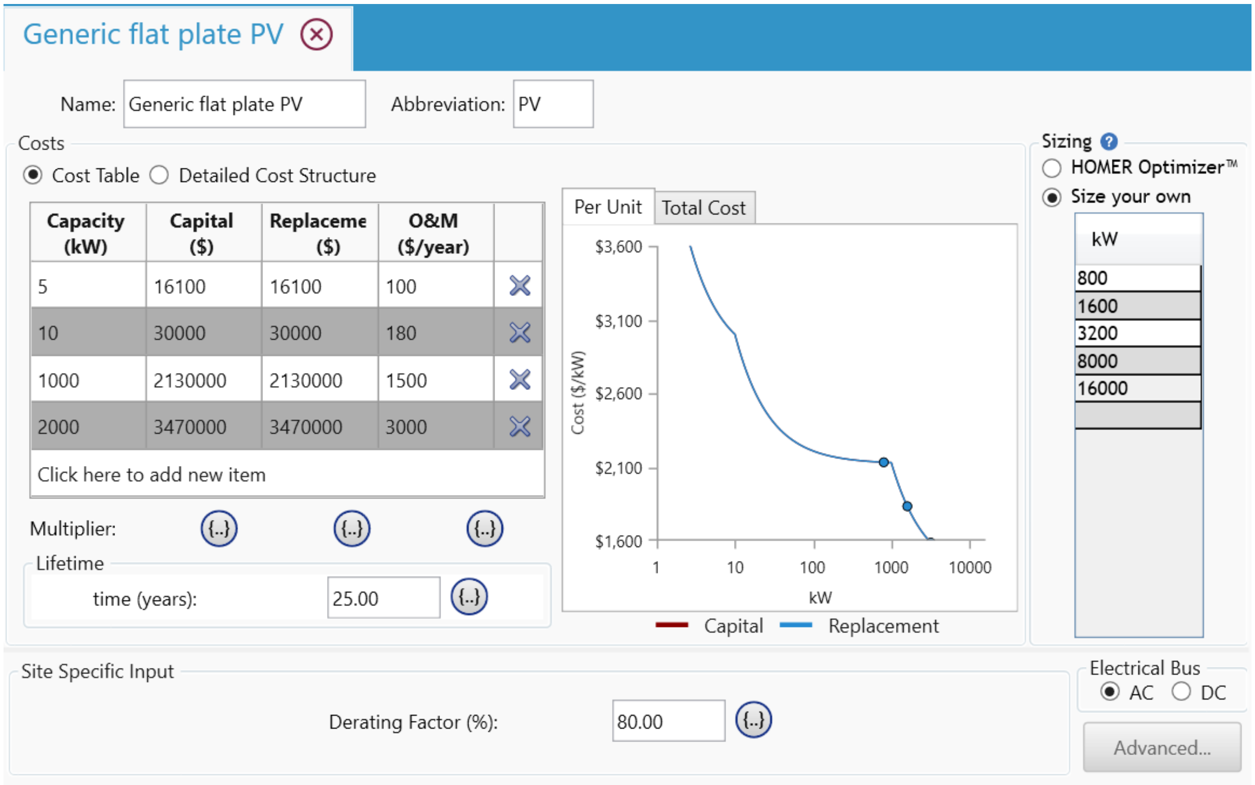


Figure 10: UL Homer Grid's cost of PV for different installation sizes. This project focuses on a 1,600kW installation.

Storage, Converter, Generator, Wind Turbine

These items are not necessary for the simulation.

EVSE

Homer does not have an option yet for specifying a particular EVSE or a convenient way to include the cost of installing, running, operating an EVSE in their system. The costs associated with EVSE will be considered outside of Homer.

Resources

Solar GHI and Temperature

Solar and temperature data from NREL's National Solar Radiation Database is used as it is known to be reliable data for North America.

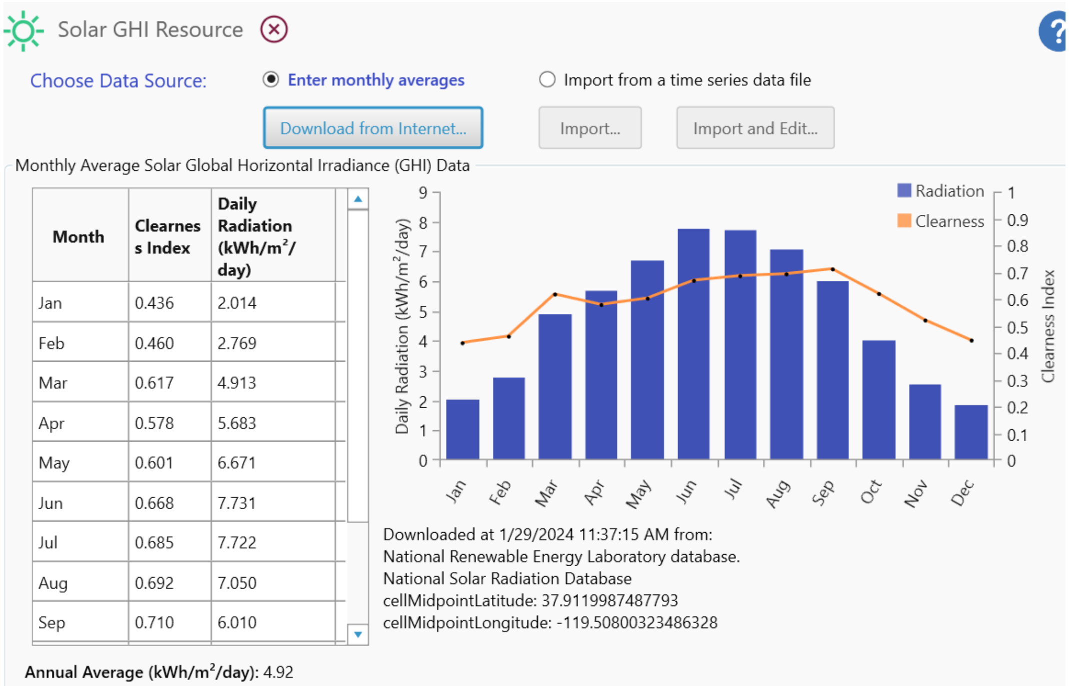


Figure 11: Reported Solar GHI Resource from UL Homer Grid.

EV Charging

Profile

Homer Grid has 2 options as template profiles for level 3 chargers, “Overnight Fleet Charger” and “Highway Charger”. The “Highway Charger” Profile is started with since the project specifically hopes to charge vehicles primarily during day hours.

Charger Output Power and Number of Chargers

The twelve 100kW chargers are modelled as 24 chargers with maximum output power of 50kW.

Scaled avg sessions/day

The system will be set up so that there is an average of 121 total charging sessions a day (same number as hotel rooms). In the summer it is likely there will be more than this, in the winter less. Twenty percent daily variability and 20% charge length variability will be used.

Vehicle type and average charging duration

The default of 30% large EVs and 70% small EVs will be for this project. It is assumed that customers are unlikely to want to arrive at the hotel at 0% charge, so charging the battery ~70% will be taken as the average charging amount. For large EVs this will be ~75kWh (1 hour, 30 minutes) and small EVs ~35kWh (42 minutes).

Usage Profile

The profile will be set up on a 100 car a day basis for peak July and August. The "Scaled avg session/day" takes the proportions from the usage profile and scales it to the appropriate charging sessions a day later. Maximum load will be assumed May through September with 80% of the daily sessions between 10 a.m. and 4 p.m. December, January, and February will be 70% of the usage of the maximum months with usage scaling down to those times. No distinction is made between weekdays and weekends at such a popular location. The overall load profile before scaling is shown below.

Yearly Load Data

Weekdays Weekends

Hour	January	February	March	April	May	June	July	August	Septembe	October	November	December
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	1.400	1.400	1.600	1.800	2.000	2.000	2.000	2.000	2.000	1.800	1.600	1.400
9	2.800	2.800	3.200	3.600	4.000	4.000	4.000	4.000	4.000	3.600	3.200	2.800
10	7.700	7.700	8.800	9.900	11.000	11.000	11.000	11.000	11.000	9.900	8.800	7.700
11	9.100	9.100	10.400	11.700	13.000	13.000	13.000	13.000	13.000	11.700	10.400	9.100
12	10.500	10.500	12.000	13.500	15.000	15.000	15.000	15.000	15.000	13.500	12.000	10.500
13	9.800	9.800	11.200	12.600	14.000	14.000	14.000	14.000	14.000	12.600	11.200	9.800
14	9.800	9.800	11.200	12.600	14.000	14.000	14.000	14.000	14.000	12.600	11.200	9.800
15	9.100	9.100	10.400	11.700	13.000	13.000	13.000	13.000	13.000	11.700	10.400	9.100
16	3.500	3.500	4.000	4.500	5.000	5.000	5.000	5.000	5.000	4.500	4.000	3.500
17	2.100	2.100	2.400	2.700	3.000	3.000	3.000	3.000	3.000	2.700	2.400	2.100
18	1.400	1.400	1.600	1.800	2.000	2.000	2.000	2.000	2.000	1.800	1.600	1.400
19	1.400	1.400	1.600	1.800	2.000	2.000	2.000	2.000	2.000	1.800	1.600	1.400
20	0.700	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700
21	0.700	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700
22	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 3: Number of cars charged per hour for the 12-charger port DCFC EVSE system. Values are scaled down in this table to 100 cars per day in the peak summer months.

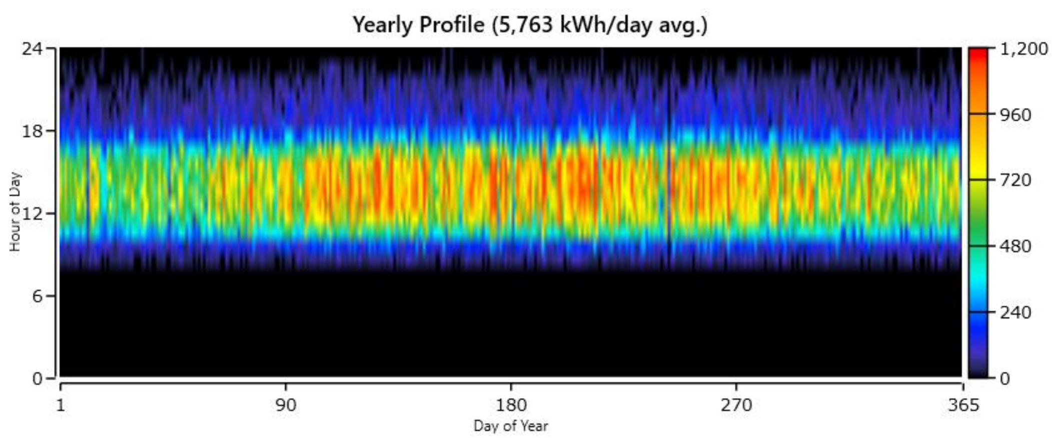


Figure 12: Heat map of EV charging throughout the year. Charging is modelled as primarily during daylight hours and tailing off as guests arrive towards the end of the day.

UL Homer Grid Results

Electricity Summary

Homer Grid estimates the electric demand from the chargers to 2,103,399 kWh from 44725 charging sessions a year with an average of 47kWh delivered per charge.

Effects of Different Solar Array Sizes

Below is reported information from Homer Grid for different size solar systems. The system size of 1,310kW was added to the analysis as it was found that this was the size at which the net energy consumption produced by the solar panels equals the energy consumed by the EVSE. At this point, 35% of the energy used to charge the EVs originates from the grid.

kW System Size (kW)	Solar (kWh/yr)	Grid Purchased (kWh)	% of Charge from Grid	% of Solar Used for the EV Load	% of Solar Sold to Grid	% Renewables Provided to EVs	% Non-Renewables used by Evs
16,000	25,684,974	197,305	9.4%	8%	92%	99%	1%
8,000	12,842,487	233,306	11.1%	16%	84%	98%	2%
3,200	5,136,995	354,212	16.8%	38%	62%	94%	6%
1,600	2,568,497	614,722	29.2%	66%	34%	81%	19%
1310	2,103,413	738,852	35.1%	74%	26%	74%	26%
800	1,284,249	1,109,822	52.8%	88%	12%	54%	46%
400	642,124	1,549,340	73.7%	96%	4%	29%	71%
100	160,531	1,953,759	92.9%	100%	1%	8%	92%

Table 4: Comparison of different solar plant sizes and impact on the system's renewable energy utilization calculated by UL Homer Grid. This grid tied system always allows for charging even if solar is insufficient. Also, solar is sold back to the grid if not used by the EVSE. Non-renewable energy sources are used from the grid when solar is not available.

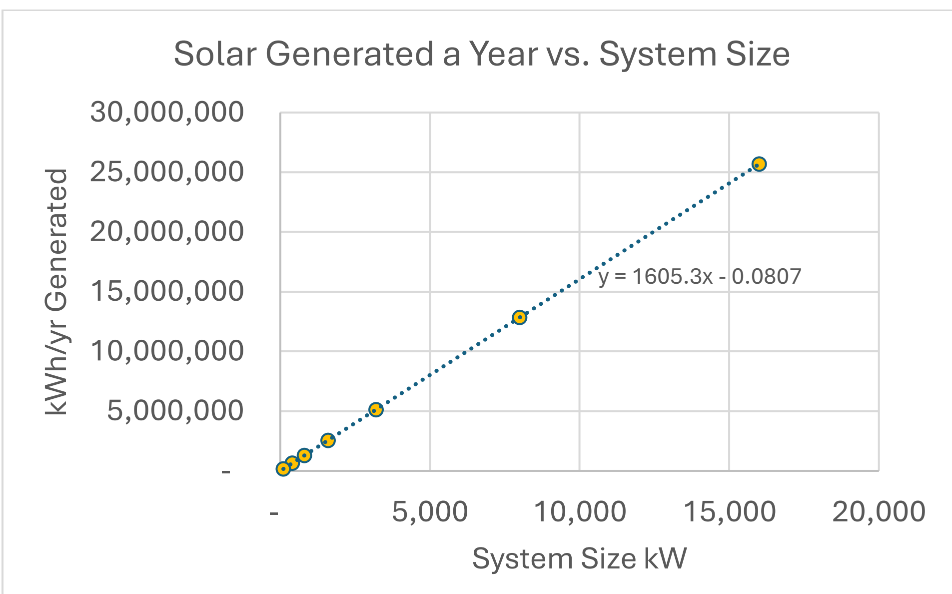


Figure 13: Plot of the solar energy generation per year compared to the rated system size.

A 1,600kW system is possible with the unused land to the west of the hotel and without changing the nearby picnic area. More rigorous design of a solar installation at that site is expected to yield enough energy to keep the EVSE at 0 net energy. A 1,600kW system also only has about 20% of the energy originating from the grid and is powered through 19% non-renewables. This value is a convenient match considering 80% of the EV charging is expected to be during sunlight hours. Eighty percent of charging during sunlight hours, 80% of system powered by renewable energy, 80% of energy comes from on-site.

Further information for a 1,600kW system is provided below.

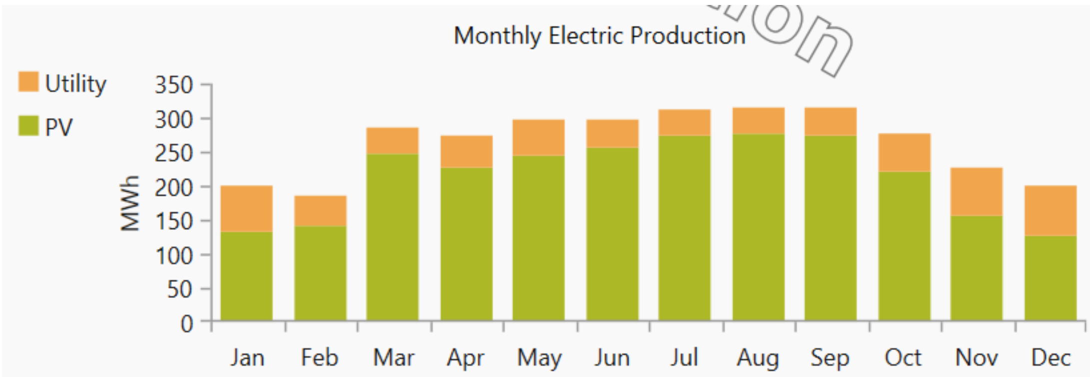


Figure 14: Monthly source of electricity used by the EVSE. A larger proportion of electricity comes from solar in the summer months than winter months.

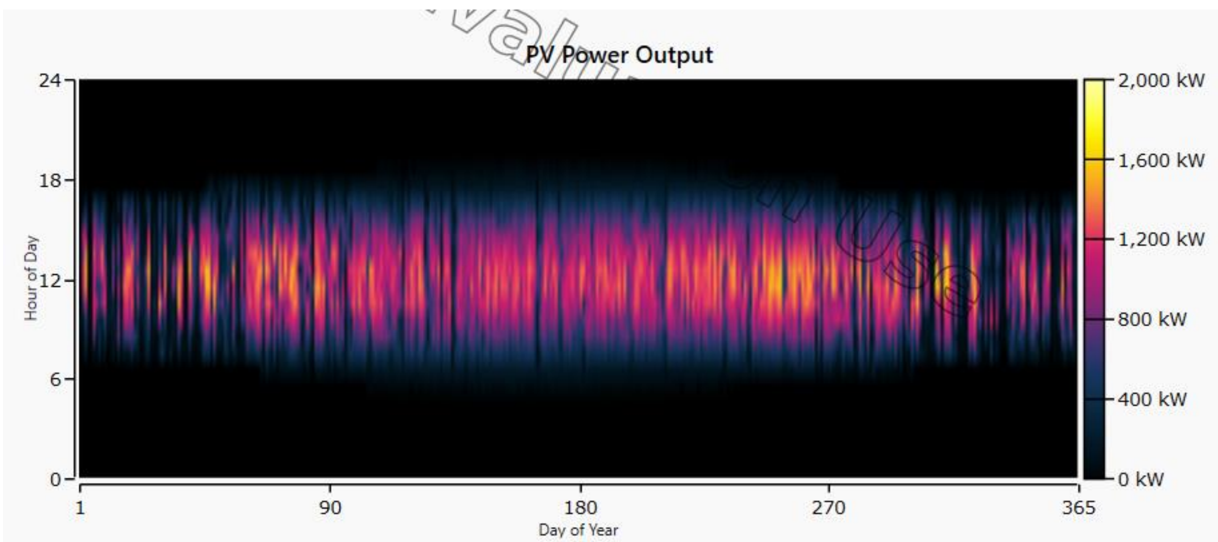


Figure 15: Heat map of the solar generation of the 1,600kW system. Solar energy production has variance incorporated in UL Homer Grid.

Carbon Dioxide Offset by the System

The excess solar created by the system results in a net displacement of 293,942 kg/year of CO_2.

Quantity	Value	Units
Carbon Dioxide	-293,942	kg/yr
Carbon Monoxide	0	kg/yr
Unburned Hydrocarbons	0	kg/yr
Particulate Matter	0	kg/yr
Sulfur Dioxide	-1,274	kg/yr
Nitrogen Oxides	-623	kg/yr

Table 5: Net reduction in greenhouse gas emission from the excess solar being sent back to the grid. The excess solar reduces carbon dioxide, sulfur dioxide, and nitrogen dioxide sent to the environment from the utility.

Estimated Project Costs

EVSE Price

The price of 12 BTC L3R-100-480 DCFC chargers will be $622,954.20 (=12*$51,912.85). Shipping is added into this price in the continental United States and they will be tax local, state, and national tax exempt if the park service buys the units.

EVSE Installation Cost

The price for installing EVSE is quite variable with the price of installation ranging from $4,000 to $51,000 in 2014 (USDOE) depending on how much work needs to be done to the existing infrastructure. The West Coast Electric Highway typically has seen their installation cost average to $40,000, due to the remote nature of some of their installations. With an older site such as this but with the units being close together the installation price per unit should be expected to be in the range of $20,000 to $40,000 ($240,000 - $480,000 total).

Solar Plant Price

NREL estimates that the average installation price for utility scale solar deployments to be $1.06 per Watt for a total installed cost of $1,696,000 (NREL). Approximately 70% of this being accounted for by the hardware (~$1,187,200).

O&M Estimates

NREL suggests a value of 5.55% of the hardware cost for the yearly O&M cost (NREL). Assuming 5.55% for the solar plant as well, this is a cost of $99,558.48 for the EVSE and solar installation ($65,296 for the solar and $34,262 for the EVSE).

Network and Credit Card Fees

Network fees are commonly added on and in 2015 were typically $400-$900 a year. $12,000 network fee should be budgeted for each year in this project.

Recommended credit card fees of 2.5% should be expected on transactions (NREL).

Utility Charges

Even though the system does not require net energy from the grid, PG&E will still send a bill for other consumption charges and fixed rate fees. The itemized annual PG&E bill for $47,914.15 is shown below.

Annual Utility Bill Comparison

	Base Case BEV-2-NEM2	**Current Case** BEV-2-NEM2	**Savings**
Consumption Charge	$20,409.21	$20,409.21	$0
Demand Charge	$0	$0	$0
Demand Response	$0	$0	$0
Fixed Rate	$27,504.94	$27,504.94	$0
Minimum Rate	$0	$0	$0
Taxes	$0	$0	$0
Total	$47,914.15	$47,914.15	$0

Table 6: Expected yearly utility fees for the system. Even though the system produces more energy than it is projected to use, there are still utility fees at play.

Rate Group	Rate	Cost	Charge Type	Charge Class
Subscription Charge	Subscription Charge	$27,504.00	FIXED_PRICE	DISTRIBUTION
Net Surplus Compensation	Net Surplus Compensation	$0.9	FIXED_PRICE	DISTRIBUTION
Generation	Generation Charge - Peak	$97,320.77	CONSUMPTION_BASED	SUPPLY
Generation	Generation Charge - Off-Peak	-$11,557.04	CONSUMPTION_BASED	SUPPLY
Generation	Generation Charge - Super Off-Peak	-$58,664.98	CONSUMPTION_BASED	SUPPLY
Distribution	Distribution Charge - Peak	$3,880.40	CONSUMPTION_BASED	DISTRIBUTION
Distribution	Distribution Charge - Off-Peak	-$280.48	CONSUMPTION_BASED	DISTRIBUTION
Distribution	Distribution Charge - Super Off-Peak	-$3,265.13	CONSUMPTION_BASED	DISTRIBUTION
Transmission	Transmission	-$17,064.46	CONSUMPTION_BASED	TRANSMISSION
Transmission	Transmission Rate Adjustments	-$274.41	CONSUMPTION_BASED	TRANSMISSION
Transmission	Reliability Services	-$223.25	CONSUMPTION_BASED	TRANSMISSION
Public Purpose Programs	Public Purpose Programs	$14,034.10	CONSUMPTION_BASED	DISTRIBUTION
Nuclear Decommissioning	Nuclear Decommissioning	$829.87	CONSUMPTION_BASED	DISTRIBUTION
Wildfire Fund Charge	Wildfire Fund Charge	$3,258.03	CONSUMPTION_BASED	DISTRIBUTION
Competition Transition Charges	Competition Transition Charges	$178.27	CONSUMPTION_BASED	DISTRIBUTION
Energy Cost Recovery Amount	Energy Cost Recovery Amount	$330.22	CONSUMPTION_BASED	DISTRIBUTION
Distribution	New System Generation Charge	-$1,018.57	CONSUMPTION_BASED	DISTRIBUTION
Power Charge Indifference Adjustment	Power Charge Indifference Adjustment	-$5,762.57	CONSUMPTION_BASED	NONE
Wildfire Hardening	Wildfire Hardening	-$851.13	CONSUMPTION_BASED	DISTRIBUTION
Recovery Bond Credit	Recovery Bond Credit	$2,455.72	CONSUMPTION_BASED	DISTRIBUTION
Recovery Bond Charge	Recovery Bond Charge	-$2,455.72	CONSUMPTION_BASED	DISTRIBUTION
Franchise Fee Surcharge	Franchise Fee Surcharge	-$460.45	CONSUMPTION_BASED	NONE

Table 7: Breakdown of the yearly fees from the utility.

The 1,600 kW solar plant sends 465,098 kWh back to the grid over the course of the year primarily during the $0.15/kWh time periods. If this is credited back to the hotel or the park in general, this can offset $69,764.70 worth of electricity throughout the year. This could result in annual savings of $21,850.55 for the hotel/park.

Summary

The price for a 1,600kW solar plant with a system of 12 DCFC chargers (24 ports @ 50kW each, or 12 ports at 100kW) is expected to cost around $2.5 – 2.8 million dollars. 1.6-1.7 million attributed to the solar aspects of the project and 0.8-1.1 million for the EVSE aspect. This is a cost of $36,000-$46,000 per DCFC port and is in the range of similar projects (USDOE).

O&M, network, and utility connection are expected to have a yearly cost of ~$90,000 a year ($0.042/kWh). O&M + network fees are expected to be $112,000 a year while an electrical saving for the hotel from excess solar displaces ~$22,000 from the electric bill a year.

Possible Funding Mechanisms

Station Developer Led

Some station developers own stations at a particular site. They may sign a contract with a property owner and take responsibility for the upkeep and operation of the station. Other station developers may leave it up to the property owner to operate the station. Should the national park wish to retain ownership of the station, funding will need to be secured for the project.

National Park Foundation

The National Park Foundation is a nonprofit organization and supports projects such as renewable energy investments and electric vehicle infrastructure (NPF). Premier partners for them include Coca-Cola and Subaru. NPF has specifically funded the installation of a new electric vehicle charging station at the Joshua Tree National Park as well as an electric vehicle for park staff. Other projects include funding the replacement of propane powered transit buses with electric buses and installing 27 charging stations at Zion Nation Park. The phone number for the national park foundation is (202) 796-2500.

EVSE Incentives/Grants

Grants for renewable energy projects can be found with the help of the Alternative Fuels Data Center (USDOE).

Yosemite National Park is a Pending Alternative Fueling Corridor and could qualify for grants aimed at these areas. Grants that might be applied for include:

- Alternative Fuel and Vehicle Incentives
- California's National Electric Vehicle Infrastructure (NEVI) Program
- Electric Vehicle (EV) Charging Station Incentive Program Support

Past Partnerships

NPS has partnered with and completed charging installations through partnerships with DOE, BMW, and the California Energy Commission.

DOE

The Clean Cities National Park Initiative starting in 2010 with the DOE's Vehicle Technologies Office supports transportation projects that educate park visitors on the benefits of shifting to alternative fuels, advanced, vehicles, and fuel-saving technologies and strategies.

BMW

In 2016, BMW and NPS entered a partnership with BMW donating funding to install Level 2 and DCFC EVSE in parks and en route. At the 2019 conclusion almost 100 EV charging installations were completed in park, en route, and in workplace and fleet locations.

Subaru

Subaru has been a partner of the National Park Foundation's Resilience and Sustainability initiative and has provided over $55 million in support since 2013.

CALeVIP

According to CALeVIP's website, "The California Electric Vehicle Infrastructure Project (CALeVIP) provides funding for installing publicly available EV charging stations to support the rapid adoption of electric vehicles across California. CALeVIP is a key part of the state's plan to efficiently and equitably electrify the transportation sector and reduce pollution that harms the environment and human health. CALeVIP is one of the funding opportunities The California Energy Commission (CEC) offers to advance the state's transition to clean energy and transportation." CALeVIP is also able to help with recruiting regional funding partners.

Potential Timelines for EVSE and Solar Installation

Once funding has been secured/decided, a station developer selected, and initial plan on the hotel's EVSE design has been created the timelines for these projects are expected to be as follows:

- Initial application sent to PG&E: 7 days (estimate/guess)
- Pre-assessment: up to 10 days + up to 30 days (PG&E reported information)
- Pre-assessment customer approval: 7 days (estimate/guess)
- Utility Project final design and contract development: 80 days (PG&E reported)
- Pre-Contract meeting and with inspector and customer, contract signing: 7 days (estimate/guess)
- Customer proceeds with construction/electrical/park permits: 1-3 months (Sparkcharge.io))
- Customer purchases equipment/shipping time: 30-180 days (GSAAdvantage! shipping times)

- Customer constructs their portion of the infrastructure: 1-2 months for the EVSE (Sparkcharge.io), 2-3 months for the solar plant (YSG)
- Inspections: 7 days
- PG&E begins construction on their end: 4-6 weeks (PG&E reported)
- PG&E construction: 1.5-3 months (PG&E reported)

Assuming the maximum amount of time taken at each step, the steps add up to 640 days (1.75 years). If permits, shipping times, and construction are kept to their lower estimates the steps add up to 355 days (0.97 years). PG&E may take 120 days to develop their final design and contract then another 40 days to begin construction once work is done on the customer's side. Completion of the project after construction has begun is expected to take between 4-7 months.

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