

Summary of the Hydrogen Fuel Cell and Battery Electric Vehicle Stakeholder Charrette  
*Expanding Hawaii's Clean Transportation Solutions*  
January 13-14, 2015

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## Executive Summary

In 2014 the Hawaii State Energy Office convened a planning process or “charrette” analysis to provide the underlying assessments, analysis, and recommendations for an updated Hawaii Clean Energy Initiative transportation plan to significantly reduce the consumption of petroleum products in Hawaii’s transportation sector. The primary purpose of the Hydrogen Fuel Cell and Battery Electric Vehicle Stakeholder Charrette was to support the analysis with regard to the feasibility of implementing electric-drive infrastructure across the State of Hawaii that could also support grid balancing and energy assurance objectives. Hydrogen fuel cell (FCEV) and plug-in electric vehicles (EVs) are complementary technologies and both are important strategies that will contribute toward the reduction of petroleum in ground transportation. This charrette was a milestone in the Transportation Industry Analysis being conducted by The International Council on Clean Transportation (ICCT), which aims to achieve a working agreement on a revised clean transportation plan including implementation steps and conclude with a final summary report in June 2015.

This document provides a summary of the Hydrogen Fuel Cell and Battery Electric Vehicle Stakeholder Charrette, which was held to support the development of a revised transportation plan under the Hawaii Clean Energy Initiative. The two-day charrette was held on January 13-14, 2015 at the Hawaii Foreign Trade Zone No. 9 and attended by roughly one hundred representatives from federal, state and local government, military, industry, academia, and civil society.<sup>1</sup> Funding for the charrette provided through the Hawaii Strategic Development Corporation was instrumental in enabling the attendance of experts from outside Hawaii who shared their knowledge of hydrogen fuel cell and plug-in electric vehicles and fuels as well as policies and regulations to remove market barriers and accelerate the uptake of these technologies.

A primary objective of the charrette was to generate a set of actionable steps that can be realistically implemented in Hawaii in support of the state’s clean energy goals. The charrette presentations and discussions produced a number of actions that Hawaii’s State and County governments can take to enable increased uptake of electric-drive technologies, as well as policies that directly support sales of hydrogen fuel cell and plug-in electric vehicles and the development of hydrogen fueling and charging infrastructure and networks. These actions will be further evaluated in the ICCT’s transportation industry analysis in terms of their potential benefits, costs, social acceptability, and likelihood of implementation, as well as alignment with existing plans and budgets.

### ***Enabling Actions***

E-drive technologies will require coordinated investments in infrastructure and vehicles in order to gain significant market share; moreover, these investments would especially benefit from coordinated action among executive agencies and the legislature, as well as local governments, industry, utilities, and NGOs.

- Designate a leader with high-level support
- Better data collection, validation, and sharing across government agencies

### ***Hydrogen Fuel Cell Vehicles***

A number of specific actions were identified to spur the hydrogen fuel cell vehicle market.

- Establish a regulatory definition of hydrogen FCEVs as electric-drive vehicles
- Provide incentives for early adopters to purchase FCEVs
- Encourage commercial vehicle operators to replace diesels with alternative fueled vehicles, e.g. FCEVs

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<sup>1</sup> See Annex IV for a complete list of attendees.

### ***Hydrogen Fueling Infrastructure***

For early adopters to invest in purchasing FCEVs, a reliable hydrogen fueling infrastructure will be needed. It will also be important to deploy this newer technology to support the state's energy objectives

- Standardize codes and permitting to ensure safe operation of facilities
- Support the development of fueling infrastructure
- Pilot demand response systems for hydrogen electrolysis facilities

### ***Plug-in Electric Vehicles***

- State rebates for new electric vehicles
- EV rental prioritization for state & county employees
- Conduct targeted outreach to utility customers about the benefits of EVs

### ***Plug-in Electric Vehicle Charging Infrastructure***

Affordable and easily accessible charging infrastructure will accelerate the adoption of EVs.

- Deploy demand-responsive technologies
- Promote charging stations in multi-unit dwellings and workplaces
- Mitigating the Cost of Energy as a Barrier to EV Adoption through Time Variant Pricing

### ***Electric Drive Vehicle Revenue Generation***

While the policies outlined above could directly support the sale of EVs and hydrogen FCEVs as well as the development of charging and fueling infrastructure, many of these would require additional funding in order to be successful. Several complementary actions were suggested that could help generate revenues needed to implement these policies.

- Leverage airport and rental car fees to finance clean transportation programs
- Enhance taxes on petroleum imports
- Leverage federal grants for clean surface transportation

The Hydrogen Fuel Cell and Battery Electric Vehicle Stakeholder Charrette was attended by 97 stakeholders who contributed to the discussions over the two-day event. Notes from each of the sessions and the attendee list are also provided in detail.

## Background

The Hawaii State Energy Office has contracted The International Council on Clean Transportation (ICCT) to provide underlying assessments, analysis, recommendations, and facilitate stakeholder engagement to support the development of a clean transportation plan under a revised Hawaii Clean Energy Initiative (HCEI) to significantly reduce the consumption of petroleum products in Hawaii's transportation sector. The ICCT is analyzing the progress to date on the transportation section of the HCEI Roadmap 2011 Edition, and assessing what can realistically be achieved in terms of gasoline and diesel reductions by 2030. Through a series of stakeholder consultations held between November 2014 and June 2015 (collectively referred to as the "Transportation Charrette"), the ICCT will offer for consideration a new set of transportation options, goals and timeline to reduce consumption of petroleum-based fuels in the transportation sector, including aviation, ground and marine transportation.

The primary purpose of the Hydrogen Fuel Cell and Battery Electric Vehicle Stakeholder Charrette is to support the analysis with regard to the feasibility of implementing electric-drive infrastructure across the State of Hawaii that could be utilized to support grid balancing and energy assurance objectives. Hydrogen fuel cell (FCEV) and plug-in electric vehicles (EVs) are complementary technologies and both are important strategies that will contribute toward the reduction of petroleum in ground transportation. The charrette further explored the degree to which hydrogen fuel cell and plug-in EVs can contribute to reductions in petroleum-based fuels in the transportation sector. Moving forward with these advanced transportation technologies will greatly contribute to meeting this level of reduction.

DISCLAIMER: While the transportation issues discussed in this paper were brought up during the charrette in some form, the potential policy actions described in this paper have not been endorsed by all charrette participants nor by the Hawaii Strategic Development Corporation or the Hawaii State Energy Office.

## 1.1 Introduction

This document provides a summary of the Hydrogen Fuel Cell and Battery Electric Vehicle Stakeholder Charrette, which was held to support the development of a revised transportation plan under the Hawaii Clean Energy Initiative. The two-day charrette was held on January 13-14, 2015 at the Hawaii Foreign Trade Zone No. 9 and attended by roughly one hundred representatives from federal, state and local government, military, industry, academia, and civil society.<sup>2</sup> Funding for the charrette provided through the Hawaii Strategic Development Corporation was instrumental in enabling the attendance of experts from outside Hawaii who shared their knowledge of hydrogen fuel cell and plug-in electric vehicles and fuels as well as policies and regulations to remove market barriers and accelerate the uptake of these technologies. This charrette was a milestone in the Transportation Industry Analysis being conducted by the ICCT, which aims to achieve a working agreement on a revised clean transportation plan including implementation steps and conclude with a final summary report in June 2015 (Table 1).

**Table 1. Project timeline for transportation industry analysis**

Action	Nov-14	Dec-14	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15
Workshop on analysis of HCEI 2011, fuels and TDM								
Charrette on electric drive vehicles and fuels <sup>3</sup>								
Web-meetings on vehicle efficiency, aviation and marine tactics								
Narrow down strategies and tactics								
Qualitative and quantitative evaluation of tactics								
Assess complementarity with existing Hawaii policies, plans and budgets								
Second Transportation Sector Workshop – seek working agreement on plan and implementation steps								
Final report								

## 1.2 Key outcomes of the charrette

A primary objective of the charrette was to generate a set of actionable steps that can be realistically implemented in Hawaii in support of the state's clean energy goals. The charrette presentations and discussions produced a number of actions that Hawaii's State and County governments can take to enable increased uptake of electric-drive technologies, as well as policies that directly support sales of hydrogen fuel cell and plug-in electric vehicles and the development of hydrogen fueling and charging infrastructure and networks. These actions, summarized below, will be further evaluated in the ICCT's transportation industry analysis in terms of their potential benefits, costs, social acceptability, and likelihood of implementation, as well as alignment with existing plans and budgets.

<sup>2</sup> See Annex IV for a complete list of attendees.

<sup>3</sup> Hydrogen Fuel Cell and Battery Electric Vehicle Stakeholder Charrette: Expanding Hawaii's Clean Transportation Solutions, January 13-14, 2015.

### **1.2.1 Enabling actions**

The State has already undertaken significant actions to promote plug-in electric vehicles and their charging infrastructure, but hydrogen fuel cell vehicles and infrastructure are further behind. Both technologies will require coordinated investments in infrastructure, operation and maintenance, and vehicles in order to gain significant market share; moreover, these investments would especially benefit from coordinated action among executive agencies and the legislature, as well as local governments, industry, utilities, and NGOs. To facilitate this coordination, charrette participants called for designation of lead persons for hydrogen and plug-in electric vehicles with access to high-level support from the Governor's office. Such high-level support has been particularly effective in other states like California, which has established a coordinated pathway to accelerate hydrogen vehicles and fueling infrastructure.

Participants also expressed a need for better data collection, validation, and sharing across government agencies. Such data – which includes sales and total registrations of electric-drive vehicles, vehicle usage of state and county agencies, as well as vehicle-miles traveled and fuel consumption by passenger and commercial vehicles – is needed to establish a robust baseline and evaluate the potential impacts of policy actions, as well as monitor progress toward established goals.

### **1.2.2 Hydrogen fuel cell vehicles**

#### ***1.2.2.1 Establish a regulatory definition of hydrogen FCEVs as electric-drive vehicles***

Hydrogen fuel cell vehicles have not yet been deployed extensively in Hawaii; for this reason, there are some uncertainties among government agencies concerning the appropriate treatment and definition of these vehicles and their supporting infrastructure. In 2015, there is a legislative proposal to define hydrogen FCEVs as electric-drive vehicles, and confer the benefits of electric vehicles as established in previous state and local government policies. Looking forward, it is important to treat hydrogen FCEVs similarly to electric vehicles, since both have zero tailpipe emissions and the potential to utilize renewable energy sources, as well as generating less road noise than conventional vehicles.

#### ***1.2.2.2 Provide incentives for early adopters to purchase FCEVs***

Several incentives are currently offered to operators of plug-in electric vehicles, including free public parking and access to high occupancy vehicle lanes on congested highways. While these existing incentives could be extended to FCEVs through a legislative definition, a direct financial incentive could take the form of a State rebate or tax credit<sup>4</sup> for individuals or companies that purchase or lease FCEVs.

#### ***1.2.2.3 Encourage commercial vehicle operators to replace diesels with FCEVs***

While plug-in electric vehicles have been more extensively commercialized, especially for passenger cars, hydrogen fuel cell technologies are particularly well-suited to certain medium- and heavy-duty applications. Charrette participants identified several types of commercial vehicles that could be targeted for replacement with FCEVs, including airport ground equipment and shuttles, forklifts, postal delivery trucks, refrigerated container trucks, and public buses. Hydrogen fuel cell models are already available for some vehicle types, such as transit buses, while others are anticipated to become commercially available within several years.

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<sup>4</sup> The federal tax credit for plug-in electric vehicles is nonrefundable, meaning that buyers with tax liability less than the amount of the tax credit cannot take full advantage of the incentive (Brents, 2014). California offers an additional rebate for the purchase or lease of eligible electric-drive vehicles that can be fully utilized regardless of tax liability (Center for Sustainable Energy, 2015).

Since FCEVs currently have significantly higher capital costs than conventional diesel vehicles, sustained funding will likely be necessary to support the voluntary introduction of commercial FCEVs. Significant federal funds have been made available for specific vehicle types especially in areas that are not compliant with federal air quality regulations; if Hawaii were made eligible through an administrative change to the federal rules, such programs could provide essential support for the deployment of commercial FCEVs in Hawaii. Additional state-level incentives could provide targeted support, for example allowing a small increase in airport fees to finance FCEVs upgrades of ground equipment and shuttles. Financial incentives could be augmented with regulations that establish targets for the share of zero emission vehicles operated by certain service providers (e.g. airport ground equipment). Another regulatory option would be to restrict daytime freight deliveries in select areas to zero emission vehicles in order to reduce congestion, air pollutant emissions, and noise. Actions related to fueling infrastructure are discussed in the next section.

### **1.2.3 Hydrogen fueling infrastructure**

#### **1.2.3.1 Standardize codes and permitting to ensure safe operation of facilities**

In addition to addressing the regulatory definition of the vehicles themselves, Hawaii could benefit substantially from appropriating the lessons learned in California with respect to the design and permitting of hydrogen production and fueling stations, as well as education of local operators and fire departments to ensure safe operation of these facilities. Timely permitting and safe operation were identified as core components to the successful establishment of the necessary fueling infrastructure for public and private vehicles. The National Renewable Energy Laboratory (NREL) has published a template designed to streamline the permitting and development of commercial hydrogen fueling stations in California, which may also be relevant to other parts of the U.S.<sup>5</sup> California has also funded the certification of hydrogen dispensing equipment<sup>6</sup> and developed retail fueling standards and specifications for hydrogen fuel<sup>7</sup>. Hawaii could potentially adapt a template such as NREL's to streamline the process for permitting and developing commercial hydrogen fueling stations in Hawaii, and collaborate with California to align standards and specifications for retail fueling stations, dispensing equipment, and hydrogen fuel; such alignment could also reduce the costs and building and maintaining such facilities in Hawaii.

#### **1.2.3.2 Support the development of economically viable fueling infrastructure**

Hydrogen vehicles and fueling infrastructure will be most economically viable if deployed in a coordinated fashion, so that vehicle operators are guaranteed sufficient fuel availability and fueling stations can operate near capacity. Since customers are unlikely to purchase FCEVs until there is an available supply of fuel, governments may need to partially offset the capital cost<sup>8</sup> of stations and develop fueling infrastructure across the state, with an immediate emphasis on Oahu and the County of Hawaii, while providing some level of operating and maintenance support until stations receive sufficient demand to become profitable.

In addition to direct financial incentives, the State of Hawaii could partner with industry and NGOs to educate local legal and insurance industries on the costs and risks of fueling

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<sup>5</sup> Rivkin, C., Blake, C., Burgess, R., Buttner, W., & Post, M. (2012). Regulations, Codes, and Standards (RCS) Template for California Hydrogen Dispensing Stations. National Renewable Energy Laboratory, Technical Report NREL/TP-5600-56223. Retrieved from <http://www.nrel.gov/docs/fy13osti/56223.pdf>

<sup>6</sup> California Energy Commission (CEC) (2013). Program Overview. DRIVE: California's Alternative & Renewable Fuel & Vehicle Technology Program. Retrieved 26 Jan 2015 from <http://www.energy.ca.gov/drive/>

<sup>7</sup> Smith, C. & McKinney, J. (2013). 2014-2015 Investment Plan Update for the Alternative and Renewable Fuel and Vehicle Technology Program Commission Report. California Energy Commission, Fuels and Transportation Division. Publication Number CEC-600-2013-003-CMF. Retrieved from <http://www.energy.ca.gov/2013publications/CEC-600-2013-003/CEC-600-2013-003-CMF.pdf>

<sup>8</sup> For example, the State of California has offered to provide 70-90% of capital costs for fueling stations, complemented with market assurance grants for up to 3 years after successful completion of eligible facilities

facilities; this outreach could mitigate the legal barriers to developing such facilities and reduce cost of liability coverage for station operators.

### **1.2.3.3 Pilot demand response systems for hydrogen electrolysis facilities**

Electrolyzers can produce hydrogen and oxygen from water using electricity. As technology improves, the amount of electricity needed to produce a given quantity of hydrogen is expected to decline. With current technology, however, the cost of producing hydrogen could be very high if the production facility pays the average retail rate for electricity. Given that hydrogen production is a flexible load it could potentially realize a lower average cost of energy today if the price of energy reflected marginal costs. To the extent that prices can reflect dynamic events such as curtailment of renewable generation, hydrogen production can serve a dual purpose of both energy storage and transportation fuel. In Hawaii, there could be an opportunity to ensure that new hydrogen production facilities are designed to be responsive to power producers or utilities in order to generate hydrogen more cheaply and improve grid stability. Such actions could involve government-sponsored pilot projects to demonstrate feasibility of demand responsive hydrogen production in Hawaii, as well as coordination with the utilities and power producers to develop pricing mechanisms for such systems. The critical issue is that the hydrogen production facility has slack capacity to increase hydrogen production at the time of curtailment (low marginal cost), whether it is co-located with renewables or not.

## **1.2.4 Plug-in electric vehicles**

### **1.2.4.1 State rebates for new electric vehicles**

The federal government offers a tax credit of up to \$7,500 to encourage the lease and purchase of electric vehicles. Many states (including Colorado, Illinois, Louisiana, and California) offer an additional tax credit or rebate of \$2,000-\$6,000 further increase the attractiveness of zero emission vehicles and offset the incremental costs of advanced technology. Several such states with significant state-level rebates have electric vehicle market shares that are roughly 2-4 times<sup>9</sup> the national average<sup>10</sup>. While Hawaii has one of the highest rates of plug-in EV sales without offering an incentive, the state could significantly accelerate the rate of EV uptake with the addition of such an incentive. During the charrette, several outside experts gave evidence that the initial costs of state rebates pay for themselves many times over in societal benefits and increased commercialization of EVs. Moreover, state incentives can help keep federal dollars within the state to the extent that they encourage more consumers to take advantage of the existing federal tax credit. In anticipation of a concern that rebates could disproportionately benefit high-income households that can afford to purchase new vehicles, a state rebate in Hawaii could include limits on eligible household income or vehicle purchase price. Such provisions could be similar to those in California, which recently adopted legislation that will modify the state's rebate program to enhance incentives for low-income households and limit eligibility based on income<sup>11</sup>.

### **1.2.4.2 EV rental prioritization for state & county employees**

While EVs currently make up a very small share of rental car fleets in Hawaii, at least one rental car company has expressed interest in increasing the number of EV rentals, which

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<sup>9</sup> Jin, Searle, and Lutsey (2014). Evaluation of State-Level U.S. Electric Vehicle Incentives. The International Council on Clean Transportation.

<sup>10</sup> The national average combined share of new plug-in hybrid electric and battery electric vehicle sales was about 0.7% in 2014 and 0.6% in 2013. Source: Chase, N. & McFarland, A. (2014). California leads the nation in the adoption of electric vehicles. United States Energy Information Administration. Retrieved from <http://www.eia.gov/todayinenergy/detail.cfm?id=19131>

<sup>11</sup> CA SB1275 (2014, Sep 21). Vehicle retirement and replacement: Charge Ahead California Initiative. California Legislative Information. Retrieved 27 Jan 2015, from <http://leginfo.ca.gov/>

have comparable daily rates as conventional vehicles but yield fuel savings for renters. The state procurement office maintains a contract with rental car companies for state and county employees to rent vehicles for work purposes. From September through November of 2014, over 3,600 vehicles were rented by State and County employees under this contract<sup>12</sup>. This contract could be modified or supplemented to prioritize rentals of EVs, efficient hybrids, and fuel economy leaders. EV models could be especially prioritized for trips within the range of a single charge or on routes with access to fast charging stations. Such prioritization has the potential to significantly increase the number of EVs in rental car fleets at minimal or no incremental cost to the State. The program could also indirectly encourage private EV sales by familiarizing public agency employees with EVs.

#### **1.2.4.3 Conduct targeted outreach to utility customers about the benefits of EVs**

Utilities have access to the most complete information regarding what individual customers actually pay for electricity, as well as the rates they could pay with the purchase or lease of an EV. Consumers face uncertainty about the future cost of electricity, and also tend to undervalue energy savings that would occur more than a couple of years in the future. Since utilities may not have the best available information on current offerings of EV models (in terms of cost and energy efficiency), there could be a significant opportunity for collaboration between the utility or public utilities commission (PUC) and State agencies<sup>13</sup> or auto dealers. Such a collaboration could include a built-in cost and savings calculator that is populated with regularly updated information on actual electricity rates, EV costs, vehicle energy use, and annual energy savings under a range of expectations for gasoline prices and annual vehicle travel. Utility customers could be provided with access to a personalized calculator along with their monthly utility bills.

### **1.2.5 Plug-in electric vehicle charging infrastructure**

#### **1.2.5.1 Deploy demand-responsive technologies**

As Hawaii's power sector generates more and more of its electricity from renewable sources, utilities face an increasingly difficult challenge to balance the supply of electricity from fixed and intermittent sources with the demand for electricity at each moment. Solar photovoltaic (PV) systems tend to hit peak generation during midday, while wind turbines tend to generate more electricity at night when winds are stronger. Total electricity demand in Hawaii, on the other hand, tends to be lowest between midnight and 5 a.m. and increases to about 80 percent higher during the day, typically peaking between 5 p.m. and 9 p.m.<sup>14</sup>. The growing number of EVs in Hawaii could be utilized to help balance the grid and expand the share of renewable power with the right combination of policies, rates, and charging technology. For example, EVs charging overnight could use electricity from wind turbines, whereas EVs charging during midday could use electricity from solar PV systems. Additionally, demand-responsive technologies can allow vehicles and charging systems to communicate with the grid about when it is the best time to charge, helping utilities to balance overall supply and demand for electricity. Similarly, hydrogen for FCEVs could be produced as a demand-response, with the potential to benefit utilities and reduce the cost of hydrogen.

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<sup>12</sup> Enterprise Holdings, Inc. (2014). DM02768 - Hawaii Management Report: 09/01/2014 through 11/30/2014. Retrieved 21 Jan 2015 from Hawaii State Procurement Office.

<sup>13</sup> Would include the administrator of a public benefits fund if an EV or charging infrastructure rebate were implemented in Hawaii.

<sup>14</sup> HECO (2013). 24-hour Availability. Accessed 27 Jan 2015 at <http://www.hawaiianelectric.com/portal/site/heco/menuitem.508576f78baa14340b4c0610c510b1ca/?vgnnextoid=e8e0420af0db110VgnVCM1000005c011bacRCRD&cpsextcurrchannel=1>

### **1.2.5.2 Promote charging stations in multi-unit dwellings and workplaces**

Multi-unit dwellings (MUDs) and workplaces were identified during the charrette as prime targets in Hawaii for regulations and fiscal incentives to support charging infrastructure. An estimated 38 percent of Hawaii's housing units are in MUDs<sup>15</sup>. Such residences can be especially challenging environments for EV charging due to permitting requirements, assignment of parking spaces, allocation of costs for the installation and operation of charging facilities, and the need for coordination with building managers and homeowners associations. Hawaii's existing legislation prevents any entity from restricting the right of property owners in MUDs to install EV charging systems; however, this legislation neither guarantees the right of tenants to install charging systems, nor provides a mechanism for charging systems that are shared among multiple units. The simplest solution put forth during the charrette was to update building codes to ensure that enough standard 110-volt outlets are available to charge electric vehicles at new MUDs and workplaces. The State could also offer a rebate<sup>16</sup> for the purchase and installation of EV charging systems in MUDs or workplaces; such rebates or grants have been offered in several U.S. states, including Colorado, Connecticut, and Florida<sup>17</sup>. Aside from the capital and installation costs of charging systems, utility rates can have a significant impact on the cost of EV charging. HECO is currently piloting several rate options for residential and commercial EV charging; future rates could take into account and promote the adoption of demand-response technologies that signal facilities to charge when electricity is cheapest. State and County governments could make use of DOE's the [Plug-In Electric Vehicle Readiness Scorecard](#) to evaluate and track progress toward community EV readiness, including MUD and workplace charging installation.

### **1.2.5.3 Mitigating the Cost of Energy as a Barrier to EV Adoption through Time Variant Pricing**

The electricity rates charged to utility customers in Hawaii are the highest of any U.S. state<sup>18</sup>, which can create a barrier for the adoption of EVs. Prices that reflect periods of high and low cost can mitigate this barrier. Much like the production of hydrogen, EV charging is a flexible load that has the potential to be shifted to times when energy costs are lower. To the extent that EV owners can see and understand these differences through the electricity prices they pay, drivers can then alter their charging behavior to lower their overall transportation fuel cost. Time of Use (TOU) pricing is one way this price signal can be sent to customers. Also, if discounted prices were available during periods where renewable energy would otherwise be curtailed it would support a higher level of renewable generation. Building load during these curtailment periods can potentially avoid energy storage costs and/or inflated PPA prices that reflect the expectation of curtailment events.

Electricity rates charged by utilities have a significant impact on the amount of money saved by EV drivers compared to conventionally fueled vehicles. Hawaiian Electric Company (HECO) estimates that in 2012, an EV operating on Oahu could save 10 cents per mile compared to a mid-size gasoline-powered sedan, which would amount to \$1,000 saved annually assuming 10,000 vehicle-miles traveled<sup>19</sup>. Hawaiian Electric, Maui Electric and

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<sup>15</sup> U.S. Census Bureau: State and County QuickFacts. Data derived from Population Estimates, American Community Survey, Census of Population and Housing, State and County Housing Unit Estimates, County Business Patterns, Nonemployer Statistics, Economic Census, Survey of Business Owners, Building Permits Last Revised: Thursday, 04-Dec-2014 14:54:45 EST

<sup>16</sup> Some participants explained that HOAs may not be eligible to receive tax credits; however, they may be able to receive rebates for installing charging facilities.

<sup>17</sup> PlugIncentives (2014). List of U.S. Electric Vehicle and EVSE Incentives by State. Retrieved from <https://www.pluginincentives.com/blog/list-us-electric-vehicle-and-evse-incentives-state>

<sup>19</sup> Hawaiian Electric Company (2013). EV Pilot Rates: Commonly Asked Questions. Accessed 21 Jan 2015 at <http://heco.com/heco/Clean-Energy/Electric-Vehicles/Commonly-Asked-Questions/>

Hawaii Electric Light Company currently offer lower off-peak EV charging rates to up to 1,000 customers on Oahu, Maui, and Hawaii islands<sup>20</sup>. With annual sales of about 1,000 new EVs and roughly 3,000 EVs operating statewide as of 2014<sup>21</sup>, there is a need to conduct targeted outreach to potential and new EV drivers about the benefits of TOU rate savings and transition from pilot TOU programs to standard rate offerings, which will ensure that opportunities continue to exist for residential and commercial customers to utilize EVs in a manner that allows them to incur bill savings while also reducing evening peak load to maximize grid reliability issues.

### **1.2.6 Electric drive vehicle revenue generation**

While the policies outlined above could directly support the sale of EVs and hydrogen FCEVs as well as the development of charging and fueling infrastructure, many of these would require additional funding in order to be successful. Several complementary actions were suggested over the course of the charrette that could help generate revenues needed to implement these policies. Each of these actions will be explored in a follow-up analysis by the ICCT<sup>22</sup>.

#### **1.2.6.1 Leverage airport and rental car fees to finance clean transportation programs**

Hawaii receives more than 8 million visitors each year, with roughly 98% arriving by air<sup>23</sup>, and many of these visitors are renting vehicles during their stay. The large number of visitors means that the State could raise significant revenue for clean transportation programs at a very small cost to individual visitors<sup>24</sup>. A rationale exists for applying these fees when visitors are expected to benefit directly from the resulting programs, or when the funds are used to offset certain negative impacts generated by tourism (e.g. traffic congestion, air pollution, fossil fuel reliance). These funds could also be tied to related programs: for example, using an airport fee to convert ground support equipment and airport shuttles to electric drive, or levying a green fee on car rentals to support the electrification of rental car fleets.

#### **1.2.6.2 Enhance taxes on petroleum imports**

State and County fuel taxes imposed on distributors brought in \$166.8 million in revenue in fiscal year (FY) 2013<sup>25</sup>. Additionally, the Environmental Response Tax of \$1.05 per barrel of oil collected \$27.2 million in FY 2013<sup>26</sup>. Since these taxes increase the price of petroleum used for transportation, they incorporate a portion of the negative externalities caused by petroleum consumption and increase the cost effectiveness of vehicles that use alternative fuels (including electricity and hydrogen) – in addition to bringing in revenue to fund transportation and environmental programs. While raising fuel taxes could prove politically challenging for the Legislature, some surveys have found that Hawaii's residents would be willing to pay higher energy taxes to support clean energy solutions<sup>27</sup>.

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<sup>20</sup> Hawaiian Electric Company (2013). EV Pilot Rates: Commonly Asked Questions. Accessed 21 Jan 2015 at <http://heco.com/heco/Clean-Energy/Electric-Vehicles/Commonly-Asked-Questions/>

<sup>21</sup> DBEDT (2014). Monthly Energy Trends. Retrieved from <http://dbedt.hawaii.gov/economic/energy-trends-2/>

<sup>22</sup> Such analysis falls under the task, "Assess complementarity with existing Hawaii policies, plans and budgets" shown in Table 1.

<sup>23</sup> DBEDT (2015). Quarterly Tourism Data. Visitor Statistics. Retrieved from <http://dbedt.hawaii.gov/visitor/>

<sup>24</sup> For example, an additional charge of a few dollars per airport arrival or vehicle rental could generate millions of dollars in revenues. Rental cars have been taxed at \$3 per day since 2012. Source: Department of Taxation (2014). Annual Report 2012-2013. State of Hawaii. Retrieved from <http://files.hawaii.gov/tax/stats/stats/annual/13annrpt.pdf>

<sup>25</sup> Department of Taxation (2014). Annual Report 2012-2013. State of Hawaii. Retrieved from <http://files.hawaii.gov/tax/stats/stats/annual/13annrpt.pdf>

<sup>26</sup> Ibid.

<sup>27</sup> Blue Planet Foundation (2015). Barrel Tax Disbursement. Retrieved from <http://blueplanetfoundation.org/barrel-tax-disbursement.html>

### **1.2.6.3 Leverage federal grants for clean surface transportation**

Several federal programs<sup>28</sup> offer significant funding to finance diesel vehicle retrofits, purchases of low emission vehicles, and other projects that improve air quality and reduce congestion; however, some of these funds are only available to applicants in areas that are in nonattainment with National Ambient Air Quality Standards. Although Hawaii is in compliance these standards, there may still be a possibility for a federal agency to add an administrative exemption that allows the provision of federal funds to designated areas. Furthermore, Hawaii's State and County governments could dedicate additional staff time to develop applications for federal funds.

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<sup>28</sup> US EPA (2015). Funding Sources. National Clean Diesel Campaign. Retrieved from <http://www.epa.gov/cleandiesel/grantfund.htm#epa>

## 1.3 Summary of charrette proceedings

### DAY 1

#### **Background and Purpose**

**Mark Glick, Administrator of the Energy Department in DBEDT**, described the overall goals of the Hawaii Clean Energy Initiative (HCEI) and provided background to the selection of ICCT to help with the transportation and fuels analysis. He put the e-drive charrette into context for the HCEI and said he expected this technology will play an important role, given the abundant renewable energy resources in Hawaii. Mark stressed the critical importance of stakeholder involvement to move the HCEI process forward.

**Josh Miller, Researcher at the ICCT**, provided the background for the ICCT work for DBEDT. Table 1 shows the strategies under consideration by ICCT. Each will be covered by a charrette or a webinar. He provided an overall schedule for the project. A draft final report will be prepared ahead of the final charrette in about the April-May timeframe. The final report will be prepared by June 30. Josh also provided a list of relevant e-drive reports prepared by the ICCT.

**Alan Lloyd, President Emeritus of ICCT**, described why the timing of the HCEI is good for e-drive: car manufacturers are selling EVs across several platforms; Toyota and Hyundai are offering FCEVs and one can buy the Toyota FCEV, the Mirai, this year; both batteries and fuel cells can provide storage for the intermittent energy from wind and solar sources. The latter was illustrated through the power-to-gas (P2G) concept being deployed in Germany (see slides).

He also highlighted two key studies relating to the transition time and costs of e-drive technology. A National Academy of Sciences study, "Transition to Alternative Vehicles and Fuels," March 2013 found that both EVs and FCEVs will be less expensive than conventionally powered vehicles in the 2035-2040 time period. A Dr. David Green study for ICCT found that significant government and private investment will be necessary in the early years of e-drive penetration if the "valley of death" is to be overcome. However, eventually the benefits will be about a factor of 10 greater than the costs (referenced in Josh Miller's talk).

Lastly, Alan Lloyd highlighted a landmark for hydrogen as noted in the Economist's piece "Foot on the gas," "According to energy-industry experts, there are several candidates for the accolade of 'fuel of the future... and always will be.' But whereas advanced biofuels and nuclear fission can still make a fair claim to the title, hydrogen fuel cells will become a fuel of the present in 2015" (Wright, 2014, The Economist, The World in 2015).

#### **Current Status and Near Term Activities for Plug-in EVs in Hawaii**

**Jeff Mikulina, Executive Director of the Blue Planet Foundation** gave a broad overview of vehicles and gasoline consumption in Hawaii. There are some 1.3 million vehicles on the road, and they consumed 451,533,116 gallons of gasoline in 2014, costing Hawaii \$1,918,323,340. The first car in Hawaii in 1899 was an electric car. Based on current projections, Blue Planet Foundation estimates 30,000 electric vehicles by 2024.

**Mark Deutsch, EV Business Development Manager, Nissan North America**, stated that Nissan had 55% market share for EVs sold in Hawaii in 2014, with Kurt Speas in Honolulu being the #2 sales person for LEAFs in the U.S. Honolulu is tied with Portland for the number of LEAF vehicles sold in the U.S. He said the second generation LEAF would be

available by 2017 and will have about double the range. Mark shared some important “lessons learned” about EV sales, which could be applied to Hawaii. A number of suggestions to increase sales in Hawaii were:

- Education and Public Training
- Infrastructure, including public fast charging
- Photovoltaic- EV connection
- State Rebates

Of those, the first and last were directed at increasing sales of EVs in Hawaii. Nissan is also addressing the medium duty vehicle market and is producing the eNV Cargo van. He noted that about 70% of customers lease their vehicles because of the concern about the aging of technology.

**Carlos Perez, Manager of Customer Solutions, Hawaiian Electric Company** recounted their interest in EVs started about 4 years ago and are currently involved in six projects. They are gaining hands-on experience by deploying EVs in their fleet. In 2013, Hawaiian Electric Companies gained approval from the Hawaii Public Utilities Commission to operate up to 25 publicly accessible DC fast chargers across Oahu, Maui County and Hawaii Island. Hawaiian Electric has found potential site hosts’ property managers are not eager to give up parking spaces, and negotiations for site acquisition and contract are lengthy.

**Dexter Turner, President/CEO OpConnect**, mentioned OpConnect had acquired the Better Place EV charging network, which had started to install EV charging infrastructure across Hawaii. To date, they have 1500 members which is about 50% of all EV owners. They have 150 charging points – 100 public, 42 workplace and 4 multiunit dwellings (MUD). The most used site is the Ala Moana Mall in Honolulu.

The major charging station installation challenges they face include:

- Multi-Family
  - Determining which party covers cost
  - Assigned parking issues, most if not all stalls are assigned to residents leaving minimal options for charging stations- shared use
- Costs of charging stations
  - Many states offer financial incentives
- Permitting time
- Installation costs

**Michael Chang, Chief Innovations Architect and Technology Director, Hawaii Energy**, stated that Hawaii Energy has calculated that 100,000 Nissan LEAF’s will only have a small impact on electricity demand in 2023. MUD’s pose a significant problem for EV deployment since about 60% of people in Hawaii live in MUDs. This is a real issue, which must be addressed in order to get sustained EV penetration into the light duty fleet. One idea is to put in separate meters, but there is still the issue of parking space assignments. Michael described the new pilot program Hawaii Energy currently has with OpConnect to study effects of dynamic pricing and charging rates on time of day charging.

### **Current Status and Near Term Activities for Hydrogen Vehicles in Hawaii**

**General Stan Osserman, Executive Director of HCATT** gave an overview of current hydrogen activities around Honolulu. He indicated that HCATT is part of the State of Hawaii, coming under DBEDT. Its goals are to:

- Move Hawaii towards clean transportation energy
- Lead as a National Demonstration Center for Alternative Fuel Vehicles – JBPHH (designated by ARPA nearly 20 years ago)
- Manage USAF hydrogen R&D projects in Hawaii

- Support workforce development and job creation for Hawaii

General Osseman provided a description of their many projects underway (See slides). The station at Schofield has been disassembled and Hickam AFB is now the center of activities. As described above, he is working on a number of projects including a hybrid fuel cell trash truck using flared methane in a reformer to produce hydrogen.

**Dr. Richard Rocheleau, Director of the Hawaii Natural Energy Institute (HNEI)** provided a broad overview of the many research activities with which HNEI is involved. These are:

- Examining the impact of air contamination on the performance of the fuel cell stack. This takes advantage of the adverse air quality associated with volcanic activity in Hawaii.
- Carried out about 50 unattended hydrogen fills at the Marine Corp. Base, since November 2014 – when the system became operational. They have both 350 and 700 bar refill options.
- HNEI is examining hydrogen energy systems for grid management, using electrolyzers to mitigate the intermittent nature of renewable energy, a technique widely employed in Europe.
- HNEI is also examining various uses of hydrogen to offset costs, including exploring the potential use of oxygen (co-produced with hydrogen by the electrolyzer) as medical grade O<sub>2</sub>. This has significant value in Hawaii, since it has to be transported to Hawaii.
- Rick went through his calculation of renewable hydrogen pathways, with a focus on the electricity to hydrogen pathway. He calculated that if 20% of the fleet were using hydrogen fuel cells, 30% of grid capacity would be needed to generate the hydrogen. This was not an attractive outcome and Rick stated that there would need to be significant reduction in the cost of electricity and improvement in the efficiency of electrolyzers.

**Paul Ponthieux Ph.D, Chief Technology Officer, Blue Planet Research** described the extensive research that they are carrying out on the big island of Hawaii. The work is headquartered on the Puu Waawaa Ranch in Kona. They are using a business model approach to deploying hydrogen stations on Hawaii Island. The framework for the model is:

- Major population centers are approximately 50 miles apart
- 5-6 stations are estimated to give complete mobility for the island (taking advantage of the range of FCEVs)
- Low cost of entry using this approach has the ability to scale up as demand grows
- Utilize the lowest cost renewable – geothermal – which is abundant on Hawaii Island
- Initial target is the replacement of diesel fleet vehicles

On the ranch, they have an 85kw solar array, with battery backup, providing power to the ranch. They also use this electricity to produce hydrogen by electrolysis. They store the hydrogen for use in a forklift and to generate electricity through stationary fuel cells. Paul indicated that one option being examined is to use the ample geothermal resources to produce sufficient hydrogen for all the islands.

**Alex Keros, Manager, Advanced Vehicle and Infrastructure Policy, General Motors(GM)**, highlighted the delivery of 16 Fuel Cell Equinox vehicles to the military in Hawaii in February, 2012. The Navy, Air Force, and Army each had vehicles. About 6 of these vehicles remain, although the technology is now outdated.

He indicated that GM is committed to supporting Hawaii in its efforts to deploy e-drive vehicles. However, it was very important to get the commitment of all stakeholders. He cited

the case of Tyson Eckerle in California: Tyson has access at the highest level and problems get resolved quickly. This would be a good model for Hawaii.

He also mentioned the Chevy Volt and Volt 2.0. This will have 50 miles all-electric range, suitable for most daily uses. The Chevy Bolt has also been unveiled as a concept car with about a 200-mile range, selling for about \$30k. GM is committed to meeting consumer demands. He suggested that Hawaii pursue a stepwise process, in small increments if necessary, but conveying certainty to the stakeholders.

**Thor Toma, Senior Vice President, Servco Hawaii**, described their long relationship with Toyota. Thor described the 20-year history of Toyota in fuel cells and the extensive product testing. They have 5,680 patents (available to the public) associated with their FCEV work. He highlighted the Mirai, which is Toyota's first commercially available fuel cell vehicle. This will be available in the USA in 2015, as a 2016 model. It has lightweight carbon fiber storage tanks for hydrogen. Servco Automotive has just celebrated 90 years as a Toyota dealer. It is the largest Toyota dealership in Hawaii. They intend to promote the new Mirai in Hawaii and are installing their own hydrogen fuel station. They will provide public education to introduce fuel cells and help deployment.

### **Current and Proposed Legislation for Promotion of Electric Drive Vehicles**

**Senator Mike Gabbard (Oahu), Chair of the Committee on Energy and Environment**, reflected on a poor 2014 legislative year for e-drive vehicles. Specifically in 2014, Senate Bill 2651 and Senate Bill 2986 aimed at infrastructure for electric vehicles and hydrogen did not pass. He stated that the deadline for introducing bills in the 2015 session was very short – January 29, 2015. He expected Senate Bill 2651 to be brought back and a bill addressing an excise tax exemption, with the money going to hydrogen infrastructure.

**Representative Mark Nakashima (Hawaii), Member of the Transportation Committee**, agreed that the last legislative session was disappointing. This year he will:

- Support legislation being brought back by Senator Gabbard.
- Sponsor a bill to put FCEVs on the same par as other advanced vehicles.
- Be receptive to ideas from stakeholders, including ideas from this charrette.

His major focus is on the reduction of fossil fuel use in Hawaii and pressure must be kept up despite the current low prices for gasoline and diesel. He supports FCEV and EVs, with an emphasis on hydrogen because of range.

## **DAY 2**

### **Remarks and Presentations from Invited Contributors Outside Hawaii**

**Pete Devlin, Market Transformation Manager, Fuel Cell Technologies Program, U.S. Department of Energy (DOE)**, provided an overview of both key aspects of the battery vehicle program and the fuel cell program at DOE. Both technologies are included in the President's "all of the above energy strategy that develops every resource available for the 21<sup>st</sup> century." Some key points from the Pete's presentation include:

- Work on the "EV Community Readiness Projects" resulted in 16 projects in 24 states. Covered 600,000+ employees of 300+ worksites.
- DOE provides help to employers interested in installing workplace chargers.
- An analysis by Argonne National Laboratory showed that EVs and FCEVs provide the greatest reductions in petroleum use (reinforcing the importance of this charrette to the HCEI).

- DOE is extending interest beyond passenger vehicles and buses to Medium Duty (MD) and Heavy Duty (HD) vehicles – classes 3-8. They consume 22% of petroleum use in the U.S..
- DOE is concentrating on “clustering” motive fuel cells to drive hydrogen demand. A specific example shown was a diagram of fuel cell vehicles at a representative port-based complex (highly applicable to Hawaii, where imported goods come through the Port of Honolulu).

Pete highlighted several active programs designed to promote electric drive vehicles:  
(Details provided on the slides)

- There is a major program of data collection on thousands of vehicle, EVSE as part of the Transportation Electrification Initiative. This evaluates vehicle charging, equipment testing, charging station utilization and the influence of utility time-of-use electricity rates on consumer charging behavior.
- The DOE Workplace Charging Challenge, is aimed at a tenfold increase in employers offering workspace charging by 2018.
- The DOE-GSA feasibility study for a hydrogen station in downtown Honolulu showed that the 1.4 acre “Fort Armstrong” site could support a clean and economically viable 65 kg/day hydrogen station.
- The USDOE Clean Cities Coalition Program is a viable tool for Hawaii, since Clean Cities is set up to help local decisions to reduce petroleum use in transportation. Note, Honolulu Clean Cities is currently under Blue Planet Foundation

**Robert Rose, Breakthrough Technologies Institution (BTI)**, provided an overview of the fuel cell industry and provided information on international activities on hydrogen and fuel cells, which can help accelerate the technology needed for widespread deployment in Hawaii. He highlighted some of the environmental, energy, and economic benefits of fuel cells in the transportation, goods handling and power generation segments. Reliable power can be provided by fuel cells – power failures in the U.S. in 2013 cost the U.S. \$18-33 billion. He highlighted the fact that FCEVs fit the new utility model – high efficiency, distributed energy, long run back up power, grid support via electrolyzer and large renewable energy shortage.

In terms of vehicle efficiency, he cited a Toyota study highlighting the comparison of total efficiency of BEVs and FCEVs operating in fuel produced from natural gas. BEVs provided 26% and FCEVs 33% total efficiency. Fuel cells have now matured into a significant \$1.3 billion industry (DOE, 2013). He showed the global distribution of the number of shipments and megawatts by region during 2009-2014.

Major funding is being provided for fuel cell development and deployment (RD&D). In 2014, the following funding (which included expanded support for hydrogen station) was directed to fuel cell RD&D:

- US: \$150M
- EU: \$120M (\$720M committed to 2020)
- Japan: \$600M

In terms of hydrogen infrastructure, there is major government support:

- California: \$100-\$200M (10 year program through 2023)
- Japan: \$128M through 2015
- Europe: \$475M (multiyear)

It is to be noted that it is state rather than federal funding for hydrogen infrastructure in the U.S. It is also very significant that both Toyota and Honda are providing support for hydrogen stations in California and in the Northeast of the U.S. This is a strong

manifestation of the interest and commitment that these manufacturers have to the successful deployment of FCEVs. Bob also highlighted the new Japanese energy plan including an illustration of the potential central role to be played by hydrogen (see figures in Rose presentation). This plan expects 50-70% of the new car fleet in 2030 will be “new generation vehicles” – natural gas, BEV, and FCEV. Lastly, the current and planned deployments of hydrogen stations in the U.S. (10 in CA), Japan (31 in 2014), Europe (30 in 2014) and Germany (50) were graphically displayed on the relevant maps.

**Eileen Tutt, Executive Director, California Electric Transportation Coalition**, gave a presentation on behalf of the California Plug-in Electric Vehicle Collaborative (PEVC). Eileen gave a broad overview of the broad membership stakeholders of the PEVC, representing industry, government, NGOs and other interested parties. She addressed the key role of the California Public Utility Commission (CPUC). Originally, the CPUC said that utilities could not invest in electric vehicle infrastructure and education. However, this decision has been re-visited thanks to Commissioner Carla Peterman, and utilities can now be fully involved with accelerating EV deployment.

Eileen also mentioned some key points relevant to Hawaii:

- Car sharing should be carefully considered to help address the congestion issue.
- Government support is needed to provide incentives for purchase of vehicles and also need to support infrastructure including operation and maintenance.
- California has set aside some revenues to specifically address economically disadvantaged communities.
- Hawaii could bring in more federal dollars by accelerating the uptake of EVs. Each car sold brings \$7,500 incentive dollars from Washington, D.C.

**Tyson Eckerle, Zero Emissions Vehicle Infrastructure Project Manager, Office of California Governor Jerry Brown**, offered his support to Hawaii in deploying electric drive vehicles. Success in Hawaii is very important and will help California in its efforts to meet the Governor’s goal of 1.5 million electric drive vehicles on the road in 2025. This is spelled out in Executive Order (B-16-2012). In 2014, 118,505 ZEVs were sold in California.

Tyson mentioned the significant financial support by the California legislation through AB 118 (2007) and its extension AB 8 (2013). This Alternative and Renewable Fuel and Vehicle Program (ARFVP) provides \$150 million/year in state funding – CEC, \$100 million/year; with \$20 million going to hydrogen, and CARB, \$50 million/year. His job is to provide support for both BEV and FCEV infrastructure and deployment. He highlighted the public/private coordination through California PEVC, CaFCP and CalETC. One of the challenges for hydrogen station deployment is the poor economies of the stations in the early years. He explained earlier work carried out by him at Energy Independence Now (EIN). He found significant market uncertainty during the rollout, but that some market assurance grants for Operations and Maintenance (O&M) for the stations can provide a buffer against slow rollout. This recommendation has been adopted by the CEC in their awards, which allows up to \$100k/year for 3 years for O&M. This led to a strong response to a CEC solicitation for hydrogen stations – 28 stations awarded funding. He also acknowledged the entry of Toyota into hydrogen station deployment.

He expects California to continue on an aggressive path and cited the 2015 Inaugural speech of Governor Brown calling for a 50% reduction in petroleum use by 2030. Lastly, he had specific suggestions for Hawaii. These are highlighted below:

- California has gone to great lengths to start the market
  - Sharing lessons learned, driving down costs, building supply chain/experience
- Ingredients for FCEV success in Hawaii
  - Strong Leadership/Champions – from Government and/or Industry

- Strong Support – from Government and Industry
- Funding (public and/or private) to enable stations to succeed until hydrogen sales takeover

**Jaimie Levin, Senior Project Manager and West Coast Director of the Center for Transport and the Environment (CTE)**, focused on zero emission buses. Jaimie cited the difficulty of significantly increasing the share of transit ridership compared to commuters wanting to drive alone. He did not think that his examples of over a decade ago had changed very much. He also mentioned the limitations of advanced technologies in solving congestion. He highlighted the many benefits of electric drive and specifically the benefit of fuel cell buses including up to double better fuel economy than diesel buses – and no toxic emissions. The fleet of 12 FCEV buses at AC Transit has shown excellent reliability, over 15,000 miles per road call, covering over 1 million miles so far, with the lead FCEV operating for 18,300 hours. Sunline Transit in Palm Desert, California also has 3 buses operating successfully.

Increasing the penetration of FCEV buses continues to be a challenge when considering the high capital costs for vehicles and infrastructure compared to conventional buses. Reduced maintenance costs have yet to materialize and there is the usual risk avoidance for emerging technologies. Jaimie highlighted the well-known “valley of death” encountered by new technologies and geographically showed the various stages in commercialization of new, game changing technologies. Government support in the early years is critical for successful introduction of fuel cell buses. He showed that this could take different forms, from zero emission bus regulation, to financial support to pay the incremental costs for FCEV buses to convince major bus manufacturers to make a commitment to fill significant orders of fuel cell buses, with the goal of producing a fuel cell bus for less than \$1 million – a landmark.

**Dr. Abas Goodarzi, President of U.S. Hybrid**, provided an overview of his company and the work that U.S. Hybrid is carrying out in Hawaii in conjunction with HCATT. Their focus is on heavy-duty commercial vehicles. Abas estimates that 50% of the energy used was wasted because of traffic.

U.S. Hybrid has acquired United Technologies Corporation Proton Exchange Membrane Fuel Cell technology – the latter has over 50 years of experience in fuel cells, having supplied fuel cells to space missions. The fuel cell engine was chosen by Abas because it exhibits the best efficiency with zero tailpipe emissions. U.S. Hybrid is working on a variety of platforms including shuttle buses, drayage trucks, refuse trucks and street sweepers, in addition to transit buses. Abas confirmed the excellent performance of the UTC fuel technology, which is used in the Van Hool buses operating in the AC Transit fleet in California (previously discussed by Jaimie Levin). One bus has already exceeded the DOE 2016 Life Target for buses.

### **Breakout Session 1: Hydrogen**

**Mitch Ewan, Hydrogen Systems Program Manager, HNEI**, led this discussion. He provided an extensive set of slides, prepared in conjunction with General Osserman. These are provided in the attachments. The specific goals identified were:

- Status of hydrogen in Hawaii
- Fueling needs and installation timeframe
- Shortfalls and Remedies
  - Role of Government, OEMs
- Hydrogen/Electricity suppliers
- Energy security & assurance

- Economic development opportunities

Several key points were made relative to existing authority and Hawaii policy. For example:

- Hawaii state policy to establish a Hawaii Hydrogen Economy (HRS 196-10).
- HCEI has expectations for hydrogen contribution to clean energy.
- Resources have been addressed through the “Hydrogen Investment Capital Special Fund” (HRS 211F-5.7).
- The Barrel Tax (HRS 243-3.5) provides some money for hydrogen related activities largely through HNEI.
- Political will and stakeholder outreach are critical components of a successful plan.
- One potential mechanism would be to locate a hydrogen implementing organization within the Hawaii State Energy Office, DBEDT.

These points and others are drawn from a draft “Fuel Cell Electric Vehicle and Hydrogen Fueling Infrastructure Implementation Plan for Hawaii,” developed by U.S. DOT, HNEI and HCATT (Oct. 14, 2014 draft). It was recognized that much work had gone into this plan, but a major weakness pointed out by Karl Fooks, President Hawaii Strategic Development Corporation, was that the plan did not ask for any money. This is a major limitation in trying to move the plan forward.

During the discussion, several points were made to provide guidance for a path to successful and sustained deployment of hydrogen and related technologies throughout Hawaii:

- Focus on fleet applications would make sense for hydrogen use and deployment of vehicles.
- Acquiring reasonable cost hydrogen to build infrastructure in the initial stages will be difficult, yet important. A few suggestions were made to address this:
  - Joe Boivin, Hawaii Gas, said that he could make LNG available at cost for use in steam reforming of methane to produce hydrogen.
  - Rene-Andre DeRosa, Lamplighter Energy, is planning on a major scale solar development, which could produce electricity for under 10 cents/kwh, thus making electrolysis more attractive.
  - Chris McWhinney, Millennium Reign Energy, said that he is working with Air Liquide on small-scale electrolysis.
- Pete Devlin, USDOE suggested that Hawaii focus on “low hanging fruit” such as refrigeration units, which would eliminate diesel pollution. Other activities could be centered on the port, to include trucks and forklifts. Key message – do not try to solve the whole energy problem at one time.
- Demonstration projects are needed so that policymakers can make informed decisions.
- All projects must be publically accessible and should have a path to commercialization.
- Jaimie Levin suggested that a multi-use hydrogen fueling would make sense, serving cars, trucks and buses.
- Leverage the work carried out in CA in the area of first responder training, permitting, and interacting with the legal and insurance industries.
- Community involvement will be essential to the success of hydrogen deployment and public education will be important. The example of the leadership of SERVCO and the HADA will be important for LDV. Similar leadership will be necessary for public transit.
- Opportunities for economic development and job creation should be highlighted when funds are sought for infrastructure building.

Given the extensive discussion in the session, the question was posed – how do we move forward aggressively across several fronts? A key opportunity to showcase leadership in renewable energy and hydrogen was highlighted by Dave Rolf, Hawaii Auto Dealers Association. He stated that the “World Conservation Congress” to be held in Honolulu in September 2016. This is the first time that this event will be hosted by the United States.

It was suggested that every effort be made to develop infrastructure in downtown Hawaii at the Fort Armstrong site and that vehicles be acquired by HCATT, SERVCO, the military, bus companies, etc. to utilize this publically accessible site. This suggestion brought enthusiastic responses from participants in the breakout session, resulting in the following action items:

- General Osserman, HCATT agreed to take the leadership role in organizing the various activities and initiatives.
- Together with other appropriate entities, HCATT will work with GSA and DOE to initiate discussions leading to the development of the Fort Armstrong site, generating hydrogen from photovoltaics – per the feasibility study.
- Work to continue to deploy hydrogen stations on Oahu and Hawaii.
- Dave Rolf will work with SERVCO, other dealers, and relevant agencies and entities in educating the community about hydrogen and FCEVs.
- Legislative proposals to accomplish these goals will be identified and provided to Senator Gabbard.

### **Action Items from EV Break-out Session**

Greg Gaug, Senior Associate, Ulupono Initiative, led the discussion. He provided an overview about Ulupono’s investments in clean transportation including BikeShare Hawaii and EV investment in Volta, and OpConnect. Greg also provided an overview regarding Hawaii’s EV Partnership Group, a public private partnership strategically planning on removing barriers to adopting EVs in Hawaii. The goal of the partnership is to be better connected with the region and to establish coordinated support from business partners in order to leverage the growth opportunities for the EV industry and to assist in removing barriers to adoption. The partnership is facilitated by Blue Planet Foundation.

The Hawaii EV Partnership has identified the following areas of focus:

- Education
- Policy
- Charging Rate Challenges
- Grid Challenges
- Infrastructure and Charging Challenges
- EV Design and offerings

The EV break-out session discussed programs and technologies that can help to address barriers to EV adoption and charging infrastructure installation in Hawaii. Local companies; EV Structure, and Volta provided insight regarding some of the main barriers to EV charging station installation in Hawaii while FreeWire, General Motors, and PlugShare, shared case studies and data to support breaking down barriers specifically within innovative charging station solutions, and workplace charging .

Several issues were raised at the BEV breakout session, which if properly addressed, would help with a sustained deployment of electric vehicles in Hawaii. These were:

- Lack of adequate charging access for those who live in Multiunit dwellings (MUD). 39% of Hawaii’s residents reside in MUDs and 61% reside in single family homes. Installing charging stations in shared parking scenarios such as MUDs is more complex than in a single-family residence garages because parking supply is

generally low and the ownership or access of parking stalls can further complicate installation. The greatest challenges to installing charging stations in MUDs is in complexes where electric meters and electricity supply are spaced far from the preferred EV stall, electric supply cannot accommodate the installation of a 220volt, and parking spaces are deeded or allocated. Stakeholders in Hawaii are working to solve the challenges of installing charging stations in MUDs. It was suggested that Hawaii should work with DOE and California (such as California Plug in Collaborative) to focus on actions to address the challenges. This will include policy and planning organizations, which can help solve the issues as well as exploring state support for charger station installation.

- Enhanced workplace charging access could have a beneficial effect on EV sales and help provide charging to those who reside in MUDs. While Nissan has not found the availability of workplace charging to increase sales, it was generally felt that Hawaii should utilize the DOE Workplace Challenge Program. In this way, Hawaii is leveraging industry to drive more infrastructure, and hence EVs. General Motors provided case studies of mainland workplaces who are taking a leadership role by offering charging to employees.
- Need for rental car fleet to increase EV offerings and make available to Government employees. The rental car fleet was seen as a valuable tool for educating the public and visitors to the benefits of EVs. Broader education of the public to understand the benefits of EVs to protect the unique and beautiful Hawaiian environment should be undertaken.

Several recommendations were raised, which if properly addressed, would help with a sustained deployment of electric vehicles in Hawaii. These were:

- Potential utilization of DBEDT tourism forms for visitors onboard airlines should be explored to see who would rent EVs, with the aim of increasing demand for rental car companies.
- It is encouraging to see companies with “new technologies” looking at Hawaii as a growth market. Examples are Volta, Plugshare and Freewire. The benefits of the state working with these companies can result in more EVs and more jobs.
- The utilities play an important role in the effective deployment, use and economic benefits of EVs. Specific areas of importance are load balancing/shifting and grid integration. Better planning for PV installation is an urgent need.

## Annex I – Glossary<sup>29</sup>

**B5** — Diesel fuel with 5 percent biodiesel blended in

**BEV** — Battery electric vehicle

**CNG** — Compressed natural gas

**DOE** – Department of Energy (U.S.)

**DBEDT** — Department of Business, Economic Development, & Tourism

**Electric-drive vehicle** – Includes hydrogen fuel cell and plug-in electric vehicles

**EV** — Electric vehicle, including battery electric and plug-in hybrid electric vehicles

**FCEV** — Fuel cell electric vehicle

**FTA** — Federal transit administration (U.S.)

**FY** – Fiscal year

**HCEI** — Hawaii Clean Energy Initiative

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<sup>29</sup> This master list may include entries that are in addition to those listed in the document.

**HDOT** — State of Hawaii Department of Transportation  
**HDV** — Heavy-duty vehicle, including trucks, buses, and vocational vehicles class 3-8  
**HECO** – Hawaiian Electric Companies  
**HNEI** — Hawaii Natural Energy Institute  
**ICCT** — International Council on Clean Transportation  
**LDV** — Light-duty vehicle, including cars and light trucks class 1-2  
**LT** — Light truck  
**MGY** — Million gallons per year  
**MPG** — Miles per gallon  
**NHTSA** — National Highway Traffic Safety Administration  
**PHEV** — Plug-in hybrid electric vehicle  
**PUC** – Public utilities commission  
**PV** – Photovoltaic  
**TDM** — Travel demand management  
**VMT** — Vehicle-miles traveled  
**US EPA** — United States Environmental Protection Agency

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## Annex III – Charrette Materials

### *FINAL HYDROGEN & EV Stakeholder Charrette Agenda & Day 1 Presentations [PDF]*

- Final charrette agenda
- Context for E-drive in HCEI [Presentation] – Alan Lloyd and Joshua Miller (ICCT)
- Morning and afternoon presentations
  - Current Status and Near Term Activities for Plug-in EVs in Hawaii – Jeff Mikulina (Blue Planet Foundation), Marc Deutsch (Nissan North America), Carlos Perez (Hawaiian Electric Companies), Dexter Turner (OpConnect), Michael Chang (Hawaii Energy)
  - Current Status and Near Term Activities for Hydrogen Vehicles in Hawaii – Brigadier General (ret) Stan Osserman (Hawaii Center for Advanced Transportations), Dr. Richard Rocheleau (Hawaii Natural Energy Institute), Paul Ponthieux (Blue Planet Research), Alex Keros (General Motors), Thorton Toma (Servco Hawaii)

### *FINAL HYDROGEN & EV Stakeholder Charrette Day 2 [PDF]*

- Morning and afternoon presentations
  - Welcome Remarks and Presentations from Invited Contributors Outside Hawaii – Pete Devlin (U.S. Department of Energy), Robert Rose (Breakthrough Technologies Institute, Eileen Wenger Tutt (California Electric Transportation Coalition), Tyson Eckerle (California Governor’s Office of Business and Economic Development), Jaimie Levin (Center for Transportation and The Environment), Dr. Abas Goodarzi (U.S. Hybrid)
  - Breakout Session 1: Hydrogen – Mitch Ewan, (Hawaii Natural Energy Institute)
  - Breakout Session 2: Plug-in EVs – Todd Ritter (EV Structure), Arcady Sosinov (FreeWire), Alex Keros (General Motors), Greg Gaug (Ulupono Initiative)

## Annex IV – Hydrogen Fuel Cell and Battery Electric Vehicle Stakeholder Charrette Attendees List

January 13-14, 2015

<b>Last Name</b>	<b>First Name</b>	<b>Organization</b>
Angelo	Michael	Hawaii Natural Energy Institute
Ashley	Thomas	PlugShare
Barboza	Herb	Oahu Transit Services, Inc.
Benson	Mark	Honolulu Ford
Boivin	Joseph	Hawaii Gas
Bonifacio	Noelani	Office of Senator Sam Slom
Cattermole	George	Renewable Energy Action Coalition of Hawaii
Chang	Michael	Hawaii Energy
Chin	Jonathan	DBEDT
Cole	John	Hawaii Natural Energy Institute
Colquitt	Christopher	General Motors

Conselva	Derek	EV Structure
Corpuz	Lester	Forest City Hawaii
De Rosa	Rene-Andre	Lamplighter Energy
Deutsch	Marc	Nissan North America
Devlin	Pete	U.S. Department of Energy
Dmohowski	Mitch	Eurus Energy
Eckerle	Tyson	Office of Governor Jerry Brown
Escajeda	Miles	BMW of Honolulu
Espiritu	Justine	EV Structure
Ewan	Mitch	Hawaii Natural Energy Institute
Finch	Jeff	Aloha Petroleum, Ltd.
Fooks	Karl	HSDC
Gabbard	Mike	State of Hawaii Senate
Gaug	Greg	Ulupono Initiative
Glick	Mark	DBEDT
Goldstein	Brian	MindSpark Ventures
Goodarzi	Abas	US Hybrid
Hahn	Dale	Office of Senator Brian Schatz
Haneberg	Scott	State of Hawaii
Hata	Bryan	Servco Pacific Inc.
Horiuchi	Jayson	State of HI, Division of Consumer Advocacy
Ichimura	Lance	Servco Pacific Inc
James	Rachel	U.S. Representative Tulsi Gabbard
Jung	David	B.T. Trans, LLC
Kahele	Gilbert	State of Hawaii Senate
Kelly	Ken	NREL
Keros	Alex	General Motors
Kohatsu	Kelvin	Hawaii Electric Light
Kuroda	Maki	E Noa Corporation
Kvam	Erik	Renewable Energy Action Coalition of Hawaii
Ky	Richard	Servco Pacific Inc.
Landry	Randall	Hawaii Department of Transportation
Larson	Margaret	DBEDT
Laut	Sheila	Chargepoint
Law	Bryan	Bryan YY Ho Law Office
Lawlor	Shem	Blue Planet Foundation
Levin	Jaimie	Center for Transportation and The Environment
Liu	Creighton	Hawaiian Electric Industries
Lloyd	Alan	International Council on Clean Transportation
Lum	Jackie	Leidos
Maeyama	Yukiko	HSDC
Martin	Todd	US Hybrid
McWhinney	Chris	Millennium Reign Energy LLC
Mikulina	Jeffrey	Blue Planet Foundation
Miller	Joshua	International Council on Clean Transportation

Mykleseth	Katie	Honolulu Star-Advertiser
Nakanishi	Craig	HSDC
Nakashima	Mark	State of Hawaii House of Representatives
Ogden	Keri	The Rice Partnership
Osserman	Stan	HCATT
Palms	Tim	BMW of Honolulu
Papoli	Aryan	US Hybrid
Peck	Theodore	Tian Shan Renewable Energy LLC
Penton	Arden	Volta Industries
Perez	Carlos	Hawaiian Electric Companies
Ponthieux	Paul	Blue Planet Research
Purcell	Dan	Public
Ritter	Todd	EV Structure
Rocheleau	Richard	Hawaii Natural Energy Institute
Rolf	David	Hawaii Automobile Dealers Association
Rose	Bob	BTI
Russell	Ed	HCATT
Sakamoto	Sherri	State of Hawaii
Shimoyoshi	Yoko	APEV/Hawaii Clean Energy Foundation
Snyder	Michael	HEVN / Hawaii Clean Energy Foundation
Sosinov	Arcady	FreeWire Technologies
Sparlin	Kym	DBEDT
Speas	Kurt	Tony Nissan
Sullivan	Ben	County of Kauai
Swislow	Jawann	FreeWire Technologies
Tamayoshi	Adam	Oahu Transit Services, Inc.
Togami	Tadahiro	Hitachi
Toma	Thor	Servco Hawaii
Tome	Maria	Hawaii Public Utilities Commission
Tsuha	Wally	Hawaii Clean Energy Foundation/Tsuha Foundation
Turner	Dexter	OpConnect Hawaii
Viray	Lynda	DBEDT
Wallsgrove	Richard	Blue Planet Foundation
Want	Mark	DBEDT
Wee	Sherilyn	UHERO
Wenger Tutt	Eileen	California Electric Transportation Coalition
Yajima	Tiffany	Ashford & Wriston, LLP
Yamamoto	Mark	Hawaiian Electric Company
Yao	Jimmy	Hawaiian Electric Company
Yee	Todd	Servco Pacific (Toyota Hawaii)
Yonan Jr.	Alan	DBEDT