Lessons Learned:
The Early Adoption of Electric Vehicle Charging Stations from the Perspective of Oahu's Commercial Properties

October 2012

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Executive Summary

This report focuses on some of the changes being made in Hawaii's transportation sector, specifically in the transition towards the adoption of electric vehicles (EVs). The shift from gasoline-powered vehicles to electric-drive vehicles is still in its early stages, and cannot succeed without the necessary charging infrastructure to power EVs. In order for car-buyers to feel confident in purchasing an EV, charging infrastructure must be in place in order to minimize an EV driver's "range anxiety"—the fear of being stranded with a dead battery and nowhere to recharge. Therefore, the adoption of public charging locations plays a vital role in limiting EV drivers' range anxiety, and transitioning toward an electrified transportation system. The islands of Hawaii have limited driving ranges, and consequently EV drivers' range anxiety is naturally limited. This fact, combined with the fact that the State of Hawaii is 90% dependent on imported fossil fuels, has provided the impetus for Hawaii to become a test bed for the adoption of EVs and chargers. The Hawaii State Legislature has been in support of EVs since 1997 and beginning in 2009 the Hawaii State Energy Office implemented Hawaii EV Ready program that incentivized and supported the expansion of EVs and EV chargers throughout Hawaii (see Section 1.1.3 and 1.1.4 for more information on these policies). This report identifies the lessons learned from early adopter commercial properties that installed EV charging stations on the island of Oahu—Hawaii's commercial center which has experienced the greatest growth in EV drivers and chargers as compared to its neighbor islands. This research reflects the installation of over 76 charging stations among 22 different properties, which is estimated to make up 59% of the total properties that have installed chargers on Oahu as of January 2012 (see Section 1.3 for information on the research methodology, and Section 2.0 for a report of research participants).

The major findings reported by Oahu's early adopter commercial properties that installed publically available EV charging stations are listed below, and explained further in Section 2.

1) **Properties benefitted from researching chargers and utilizing industry professionals and property associations.**

Early adopters that installed charging stations found it beneficial to learn about the EV industry and gain a higher level of understanding regarding the technology before installing charging stations. Many participants attended renewable energy and EV conferences to ask questions to charging station companies and EV professionals. The adoption of EV charging stations was also a topic of discussion at association and board meetings, which allowed participants to discuss processes and challenges within their industry network.

2) **Properties benefitted from identifying charging stations that best fit their needs.**

All properties that installed charging stations found it important to research the variety of charging station business models to identify the model, which meets the needs of their specific property. Overall, five different models of managing a charging station have been adopted among participants, as described in Section 2.5.

3) **The installation of EV chargers is a simple process.**

The majority of participating properties found the charger installation process to be straight forward and simple. They ran into very minor difficulties, if any at all, and had a positive experience with the charging companies that they had worked with.

4) **EV charging companies are also selling a service.**

The charging station companies that have a presence in Hawaii have created relationships with commercial properties, also known as site hosts, and are available to offer assistance. The charging station companies offered support and expertise to commercial properties throughout the stages of becoming EV ready including the charger purchase and installation. Even after installation, the companies remain available for assistance with routine checks and any technical issues that may occur with the charging equipment.

5) **For properties, incentives are helpful, but compliance is key.**

The Hawaii EV Ready Grant and Rebate Program (described in detail in Section 1.1.3) helped to alleviate capital costs for the purchase and installations of EV chargers at commercial properties. However, had these incentives not been available early adopter properties reported that they would have still installed EV charging systems to be in compliance with the Hawaii State EV parking regulation (described in Section 1.1.4).

6) **Without widespread standards for how to install and manage EV chargers, properties are defining their own best practices and early adoption trends are slowly emerging.**

Because the EV market is so nascent, there is no one single way of installing and managing a charging station. This study identified common trends among the early adopters that were polled, which are highlighted below:

- The two major installation concerns include construction and electrical load. The good news is that 21 of 22 (95%) properties reported that they only had to complete electrical routing and 19 of the 22 (86%) properties had enough building electrical capacity and did not have make upgrades.
- Eighty-eight percent of properties reported that following installation of the charging station, the maintenance, operation, and management has not been difficult. Seventeen out of 22 (77%) of properties reported charging station companies had been managing the charging stations.
- Seventeen of 22 (77%) properties polled are not requiring EV drivers to pay for the use of the charging station and are treating the charging station as a property amenity or are offsetting the charge costs through advertisement supported EV charger business models. This trend may be strictly among early adopters, since those polled also expressed that they plan to eventually charge for the use of the EV charging stations once there is a noticeable increase in demand.

The research and findings in this report are important for the success of the deployment of EVs in Hawaii, and even nationally, because they offer insight into the challenges and opportunities faced by early adopter commercial properties that are installing charging stations.

1.0 Introduction

The State of Hawaii is 90% dependent on imported fossil fuel which provides the impetus for Hawaii to become a test bed for the adoption of EVs and chargers. Shifting from fossil fuel to electric power is a new concept for many drivers and thus EV education is still needed across Hawaii.

The State of Hawaii, in partnership with the U.S. Department of Energy (DOE), formed the Hawaii Clean Energy Initiative (HCEI), which sets an aggressive goal to reach 70% clean energy by 2030. The adoption of EVs is needed to reach HCEI's transportation goal of reducing petroleum use for ground transportation by 70%.

Honolulu Clean Cities (HCC) supports HCEI and is dedicated to reducing petroleum consumption in transportation. This report discusses HCC's findings from research conducted targeting early adopters of EV charging stations.

1.1 Background to the Project

This section defines the commonly used terminology related to EVs and charging stations (also known as Electric Vehicle Supply Equipment (EVSE) in order to identify a working vocabulary that will be used throughout the report. This section will also discuss programs that were implemented in the State of Hawaii to expedite the adoption of EVs and charging infrastructure across all Hawaiian Islands. This section is not intended to provide all background information regarding EVs and charging stations.

1.1.1 Electric Vehicles (EVs)

This report focuses on the charging equipment and infrastructure necessary to charge a Plug-In Electric Vehicle (PEV). Being an EV infrastructure-focused report, the type of EV that is being plugged into the installed charging equipment is not of concern. EVs come in two types, All-Battery Electric Vehicles (BEVs) and Plug-In Hybrid Vehicles (PHEVs), the chart below displays aspects of these two types of EVs.

Table 1. Overview of the Two Types of Plug-In Electric Vehicles (PEVs)[1]		
	All-Battery Electric Vehicle (BEV)	**Plug-In Hybrid Vehicle (PHEV)**
Quick Facts	• Electric powered motor only • Plug into any electrical power outlet to charge battery	• Electric powered motor AND internal combustion engine (ICE) • Can run completely on electric motor until battery is depleted, then run as an ICE
Benefits	• No tailpipe emissions	• Less tailpipe emissions than conventional vehicle • Shorter charge time because electric battery is smaller than EVs
Range	• 100 miles on a fully charged battery	• 25 to 50 miles using only the electric motor
Examples of models available in Hawaii	• Nissan Leaf • Mitsubishi i-MiEV	• Chevy Volt • Toyota Plug In Prius

1.1.2 Electric Vehicle Supply Equipment (EVSE)

This report uses the terms "Electric Vehicle Supply Equipment (EVSE)," "charging station," and "charging systems" interchangeably. California Article 625 defines EVSE as:

> *"The conductors, including the undergrounded, grounded, and equipment grounding conductors, the electric vehicle connectors, attachment plugs, and all other fittings, devices, power outlets or apparatuses installed specifically for the purpose of delivering energy from the premises' wiring to the electric vehicle."*[2]

In charging stations, EVSEs are used to deliver a safe flow of electricity from an electrical source to a PEV. There are currently three levels of chargers that can be installed at homes, workplaces, or public stations. The three levels include:

1. **Level 1 –** The Level 1 charges through a 120-volt outlet, such as standard household outlet, and adds about 2 to 5 miles of range to an EV per hour of charging time.
2. **Level 2–** The Level 2 charges through a 240-volt electrical service and uses the same type of plug as the Level 1 charger. The Level 2 charger is becoming a preferred installation choice of PEV drivers because it can add 10 to 20 miles of range to an EV for every hour of charge time, which means a completely depleted battery can be restored to full power through an overnight charge.

[1] National Renewable Energy Laboratory (NREL). (2012 April). *Plug-In Electric Vehicle Handbook for Public Charging Station Hosts*. Retrieved from http://www.afdc.energy.gov/afdc/pdfs/51227.pdf.

[2] Kateley, S., & Rawson, M. (1998 August 31). *Electric Vehicle Charging Equipment and Design and Health and Safety Codes*. Retrieved from http://www.energy.ca.gov/papers/98-09-23_KATELEY.PDF.

3. **Direct Current (DC) fast-charging equipment:** This charger uses a 480-volt input that allows for rapid charging and can add 60 to 80 miles of range to a BEV battery in 20 minutes. DC fast-chargers are ideal for high traffic areas and public charging stations.[3]

Some EVSE charging station companies with a presence in Hawaii include AeroVironment, Better Place, Coulomb Technologies, Schneider Electric, Volta Industries, and Voltec SPX. The table below provides images of select chargers found in Hawaii during the research for this report.

Table 2. Examples of EVSE Found in Hawaii

				
AeroVironment	Better Place	Schneider Electric	Volta Industries	Voltec SPX

1.1.3 Additional Terminology

The following terms are used interchangeably to explain the different players that took part in this research:

- "Participating properties," "properties," "early adopters," "interviewees" all define the commercial properties that took part in this research
- "Charging companies," and "EVSE companies," both define companies that sell the EVSE and associated services (See Table 2 for examples).

1.1.4 Hawaii's EV Ready Program

In an effort to make Hawaii less dependent on liquid petroleum fuels, the Hawaii State Department of Business, Economic Development and Tourism (DBEDT) developed the Transportation Energy Diversification Project in 2009 to accelerate the adoption of EVs and charging equipment across the State. The project comprised of the Hawaii EV Ready Rebate

[3] National Renewable Energy Laboratory (NREL). (2012 April). *Plug-In Electric Vehicle Handbook for Public Charging Station Hosts*. Retrieved from http://www.afdc.energy.gov/afdc/pdfs/51227.pdf.

Program and Hawaii EV Ready Grant Program, and offered funding to Hawaii residents and businesses for the purchase of EVs and chargers.[4]

Hawaii's EV Rebate Program was available to Hawaii residents, businesses, government agencies, and nonprofit entities following the purchase of new EVs for use in Hawaii and for the purchase and installation of charging equipment in Hawaii. The rebates offered up to 20% of the purchase price of an EV with a maximum of $4,500 per vehicle and up to 30% of the cost of a charging equipment and installation with a maximum of $500 per system. EVs and chargers purchased on or after August 1, 2010 were eligible for this program and as of May 3, 2012 all available rebate funds had been exhausted.[5]

The Hawaii EV Ready Grant Program began in March 2011 when the Hawaii State Energy Office awarded grants to six organizations. The grants were awarded to Better Place, AeroVironment, GreenCar Hawai'i, County of Kauai, City and County of Honolulu, and Plug In America. These organizations were selected to speed up EV market acceptance across Hawaii with projects including charging station installations, outreach and education, data collection, and the purchase of EVs. Grant awardees Better Place and AeroVironment were selected to install EV chargers across Hawaii.

1.1.5 Hawaii State Electric Vehicle (EV) Parking Requirement

To encourage greater adoption of EVs and clean energy, the State of Hawaii gave commercial properties a push to install EV chargers in their parking facilities. In 2009, the Hawaii State Legislature passed Act 156, the "Hawaii State Plug-in Electric Vehicle (EV) Parking Requirement." The law states:

> *"All public, private, and government parking facilities that are available for use by the general public and that include at least one hundred parking spaces must designate at least 1% of the spaces specifically for EVs by December 31, 2011…The spaces designated for EVs will continue to increase by 1% for each additional 5,000 registered EVs until the percentage reaches 10%."* [6]

This law was revised in 2012 to Act 089 or SB 2747 to require that:

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[4] State of Hawaii, Department of Business, Economic Development, & Tourism. (2012 March). *Hawaii State Energy Office EV Ready Fact Sheet.* Retrieved from http://energy.hawaii.gov/wp-content/uploads/2011/09/DBEDT-EV-Fact-Sheet-MAR-2012_final.pdf.

[5] Hawaii State Energy Office, Department of Business, Economic Development & Tourism (n.d.). *Hawaii's Electric Vehicle (EV) Ready Program.* Retrieved from http://energy.hawaii.gov/programs/transportation-on-the-move/ev-ready-program.

[6] Alternative Fuels & Advanced Vehicles Data Center. (2011 June 15). *Hawaii Incentives and Laws for EVs*. Retrieved from http://www.afdc.energy.gov/afdc/laws/laws/HI/tech/3270.

"*Places of public accommodation with at least 100 parking spaces available for use by the general public designate at least one space for the exclusive use of EVs, and be equipped with an EV charging system by July 1, 2012*."[7]

1.2 Project Overview

This report is one of many efforts being conducted under the Department of Energy "Clean Cities Community Readiness and Planning for Plug-In Electric Vehicles and Charging Infrastructure" grant that was awarded to the University of Hawaii Maui College (UHMC) in September 2011. UHMC has partnered with a number of organizations to create the Maui Electric Vehicle Alliance (EVA), which also includes the Hawaii State Energy Office, HCC, and the University of California San Diego.

The Maui EVA team is using grant resources to identify Maui's EV deployment planning needs including but not limited to; charging station equipment and infrastructure, EV policy, EV outreach and education, energy grid system analysis, and synergies with the visitor industry, local residents and businesses.

The primary goal of the grant project is to develop an EV Implementation Plan for the island of Maui. The plan is Maui's initial step towards their goal of electrifying Maui's transportation sector along with shifting to the use of renewable energy sources. The plan is intended to provide a model that can be adapted for broader application across the State of Hawaii and other regions of the United States.

1.2.1 Honolulu Clean Cities' Role

As a sub-recipient of the aforementioned DOE grant, HCC conducted research, evaluated data, and documented lessons learned from early adopters of commercial EV charging stations. This report reflects HCC's findings from these efforts. The project aimed to identify opportunities, gaps, and needs affecting EV implementation across Hawaii in efforts to resolve challenges and barriers associated with EV charger installations at commercial properties. This report documents accomplishments, steps, and lessons learned from businesses that have installed charging equipment, and may be used to advise Hawaii's EV planning and improvement efforts.

This report is incorporated into Maui EVA's final implementation plan. With this information, Hawaii's EV stakeholders can work to remove barriers to adoption of EV chargers that business industries and commercial property managers have faced.

1.3 Methodology

The HCC team supporting this research project used input from EV and EVSE experts in Hawaii to define the optimal way to engage commercial properties in this research project. HCC was able to leverage input from Hawaii's transportation specialists including HCC's board members,

[7] Ibid.

colleagues at the Hawaii State Energy Office, and transportation experts at the National Renewable Energy Laboratory (NREL). This team defined both the methodology for collecting research, as well as the content of the research materials. The final methodology used to conduct the research for this report included three major stages with each company: the pitch, questionnaire, and interview.

The initial correspondence with potential research participants was intended to attract early adopter participants to engage in the research project. This outreach stage explained the project's purpose, process, and disclaimers related to engaging in the research. Participant outreach was a crucial first-step towards identifying the organization's EV point of contact and obtaining their agreement to participate. Initial correspondence was conducted through in-person meetings, email, and phone calls with contacts provided through a wide range of stakeholders such as the Hawaii State Energy EV Specialist and EV Ready grant-awarded companies.

After pitching and introducing the research project, the research participants were given a HCC developed "Lessons Learned from Oahu Commercial EV Charger Installations" questionnaire. This questionnaire included non-scientific questions to gain the participants' initial perspective on their specific EV charger installation. The online questionnaire featured a "forwarding" option allowing the participant to forward the questionnaire to others within the same organization in efforts to gain a holistic understanding of the EV charging station installation process. The questionnaire covered five core areas including; planning & permitting, installation, cost & payment, managing the charging station, and business development. The questionnaire was created and operated through SurveyMonkey, which provided convenient distribution, data collection, and analysis. The online questionnaire yielded a larger participation rate and more quantifiable results than could have been achieved by interviews alone. The complete questionnaire has been made available in Appendix A.

The responses collected from the questionnaire fed into follow-up in-person interviews, which provided the opportunity to gain a better understanding of specific lessons learned from each commercial property. The interviews provided clarity of the decision process and specific step-by-step course needed for the installation of charging stations at the early adopter properties. The structure of the interview questions used in this research has been made available in Appendix B.

2.0 Findings

This report is based on case studies of 22 commercial properties, reflecting a total of 76 installed public charging stations, located on Oahu. The participants represented a variety of different industries such as medical facilities, shopping centers, service locations, hotels and resorts, condominiums, business centers, and schools. As shown in Table 3 below, the case studies were divided into three types of entities that tallied a total of 13 local businesses, seven hotels, and two multi-unit dwellings (MUDs).

Table 3. Breakdown of Research Participants				
Entity	**State Grant Installations**		**Non-Grant Installations**	
	# of Properties	# of Chargers	# of Properties	# of Chargers
Businesses (Retail, Service, Parking Lots)	6	15	7	17
Hotels	5	35	2	3
Multi-Unit Dwellings	2	6	0	0
Total:	**13**	**56**	**9**	**20**

The Hawaii State EV Ready Grant or Rebate Programs were utilized by 13 of the 22 project participants, while the remaining 9 properties installed chargers independent of the Hawaii EV Ready Programs. Findings indicate that the charging station adoption process was not significantly different between grant supported charging station installations and non-grant charging station installations. The main distinction between the two processes was the overall cost of the charger purchase and installation, since the chargers installed under the grant program had a subsidized cost.

As of January 2012, an estimated 129 charging stations had been installed at approximately 58 properties on the island of Oahu; therefore, the 76 charging stations that are represented in this project made up 59% of Oahu's EV chargers. As of September 2012, there are now 177 installed charging stations on Oahu.

2.1 Planning

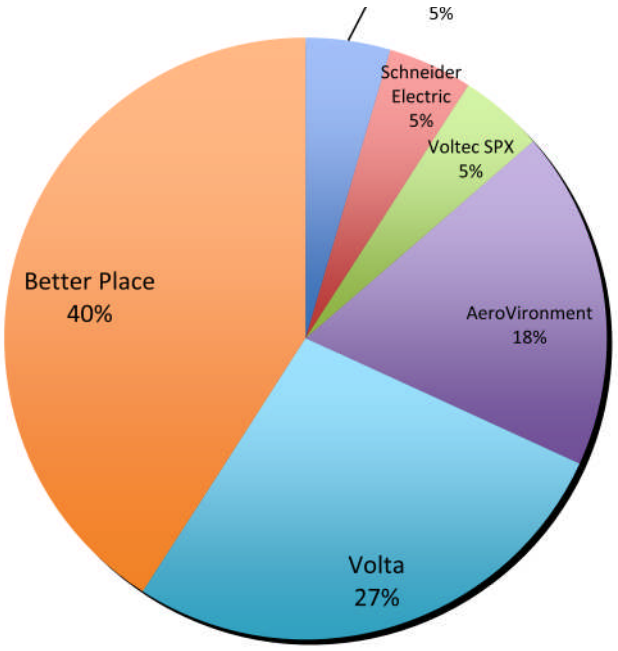
Like other facility modifications, the addition of an EV charging station needs to be well planned before action can be taken. There are three initial planning steps which charging station site hosts need to consider: education on the EV industry, researching and selecting an EV charging company to work with, and deciding on appropriate charging equipment to install.

For early adopters, very little was known of EVs and charging station by individuals outside of the EV industry; therefore many property representatives took the initiative to educate themselves on the equipment before committing to a charging station of their own. Researching news articles, conducting web searches, and meeting with EV specialists, charging companies, and associations were some of the avenues managers used to educate themselves. After gaining an understanding of the EV industry, participating properties made the decision to install charging stations. When asked why properties installed charging stations, the following were the most popular responses:

1) Required by Hawaii State Law (73%)
2) Support sustainable energy (64%)
3) Consumer demand (18%)

The selection of an EV charging company depends heavily on the specific function of the property or business, such as a hotel, shopping mall, or office building. Participants found that not all EV charging companies are alike and that research was important to find the service appropriate for each specific property. For example, hotels chose EV charger business models that provided ease and convenience for their guests, while the majority of shopping centers went with a brand that added aesthetics and advertising to the EV stall. Another planning aspect participants considered is that garage installations are less complicated because they have their own power source, while ground-level parking lots pull from the facility's electricity and may require advanced metering to separate out EV charging costs. The Hawaii EV Ready Grant Program's financial incentives were also a major consideration for properties when researching the costs for charger installation. Although price discounts were an incentive for businesses, properties proactively researched to ensure that the subsidized Hawaii EV Ready grant awardees, Better Place and AeroVironment, aligned with their specific business needs before selecting them.

Figure 1. Chargers Installed
Total Properties Reported: 22

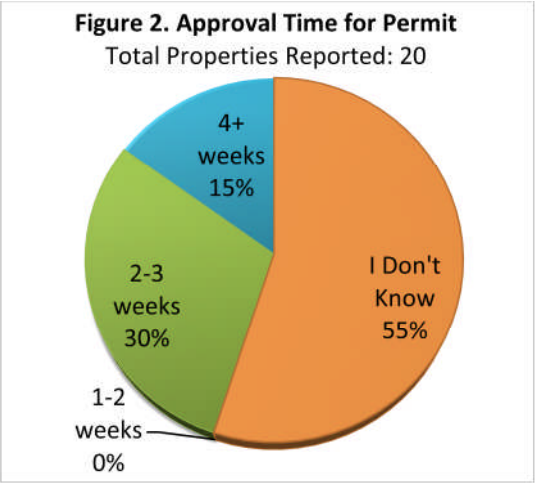


As mentioned in Section 1.1.2, there are currently three different levels of charging equipment that properties can consider. The 240-volt Level II chargers are the most readily available EV charging equipment sold in Hawaii; an overwhelming 91% of properties selected Level II chargers, while the remaining 9% of properties went with a Level I charger to fulfill basic charging needs. Some properties considered the purchase of a DC fast charger, however, all of them felt that a Level I or Level II charger provided more of an incentive for EV drivers to spend time at the locations hosting the charging stations, and would ultimately bring more business and popularity to these locations.

2.2 Permitting

According to the City and County of Honolulu Department of Planning and Permitting (DPP), there is only one type of permit that is applicable for EVSE installations on a commercial

property on the island of Oahu. EVSE installations fall under Category 2 Building Permits and should take approximately 14 calendar days to receive approval. The cost for a DPP building permit starts at $18 and increases depending on the value of work being done. For the City and County of Honolulu, applications must be created and submitted online.[8]



Of the participants polled, 90% of the properties received a building permit for the installation of EV chargers. Figure 2 displays the length of time it took for properties to receive approval after submitting a building permit application. Over half of the properties did not know how long it took to receive permit approval because the charging companies took care of permitting for them.

Some interviewees expressed the need to streamline the commercial permit process and many of the property, facility, and operations mangers did not want to manage the task of applying for a building permit and appreciated that the charging companies managed the permitting process for them. Some interviewees suggested that the development of a permit specific to EV charger installations would benefit Oahu properties and permitting officials to alleviate any informational processes that are not specifically associated with EV charging stations such as civil and landscaping data.

2.3 Installation

After all planning and permitting aspects have been decided, interviewees found the installation of charging stations required two major considerations: construction requirements and electrical load.

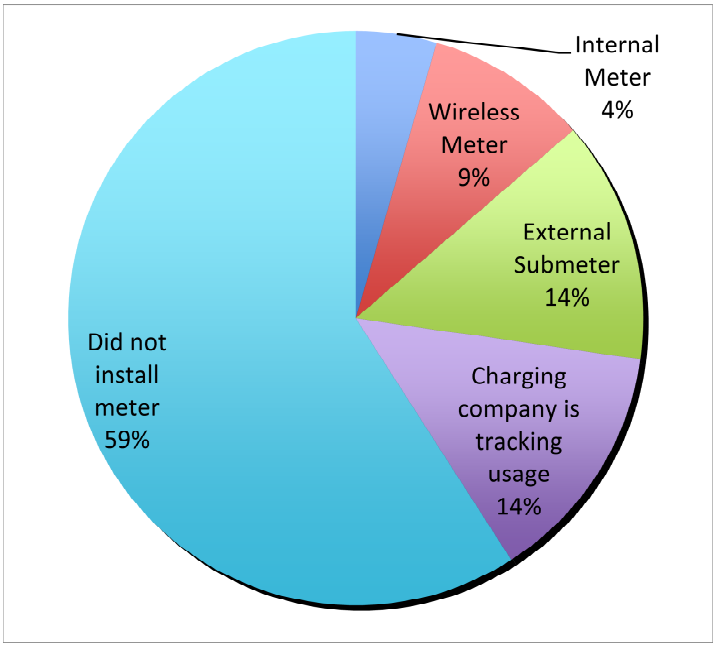
The two main construction actions that may be involved in EV charger installations are conduit piping and trenching. Conduit piping is a system used for electrical routing that all participating properties performed for EV charger installations. Properties reported that the conduit run was anywhere from 10 to 150 feet per charger. If an EV stall and charging station is located close to a power source the conduit run would consequently be shorter and thus costs can be minimized. Only three of the 22 facilities required additional trenching.

[8] City & County of Honolulu, Department of Planning and Permitting (DPP). (2011). *Permitting Information*. Retrieved from http://www.honoluludpp.org/permitinfo/

The electrical capacity of a site is a key element for the installation of a charging station. If a facility does not have enough electrical capacity to accommodate the chargers then an upgrade may be possible by installing an electrical transformer or additional electrical paneling. Ninety percent of the participating properties that engaged in this study had enough electrical capacity to support the charging station. Only three properties elected to install an electrical transformer and only two properties needed to add capacity from electrical paneling.

Beyond electrical capacity at the properties, there is also the need to consider how to track electrical usage. Over half of the properties studied wanted to be able to track the specific electrical usage from the charging stations using internal meters, wireless meters, or external submeters. Internal and wireless meters help to track the electrical usage coming from the EV charger while external submeters track and store consumption (kWh) and demand (kW) information for specified time periods. The early adopters found value in including a meter or submeter so that they could better track and evaluate the electricity demands needed for EV chargers. Figure 3 displays the different types of metering that were used.

Figure 3. Metering to Track EVSE Electrical Usage
Properties Reported: 20



Very few properties had an on-site electrician; therefore the charging companies or an outside electrician completed the majority of installations. Unanimously, 100% of participants who worked with charging companies or outside electricians were very pleased with the professionalism and workmanship that was provided.

2.4 Costs and Payment

Properties faced two major expenses when installing charging stations: capital cost and installation cost. The capital costs for the charging equipment and installation depended on a property's choice of charging station business model and placement of the charging station. The average cost of a Level 2 EV charger ranges from $2,000 - $6,500.[9] For the participants of this project, the charging equipment (capital cost) was reported to have ranged between $500 and $15,000. The installation costs per property ranged from $500 to over $20,000 depending on the number of chargers installed and type of construction involved. The average installation

[9] Plug-In America. (2012 May). *Hawaii EV Ready Guidebook for Commercial Charging Stations*.

cost of an EV charger on a commercial property is between $5,000 and $11,500 for a single unit. Nearly half of the properties had budgeted for the purchase and installations of EV chargers and of those, 83% were able to stay within the allotted budget. The purpose of this project was to gain an understanding of the installation process; therefore budget specification was not a central point of research.

In October of 2012, Plug-In America published the "Hawaii EV Ready Guidebook for Commercial Charging Stations." This guide listed 8 different charging station business models for site hosts to consider. [10] Of these 8 business models, the following five models were selected and used by participating properties:

- **Free, or Free with Restrictions –** This model treats the charging station an amenity for property visitors and is ideal for short-term charge sessions. The property manages the electricity cost from the charger and bundles the cost into the overall electricity bill for the facility.
- **Advertising Supported –** These charging stations provide advertising to offset the costs of that station installation and operation. Host sites have the option to obtain revenue share by contributing to capital and installation costs or host that charging station for free and receive no revenue from the advertising. Retail properties were the majority of participants that utilized this type of business model.
- **Point of Sale Billing –** Credit card payment, access cards, or telephone activation are available for EV drivers through these charging stations. Site hosts may receive these payments directly or from reimbursement from the service provider.
- **Membership or Subscription Plan –** EV drivers join in a monthly or annual charging network with a charging service provider. Some of these membership and subscription plans are still in development in Hawaii.
- **Valet Charging –** This type of business model is most common at hotel and resort locations. For hotel and resort guests the EV charger is an amenity included in the room fee and for the general public, a parking fee is collected and a valet attendant charges the vehicle and returns the vehicle to the EV driver.

Property owners have expressed that the most difficult decision in planning for an EV charging station is whether or not to charge EV drivers for the use of the charging station. Like any other electric powered amenity, electricity for charging is an operating cost to the facility. Only five (23%) of the properties polled are collecting payments from EV drivers for the use of the charging stations through a charging network or point of sale billing. The remaining 17 (77%) properties polled are offering free charge sessions to EV drivers by treating the charging station as a property amenity or through advertising supported business models. A few properties that are offering free charges wanted to be able to regulate the charging stations' time of use and chose to hold training sessions with their parking attendants and security department to familiarize their staff with the usage and technology of the equipment. Nevertheless, recovering electricity costs remains a concern for properties offering free charges and they

[10] Plug-In America. (2012 May). *Hawaii EV Ready Guidebook for Commercial Charging Stations*.

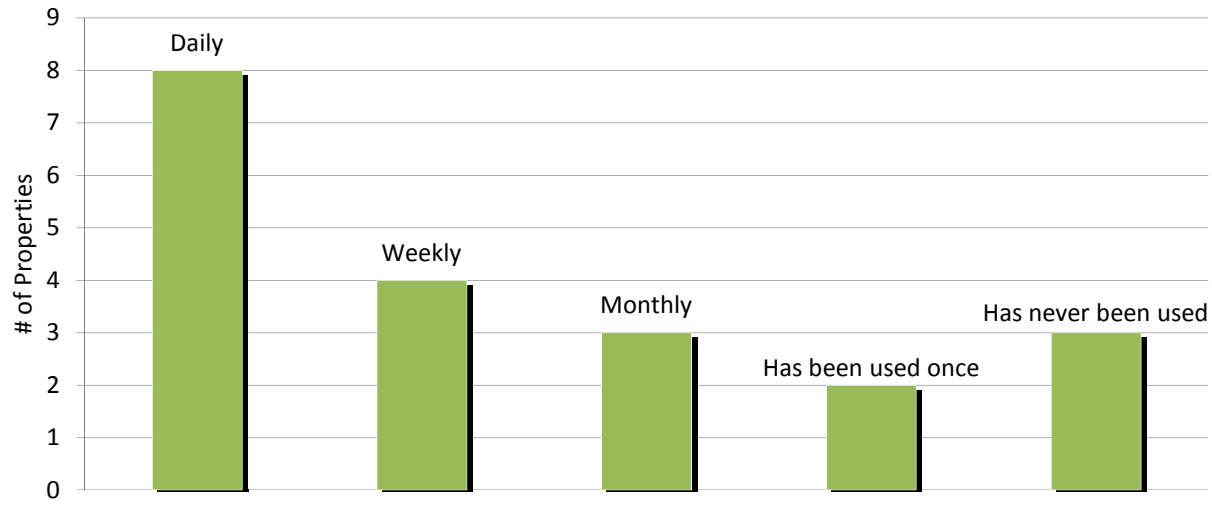
eventually plan to charge a fee for the use of the EV charging stations once there is a noticeable increase in demand.

2.5 Managing the Charging Station

The research conducted showed that there was very little upkeep needed to maintain an EV charging station; 88% of respondents stated that the overall maintenance, operation, and management of the charging stations have been as expected, or easier than expected since installation. This finding may be due to the fact that the EV charging companies created a relationship with the property (their clients) and continued to stay involved with site hosts even after the installation of a unit. This supported the overall finding that charging companies are selling a service in addition to the charger itself. Respondents reported that EV charging companies have routinely checked on the installed equipment at the property or remotely and responded to any reported technical issues.

Site hosts across all commercial entities that were interviewed (businesses, hotels, and condominiums) reported that the charging stations located on their properties have been used daily, weekly, or monthly. However, most properties located in Waikiki reported that since installation the charging stations have never been used or have been used only once; this may be due to the high amount of foot traffic in the Waikiki area. As early adopters, participants in all commercial sectors expressed their concern that the EV market is slow to develop and worry that EV charging stations may never reach a high demand rate in Hawaii.

Figure 4. Frequency of Charging Station Use from January 2012 - June 2012
Total Properties Reported: 20



2.6 Business Aspects

The decision for commercial properties to install a publically available EV charging station is an investment of time and brings value to businesses. On average it took businesses 10½ months from the planning stage to the completion of charger installation. However, some interviewees noted that the time commitment was minimal when considering the long-term benefits that chargers can add to their business operations. Some of the benefits expressed by commercial properties included:

- A charging station can be incorporated into a business's sustainability strategy and can be used to gain a LEED Innovation Design credit. Businesses who installed EV chargers also showed support of Hawaii's Clean Energy Initiative to reduce its dependence on imported petroleum.
- A charging station can be an added amenity to the property and a service to its clientele, similar to offering an ATM machine.
- A charging station can help to serve as a marketing tool. An event to publicize a newly available EV parking stall and charging station can bring media coverage and positive press to a property. Half of project participants took advantage of promotional opportunities and chose to advertise the availability of their charging stations.
- A charging station can communicate an organization's community leadership and improve. EV chargers act as a visible way for businesses to differentiate themselves from competitors.
- A charging station installation shows compliance with Hawaii State Act 089 of installing one EV charging station for public parking accommodations with 100 stalls or more.

Properties expressed that the installation of chargers has been a positive impact on them personally and the business as a whole. For example, 40% of polled properties noted that their installation is likely to motivate them to purchase an EV or EVSE for personal use. Of those polled, approximately 75% noted that they would recommend the purchase and installation of an EV charger to other commercial properties.

3.0 Conclusion and Next Steps Gained from the Lessons Learned

3.1 Conclusion

The EV and charging station market in Hawaii is still in early development and is managing implementation challenges like any new technology. Although there is still concern that EVs are slow to reach a high demand, early adopters are true pioneers in helping to advance the EV market. As early adopters, the participating properties appreciated the novelty of EV charging technology, gained knowledge, and were able to realize the potential cost savings of EV charging equipment before the industry hits mainstream. The participants' willingness to share their installation experiences demonstrates an interest in the EV market and a growing network

of “EV Ready” commercial properties. The lessons learned from early adopters will act as a noteworthy resource for other local and national properties wanting to install EV chargers. For a synopsis of the major lessons learned from this project please reference the report’s Executive Summary.

3.2 Next Steps

Due to the fact that adoption of EV chargers in Hawaii is still in its early stages, the project experienced a few aspects of study bias. The biases documented include:

- The majority of commercial properties interviewed are located in the city of Honolulu. Although there was input from the north and east parts of Oahu, the representation was minimal.
- The study experienced difficulty in MUD participation. These properties face unique challenges to EV charger installations due to multi-stakeholder involvement and operations of MUD parking facilities.
- Because the research project targeted early-adopters, the barriers faced by commercial properties that did not install charging stations is not reflected.

This report collected data from 22 properties, which totaled 76 installed charging stations on Oahu. With more time and participation the findings would be able to include properties that are completing charging station installations in the months to come and extend the project to encompass other locations across the State of Hawaii.

The developing EV market allows for further areas of research to gain insight into EV infrastructure opportunities and challenges. Next steps include:

- Maintain relationships with early adopters to further gauge the use of publically available charging stations.
- Determine what market segment most uses public charging stations, how often they use the chargers, what hours they use the chargers, and how long they are charging their vehicles. This research will inform decision makers on how to increase charger use and meet market demands.
- Research how future EV infrastructure can be developed to better meet the specific interests and needs of Hawaii’s EV drivers and charging station site hosts.
- Survey properties in remote areas and destination points, workplace properties, MUDs, and commercial properties that have not installed EV chargers to identify the lessons learned, barriers, and incentives to installing EV chargers.
- Understand the likelihood that changes will occur within the EV industry and communicate the need for adaptability as EV technologies improve.
- Expand data to incorporate recent DC fast charger installations.
- Consider financing mechanisms to help incentivize the installation of EV chargers and understand the costs associated with operating and maintaining charging stations.

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HCC would also like to thank the many individuals and organizations that made this research project and findings possible, including Maui EVA who managed the grant efforts and worked closely with HCC in the completion of this report. First and foremost, the time and efforts of participating commercial properties that not only successfully navigated the installation of chargers, but also took the time to take part in this study was paramount. Though HCC respects the confidentiality of the 22 properties that took part in the research, the time that they took to research and respond to this study's questionnaire and interviews was vital to our findings.

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Though seemingly obvious, this project was made possible only by the Honolulu Clean Cities Coalition itself and HCC's board members who consistently volunteer their time and efforts to support the mission of HCC.

Appendix A

Internet Questionnaire

Lessons Learned from Oahu Commercial EV Charger Installations

Honolulu Clean Cities (HCC) has developed this questionnaire to report lessons learned from Oahu's businesses that have adopted EV-infrastructure. The funding for this study comes from a Department of Energy grant titled, "Clean Cities Community Readiness and Planning for Plug-in Electric Vehicles and Charging Infrastructure."

Grant Background:

In September 2011, the aforementioned Department of Energy grant was awarded to the University of Hawaii Maui College (UHMC). UHMC has partnered with a number of organizations to create the Maui EV Alliance, which includes in the Hawaii State Energy Office/DBEDT, Honolulu Clean Cities Coalition, and the University of California San Diego. The overall purpose of the grant is to develop an EV Implementation Plan for Maui County which can be adapted for broader application across the State and country.

HCC's Role - Questionnaire and Interviews:

The questionnaire you are about to complete will feed into a final "lessons learned" report that HCC will compile, which aims to document the accomplishments, steps, and lessons that businesses have learned in the process of becoming EV Ready. The report will serve as a roadmap/model for all four Counties in Hawaii and other US states planning the rapid deployment of EVs and charging stations. The report will also serve to build electric vehicle consumer confidence, foster the adoption of EV infrastructure and institutional use.

Navigating the Questionnaire:

The estimated completion time for this survey is 5 minutes.

The questionnaire covers five core areas:
- *Planning & Permitting*
- *Installation*
- *Cost & Payment*
- *Managing your Charging Station*
- *Business Aspects*

You can feel secure that your name and identifying information will be kept confidential and the data collected will be used for planning and research purposes only. The answers you provide will be used in a final implementation report and will be generalized into separate Oahu industry responses that will be available as a public resource.

To progress through this questionnaire, please use the following navigation buttons:

Next button to continue to the next page.
Previous button to return to the previous page.
Exit the Survey Early button if you need to exit.
Submit button to submit your questionnaire.
Questions marked with an asterisk **(*)** require an answer to proceed.

*Please forward this questionnaire to any other company members that could provide further information.

Lessons Learned from Oahu Commercial EV Charger Installations

*Please provide your contact information.

Name:

Company:

Title:

Property Address:

City/Town:

ZIP:

Email Address:

Phone Number:

*What type of Oahu property are you?

- Multi-Unit Dwelling Facility (Condo, Apartment, Townhouse)
- Hotel
- Business (Retail, Service, Parking Lot)
- Other (please specify)

Why did you decide to install an EV charger? (Check all that apply)

- [ ] Required by Law
- [ ] Support Sustainable Energy
- [ ] Consumer Demand
- [ ] Hawaii Green Business Program
- [ ] LEED Certificiation - Innovation Design Credits
- [ ] Company owns Electric Vehicle(s)
- [ ] Other (please specify)

Who owns the EV charger?

- ○ Business
- ○ Charging Company
- ○ Resident
- ○ Other (please specify)

Planning & Permitting

What brand charger did you install? (Check all that apply)

- ☐ AeroVironment
- ☐ Better Place
- ☐ Coulomb Technologies
- ☐ Volta
- ☐ Other (please specify)

What level charger did you install? (Check all that apply)

- ☐ Level I (120V)
- ☐ Level II (240V)
- ☐ DC fast-charger (480V)

Please specify your reasons for installing this level charger:

Lessons Learned from Oahu Commercial EV Charger Installations

Planning & Permitting

***How many EV chargers did your company install?**

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5+ (please specify)

How many vehicle charge ports are on each charger? (Check all that apply)

- ☐ 1
- ☐ 2

Planning & Permitting

***When did your company begin planning for implementation of the EV charging station? (Estimate is Ok)**

MM DD YYYY

Date: ___ / ___ / _____

***When was the EV charger installation completed? (Estimate is Ok)**

MM DD YYYY

Date: ___ / ___ / _____

Lessons Learned from Oahu Commercial EV Charger Installations

Planning & Permitting

Did you receive a building permit for the installation of your charger?

- ○ Yes
- ○ No

How long did it take for your company to receive permit approval?

- ○ I Don't Know
- ○ 1-2 weeks
- ○ 2-3 weeks
- ○ 4+ weeks (please specify)

Lessons Learned from Oahu Commercial EV Charger Installations

Planning & Permitting

Who physically installed the EV charger? (Check all that apply)

- [ ] Charging Company
- [ ] On-Site Contractor
- [ ] On-Site Electrician
- [ ] Hired Outside Electrician
- [ ] I Don't Know

How did you determine the placement and location of your charging station? (Check all that apply)

- [ ] Near an entrance
- [ ] Cost effective
- [ ] Guest stall
- [ ] Performed a site inspection
- [ ] Other (please specify)

Lessons Learned from Oahu Commercial EV Charger Installations

Installation

What type of construction was involved in the installation of the charger? (Check all that apply)

- [ ] N/A
- [ ] Conduit Piping
- [ ] Trenching
- [ ] Other (please specify)

Did you have to upgrade the building's electrical capacity? (Check all that apply)

- [ ] No, we had enough electrical capacity
- [ ] Installed additional electrical paneling
- [ ] Installed electrical transformer
- [ ] Other (please specify)

Did you include any metering to track the electrical usage of your charger? (Check all that apply)

- [ ] N/A
- [ ] External Submetering
- [ ] Wireless Metering
- [ ] Other (please specify)

Cost & Payment

Did you utilize any federal or local incentive programs? (Check all that apply)

- ☐ No, funded program independently
- ☐ The Hawaii EV Ready Grant Program
- ☐ The Hawaii EV Ready Rebate Program
- ☐ Alternative Fuel Infrastructure Tax Credit
- ☐ HECO EV Time of Use Rates
- ☐ Other (please specify)

Cost & Payment

How much did your charger cost? If multiple chargers were installed, please check the average cost.

- ○ $ Under 1,000
- ○ $ 1,001 - 4,000
- ○ $ 4,001 - 7,000
- ○ $ 7,001 - 10,000
- ○ $ 10,001 - 15,000
- ○ $ Over 15,000
- ○ I Don't Know

What was the total cost of installation for your charger(s)?

- ○ $ Under 1,000
- ○ $ 1,001 - 5,000
- ○ $ 5,001 - 10,000
- ○ $ 10,001 - 15,000
- ○ $ 15,001 - 20,000
- ○ $ Over 20,000
- ○ I Don't Know

Lessons Learned from Oahu Commercial EV Charger Installations

Cost & Payment

Did you have a budget for the purchase and installation of your EV charger?

- ○ Yes
- ○ No

Were these costs more or less than your company had budgeted for?

	Much Less	Somewhat Less	Within Budget	Somewhat More	Much More	N/A
(Choose One)	○	○	○	○	○	○

Do you anticipate a Return on Investment?

- ○ Yes
- ○ No
- ○ I Don't Know

Cost & Payment

Are you charging for the use of the charging station or stall?

- ○ Yes
- ○ No

Cost & Payment

How do you manage payment for the use of your charging station? (Check all that apply)

- ☐ Membership or Subscription Plan (monthly or annual plan)
- ☐ Point of Sale Billing (credit card, call in number, swipe card)
- ☐ Valet Charging
- ☐ Fee Bundling (Drivers provide access code)

Other (please specify)

How much does it cost to use your charging station?

- ○ N/A
- ○ $/per half hour
- ○ $/per hour
- ○ $/per session
- ○ $/per day

Please specify dollar amount & time duration:

Lessons Learned from Oahu Commercial EV Charger Installations

Managing Your Charging Station

Who manages your charging station? (Check all that apply)

- ☐ Charger Company
- ☐ Site Host
- ☐ Resident
- ☐ Other (please specify)

The overall maintenance, operation, and management of the charging station been:

	Easier than Expected	Somewhat Easier	As Expected	Somewhat Harder	Harder than Expected	N/A
(Choose one)	○	○	○	○	○	○

Would you recommend the purchase and installation of an EV charger to fellow businesses?

	Won't Happen	Might Happen	Likely to Happen	Very Likely to Happen	Sure to Happen	N/A
(Choose one)	○	○	○	○	○	○

Lessons Learned from Oahu Commercial EV Charger Installations

Business Aspects

Do you have chargers at any other business locations, locally or nationwide?

- ○ No
- ○ Yes

(please specify)

How do you advertise the charging station and location? (Check all that apply)

- ☐ Do Not Advertise
- ☐ Signage (garage/parking spot)
- ☐ Print (brochures, newspaper ad, etc)
- ☐ Web
- ☐ Press
- ☐ TV/Movie Ads
- ☐ Event
- ☐ Other (please specify)

Are you partnering with any rental companies or hotels? (Check all that apply)

- ☐ No
- ☐ Rental Company
- ☐ Hotel
- ☐ Other

please specify company or business:

Business Aspects

Since installation, what is the charging station's average frequency of use?

- ○ Has been used once
- ○ Daily
- ○ Weekly
- ○ Monthly
- ○ Has never been used
- ○ Other (please specify)

Will this experience with EVs and chargers motivate you to purchase an EV and charger for your personal use?

	Not Likely	Likely	Very Likely
(Choose one)	○	○	○

Thank You!

Mahalo for your participation. We appreciate your time and input and hope to use this information to improve the quality of life here in Hawaii by supporting sustainable practices.

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Appendix B

Interview Questions

Interview Questions:

GRANT PROGRAM

1. What role did Better Place or AeroVironment have in this process?
2. What role did the business have in decision-making?

PLANNING

1. Why did you select this type of charger?
2. What steps did you take to educate yourself on Electric Vehicles and chargers?
3. How did you select what charging company to work with?

PERMITTING

1. Who acquired the permit for the charger?
2. How was the permitting process?
3. Did you run into any issues with acquiring a permit?

INSTALLATION

1. How far did you run the conduit?
2. Did the contractor you selected meet your expectations for the installation?

COST & PAYMENT

1. Did you have any concerns with buying and installing a charger?
2. Do you have a time limit for the use of the charger or stall?
3. How did you decide on a price to charge users?
4. How is the HECO payment handled?
5. Have you signed up for HECO's EV rates?

MANAGING THE CHARGER

1. How/Are you managing, operating, and maintaining the charger?
2. Have you had any technical problems with your charger? Who do you report problems to?
3. Now that the charger is installed, do you have any concerns?

BUSINESS ASPECTS

1. Do you consider your business as being socially responsible?
2. Did you modify any mission statements or business plans incorporating the charger?

LESSONS LEARNED

3. If so how did those installations differ from the one in Hawaii?
4. What would you have done differently?
5. What advice would you give to a first time adopter of EV chargers? What resources (people, organization, etc) would you refer them to?
6. What lessons did you learn from your experience?
7. What lessons can others learn from your experience?
8. What other incentives would you like to see to help foster greater societal adoption of EVs?