HAWAII EV READY

Guidebook for Commercial Electric Vehicle Charging Station Installations

May 2012

prepared by

Plug In America

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Better Place Hawaii

Enterprise Holdings, Inc.

EZ EV Options

GreenCar Hawaii, LLC

Volta Charging

Disclaimer

Executive Summary

The *Guidebook for Commercial Electric Vehicle Charging Station Installations* presents an organized methodology for planning, installing, and operating electric vehicle charging infrastructure at commercial facilities in Hawaii.

Hawaii-specific installations are featured throughout the Guidebook. However, the recommended order of topics and best practices contained in this Guidebook are applicable anywhere in the world where electric vehicles (EVs) can be expected to play a role in the transportation system.

The essential premise of this Guidebook is that successful charging station outcomes result from a prescribed process that includes planning, best installation practices, and implementation of an operating plan. By following the recommended course of study in the Guidebook, site hosts will be able to make informed decisions at each step in the process of installing charging stations at their facilities.

A comprehensive listing of charging business models is included to help property owners and operators evaluate the financial aspects of funding and operating charging stations.

State-of-the-art recommendations on charging station signage, accessibility, and multiple unit dwelling installations are also included in the Guidebook.

The recommendations and practices in this Guidebook are based upon millions of miles of real-world EV driving experience, including fueling from both private and public charging stations. Plug In America additionally draws from its professional experience advising government agencies, organizations, and businesses on the subject of EV charging infrastructure.

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Introduction

This Guidebook is targeted to owners and operators of commercial properties interested in installing electric vehicle charging stations in Hawaii. Charging locations include businesses, retail stores, hotels, multiple unit dwellings (apartments, townhouses, condominiums) and both privately and publicly owned parking lots.

Users of public EV charging infrastructure come from all walks of life, including employees, customers, tourists, fleet operators, and the general public. While the majority of EV charging will take place at home or the workplace, public charging stations can significantly increase the utility and comfort factor of electric vehicles for many drivers by providing a means to extend the range of the vehicle.

About This Guidebook

Successful charging station projects are the result of an orderly process of planning and installation, as well as the implementation of sound operating practices. To this end, topics in this Guidebook follow an intentional and logical flow. Starting at the beginning and working through the various aspects of electric vehicle charging in the order presented will enable you to follow best industry practices and to make good decisions during the course of your project.

A summary flowchart depicting the process of planning, installing, and operating EV charging stations at commercial sites is shown on page 35. The most efficient route to getting a charging station in place is to follow the steps in this Guidebook, as summarized in the flowchart.

Note that the online version of the Guidebook includes live links, both to listed webpages as well as to topics within the Guidebook itself. Using your pointing device to choose an entry in the Table of Contents will display that page. Page number references throughout the document are also linked to their locations. Additionally, choosing a step from the flowchart on page 35 will take you to the relevant topic.

It is important to keep in mind that the Guidebook has been prepared at a time when laws, regulations and industry practices related to electric vehicles are evolving rapidly, so it is advised to check for updated information and guidelines as they become available to the EV charging industry.

An excellent companion resource for electric vehicle owners wishing to install charging equipment at their private residence, the *Plug In Electric Vehicle Handbook for Consumers,* is available from the U.S. Department of Energy at: www.afdc.energy.gov/afdc/pdfs/51226.pdf

Individuals interested in purchasing or leasing an electric vehicle are also encouraged to study EV charging information available from auto dealers, charging equipment providers, your local utility and consumer organizations such as Plug In America. www.pluginamerica.org

Background

Hawaii residents have long recognized their overreliance on petroleum-based fuel for transportation and energy. This dependency upon oil has created a vulnerable economy heavily impacted by the price of crude oil, most of which is imported from foreign countries. For every barrel of crude oil imported into Hawaii, about one-third is used for ground transportation, one-third for air transportation, and the remaining third for the production of electricity.

To help make the shift from petroleum-based fuel, the state partnered in 2008 with the U.S. Department of Energy to create the Hawaii Clean Energy Initiative (HCEI). A goal under this initiative is to reduce oil consumption by 70 percent by 2030 (30% from energy efficiency, and 40% from renewable energy). Attainment of these goals will keep a substantial amount of the nearly $6 billion spent annually on imported oil here in the islands, creating jobs and benefiting the economy.

Hawaii's Leadership

Hawaii has been a national leader by adopting policies and laws that promote the use of electric vehicles as a viable means of travel. In 1997, Hawaii was the first state to approve free public parking and single-occupant use of High Occupancy Vehicle (HOV) lanes for owners of electric vehicles. Since then, additional legislation has been passed requiring owners of large public parking facilities to install EV charging equipment, government agencies to procure vehicles less reliant on petroleum-based fuels, and provisions making it illegal to prevent a person from installing EV charging equipment in a multiple unit dwelling (MUD) as long as it meets relevant safety, design, and insurance requirements.

In August of 2010, the Hawaii State Department of Business Economic Development and Tourism (DBEDT) launched an EV Ready Rebate Program for the purchase of commercially available electric vehicles and electric vehicle supply equipment (EVSE, aka "chargers"). This program was made possible with funding provided by the American Recovery and Reinvestment Act of 2009 (ARRA), from the U.S. Department of Energy (DOE). In March of 2011, DBEDT established an EV Ready Grant Program awarding over $2 million in ARRA stimulus funds for the systematic deployment of charging stations across the state. These complementary programs have the aim of accelerating the adoption of electric vehicles and related charging equipment in Hawaii. This Guidebook was produced with funds from the EV Ready Grant Program.

Powering our vehicles with locally-produced renewable energy, lessening vehicle miles traveled (VMT) and improving vehicle efficiency standards will continue to drive down Hawaii's dependence on oil. Utilizing new energy supplies, modernizing the electric grid, and selling EVs and their supporting infrastructure will result in a stronger economy, a cleaner environment and an improved quality of life for all of Hawaii's people and its visitors.

Factory produced 2002 electric Toyota RAV4 EV in Kaneohe, Hawaii

Electric Vehicles in Hawaii

Electric vehicles come in all shapes, types, and sizes, ranging from battery electric vehicles (BEVs) that are completely dependent on electricity, to plug-in hybrid electric vehicles (PHEVs) which use a combination of grid electricity and a liquid or gaseous fuel to assist in providing power and extending the range of the vehicle.

Hawaii is an ideal environment for electric vehicles. Typical daily commute distances, on the order of 25 miles or less, are short. Weather conditions are characterized by moderate temperatures with little seasonal variation compared to the mainland. Historically, Hawaii has had the highest gasoline prices in the country. Today's electric cars fit these conditions very well.

Advantages

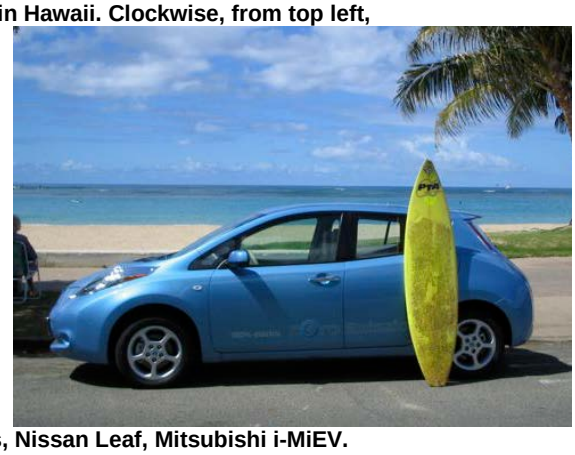
All-electric EVs from Nissan, Ford, Mitsubishi, and other automakers are equipped with batteries that provide more than enough range (60-100 miles) for the majority of drivers' daily needs. The fact that Hawaii does not have high summer heat or very cold winters means that the air conditioning and heating systems in today's EVs do not pull as much energy from the batteries in order to keep occupants comfortable and windows clear. The efficiency of an EV is vastly superior to that of a traditional internal combustion engine (ICE) vehicle, which means that even though Hawaii's grid power is predominantly produced from petroleum, one's fuel cost (in this case electric) is cut roughly in half.

Other advantages to driving electric include vastly lower vehicle maintenance cost, reduced overall emissions (helping to preserve Hawaii's air quality), and a better driving experience. EVs drivers everywhere enjoy quiet rides. The quick acceleration that comes with electric drive, combined with a lower center of gravity (batteries and motor are positioned low in the chassis), make EVs fun to drive.

Learn more

To learn more about the advantages of EVs, which cars are available now, and which are coming, go to www.pluginamerica.org, www.goelectricdrive.com and http://goev.heco.com/.

These EVs are currently available in Hawaii. Clockwise, from top left,



Chevy Volt, Toyota Plug-in Prius, Nissan Leaf, Mitsubishi i-MiEV.

Charging Electric Vehicles

Whereas internal combustion vehicles are usually fueled at periodic intervals in a matter of minutes, electric vehicles are normally charged at the end of each trip or day. Although EV charging does take longer, it does not require driver attendance and can be mostly done overnight. The owner's car charges when they are sleeping and lower nighttime electrical rates are in effect. EVs are typically "full" every morning, ready for that day's travel needs.

It is useful to keep in mind that the typical Hawaii driver travels fewer than 25 miles per day. When considering electric vehicle charging equipment for commercial operations, the site host has three options on the type of charging to install: AC Level 1, AC Level 2 or DC Fast Charge. Each type will play an important role in the everyday charging of EVs in Hawaii.

Level 1 Charging

Level 1 charging is simply a standard 120-volt AC outlet protected by either a 15 or 20-amp circuit breaker with a ground fault interrupter (GFI). The installation cost for Level 1can be as little as a few hundred dollars. Neighborhood electric vehicles (NEVs) typically use standard extension cords to plug into Level 1 outlets. Larger BEVs and PHEVs can also utilize standard 120-volt outlets through the use of a special cord equipped with a J1772 connector on one end (which plugs into the vehicle inlet), and a standard 3-prong plug on the other.

J1772 Connector

Level 1 charging is the slowest charge rate, capable of charging a Nissan Leaf to half its battery capacity in 8 to 10 hours. Level 1 charging for customers is most appropriate in locations where EVs are parked for longer periods of time, such as airports (long-term lots), and employee parking areas.

Level 2 Charging

Level 2 charging utilizes a 208 or 240-volt dedicated circuit, protected by a circuit breaker rated between 40 and 80 amps. Typical power delivery is either 3,300 or 6,600 Watts. All full-performance BEVs and PHEVs come with a standard inlet on the vehicle to accept charging from a J1772-equipped cord coming from the Level 2 EV charger. The cost of installing a Level 2 charger ranges from a few to many thousands of dollars.

Level 2 charging is much faster than Level 1, capable of fully recharging a Nissan Leaf with a depleted battery in about 6 hours. (Model year 2013 and subsequent Leafs are equipped with a 6.6kW onboard system that will cut this time in half.) Level 2 charging is most appropriate for locations where the EV driver typically parks for a shorter period of time (on the order of two hours) while they attend a meeting, go to a restaurant, or do some shopping. EV drivers think of their stops at publicly available Level 2 chargers as "opportunity charging," because it offers them the opportunity to extend the range of their vehicle that day. Level 1 charging does not provide a meaningful amount of range extension in such a short period of time.

Charging Level	Description	Volts	Amps	Power	Cost ($)
AC Level 1	slow charging	120	up to 16A	1+ kW	hundreds
AC Level 2	medium charging	208/240	up to 80A	3.3+ kW	thousands
DC Fast	fast charging (also "rapid" or "quick")	200 - 600	up to 80A	25+ kW	tens of thousands

DC Fast Charging

Unlike Level 2 chargers that take 3 to 8 hours to fully recharge a depleted battery pack, DC Fast Chargers can charge an EV from 20% capacity to 80% in under 30 minutes. DC Fast Chargers can deliver power from 25kW to as much as 240kW under current and planned standards. DC Fast Chargers utilize a different plug on their supply cord, and a matching inlet on the vehicle.

Both the Nissan Leaf and the Mitsubishi i-MiEV offer DC fast charging capability. Other automakers have not yet announced their fast charging plans. The installation and equipment costs for a DC Fast Charger ranges from $50,000 to $100,000 which is higher than the costs for Level 1 Charger and Level 2. (See Table on Page 9.) The electrical supply to the site for a Fast Charger must be commercial-grade, typically 208 or 480-volt 3-phase AC. For more information about charging level standards, see Appendix B of this Guide

Some commercial enterprises are viewing DC fast charging as a business opportunity, similar to operating a gas station. Unlike gas station customers, however, EV drivers may visit DC Fast Chargers only infrequently, based on a need to travel a greater distance on a given day. Or they may have no other access to convenient overnight charging where they live, in which case they may rely heavily on DC fast charge stations. Fleets may need DC fast charging to meet their higher daily mileage requirements. Sites where DC fast charging might be appropriate include tourist or rest stops, major roadway intersections, convenience stores, or even gasoline stations.

DC Fast Charging Benefits

DC fast charging installations offer a number of benefits and opportunities, including:

1. Rapid charging for EV drivers who need to travel longer distances and don't want to wait for the time it would take using Level 1 or 2 charging.
2. The ability for someone to own or operate an EV when they do not have access to Level 1 or 2 charging at their home or workplace.
3. A potentially profitable business for the charging station owner or investor(s).

DC Fast Charging Challenges

DC fast charging installations also raise a number of challenges for property owners and utilities, specifically:

1. The higher power requirements of a DC fast charge installation may require costly additional electrical service upgrades to the site.
2. The demand placed on the grid by transient high power loads created by DC Fast Chargers may require utility upgrades to existing local infrastructure supplying the site.
3. Demand-based electricity rates can result in higher electricity costs to the site host.
4. There may be local zoning restrictions on the siting of retail DC fast charging locations (similar to restrictions on the siting of gas stations).

Despite these challenges, many states, including Hawaii, are moving rapidly to deploy large numbers of DC Fast Chargers, with hundreds of DC Fast Chargers planned for 2013-2014. For more information about DC Fast Charging, see Appendix B of this Guide.

How Much Does It Cost To Charge An Electric Car?

Providing EV charging services can be done using your existing electrical meter or an additional one can be installed and connected directly to the EV charger. A dedicated meter (not necessarily available on all islands) allows you to isolate and track electricity consumption of your EV charger(s). A licensed electrician is required to install new metering infrastructure, and the utility company will provide a new EV-Commercial (EV-C) meter at no additional cost.

Regardless of whether you use one meter or two, HECO offers pilot program Time of Use (TOU) off-peak usage incentives. Charging "off-peak" (currently defined as after 9:00 p.m. and before 7:00 a.m.) on weekdays and anytime on weekends will be at a lower cost than the standard rate. Charging during on-peak hours (7:00 a.m. to 9:00 p.m. on weekdays, except holidays) will be at rates higher than the standard commercial rate. Check with your utility for current TOU tariff schedules. For more information on EV TOU rates and metering options, contact HECO at 808-543-GoEV (4638) or visit http://goev.heco.com/

Below is an example showing the approximate cost savings over internal combustion engine (ICE) cars when charging an EV using 240 volts (Level 2) during off-peak charging periods. You will find the official US government source for fuel economy information at www.fueleconomy.gov.

Assumptions:

EV battery capacity = 24 KW; Electricity (kWh) per mile .34 kWh; Electricity Cost 36 cents kWh
12,000 Miles Per Year, Six Years with a total Mileage of 72,000 Miles

* These estimates are illustrative only. Actual gasoline and electricity prices are subject to market conditions, which are generally assumed to exert upward pressure on costs for the foreseeable future.

Operating Cost Comparison Chart: Internal Combustion vs. Electric Vehicle in Hawaii*

Fuel Operating Cost Comparison ICE vs. BEV	**Internal Combustion (ICE)** TYPE: Compact car RANGE: 360 miles. MPG: 30 miles per gallon TANK SIZE: 12 Gallon Tank GASOLINE: $4.50/gallon **Cost for a Tank of Gas for 360 Miles: $54.00**	**Battery Electric Vehicle (BEV)** TYPE: Nissan LEAF BATTERY CAPACITY = 24 KW RANGE: 70 miles .34 kWh per mile COSTS: $0.36 / kWh **Electricity Fuel Cost for 360 miles: $44.06**	**Usage** TERM: 6 Yrs. USAGE: 12,000 mi. / year TOTAL Mileage: 72,000
Fuel	**Gasoline (ICE)**	**Electric (BEV)**	**Fuel Cost Savings**
Cost (per mile)	$0.15	$0.1224	$0.0276
Six Year Total Fuel Cost	$10,800	$8,813	$ 1,987
Maintenance Costs	**Gasoline (ICE)**	**Electric (BEV)**	**Maintenance Savings**
Routine Service and Maintenance	$6,000	$2,000	$4,000
TOTAL Costs	**$16,800**	**$10,813**	**$5,987 SAVINGS**

How Much Does a Charging Station at a Commercial Site Cost?

The cost to install EV charging infrastructure varies widely, depending on a multitude of factors. Discussed in more detail under Planning a Charger Installation, these factors include:

- Charging level (1, 2, or DC Fast)
- Type of charger (unmetered, simple metered, and fully metered/networked)
- Facility characteristics (capacity of electric service, proximity to equipment, possible need to upgrade service or electric distribution panel)
- Desired location of charging stalls at your property
- Installation cost (conduit, equipment, signage)

The following table illustrates the range of total equipment and installation cost for each of the three charging levels. Charging times for representative EVs are shown in order to provide a sense of how long vehicles may occupy a charging station for the purposes of recharging.

Charger hardware cost will largely be dictated by your choice of features and preference for design or brand, similar to the range of pricing for automobiles and other consumer technology. A much wider range will be attributable to the cost of installing the hardware. Charging stations that can be installed near to an electrical panel with existing space and capacity will cost the least. Those that require long conduit runs, trenching, and panel upgrades will cost much more.

Table showing typical Plug-in Electric Vehicle charging times at different charging levels, along with the range of equipment and installation costs

Charger Type	Charge to	Time to Charge Vehicles with Varying Battery Sizes			Charger Hardware Cost[1]	Installation Cost[2]	Estimated Total Cost
		Chevy Volt 16 kWh	Mitsubishi i-MiEV 16 kWh	Nissan Leaf 24 kWh			
AC Level 1 1+ kW 120VAC	Half	5 hrs	8 hrs	10 hrs	$100 - $500	$100 - $500	$200 - $1000
	Full	10 hrs	16 hrs	20 hrs			
AC Level 2 3.3+ kW 240VAC	Half	1.5 hrs	2.5 hrs	3 hrs	$500 - $1500 home	$500 - $2500 home	$1000 - $4,000 home
	Full	3 hrs	4.5 hrs	6 hrs	$2000 - $6500 commercial	$3,000 - 5,000 commercial	$5,000 - $11,500 commercial
DC Fast 50+ kW 100-600VDC	Half	N/A	10 min	20 min	$25,000 - $50,000	$25,000 - $50,000*[3]	$50.000 - $100,000
	Full	N/A	30 min	45 min			

[1] *Hardware costs are trending downward quickly*

[2] *For hard to serve installations, costs can vary considerably upwards*

[3] *Higher-cost units have multi-car charging capability*

Planning a Charger Installation

The key to a successful charger installation is proper planning. Charging stations that meet the needs of users and are used regularly are the measure of success. To this end, this Guide separates a charging infrastructure project into three major components, or steps. Each term is described in the Glossary on page 36 using the following nomenclature and hierarchy:

Charger > Charging Station > Charging System

In practical terms, the electrical device with the attached cord and charging connector that plugs into an EV is referred to simply as the "charger," even though much of the actual charging circuitry is onboard the vehicle. After reading the material in the remainder of this section, you should be able to narrow down your choice for the type of charger that is best for your situation.

The next section in this Guide, Installing a Charging Station, provides the information you need to go about installing the charger, but includes other considerations pertinent to the installation, as well. These include the location of the charger in your lot, other equipment needed to support the charger (conduit, circuit breakers, metering devices, etc), and signage for drivers and users.

The last section of the Guide, Operating a Charging System, makes the point that there is more to a charging infrastructure project than installing hardware and putting up signs. For stations to be used regularly, drivers must have confidence that they will be operational when they need them. A plan for monitoring and maintaining your stations is critical to minimize downtime. Additionally, you may need to keep records for usage, billing, and future planning purposes. We use the phrase "charging system" to reflect the complete nature of this new asset to your facility.

Charging Business Models

The first step in planning a charging station installation is to think about who is most likely to charge their EV at your facility. Your audience may be narrowly defined, such as building tenants or employees. Or it may be broader, characterized as customers, visitors, vendors, or a combination of these. The needs of each group may be different, so it is important to install equipment and operate a system tailored to meet these needs. The situation is complicated further due to the emergence of companies intent upon selling a number of products and services for EV charging in a rapidly developing marketplace. It is important to note that no one size fits all. Here are the basic elements you should consider as you plan your system.

Match the Charging Level to the User Base

The fundamental concept is to match charging level (1, 2 or DC Fast) to the user base. A good rule of thumb is that if EVs are going to be parked at your location for a long period of time, say four or more hours, then Level 1 charging may be an entirely useful and adequate solution. If, however, EVs are parked for shorter periods of time, say two hours or less, then Level 2 charging can be the best solution. Airport parking is illustrative; where long-term parking is best served by Level 1 outlets, while short-term should be Level 2. Having Level 2 chargers in long-term parking would result in EVs being fully charged in only a few hours, only to then block access by others to expensive equipment for the remainder of their stay.

Consider the Expense

Next, you should consider the likely expense of installing the different levels of charging at your facility. Level 1 outlets are commonplace and relatively inexpensive. They may not require any upgrades to your electrical service panel or its supply. On the other hand, and at present, there are no suppliers with a Level 1 solution that includes features like secure access, billing, or data reporting.

Eaton DC charger user interface.

Level 2 chargers range in complexity from simple units, like those installed in residences (with a power draw similar to an electric dryer), to those that are fully networked and offer either restricted access or open access subject to point of sale payment. Simple Level 2 chargers cost less than $1,000, while the most expensive fully featured units cost $6,000 or more (plus installation). The table on page 9 shows the range of total costs you can expect for your project.

DC fast charging is a special case, where the total cost of an installed station can readily exceed $20,000. Dedicated fast charging locations that are designed and located much like gas stations can cost $250,000 or more. Most, if not all, of these installations will not be financially viable without some means of billing users for the higher capability they provide in order to recover the cost of installation and operation. Learn more about DC fast charging on page 7.

Range of Features

The features offered with EV chargers vary widely, starting with simple hardware that basically functions only as a device that makes a connection to the vehicle, ensures that the connection meets safety standards, and lets the current flow. Additional features can include:

- Display of data such as length of current charging session, charging rate in kW, total energy delivered (kWh), error messages, and more.
- Display of advertising on a screen.
- Usage data recording and transmittal.
- Credit card billing information and swiping terminal.
- Access card recognition (RFID).
- Networking capability (wireless or hard-wired).

Should Users Pay to Charge?

Electric vehicle charging for your user base can be provided as a complimentary service or for a fee. Each has its merits as well as its challenges. Depending upon your type of business, existing customer transaction methods and electrical meter connection, you may determine that providing complimentary charging offsets the complications of point of sale billing, and credit card transactions and accounting. Or you may need to charge a fee in order to meet the requirements of a homeowner association (HOA) or other controlling policy governing your site.

You will find a summary of various charging business models listed on the following page. Note that (at present in Hawaii) if you choose to collect fees for using your charging station(s), you cannot specifically charge for the sale of electricity. You can, however, charge a fee for using the charging station. Some station hosts charge a flat fee to begin charging, while others charge for the amount of time the EV is plugged in, or a combination of the two. Parking charges may or may not be included in the fee to use the charging station.

Examples of Charging Station Business Models

- **Free, or Free with Restrictions** – This system may be beneficial for short-term stays, such as two hours or less. Appropriate signage posted at the charger indicates hours and days of operation. Many site hosts choose to provide free charging, viewing it as an amenity to their patrons, as well as a lower-cost alternative to expensive networked installations. Research shows that EV drivers quickly learn the whereabouts of free stations and seek them out. They also frequently reward site hosts by shopping at their businesses and suggest that fellow drivers do the same.
- **Advertising Supported** – A charging station owner or operator may provide charging for free, or for a nominal fee, offsetting the cost of the station installation and its operation through advertising revenue. Advertising may be displayed at the charging station electronically or through display graphics conforming to sign codes or site host standards and policies. Advertising-supported stations have been installed at retail shopping locations in Hawaii at little to no expense to the property owner or the operator.
- **Adopt a Charger** – Businesses or philanthropic organizations may choose to fund some or all of the expenses associated with the installation and operation of a charger. EV drivers then enjoy free or subsidized charging. Chargers are being installed in national and local parks under this scheme by the non-profit Adopt a Charger organization. www.adoptacharger.org
- **Point of Sale Billing** – Stations support credit card payment, radio frequency identification (RFID) card access, or both. Some stations additionally provide a toll-free number that users can call to arrange payment and initiate charging. In the case of networked charging stations, charger availability and (possibly) reservation status may be determined remotely using mobile devices or the internet. Site hosts receive monetary proceeds directly or indirectly through a service provider.
- **Membership or Subscription Plan** – The EV owner participates in a monthly or annual plan with the charger manufacturer or a third-party service provider. Station owners can log into the networked system, configure access preferences and rates, post advertisements (if supported) and track usage history and electrical consumption. Plans vary widely among providers, as payment schemes and business models are still evolving.

Volta **advertising-supported charger at a shopping mall.**

Adopt a Charger **installation, Crissy Field, San Francisco.**
Photo courtesy of Marc Geller

Better Place **charger supporting RFID cards and membership plan.**

- **Fee Bundling** – EV drivers are provided unique access codes to use the charger. Codes are entered via a keypad or card reader. The fee for charging is added to the customer's account with the site owner or operator.
- **Valet Charging** – This system may work well for businesses like restaurants or hotels where valet parking services already exist. Valet staff, park, charge, and return EVs as requested by the owner. If a fee is collected, it may be added to the parking fee, room fee, and other transactions on the customer's account. The valet EV charging model is in operation at a number of hotels in Hawaii and on the mainland.

***Eaton* charger supporting credit cards.**

- **EV Car Sharing** – A car sharing company pays the property owner for the right to park and charge EVs in the business owner's or manager's parking lot. The car sharing company handles all financial transactions and reimburses the property owner or operator based upon an agreed set of terms. EV car sharing is available at some sites in Hawaii.

EV car sharing service operated by *GreenCar Hawaii.*

How Much to Charge Customers?

If you choose to charge a fee to use your charging station, there are a number of payment schemes to consider. The marketplace for EV charging is still developing, and fee structures are sure to evolve, including subscription plans offered through various charging equipment providers. For individual charging sessions, a common method being employed on the mainland and in Hawaii is to charge a fee to connect in addition to a fee for the length of charging time.

Example EV Charging Fee: $1 to connect + $1 per hour of charging, ($2 minimum total fee)

Charging equipment providers can supply more information on the types of fee structures supported by their products. As with any fee-based offering, you will need to consider the impact of price on demand, as well as the costs involved in providing charging services to EV drivers.

What Type of Equipment Should I Choose?

Electric vehicle chargers come in all shapes and sizes, and more offerings are sure to become available soon. At the time of publishing this Guide, over three dozen companies are marketing what the industry typically refers to as Electric Vehicle Supply Equipment (EVSE). As has already been mentioned, and for the purposes of clarity and common usage going forward, we refer to them collectively as "chargers."

At this point in your planning, you should know:

- The characteristics of the user base you wish to serve.
- The charging level that is best suited to those users' needs.
- The business model and payment methods (if applicable) you wish to employ.
- Any additional features important to your equipment choice, such as wireless or wired network capability, wall versus pedestal mounting, etc.

The vast majority of chargers on the market are Level 2. DC Fast Chargers are much more expensive than Level 1 or 2. Note that Level 1 charging does not require the installation of specialized equipment designed specifically for EV charging, as is the case with Level 2 and DC fast charging. See Level 1 Charging on page 6.

For an up-to-date listing of available chargers that have received approval from a nationally recognized testing laboratory (UL, for example), visit www.pluginamerica.org and select "Charging."

Making Your Equipment Choice

As this guidebook illustrates, there are a multitude of considerations and best practices involved in creating a successful charging installation at a commercial facility. Unless you or someone on your staff has the time and ability to do research and manage the process from start to finish, you should use the services of a professional with EV charging installation experience. See Finding an EV Charging Professional on page 19.

***ShorePower* pedestal-style EV charger.**

***Better Place* wall-mounted dual EV charger.**

In other words, there is usually much more involved than just buying a charger at your local home improvement center and having someone install it. An experienced electrical contractor, consultant, or EV service provider can review equipment options with you and recommend a specific equipment choice.

The following additional factors will help you narrow your equipment preference:

- Indoor or outdoor – Most chargers are rated for outdoor use. If your application is likely to be subjected to the elements, be sure to verify its rating for outdoor use.
- One port or two – Some chargers on the market offer dual-port (or dual-head) capability. These chargers are comprised of one main box that has two cords with plugs coming out of it. Placing the charger between parking spaces allows two vehicles to charge at the same time. Equipment and installation costs may be lower with this option, when measured on a cost-per-parking-space basis.
- Usability – As with any new technology, equipment that is easy to use can significantly impact the experience of EV drivers who charge at your facility. Chargers with clearly labeled buttons, usage steps, or menu screens are more likely to enjoy repeated use. They are also less likely to generate service inquiries and complaints.
- Design – Chargers vary widely in terms of design aesthetics. Property owners and homeowner associations (HOAs) may prefer one design over another.
- Maintenance and warranty support – You may prefer to choose hardware from a manufacturer with local dealer representation capable of quickly addressing any maintenance or performance issues that may arise.

***AeroVironment* charger with dual port capability.**

***Coulomb* charger featuring Level 1 and Level 2 charging.**

Electric Utility Considerations

Earlier in this section, we discussed the importance of matching the level of charge to the user base and the typical length of stay. Equally important is matching the charging system electrical load to the electrical power supply available. Since most existing developments are not constructed with significant excess capacity to be able to handle new loads such as EV charging, it will be important to do an electrical load assessment. The existing electrical system will need to be evaluated to determine the type of electrical improvements that may be required by the owner, and possibly the utility company. If you are planning to install, or have already installed solar photovoltaic (PV) power at the property, this may be the time to integrate EV charging to reduce on-peak and overall monthly utility expenses.

There are several key electric utility considerations in planning your project, including:

1. Have a "load assessment" or "load calculation" performed by an electrical contractor or design consultant to determine your electrical capacity.
2. Check with charging station companies and service providers to see if this service may be provided free or at a reduced cost.
3. Understand your current billing service and rates, and determine if you have "demand" service or "non-demand," as this may affect the rate for EV charging.
4. Check with your utility company to see if EV commercial (EV-C) billing rates are available and if you qualify for a pilot installation of a dedicated EV meter.
5. Determine the number of chargers planned for your project, and decide what level (or combination of levels) they will be: Level 1, Level 2, or DC Fast Charge.
6. Understand that a "closed" or final electrical permit will be required before a dedicated EV meter can be placed by the utility.
7. Determine whether renewable energy sources such as solar photovoltaic can be integrated into your project.

Learn More

For more information and to see a list of commonly asked questions about commercial and residential charging and a comprehensive list of EV-related resources, visit the link below hosted by Hawaiian Electric Company. http://goev.heco.com/. You can also email HECO for more information at GoEV@heco.com.

The Resources section of this Guide also lists general utility contact information and addresses for each island.

Multiple Unit Dwellings

Installing chargers in multiple unit dwellings (MUDs), which are commonly referred to as condominiums or apartment complexes, is more complex than in a single-family residence garage or carport because the homeowner or renter (EV owner) is not necessarily the owner of the land or of the space(s) where vehicles park, and due to typically increased distance to an adequate supply of electricity or meter. Because MUDs provide for guest or public parking, they must be treated from a municipal standards perspective, because public parking requires specific design elements. The challenge of installing chargers in MUDs is greatest in existing complexes where electric meters and electricity supply are already in place, parking spaces are deeded or allocated, and financing/billing mechanisms are not in place for residents or guests charging their cars with electricity.

The key issues concerning charger installations in MUDs are listed in the table below and should be carefully considered by residents before deciding to purchase a plug-in electric vehicle, or by the homeowner association (HOA) when considering an installation.

Item	Planning Considerations
Ownership of Electrical Work and Circuit	Decide who will authorize, pay for and own the permanently installed circuit from the meter to the charger
Charger/EVSE	Determine location and ownership
Metering	How will electricity be metered and payments made?
Insurance	Determine whether there will be a requirement for additional insurance covering the charging equipment or improved property
Construction	Determine who is responsible for project design, engineering, and construction costs
Site Improvements and Operations	Signage, landscaping, equipment protection, ADA improvements, enforcement

Multiple Unit Dwelling Residential Charger Installation Considerations

Source: Electric Vehicle Charging Infrastructure Deployment Guidelines for the Oregon I-5 Metro Areas of Portland, Salem, Corvallis, and Eugene

While the above items are significant and are not to be taken lightly, charging stations can also provide value to both the property owner and residents. As full-performance electric vehicles become mainstream, it is expected that MUDs offering the benefit of charging for their residents or guests will be highly desirable places to live.

HOAs that embrace the benefits of EVs in the community may be recognized by local governments and utility companies as innovative. They will also be lauded for supporting the state's policies and laws regarding electric vehicle charging installations in multi-family residential dwellings (see Appendix A).

Learn More

HOAs may choose to contact their local planning and permitting agencies as well as utility company to seek out additional information on the installation of charging equipment on common property. Local officials may serve as facilitators between residents, HOAs, equipment manufacturers and utility companies and act as a source of information to help take the guesswork out of installing electric vehicle supply equipment in MUDs. In addition, local agencies can provide information as to how the presence of EV charging systems may increase property values.

Three excellent resources for all stakeholders involved in the consideration and installation of electric vehicle chargers in multiple unit dwellings are:

1. San Diego Gas and Electric, CA – Training and Consulting
   www.sdge.com/training-and-consulting

2. Pacific Gas and Electric, CA – EV Charger Installation Process
   www.pge.com/myhome/environment/whatyoucando/electricdrivevehicles/installationprocess

3. UCLA, Luskin School of Public Affairs - June 2011
   Visit the following website to download a copy of *Addressing Challenges to Electric Vehicle Charging in Multifamily Residential Buildings*:
   http://luskin.ucla.edu/content/addressing-challenges-electric-vehicle-charging-multifamily-residential-buildings

Choosing an Installer, Contractor, or EV Service Provider

When it comes time to think about who to hire to bring your project to fruition, you have the same options you would if you were looking to install other building improvements at your property. If your business has facilities personnel on staff, you may choose to manage the job in-house, similar to how you may have handled HVAC or other upgrades in the past. Most property owners and operators, however, will opt to use the services of a professional contractor, consultant or EV service provider. This section helps guide your search for a professional and offers suggestions for choosing one for your project.

Note that while the circuitry needed for Level 2 EV charging equipment is fundamentally no different than that which supplies any number of other 240-volt appliances, such as stoves, dryers, and air conditioners, the subject area is new to many people, including electricians, contractors, and permitting agencies. As with any new technology, there can be delays in the process.

At this point in your planning, you have:

- Determined the characteristics of the user base you wish to serve.
- Specified the charging level that is best suited to those users' needs.
- Selected the business model and payment method (if applicable) you wish to employ.
- Chosen your preference for charging equipment and its associated feature set.

Finding an EV Charging Professional

Most facility owners and operators will choose to hire an outside contractor or EV service provider who specializes in the sale and installation of EV charging stations. Like the solar photovoltaic industry, companies range from those who just sell equipment and use a third-party installer, to those who provide a turnkey solution that includes signage.

A few companies are referring to themselves as EV "service providers," because their business model is to provide complete charging solutions. These solutions may include providing charging equipment at little or no cost to the property owner (including installation) in return for the right to handle customer billing, pricing, and subscription plans. Similar companies have been successful with this kind of model in the PV industry.

Because the EV charging industry is new and growing, there is no single source for a comprehensive listing of contractors, consultants, and professionals doing business in the area. Nor is there yet a local trade association where businesses are listed. Here are some tips for finding a professional on your island:

- Ask your present electrical contractor if they install charging stations or can refer you to someone who does.
- Talk to your local EV auto dealership and ask for referrals.

- Check with local PV system installers. Many PV companies are now getting into the EV charging business, due to the synergies with solar energy and similar planning, permitting, and installation aspects.
- If you have already installed a solar PV system, ask the company you used if they also install EV charging stations.
- Ask other commercial site owners you may know that have installed charging stations about their experience and ask whether they would recommend the contractor they used.
- Companies and contacts who have completed UL's Electric Vehicle Charging System Installation training course can be found at www.ul.com/electricvehicle/evinstallers/
- One listing of businesses seeking to offer EV charging services in Hawaii can be found by visiting http://electricvehicle.hawaii.gov. Refer to EV Ready Shared Contact Information.

Workers dig conduit trench from electrical supply point to EV charger location.

Photo courtesy of Electric Vehicle Support, Seattle, WA

Obtaining a Permit

All commercial electric vehicle charging station installations will require a permit. In general, only a building or electrical permit will be required. However, if extensive landscape, parking lot, electrical or structural alterations are involved, the services of an engineer and/or architect, as well as electrical design consultant, may be necessary. In these cases, additional permits may be required covering the appropriate project elements.

Planning Ahead

In most cases, your contractor will apply for the necessary project permits on your behalf. Contacting your local permitting agency early in the planning process can save you and your contractor valuable time, steps and expense. The permitting department will describe:

- The type of permit(s) you will need.
- Information required to complete the application.
- Permit fee structures.
- What the permit itself will consist of, and how to post it at the jobsite.
- The inspection process.
- The close-out process at completion.
- Utility coordination steps in order to energize your charging station(s).

Working with the utility company in advance and having electrical load assessments conducted will also save you (or your contractor) time and additional visits to the permitting agency. If you have access to a set of as-built (recorded) drawings of your property, they will serve as an excellent starting point for identifying sources of electrical power, panel boxes and approximate circuit locations.

If your property is in a designated "flood zone," the permitting agency will specify which elevations may be too low to locate new panel boxes and switching circuitry. The agency may also impose additional grounding requirements.

For your permit, you will likely need to provide the following specific information:

1. Property address, zoning or land-use, and owner identification.
2. Source of electric power, panel size and circuit information.
3. Parking stall dimensions, aisle widths and support column placements.
4. Lighting, location of accessible parking spaces and accessible routes to building entrances.
5. Location, number, charging level and certifications and/or labels for charging equipment.
6. Charging equipment installation details and dimensions.
7. Charging business model (free, point of sale billing, subscription/membership, etc.).

See the Resources section of this Guide for contact information for each county permitting agency.

Installing a Charging Station

Selecting a Location for Charging

Public charging at commercial locations will occur in parking lots (off-street) or along access roadways (on-street). The majority of commercial chargers will be installed in surface parking lots and in parking garages where access can be controlled, longer charging sessions can be provided and proximity to moving traffic is not a safety issue. Electric vehicle charging stations in parking lots and adjacent to roadside curbs should include:

- An outdoor-rated charger.
- Electrical supply conduit and wiring.
- Protective bollards and/or a raised curb or wheel stops.
- Signage and adequate lighting.

Because public charging stations will usually be in close proximity to pedestrians and other parked vehicles, protecting the general public through sound design and installation practices is paramount.

Automakers have not standardized the location of the charging inlet on EVs, so consideration should be given to how motorists may choose to orient their vehicles for charging in a given parking space. Care should be taken to not create any undue hazards or conflicts, such as charging cords that present a trip hazard to pedestrians or block access by maintenance personnel to other features of the site, such as landscaping and lighting. Generally, locating a charger so that it is near the front left side of a parked EV is considered best practice.

In order to control the cost of installing a charging station, the proximity to nearby electrical service panels or utility rooms is often the controlling factor when selecting charging locations at your property. For many commercial parking facilities, the cost of running electrical conduit can represent a significant portion of the job. The shorter the electrical run, the lower the cost of the project.

Charger installed for parallel EV parking in lot near pathway to building entrance.
Photo courtesy of Sharon Saris, Monterey Bay Electric Vehicle Association

Parking Lots and Garages

Off-street electric vehicle charging station installations present greater opportunities to locate charging equipment out of pedestrian traffic and travel lanes. At the same time, most charging stations will be installed in existing parking lots, and a certain amount of retrofitting will be necessary.

Considering the prospective users of your charging station(s) and the amount of time they are likely to leave their EV parked and charging will help you decide which areas of the facility are best suited for charging purposes. Placing EV parking spaces close to the front entrance of commercial establishments may not always be the best solution. Existing accessible (ADA) parking spaces and heavy pedestrian traffic occur near the main entrances and along walkways to buildings. Locating charging stations away from main entrances may aid in lessening pedestrian conflicts with charging cords. Locating a charging station in a high parking turnover area is not desirable since the EV using the station may remain parked for several hours while charging.

Most off-street charging stations will be positioned either diagonally or perpendicular to the driving aisle. Scouting locations in existing lots where a stall can be widened through restriping or minor physical alterations can prove beneficial to both EV drivers, as well as non-EV drivers parked adjacently, by providing more space around chargers and vehicle charging inlets.

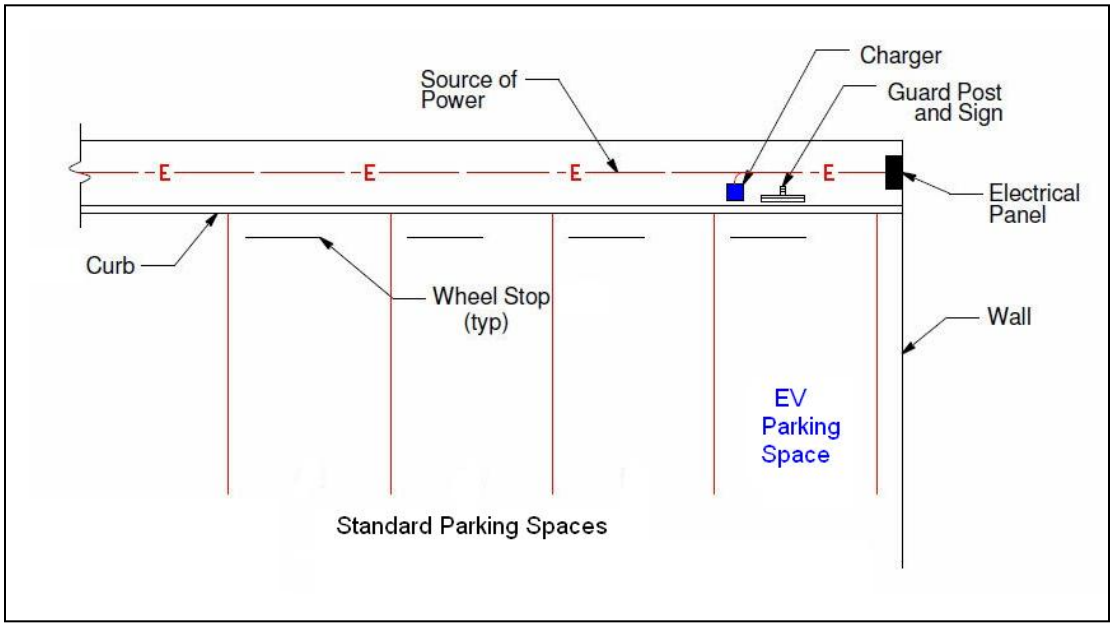


Figure 1. Off-street EV charging station using a wide parking space located near electrical service.

Figure 1 illustrates a slightly widened perpendicular parking space at the end of a row, near an existing electrical panel. Placing the charger on or just slightly to the right of the parking divider line will provide future opportunities to convert the single charger to a dual-port charger which can serve a second stall adjacent to the first. Best installation practices include:

- The installation of bollards to protect the equipment. These are highly recommended when the parked vehicle and charging equipment are on the same surface.
- Good lighting and convenient access to the charger and its controls.

- Placement of clearly legible signs identifying the charging station, and to enable enforcement of displayed charging policies.
- Providing shelter from direct sun or rain.

***Coulomb* charging stations at resort hotel on Oahu.**

On-Street Charging

While it is not expected that large numbers of electric vehicle charging stations will be installed along high-traffic roadways, it may be necessary to install a charger on a less-trafficked street or access roadway and designate that space for EV charging. As noted earlier, automakers have not standardized the location of the charging inlet on EVs. Inlets may be found on the front, either side, or rear of a vehicle. Choosing a parallel parking space at the end of a row (in the direction of travel) will reduce the amount of pedestrian traffic around the charger, cord, and inlet.

Figure 2 on the following page illustrates the placement of the charger near a no-parking zone, minimizing the possibility of pedestrians walking between the charger and vehicle's charging inlet. Note that the charging equipment is located toward the front of the parking space. Dual-port chargers are not recommended for installation in parallel parking situations, because of the longer distance that cords would need to be draped to reach the charging inlets on two cars.

For on-street charging stations, all equipment should be located sufficiently behind the face of curb so as to prevent accidental damage by vehicles. It is standard practice for curbside parking to provide good lighting and convenient access to the sidewalk. As with off-street charging stations, placement of clearly legible signs to identify the EV charging station and to display parking regulations or policies is highly recommended.

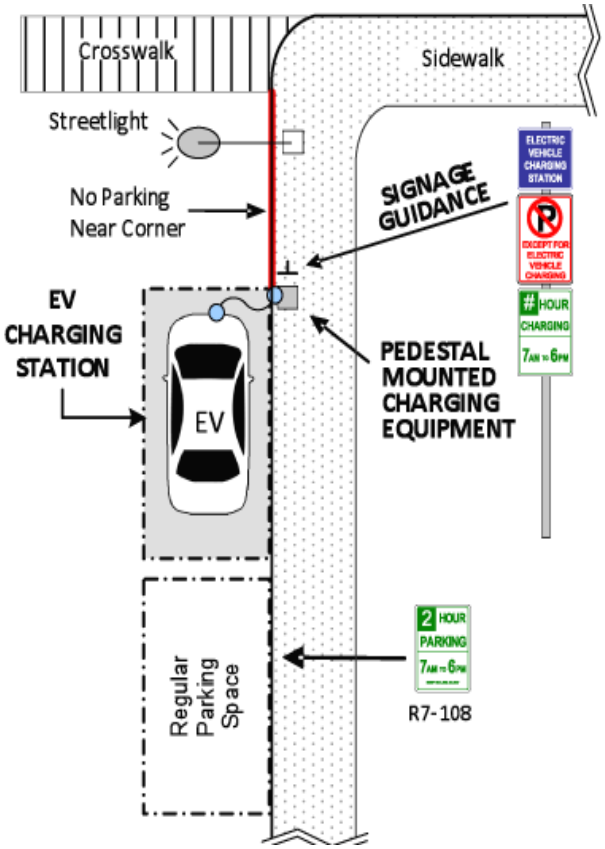


Figure 2. On-street charger mounted in last space on the block.
Source: Electric Vehicle Infrastructure: A Guide for Local Governments in Washington State

Vehicle with inlet located in the front center position.

On-street parallel EV parking space features pedestal-mounted charger.

Accessible Chargers

The Federal Americans with Disabilities Act (ADA) applies to Electric Vehicles Charging Stations installed in parking lots. However, there are no established criteria for Charging Stations in the current ADA Guidelines. To establish good faith efforts to comply with ADA, the Hawaii State Energy Office strongly recommends that private (commercial) entities arrange for one of the Charging Stations to comply with these guidelines:

- An accessible charging station should be close to, but no farther than 200 feet from the primary building entrance or to an accessible pedestrian entrance of the parking facility.
- An accessible charging station should not displace an existing accessible parking space that is required to be nearest a primary building entrance (as defined by Hawaii Administrative Rules, Title 11, Chapter 19).
- Unless an accessible charging station is intended solely for persons with disabilities, it does not require signs, markings or an "International Symbol of Access" designating the space as reserved for persons with disabilities as defined by the Hawaii Administrative Rules, Title 11, Chapter 19.
- The area in front of the charger should be level (or less than a 2 percent slope), as is presently required for accessible fuel pumps in gas stations. To meet minimum maneuverability and clearance requirements for persons with disabilities, the clear width between the parked EV and the accessible charger controls and/or cord handle, as well as the unobstructed path of travel to the equipment should be no less than 3 feet.

This accessible EV charging station features an unobstructed path of travel to the charger, and accessible controls. Raised curbing and wheel stops protect charging equipment from vehicle damage.

- A minimum 5-foot clear area to turn a wheel chair near the accessible chargers is desired in existing public parking facilities and should be provided in new construction.
- Protective guard posts (bollards) should not encroach upon the minimum clear width of 3 feet. Accessible controls, and/or the cord handle, should be installed between 36 and 48 inches above the level surface (parking surface) in front of the charger, and no greater than 10 inches behind the face of a raised island or curb.
- Accessible electric vehicle charging equipment (the charger) should comply with the Americans with Disabilities Act Accessibility Guidelines, Section 309 Operable Parts (note these guidelines apply to equipment that has been approved for public use by Underwriters Laboratories (UL) or other third party safety certification and labeling laboratories, and approved by the National Electric Code, Section 625).
- An accessible route should be provided from an accessible EV parking stall to the accessible EV charging equipment. An accessible EV charging station should connect to an accessible route to the accessible building entrance. Accessible routes shall comply with ADAAG Chapter 4.
- A parking stall and access aisle serving an EV charging station should be 192 inches wide combined. The parking stall at an accessible EV charging station should comply with ADAAG Section 302. Access aisles must take into consideration use from either side to accommodate differences in location of charging inlets across vehicles. The differences in charging inlets across vehicle and the design of the vehicles may require the driver, both able bodied or with a disability, to back into the parking space.
- In new parking facility construction, the first charging station should be fully accessible and be designed to accommodate wheelchair lift equipment in an adjacent access aisle. In new and existing parking facilities, consultation should be made with the local building and permitting departments on how to provide charger accessibility and other reasonable accommodations.
- Because the "accessible element" is the charger, and given that electric vehicles have charging inlets on the front, rear or either side of the vehicle, it is not recommended to install painted or marked access aisles or paths of travel on either side of the charging station.

Public entities in Hawaii installing charging stations at state or county facilities are required to consult with the State of Hawaii, Disability and Communication Access Board per Hawaii Revised Statutes 103-50. Phone: (808) 586-8121; Email: dcab@doh.hawaii.gov .

Signage

Commercial parking lot operators are encouraged to post signs to promote and/or regulate the use of electric vehicle charging stations intended for public use. Local and State agencies posting regulatory or guide signs in the public right of way must do so in a manner that is consistent with the United States Department of Transportation's (USDOT) Manual on Uniform Traffic Control Devices (MUTCD) http://mutcd.fhwa.dot.gov/pdfs/2009/part2a.pdf .

Traffic control signs (including parking regulations) on private roads intended for public use must also conform to the MUTCD. More information about purpose, placement, and visibility of signs is contained in Part 2, Chapter 2A of the MUTCD.

Signs in private parking facilities for public use are not required to meet MUTCD standards, but owners and operators are encouraged to do so. Signs with different shapes, colors and messages than those contained in the MUTCD may be posted in private facilities, but are not legally enforceable. Three different types of signs are discussed in this section: general service signs (guidance), regulatory signs (enforceable) and special signs (information or trailblazer).

General Service Signs

General Service Signs provide driver guidance to EV charging stations. At the time of this writing, a few General Service Signs exist in the MUTCD. These blue and white signs should be installed at a suitable distance in advance of the exit point or intersecting roadway, at decision points in parking lots or at the EV charging station. Guide signs can be effective when used on local streets and private roads to inform motorists of the intersecting street or driveway to enter for charging purposes. The colors used for General Service signs on streets for public use are as follows:

Letters	Symbols	Arrows	Borders	Background
White	White	White	White	Blue

The General Service Signs with recommended sizes currently approved in the MUTCD are pictured below. The G66-21 (CA) sign was added to the California MUTCD to be used on local roadways. It may also be used in public parking facilities for directional purposes and at each individual charger. The D9-11b (Alternate) sign may be combined with either the G66-21 (CA) or the D9-11bP.

G66-21 (CA)

Parking Facility 12" x 12"
Parking Facility 18" x 18"
Local Road 24" x 24"

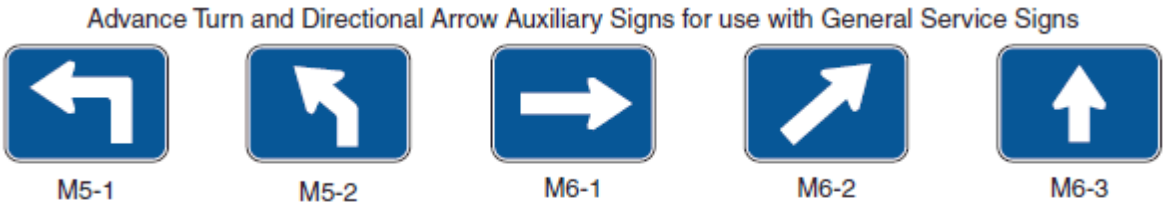
D9-11bP

Parking Facility 16" x 12"
Local Road 24" x 18"

D9-11b (Alternate)

Parking Facility 12" x 12"
Local Road 24" x 24"

Comment: On April 1, 2011, the Federal Highway Administration (FHWA) issued an Interim Approval for use of an alternate D9-11b sign to the States of Oregon and Washington. State of Hawaii DOT officials have requested use of the D9-11b (Alternate). When FHWA grants approval, it will be available for use in public and private commercial applications.



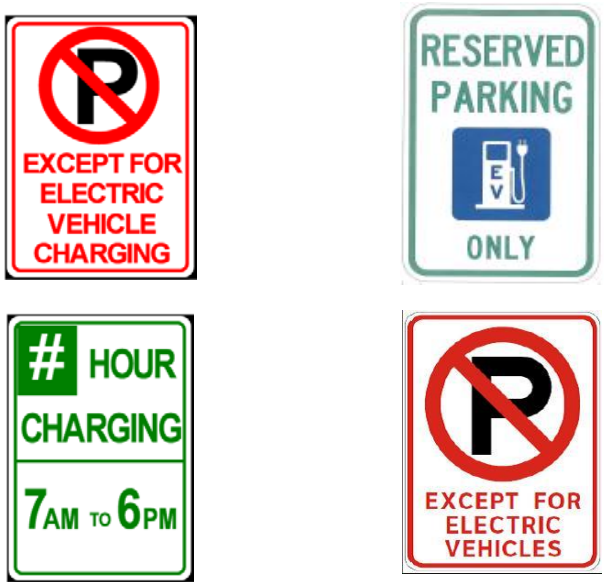
The M-series directional arrow auxiliary signs may be 12" (w) x 9" (h) on local public and private roadways or as small as 8" (w) x 6" (h) in parking facilities.

General Service Guide signs directing EV drivers to charging stations.

Regulatory Signs

Regulatory signs are required in order to enforce the time duration and days that electric vehicles are permitted to charge or park, or to restrict internal combustion engine vehicles from occupying the space. Currently, no regulatory signs exist for the enforcement of electric vehicle charging stations in the federal MUTCD, however signs have been developed for testing in Oregon and Washington. Michigan has also approved a regulatory sign that has been added to its Standard Highway Signs Book. It is recommended that those signs being tested in Oregon and Washington, and approved for use in Michigan should also be used in Hawaii until such time as the state adopts standard signs.

There are two types of regulatory parking signs, *prohibitive and permissive*. Green and white *permissive* signs designate where limited-time, or parking in a certain manner is permitted. Red and white *prohibitive* signs designate parking prohibitions at all times or specific hours or days. Illustrations of the four regulatory signs suggested for use in Hawaii appear below. The permissive signs may have variations in the wording to meet the situation. To be lawful, each of the signs should be no smaller than 12" (w) x 18" (h) and placed immediately adjacent to the charger at heights and locations as prescribed in Part 2, Chapter 2B of the federal MUTCD.



Examples of Regulatory Signs

The prohibitive sign on the upper left of the figure above requires that the electric vehicle parked in the space be connected or "plugged in" to the charger. The example to the right is patterned after the standard sign that reserves parking for persons with disabilities. Both signs simply identify a space as an EV charging station with no time limits.

The prohibitive sign on the lower right in the figure restricts non-electric vehicles and allows for the parking of an electric vehicle without being plugged in. For example, it could be used in a space adjacent to a charger where EV drivers could park until the charger is available for use. All three of these prohibitive signs are intended to make it unlawful for any non-electric vehicle to occupy the space.

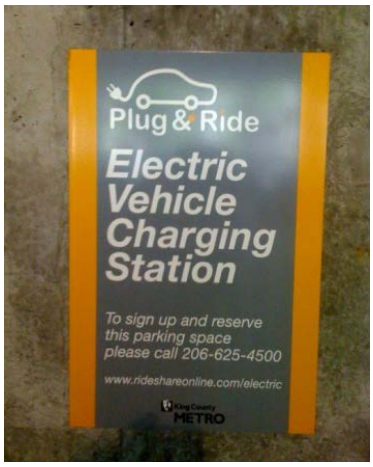
The permissive sign on the lower left of the figure above could be used to designate the number of hours and days an EV is permitted to stay connected to the charger. To be in compliance with MUTCD standards, permissive signs may be used in combination with a prohibitive sign, as long as they are installed below or to the right of the prohibitive sign.

Special Signs

Special signs are those that provide additional information to the driver. They do not follow the standards set forth in the federal MUTCD. Generally speaking, special signs are used by the private sector to assist in guiding motorists to their destinations or to identify features or supported programs at a facility. Distinct colors, images, artwork and themes may be used to differentiate signs from one commercial entity to another.

Cities and counties will also often use special signs for tourism or economic development purposes to guide motorists to points of interest or to inform users of their responsibilities when using particular equipment. Special signs should not be expected to support enforceability, such as non-electric vehicles occupying EV spaces. Regulatory signs provide this capability. Examples of special signs for EV charging stations are shown on the following page.

This special sign identifies a charging station at a Shopping Center.
Photo courtesy of LightMoves



A special sign used at a Park and Ride lot. The charger must be reserved for use, making it legal for ICE vehicles to park in this space when not reserved.

A special sign installed by department store offering free charging to customers while shopping.

Operating a Charging System

The material presented in this Guidebook clearly makes the case that providing EV charging at your facility involves more than just buying a piece of charging equipment (the **charger**) and installing it. We have further used the term **charging station** to refer to all components at the EV charging stall in your lot, including the parking space, charger, electrical supply, access pathways, equipment protection (bollards, wheel stops), network connectivity (if applicable), and signage (both at the parking space and directional).

Once your hardware and signage have been installed, you must set about operating the **charging system** as a whole. Similar to other systems at your facility used by visitors or tenants, you will need to devote attention to managing them. Successful charging stations will be those that are easy to find and use, and that are kept operational. Following are the basic areas to consider in operating your charging system.

Access to Your Charging Station

Access to your charging station(s) may be provided free of charge or for a fee, as discussed in the Charging Business Models section on pages 10-13. Even if you decide not to charge a fee, you may want to control access to a list of approved users. In the case of controlled access, you will need to put methods in place to authorize access. These methods may be included with the charging equipment you installed, or be provided by the contractor or EV service provider you chose for your project. Networked chargers provided by various manufacturers include methods for users to sign up online and receive an access card.

A key aspect to publicly available charging stations is the ability for EV drivers to locate them on a map. The Hawaii State Energy Office maintains a database of publicly available charging stations at http://electricvehicle.hawaii.gov. If your station is to be openly available, you will need to get the particulars of its location (name, address, map location, charging level, fee structure) listed with the EV charging network provider or charging station manufacturer. Charging stations can appear on in-car GPS devices, smartphone apps, and the internet. If your business has a website, you may want to list your charging station(s) there, including information about access, hours of availability, and driving directions.

Ecotality chargers in Waikiki hotel parking garage.

Another aspect to managing your system is keeping the charging stations from being blocked by non-EVs, or ICE vehicles as they are typically referred to. The signage recommendations in this guide are designed to help with this and have been developed using prior experience from California, where public charging stations have been available for many years. If you have towing or enforcement policies already in place at your facility, you can include your charging station access policies with those. Or, you may need to develop them anew. Some site hosts prefer to first see how it goes before resorting to additional signage or enforcement controls.

Maintenance and Oversight

Surveys of EV drivers on the US mainland show that a top complaint is charging stations that are out of service when they arrive at them. If your system includes networked stations, you should receive system status information on a real-time basis, or have the ability to query status remotely at any time. Make sure that someone at your facility is tasked with overseeing system status.

Charging hardware will require regular maintenance, and signs, markings, and other associated equipment may require occasional upkeep, as well. Check with your hardware supplier, contractor, or service provider for specific maintenance and update requirements for your equipment. Existing maintenance personnel at your facility may be able to oversee your charging stations.

Every charger should display 24-hour emergency contact information as well as instructions for operating the equipment. Make sure this information is clear and readable for your users.

If nighttime access is to be provided or daytime charging will occur in a covered parking garage, be sure that lighting is adequate to illuminate charger controls, signs, electrical cords/plugs, and the access route to and from the charger. You may already have proper lighting, as required by local building codes for parking garages.

Data Collection and Reporting

You may have determined that you want your charging system to generate records regarding usage of the charger(s) so that you can track the effectiveness of your investment, as well as for planning purposes for future system expansion. Additionally, if you have chosen to recover

Eaton DC charger touchscreen display.

some of your cost involved in providing charging services, you will need an audit trail of financial transactions.

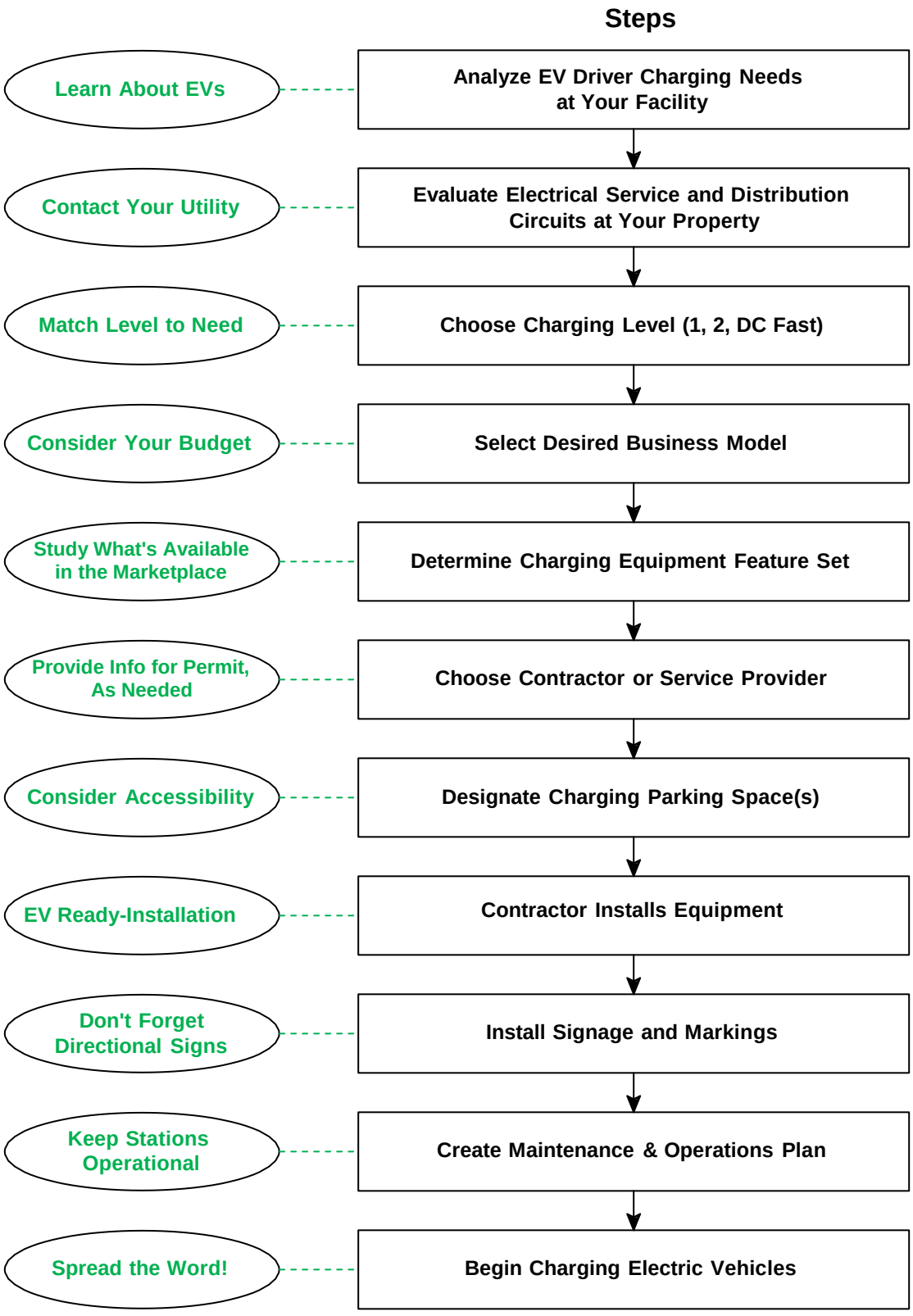
Data availability from chargers currently on the market varies widely, ranging from none (simple electricity pass-through chargers) to quite robust, with detailed usage data on every charging event, remotely accessible in the case of networked chargers.

The types of data that can be generated include:

- Charging event start and stop times
- Amount of energy delivered at each charging event (kWh)
- Profile of power delivery over the course of a charging event (min/max/average kW)
- Unique user identification (account number, vehicle type)
- Customer billing or payment information (payment or subscription particulars)
- Charger availability history (out of service times, reservation data)
- Performance history (error messages, software updates)

An additional consideration is the additional expense that may be incurred in terms of the time involved for someone at your facility to track, archive, evaluate, and create reports for property owners or operators. This can affect your business model choice. Some properties, such as shopping malls, have chosen to install simple chargers, not only because of lower cost, but also to avoid adding non-critical overhead to their business for something they see as an amenity designed to attract EV drivers as customers to their stores.

Commercial Charging Station Project Flowchart



Glossary

Common Terms

120-volt AC outlet – A regular U.S. household electrical outlet that can be used to charge most electric vehicles.

240-volt AC outlet – Commonly used to power larger appliances, such as electric dryers, stoves, or air conditioners, it can provide faster charging of BEVs and some PHEVs than a 120-volt outlet.

Battery Electric Vehicle (BEV)
Any vehicle that operates exclusively on power from the electric grid that is stored in the vehicle's batteries.

CHAdeMO – The trade name of a quick charging method for BEVs that delivers up to 62.5kW of high-voltage direct current via a special connector. The Japanese CHAdeMO standard for DC fast charging differs from that currently under development by SAE International. Some electric vehicles, such as the Nissan Leaf and Mitsubishi i-MiEV, already support DC fast charging using the CHAdeMO standard.

Charger – *See Electric vehicle charger.*

Charging station – *See Electric Vehicle Charging Station.*

Charging system – *See Electric Vehicle Charging System.*

Commercially available – Commercially available technologies are defined as those that are available for purchase and unrestricted use by the general public, and are fully compliant with all applicable emissions and safety regulations.

DC fast charging – Specialized chargers that use DC voltage to charge a plug-in vehicle at much faster rates than Level 2. For example, a Nissan Leaf can charge to 80 percent of capacity within 30 minutes.

Electric Vehicle (EV) – A generic term that includes BEVs, plug-in hybrid electric vehicles (PHEVs), neighborhood electric vehicles (NEVs), and motorcycles. EVs may also be referred to collectively as Plug-in Electric Vehicles (PEVs).

Electric vehicle charger – An electrical appliance designed specifically to charge batteries within one or more electric vehicles. A dual charger is one that can charge two vehicles simultaneously. Charger styles include pedestal and wall or pole-mounted. Chargers are also called electric vehicle supply equipment (EVSE), and may also be referred to as charging stations or battery charging stations.

Electric Vehicle Charging Station (EVCS)
A public or private parking space that is equipped with and served by a charger that has as its primary purpose the transfer of electrical energy to a battery or other energy storage device in an electric vehicle. A complete charging station includes appropriate signage, and may include other features, such as pavement markings, bollards, wheel stops, etc.

Electric Vehicle Charging System
The complete EV charging installation at a public or commercial site, consisting of one or more charging stations, communications, directional signage, and an operating plan that covers usage, maintenance, data collection, and billing (as appropriate).

Electric Vehicle Supply Equipment (EVSE) – Equipment necessary on the premises to support the charging of an electric vehicle. Electric vehicle supply equipment complies with Article 625 of the National Electrical Code (NEC) and delivers electricity from a source outside an electric vehicle into one or more electric vehicles.

Electric Vehicle Service Provider (EVSP)
A supplier of electric vehicle charging services, which may include EVSE, networked communications, and subscription or billing capability.

Hybrid Electric Vehicle (HEV) – A type of vehicle that combines a conventional internal combustion engine (ICE) propulsion system with an electric propulsion system. HEVs do not receive energy from the grid and do not have plugs.

Inlet – The device or receptacle on the electric vehicle into which the charging connector is inserted for charging and information exchange.

Internal Combustion Engine (ICE)
Engines that burn gasoline or other fuel for energy, found in every conventional vehicle (including hybrids) today.

J or J1772 Connector – *see SAE J1772™*

Kilowatt – A unit of power (rate of energy use), equal to 1,000 watts.

Kilowatt-hour – A unit of electrical energy equal to consuming 1,000 watts for one hour.

Level 1 charging – Charging from 120-volt AC outlets, or from chargers with 120-volt AC connections.

Level 2 charging – Charging from chargers with 208/240-volt AC connectors. Level 2 is faster than Level 1 charging, utilizing both higher voltage and current.

Level 3 charging – (also known as fast charging or DC Fast Charging). The fastest charging level, using specialized high-power DC chargers. DC fast chargers currently in use in the United States use the CHAdeMO standard connector. DC fast charging standards from SAE International remain under development.

Miles per gallon equivalent (MPGe)
A measure of the average distance traveled per unit of energy consumed. Used by the Environmental Protection Agency (EPA) to compare energy consumption of EVs with the fuel economy of conventional ICE vehicles.

National Electrical Code (NEC)
NEC section 625 is that portion of the electrical code that covers electrical conductors and external equipment used to charge an electric vehicle.

Neighborhood Electric Vehicle (NEV)
An EV designed to operate at a maximum of 25 miles per hour on streets with lower speed limits.

Off-peak charging – Charging electric vehicles during periods of low energy demand on the grid (typically overnight while most people are sleeping).

Plug-in Hybrid Electric Vehicle (PHEV)
A vehicle that uses electricity from the grid as its primary energy source, along with another fuel, such as gasoline. Examples are the Chevy Volt and Toyota Plug-in Prius.

SAE – SAE International, formerly the Society of Automotive Engineers.

SAE J1772™ – The North American design standard for Level 2 charging connectors for electric vehicles, adopted by SAE International. All of the major automakers have adopted this standard so that Level 2 charging stations will be compatible with modern EVs.

Time-Of-Use Metering (TOU) – A utility rate structure with different rates for electricity used at different times of the day, depending on grid demand. It can provide low-cost charging for electric vehicles that plug in during low-demand (off-peak) hours.

Underwriters Laboratories (UL)
Provides third party safety certification and labeling of EV charging equipment.

Zero Emission Vehicle (ZEV) – A vehicle that does not produce any tailpipe emissions. A BEV would qualify, but a PHEV would not.

Acronyms

AC – Alternating Current

ADA – Americans with Disabilities Act

ARRA – American Recovery and Reinvestment Act of 2009

BEV – Battery Electric Vehicle

CZMA – Coastal Zone Management Act

DBEDT – Department of Business, Economic Development and Tourism (Hawaii)

DC – Direct Current

DOE – US Department of Energy

DOH – Department of Health (State of Hawaii)

DOT – Department of Transportation (State of Hawaii)

DPP – Department of Planning and Permitting (City and County of Honolulu)

EPRI – Electric Power Research Institute

EREV – Extended Range Electric Vehicle

EV– Electric Vehicle

EV-C – EV Commercial

EVCS – Electric Vehicle Charging Station

EVI – Electric Vehicle Infrastructure

EVSE – Electric Vehicle Supply Equipment

FHWA – Federal Highway Administration

GFI – Ground Fault Interrupter

HCEI – Hawaii Clean Energy Initiative

HECO – Hawaiian Electric Company

HELCO – Hawaii Electric Light Company

HOA – Homeowners Association

HOV – High Occupancy Vehicle

HVAC – Heating Ventilation and Air Conditioning

ICE – Internal Combustion Engine

KIUC – Kauai Island Utility Cooperative

kW – Kilowatt

kWh – Kilowatt-hour

MECO – Maui Electric Company

MUD – Multiple Unit Dwelling

MUTCD – Federal Manual on Uniform Traffic Control Devices (within FHWA)

NECA – National Electrical Contractors Association

NEC – National Electrical Code

NEV – Neighborhood Electric Vehicle

OP – Office of Planning (within DBEDT)

OSHA – Occupational Safety and Health Administration

PEV – Plug-in Electric Vehicle

PHEV – Plug-in Hybrid Electric Vehicle

PV – Photovoltaic

RFID – Radio Frequency Identification subscription service access card

SAE – SAE International (formerly Society of Automotive Engineers)

TOU – Time Of Use

UL – Underwriters Laboratories

USDOT – United State Department of Transportation

VMT – Vehicle Miles Traveled

Resources

Electric Utility Company Contact Information

Utility	Office Address and Hours	Customer Call Centers
HECO (Oahu)	900 Richards Street Honolulu, HI 96813 7:30 am to 5:00 pm 820 Ward Avenue Honolulu, HI 96814 7:30 am to 4:00 pm	808-548-7311 7:30 am to 6:00 pm
MECO (Maui, Molokai, Lanai)	210 W. Kamehameha Avenue Kahului, HI 96732	808-871-9777 From Molokai and Lanai, toll free 1-877-871-8461 8:00 am to 5:00 pm
HELCO (Big Island)	1200 Kilauea Avenue Hilo, HI 96720 7:30 am to 4:30 pm 74-5519 Kaiwi Street Kailua-Kona, HI 96740 7:30 am to 3:30 pm HELCO Baseyard Kamuela, HI 96743 7:30 am to 3:30 pm	808-969-6999 7:30 am to 4:30 pm 808-329-3584 7:30 am to 3:30 pm 808-885-4605 7:30 am to 3:30 pm
KIUC (Kauai)	4463 Pahe'e Street, Suite 1 Lihu'e, HI 96766-2000 Monday - Friday 7:30 am - 4:30 pm	808-246-4300 7:30 am to 4:30 pm

County Permitting Agencies for Charger Installations

Agency	Department/Division	Address	Phone/Website
City/County of Honolulu	Department of Planning and Permitting Land Use Permits Division	650 King Street Honolulu, HI 96813	Electrical Code Branch 808-768-8239 Zoning Plan Review 808-768-8252 www.honoluludpp.org/permitinfo
Hawaii County	Department of Public Works/Building Division	East HI Aupuni Center 101 Pauahi Street, Suite 7 Hilo, HI 96720 West HI Hanama Place 75-5706 Kuakini Hwy Suite 109-111 Kailua-Kona, HI 96740	808-961-8331 808-323-4720 www.hawaiicounty.gov/public-works-building
Kauai County	Department of Public Works/Building Division	4444 Rice Street Suite 175 Lihue, HI 96766-1340	808-241-4854 www.kauai.gov/buildingpermits
Maui County	Department of Public Works/Development Services Administration	250 S. High Street Kalana Pakui Bldg Wailuku, HI 96793	808-270-7379 www.co.maui.hi.us

Publications and Reports

The following publications and reports offer additional background and guidance relevant to the installation of electric vehicle charging infrastructure.

Electric Vehicle Charging Infrastructure Deployment Guidelines, British Columbia,
prepared for Natural Resources Canada and BC Hydro, July 2009
www.psrc.org/assets/3754/M_Vancouver_Deployment_Guidelines_2009.pdf

Electric Vehicle Infrastructure: A Guide for Local Governments in Washington State,
prepared by the Puget Sound Regional Council, July 2010
www.psrc.org/transportation/ev/model-guidance

Ready, Set, Charge California! A Guide to EV-Ready Communities,
prepared by the Bay Area Climate Collaborative, November 2011
Guide to EV Ready Communities California

EV Charging for Persons with Disabilities,
prepared by Virginia Clean Cities and Clean Fuels Ohio, February 2012

This report covers accessible parking, access from vehicle to charging equipment, using the EV charging station, returning to recharge the vehicle, accessing the destination, and fast charger considerations.
www.vacleancities.org/news/new-report-on-ev-charging-stations-for-persons-with-disabilities

Plug-In Electric Vehicle Handbook for Fleet Managers;
Plug-In Electric Vehicle Handbook for Electrical Contractors;
Plug-In Electric Vehicle Handbook for Public Charging Station Hosts,
prepared by the National Renewable Energy Laboratory (NREL), U.S. Department of Energy, April 2012.
www.afdc.energy.gov/afdc/pdfs/pev_handbook.pdf

Organizations

The following organizations conduct public outreach and education and maintain up-to-date information on best practices regarding the installation of electric vehicle charging infrastructure:

Honolulu Clean Cities Coalition
www.honolulucleancities.org

Plug In America
www.pluginamerica.org

Plug-in Electric Vehicle Collaborative (California)
www.evcollaborative.org

Appendices

Appendix A: Hawaii Electric Vehicle Legislation and Laws

Hawaii is a leader among the states in establishing policies designed to promote the electrification of transportation. Since the late 1990's the state of Hawaii has taken steps to integrate EV's into the state's transportation policy goals.

Hawaii has made progress in providing policies to incentivize EV including:

- Providing free parking
- Providing access to High Occupancy Vehicle (HOV) lanes
- Providing access to preferential parking spots with charger
- Defining EV to include electric and plug in hybrid EVs

Listed here are the legislative acts and statues that have been enacted and are in effect at the time of publication of this Guidebook. To check for revisions or additions to existing policy and law, visit the Hawaii Electric Vehicle (EV) Ready Program webpage at: http://electricvehicle.hawaii.gov. Additionally, the Hawaii State Legislature website at http://capitol.hawaii.gov offers current and archived information about House and Senate procedures and members. The site also provides access to legislative information including Hawaii Revised Statutes (HRS), bill status, and current hearing information.

Act 89 S.B.2746 (2012, supersedes Act 290 of 1997)

The department of transportation may adopt rules pursuant to chapter 91, Hawaii Revised Statutes, for the registration of, and issuance of special license plates for, EVs.

An EV on which an EV license plate is affixed shall be exempt from payment of parking fees, including those collected through parking meters, charged by any state or county authority in this State, except that this exemption shall not apply:

- For more than two and one-half hours of metered parking, or the maximum amount of time the meter allows, whichever is longer; or to parking fees assessed in increments longer than one twenty-four-hour day, including weekly, monthly, or annual parking permits.

An EV on which an electric vehicle license plate is affixed shall be exempt from high occupancy vehicle lane restrictions.

Act 168 S.B.2747 (2012, supersedes Act 156, HRS 291-71)

The purpose of this Act is to clarify requirements pertaining to parking spaces for EVs. Specifically, it declares that places of public accommodation with at least one hundred parking spaces available for use by the general public shall have at least one parking space exclusively for EVs and equipped with an EV charging system located anywhere in the parking structure or lot by July 1, 2012; provided that no parking space designated for electric vehicles shall displace or reduce accessible stalls required by the Americans with Disabilities Act Accessibility Guidelines.

HRS 103D-412 (2009)

This procurement policy applies to all state and county entities. Beginning January 1, 2010, when purchasing new vehicles, all state and county entities shall seek vehicles with reduced dependence on petroleum-based fuels that meet the needs of the agency. Priority for selecting vehicles shall be as follows:

(1) Electric or plug-in hybrid electric vehicles;
(2) Hydrogen or fuel cell vehicles;
(3) Other alternative fuel vehicles;
(4) Hybrid electric vehicles; and
(5) Vehicles that are identified by the United States Environmental Protection Agency in its annual "Fuel Economy Leaders" report as being among the top performers for fuel economy in their class.

Act 186 HRS 196-7.5 (2010)

This act, codified into statute that:

- No person shall be prevented from installing an electric vehicle charging system on or near the parking stall of any multi-family residential dwelling or townhouse that the person owns.
- Every private entity may adopt rules that reasonably restrict the placement and use of electric vehicle charging systems for the purpose of charging electrical vehicles in the parking stalls of any multi-family residential dwelling or townhouse; provided that those restrictions shall not prohibit the placement or use of electric vehicle charging systems altogether. No private entity shall assess or charge any homeowner any fees for the placement of any electric vehicle charging system; provided that the private entity may require reimbursement for the cost of electricity used by such electric vehicle charging system.
- Under certain provisions, any person may place an electric vehicle charging system on or near the parking stall of any multi-family residential dwelling or townhouse unit owned by that person.
- If an electric vehicle charging system is placed on a common element or limited common element: (1) The owner and each successive owner of the parking stall on which or near where the system is placed shall be responsible for any costs for damages to the system, common elements, limited common elements, and any adjacent units, arising or resulting from the installation, maintenance, repair, removal, or replacement of the system. The repair, maintenance, removal, and replacement responsibilities shall be assumed by each successive owner until the electric vehicle charging system has been removed from the common elements or limited common elements. The owner and each successive owner shall at all times have and maintain a policy of insurance covering the obligations of the owner under this paragraph and shall name the private entity as an additional insured under the policy; and (2) The owner and any successive owner of the parking stall on which or near where the system is placed shall be responsible for removing the electric vehicle charging system if reasonably necessary or convenient for the repair, maintenance, or replacement of the common elements or limited common elements.

Appendix B: Charging Level Standards

The following table was created from material published by SAE International (formerly the Society of Automotive Engineers). It represents the latest available information regarding the specific definitions of both AC and DC charging levels by that organization. For more information, contact SAE International: www.sae.org

AC Level 1 (SAE J1772™)	120V, 1.4kW, 12A 120V, 1.9kW, 16A	DC Level 1 (tbd)	200-450V DC, up to 36kW (80A)
AC Level 2 (SAE J1772 ™)	208V or 240V, up to 19.2kW, 80A	DC Level 2 (tbd)	200-450V DC, up to 90kW (200A)
AC Level 3 (tbd)	> 20kW, single and three-phase	DC Level 3 (tbd)	200-600V DC, up to 240kW (400A)

Note that as of the date of publication of this Guidebook, standards have not been ratified by SAE International for anything but AC Levels 1 and 2. The Japanese CHAdeMO standard for DC fast charging differs from the standards currently under development by SAE International. However, the marketplace may ultimately decide which standard becomes most popular, as tens of thousands of new generation EVs are already on the road in Japan, Europe, and the United States; vehicles capable of being charged via CHAdeMO, and supported by hundreds of operational CHAdeMO DC Fast Chargers. These chargers are also being installed in Hawaii. For more information, contact the CHAdeMO Association: www.chademo.com

Prototype SAE "Combo" DC Fast Charging Plug
Photo courtesy of Darrell Dickey

CHAdeMO DC Fast Charging Plug
Photo courtesy Ford Motor Company

STATE OF HAWAII

Plug In America