Hawaii Clean Energy Initiative Transportation Energy Analysis

Final Report
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Prepared for:

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Hawaii State Energy Office

Submitted by:

THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

Acknowledgements

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Disclaimer

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iii. Foreword

Hawaii is undergoing the most important energy transformation since Captain William Matson converted the Falls of Clyde from a sugar transport to an oil tanker bringing liquid petroleum to our shores in 1907. Ninety years later, petroleum had grown to account for more than nine-tenths of the state's energy use at a cost of $2.76 billion, making Hawaii the most oil-dependent state in the nation.

After a century of oil, Hawaii is manifesting its clean energy future via a policy framework and stakeholder collaboration known as the Hawaii Clean Energy Initiative (HCEI). With a partnership between the State of Hawaii and the U.S. Department of Energy that was initiated in 2008 and reaffirmed in 2014, HCEI has set the most aggressive targets for energy efficiency and renewable energy in the nation. By 2015, Hawaii had greatly exceeded its interim targets for its renewable energy and energy efficiency portfolio standards (RPS & EEPS) and made history with its statutory provision to achieve 100% renewable energy in the electricity sector by 2045.

While much of the progress in Hawaii's clean energy transformation has taken place in the electricity sector, ambitious goals for reducing petroleum in the transportation sector have also been pursued. However, progress towards those goals have not met expectations. When considering that transportation accounts for two-thirds of the state's oil consumption, the Hawaii State Energy Office recognized the need for a renewed effort. The first step would be a comprehensive, analytic review of the progress to date towards meeting the HCEI transportation goals and the convening of a broader group of stakeholders representing the diverse interests that exist in the transportation sector. The International Council on Clean Transportation (ICCT) was contracted to carry out the analysis, convene stakeholders, and develop a new set of actionable tactics to reduce petroleum-based fuels in the transportation sector. ICCT was also tasked to take into consideration the rapid pace of technological change, innovation, and integration of energy in the electricity and transportation sectors.

This report is the result of that first step: nearly two dozen tactics to be pursued now as well as enabling actions and further analysis to develop a larger pipeline of petroleum reducing tactics to be pursued in the long term. The next step will feature a reconvening of stakeholders to collaborate on the development of an energy in transportation roadmap that will most certainly be a major focus of HCEI for many years to come. Together, we can make sure that Hawaii's energy transformation is comprehensive, inclusive and successful.

Mark Glick
Energy Administrator

iv. Executive Summary

In 2014, the Department of Business, Economic Development & Tourism's (DBEDT) Hawaii State Energy Office (HSEO) convened energy and transportation stakeholders to update plans for significantly reducing the consumption of petroleum products in Hawaii's transportation sector. The International Council on Clean Transportation (ICCT), an organization that leverages the collective expertise of a global network of specialists to promote policies for clean, efficient transportation, was procured to provide underlying assessments, analysis, recommendations, and stakeholder engagement to support the development of a new energy plan for transportation under the Hawaii Clean Energy Initiative (HCEI). The ICCT conducted a series of stakeholder consultations offering for consideration a new set of transportation options, and recommendations to reduce consumption of petroleum-based fuels in the transportation sector, including aviation, ground and marine transportation.

Development

The ICCT began the Transportation Energy Analysis with over 40 phone interviews of local stakeholders to gather insights on recent progress, relevant data, suggested policy options, and a future outlook of Hawaii's transportation sector. After developing a master list of nearly 100 potential tactics that could contribute to reduced petroleum consumption in the transportation sector, the ICCT developed a short list of 38 tactics for consideration for further review by transportation stakeholders for inclusion to an updated HCEI energy in transportation roadmap. Based on current conditions, ICCT evaluated the short list of tactics according to their petroleum benefits, costs, social acceptability, and likelihood of implementation, as well as several additional indicators. The evaluated tactics were presented and refined within a series of webinars and in-person meetings with participation from over 100 stakeholders from Hawaii and other U.S. states, and then ranked using a rigid framework to ensure transparency in the ICCT's primary and secondary recommendations.

Primary and secondary targets are recognized if they are likely to have:

- Measureable petroleum reduction benefits
- Monetary savings that outweigh the costs of implementation
- Social acceptability
- Likelihood of implementation

Table 1. Potential petroleum reduction in 2030 with recommended tactics

Sub-sector Tactic	Recommendation / Potential petroleum reduction in 2030 (MGY)
Vehicle Efficiency	**~24 MGY**
Federal vehicle fuel economy standards	16
High efficiency taxis	3.6
Procure EVs and efficient vehicles for public fleets	0.4 to 1.0
Green freight	1.1
Vehicle retirement incentives for low-income groups	1.1
Rental car efficiency program	1.4
Feebates for vehicle fuel efficiency	
Replacement tires	
Vehicle-Miles Traveled	**29 to 34 MGY**
Transit-oriented development	23
Infrastructure for alternative transportation modes	with above
Gasoline and diesel taxation	
Carsharing for public fleets	0.3 to 1.1
Dedicated parking for carsharing	1.2 to 1.7
Secure state support and funding of bikeshare	0.14
Commuter benefits legislation	0.7 to 3.6
Support of TDM by large employers	with above
Telecommuting by public employees and large employers	3.9 to 4.9
Flexible scheduling for work and classes	with above
VMT pricing program	
Price parking to recoup costs and promote alternative	
Electric-Drive Vehicles	**< 1 MGY quantified**
State rebates for electric-drive vehicles	242 gal/EV
EV rental prioritization for state and county employees	0.024 to 0.034
Time-of-use and EV charging rates	242 gal/EV
Promote government, private, and commercial	
Support economically viable hydrogen fueling	
Alternative Fuels	**–**
Cellulosic biofuel	
Sugarcane ethanol	
Support the consumption of CNG and LNG in vehicles	
Aviation	**7 MGY**
Financial support for winglet retrofits	4
Airport infrastructure support	3
Financial support for aircraft fleet renewal	
Increase the barrel tax	
Fuel efficiency-based landing charges	
Consumer information such as airline fuel efficiency ranking	
Marine	**2 to 7 MGY**
Slow steaming	0.8
Propeller polishing and hull cleaning	1.5 to 6.0
Increase bunker fuel taxes under the barrel tax	
Onshore power	
Total recommended (22 tactics)	**62 to 72 MGY**

LEGEND

Primary Target	Secondary Target	Monitor for Changes	Conduct Additional Research

Targeted Tactics

Of the 38 tactics evaluated, 22 tactics were recommended with either primary or secondary priority. In total, the recommended tactics could reduce petroleum use by 62 to 72 million MGY 2030 (Figure 1). Tactics to reduce vehicle miles travelled (VMT) and improve vehicle efficiency account for most of this potential, and those targeting aviation and marine account for 7% and 5%, respectively. The analysis provided allows the evaluation of tactics to be refreshed in response to changes in conditions of the assumptions. The list of targeted tactics is expected to grow if additional analysis is conducted that incorporates broader energy ecosystem benefits including the electric sector and Hawaii's energy economy.

Near term steps for identified tactics are addressed in the Implementation section. In addition these tactics will be rolled into a comprehensive energy roadmap developed by the HSEO that integrates the transportation, electric and residential, commercial and industrial sectors.

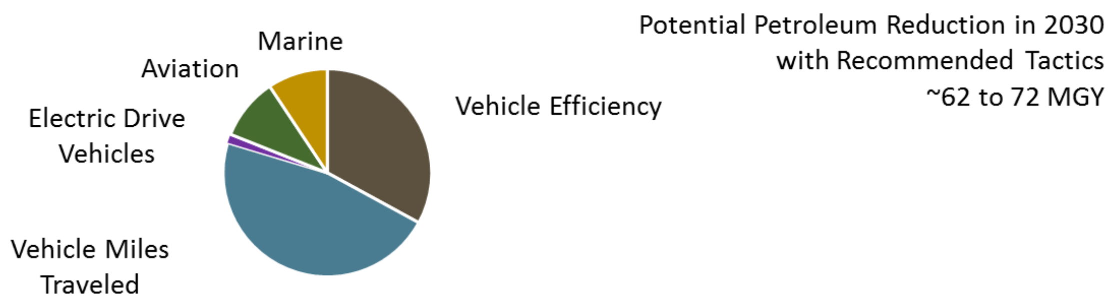


Figure 1. Quantified petroleum reduction in 2030 with recommendations by sub-sector

**note: A majority of electric-drive vehicle MGY reduction is captured in the revised baseline in Figure 2. Identified reductions in Figure 1 are incremental to the revised baseline reductions.*

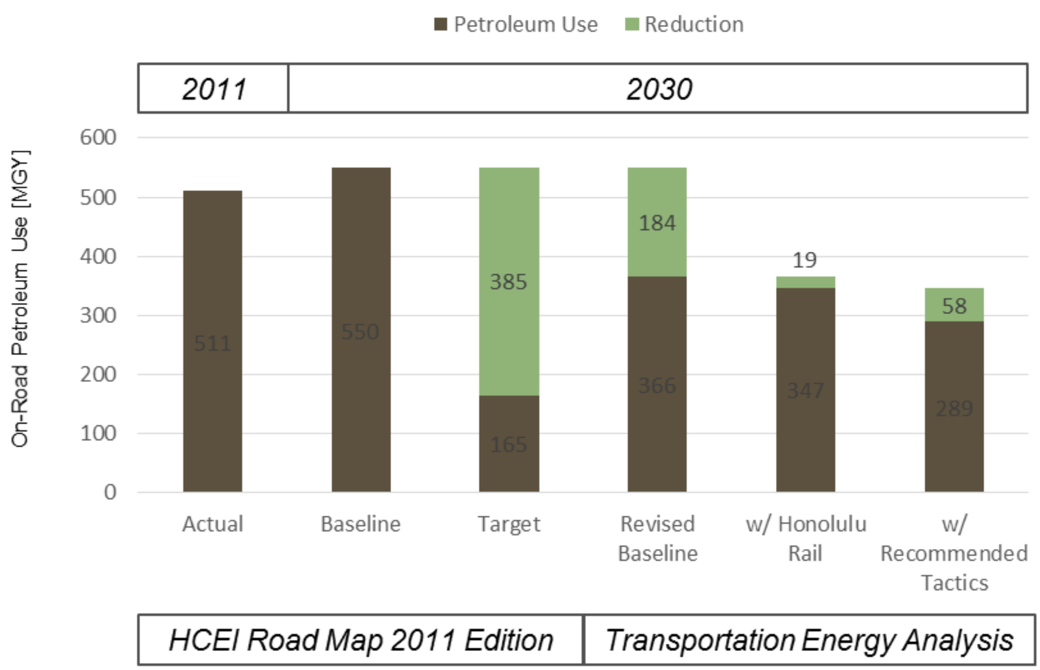
Identified Petroleum Reduction Potential in 2030

The ICCT considered recent policy developments to project on-road petroleum use in 2030. Recommended tactics in the report build on the new Transportation Energy Analysis baseline, which is 184 MGY lower than estimated in the HCEI 2011 Road Map, with the difference driven primarily by the following assumptions:

- New vehicles sold in Hawaii meet federal fuel economy standards for light-duty vehicles through 2025, and GHG standards for heavy-duty vehicles through 2018. These standards will reduce the fuel use of new light-duty vehicles by about 33% and heavy-duty vehicles by 5% to 13% compared to 2010 models.
- Sales of electric vehicles (EVs) increase to account for one in ten vehicles sold in 2030 (resulting in 43,000 EVs on the road).

- Total VMT increases in proportion to Hawaii's de facto population from 11.57 billion in 2014 to 13.40 billion in 2030 (assuming no change in per-capita VMT).
- Continuation of existing biofuel production and imports (including local production of 3 MGY biodiesel from waste fats).

Figure 2. Comparison of HCEI Road Map Target with Transportation Energy Analysis[1]



The Transportation Energy Analysis's recommended petroleum reduction tactics are intended to be updated with additional tactics periodically and reexamined to account for changing conditions of the criteria for selection. Moreover, this initial list is not the actual roadmap for action, but a scientific analysis of strategies and tactics that do not include all potentially beneficial and cost-effective actions. This report, therefore, provides a fairly comprehensive list of cost-effective, feasible actions that should be seriously considered by transportation and energy stakeholders for inclusion in an energy in transportation roadmap for action to advance Hawaii's clean energy goals in the transportation sector. New research and data for evaluation of additional tactics is essential, along with continued refinement of analysis for evaluated tactics and assumption updates for changes in market conditions.

Implementation

[1] The 62 to 72 MGY of incremental petroleum reductions noted above result from the 58 MGY in ground transportation shown in Figure 2 plus the 9 to 14 MGY identified in Figure 1.

With the conclusion of the Transportation Energy Analysis, the next step is for transportation and energy stakeholders to collaborate on an action plan framework and commit to carrying out specific actions. ICCT cites two lessons learned from successful approaches in California and other jurisdictions that may be applied to Hawaii and the HCEI energy in transportation roadmap[2]:

- The number one priority is to identify the responsible persons and Agency for implementation of the plan. To be successful, support for the plan would be needed from the Governor, legislature and key agencies including DBEDT, Hawaii Department of Transportation and City and County Governments.
- The recommendations must have the backing of the Governor and the legislature. One approach would be for this report to be used to create an Action Plan to be submitted to the Governor and the legislature. This action plan will embody the recommendations included in this report.

Suggested next steps for each of the recommended tactics are as follows.

- Develop a plan with the additional details for implementation, including refined policy design, implementation schedule, explanation of costs and benefits, and funding considerations (if applicable).Implement any enabling actions that are necessary for the success of the tactic (for example, setting binding VMT reduction goals that align objectives across state and county agencies).
- Incorporate the work in the transportation sector within a comprehensive energy road map. The road map must take into account the interdependencies throughout Hawaii's energy ecosystem to identify requirements and innovations necessary to achieve state policy goals including achieving 100% renewable energy in the electric sector.
- For each tactic, designate a lead agency and a coordinator[3] that will be responsible for taking it toward implementation. This designation should ideally come from the Administration or the Legislature in order to ensure accountability to fulfill this responsibility. Critical functions of this role include developing a detailed implementation plan which includes the following steps:
    - Collect baseline data to support evaluation of impacts;
    - Commission research as needed to support policy development;
    - Engage with all stakeholders whose support is needed for implementation;
    - Conduct education and public outreach to ensure social acceptability;
    - Monitor performance to demonstrate impacts once the tactic has been implemented.

Based on these suggestions, HSEO plans to oversee development of a draft implementation framework for the identified tactics in collaboration with key government agencies and stakeholders. HSEO will hold a follow up meeting in September 2015 in which the draft implementation framework will be vetted by stakeholders. Specific items include:

- Tactic leads
- Framework for leads to measure and report on tactic progress

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[2] These successful approaches are described further in Section V.F.

[3] Recommended tactics will require inter-agency and private sector collaboration, in addition to clearly defined roles and responsibilities.

- Method for socializing plan, results and resource requirements to key stakeholders including the Administration, legislature and State and County agencies in order to secure sustained support and necessary resources for implementation
- Process to update analyzed tactics for changes in market conditions and incorporate additional tactics into the energy in transportation roadmap

Tactic leads with support of their working groups will present tactic specific implementation plans by the end of the 4th Quarter of 2015.

I. Introduction

A. Transportation Energy Analysis

In 2014, the Hawaii State Energy Office 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 was tasked with:

- Analyzing the progress to date on the transportation section of the HCEI Road Map 2011 Edition (Section II);
- Conducting a series of stakeholder consultations held between November 2014 and June 2015, collectively referred to as the "Transportation Charrette";
- Offering for consideration a new set of transportation options (Section V.B), goals (Section V.D.3) and timeline (Section V.B) to reduce consumption of petroleum-based fuels in the transportation sector, including aviation, ground and marine transportation; and
- Assessing what can realistically be achieved in terms of gasoline and diesel reductions by 2030 (Section V.D), taking into account social acceptability, costs, funding availability, and likelihood of implementation (Section IV).

Of the nearly 100 tactics identified in the ICCT's survey of the literature and consultations with stakeholders, the ICCT prioritized evaluation of 38 tactics based on likely impact on statewide petroleum consumption and present feasibility in Hawaii. The remainder of tactics in the master list were not evaluated due to insufficient baseline data (VI.E), unclear policy definition[4], or were not prioritized in consideration of limited project timing and resources. Tactics that could enable reductions in petroleum consumption indirectly by supporting the implementation of other tactics were also evaluated qualitatively or simply included in the master list based on their priority.

[4] For example, one tactic identified by stakeholders was to consider residential density and distance to work as key determinants of transport activity. While such a recommendation could very well lead to reductions in vehicle-miles traveled and petroleum use if land use planners site residential locations closer to employment centers, it is not straightforward to link this recommendation with a specific policy action in a manner that would support analysis of costs, benefits, implementation timeline, etc.

The ICCT's analysis builds on previous work (*Road Map*[5] & *Hawaii Clean Energy Initiative Scenario Analysis*[6]) in that it:

- Focuses in depth on the Transportation sector, including aviation and marine, which account for 40 percent of statewide transportation energy use, as well as passenger vehicles, commercial vehicles, and alternative means of passenger transport;
- Considers costs, social acceptability, and likelihood of implementation in addition to the benefits of petroleum reduction tactics;
- Compiles a master list of nearly 100 tactics to reduce or enable reductions in petroleum consumption in transportation;
- Quantitatively and qualitatively evaluates a short list of tactics spanning various strategies;
- Recommends 22 tactics for consideration in Hawaii based on a systematic, transparent ranking, and;
- Delivers a model[7] and calculation spreadsheets[8] that enable the Hawaii State Energy Office with input from stakeholders to build in the quantitative analysis with up-to-date transportation data, policy assumptions, and scenarios in support of policy discussions.
- Recommends steps to better integrate tactics into planning and performance monitoring processes of relevant government agencies at the state and local levels. Stakeholders highlighted the need for such integration in the breakout session on Managing Travel Demand at the November 13, 2014 stakeholder meeting.

B. Project Timeline

The Transportation Energy Analysis was carried out from August 2014 through June 2015 (Table 2). The ICCT began by analyzing the progress to date on the transportation section of the *HCEI Road Map 2011 Edition* (Section C).

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[5] Hawaii Clean Energy Initiative (HCEI) (2011). HCEI Road Map, 2011 Edition. Retrieved from http://www.hawaiicleanenergyinitiative.org/about/

[6] Braccio, R., Finch, P., and Frazier, R. (2012). *Hawaii Clean Energy Initiative Scenario Analysis: Quantitative Estimates Used to Facilitate Working Group Discussions (2008–2010).* NREL/SR- 7A40-52442. Booz Allen Hamilton: McLean, Virginia

[7] ICCT (2014). Modified version of VISION model adapted for Hawaii. VISION 2013 AEO Base Case ©COPYRIGHT 2004 UCHICAGO ARGONNE, LLC. Retrieved from http://www.transportation.anl.gov/modeling_simulation/VISION/

[8] Model and calculation spreadsheets are available as an archive upon request from HSEO.

In advance of the first stakeholder workshop in November, the ICCT conducted phone interviews with over 40 stakeholders[9] to gather insights on recent progress, relevant data, suggested policy options, and future outlook. The list of stakeholders invited to the public workshop included members of federal, state, and local government, the military, industry, NGOs, and civil society. All stakeholders were encouraged to submit written comments, relevant data, and specific policy proposals to the State Energy Office as well as the ICCT. To augment the feedback received from stakeholders during phone interviews, in-person interviews and written comments, the ICCT conducted an online survey of stakeholder opinions on HCEI strategies and tactics (VI.A).

Table 2. Project timeline for Transportation Energy Analysis

Action	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15
Conduct survey and stakeholder interviews • Section VII.A		■	■	■							
Review of progress since *HCEI Road Map 2011 Edition* • Section II	■	■	■	■							
Transportation Sector Stakeholder Workshop, November 13, 2014 • Summary Report • Agenda and Morning Presentations • Afternoon Breakout Sessions Presentations and Transportation Survey • VMT Tactics Worksheet (Section VI.D)				■							
Hydrogen Fuel Cell & Battery Electric Vehicle Stakeholder Charrette, January 13-14, 2015 • Summary Report • Agenda & Day 1 Presentations • Day 2 Presentations & Breakout Sessions						■					
Webinars on vehicle efficiency, aviation, and marine • Vehicle Efficiency Options, January 8, 2015 • Aviation Efficiency Options, February 2, 2015 • Marine Efficiency Options, February 11, 2015						■	■				
Develop master list of tactics		■	■	■	■						
Narrow down strategies and tactics					■	■	■				
Qualitative and quantitative evaluation of tactics						■	■	■			
Assess complementarity with existing Hawaii policies, plans and budgets							■	■			
Draft report submitted to the State Energy Office									■	■	
HCEI Transportation Analysis Stakeholder Meeting, June 17, 2015											■

[9] Stakeholders interviewed in advance of the November workshop are listed as an appendix.

Incorporate stakeholder feedback in revised report											
Final report											

At the workshop on November 13, 2014, the ICCT presented an assessment of progress in the transportation sector since the *HCEI Road Map 2011 Edition*; held breakout sessions on Managing Travel Demand and Alternative Fuels; presented a preliminary master list of petroleum reduction tactics spanning various strategies; and gathered feedback from stakeholders. The ICCT continued to gather feedback from stakeholders through continued email exchange and a series of in-depth meetings and webinars[10] focusing on Vehicle Efficiency, Electric-Drive Vehicles, Aviation, and Marine. This feedback informed the revision of the master list of tactics (Section D) and refinement of the qualitative and quantitative assessment of tactics under consideration (Section E).

Based on the qualitative and quantitative assessment, the ICCT created a transparent framework for selection of key tactics to be recommended for inclusion in the revised HCEI transportation energy road Map. The ICCT then:

- Assessed the plausible reduction in petroleum use in 2030 compared with the new baseline (Section V.D);
- Assessed whether the recommended tactics are included in existing transportation plans, and suggested possible funding avenues to support implementation (Section V.E);
- Documented enabling actions that will support the implementation of the tactics (Section V.C), and;
- Presented the summary of results to stakeholders in an in-person workshop on June 17, 2015.

C. Status of Petroleum Use within Hawaii's Transportation Sector

In 2014, Hawaii's transportation sector consumed the energy equivalent of roughly 863 million gallons of gasoline (Figure 3). Ground transportation accounted for just over half of this total, with the remainder consumed by aircraft and marine vessels.[11]

[10] Materials are available at: http://www.hawaiicleanenergyinitiative.org/charrettes/transportation-charrette/

[11] It should be noted that estimates of aviation and marine fuel use can vary based on the share of activity attributed to Hawaii vs. other US states or internationally.

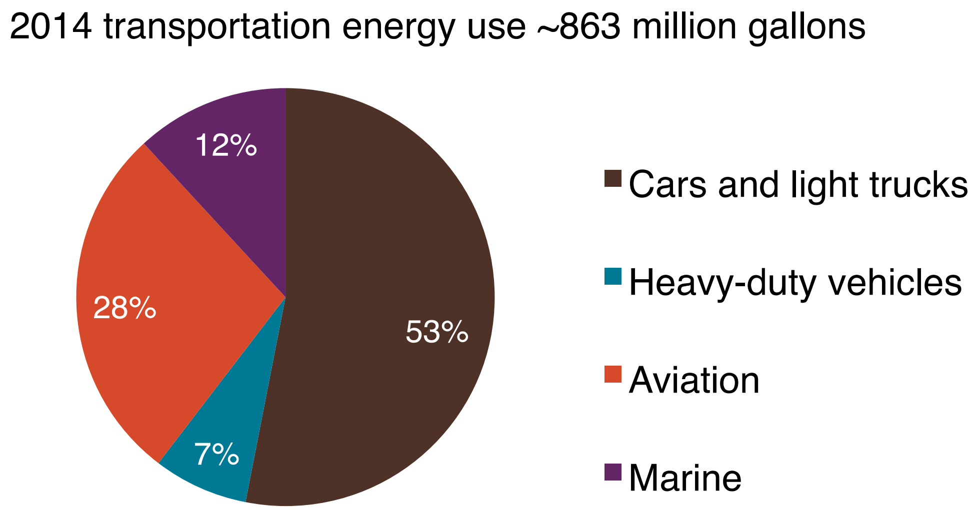

Figure 3. Transportation energy use[12] in Hawaii, 2014 (ICCT, 2014; DBEDT, 2014a; DBEDT, 2014b)

Over the course of stakeholder interviews, the question arose as to whether the State should pursue improvements to the efficiency of marine vessels and aircraft traveling to and from Hawaii as well as those traveling between islands within the state. For marine, based on available data from DBEDT, fuel sales to inter-island vessels that use ultra-low sulfur fuels (ULSF) amounted 2.69 million gallons in 2013[13]. In the same year, sales of bunker fuels to ocean-going vessels traveling to and from Hawaii amounted to 108 million gallons[14]. The volume of fuel used by ocean-going vessels compared to inter-island vessels indicates that the State should be promoting efficiency of all ships departing from Hawaii. A similar conclusion can be drawn for aviation. In 2014, although 71% of the flights departing from Hawaii were inter-island, these flights made up 3% or less of the total revenue passenger-miles (RPMs) traveled, and other domestic and international flights made up 57% and 40% of RPMs, respectively[15]. In consideration of

[12] Marine estimated based on sales of distillate and bunker fuels. Source: US EIA (2015). Distillate Fuel Oil and Kerosene Sales by End Use. Retrieved 10 Jun 2015 from http://www.eia.gov/dnav/pet/PET_CONS_821USE_DCU_SHI_A.htm.

Aviation based on DBEDT (2015). Monthly Energy Trends. Retrieved from http://dbedt.hawaii.gov/economic/energy-trends-2/.

Cars, light trucks, and heavy-duty vehicles estimated in ICCT (2014) based on gasoline and diesel use in DBEDT (2015). Source: ICCT (2014). Modified version of VISION model adapted for Hawaii. VISION 2013 AEO Base Case ©COPYRIGHT 2004 UCHICAGO ARGONNE, LLC. Retrieved from http://www.transportation.anl.gov/modeling_simulation/VISION/

[13] It should be noted that Nami Ohtomo from Young Brothers said the inter-island shipping company consumed about 5 million gallons of ULSF annually. This exceeds the total ULSF sales in Hawaii to smaller ships reported by DBEDT, indicating that there may be potential to improve the coverage of statewide data.

[14] US EIA (2015). Distillate Fuel Oil and Kerosene Sales by End Use. Retrieved 10 Jun 2015 from http://www.eia.gov/dnav/pet/PET_CONS_821USE_DCU_SHI_A.htm

[15] US DOT (2014). Bureau of Transportation Statistics via Data Base Products.

the large share of aviation activity covered by other domestic and international flights, there is opportunity for the State to promote the efficiency of all flights servicing Hawaii airports in addition to the subset of inter-island flights.

II. Status of HCEI Road Map 2011 Edition Strategies

The *HCEI Road Map 2011 Edition* laid out four strategies to achieve a 70 percent reduction in petroleum use from ground transportation, equivalent to roughly 385 million gallons per year (MGY) against a baseline projection of 550 MGY in 2030. These strategies included reduction in vehicle-miles traveled (VMT), expansion of renewable fuels, improved vehicle fleet efficiency, and expanded market share of electric vehicles (EVs)[16]. To achieve such an aggressive goal for reducing ground transportation petroleum use, the *Road Map* established interim targets for each of the four strategies; these near-term and mid-term targets are compared with recent progress in Table 3.[17]

Table 3. Comparison of 2015/2020 goals with 2014/2015 status

Strategy with 2010 baseline	2015 target	2020 target	2014/2015 Actual
Reduce vehicle miles traveled (VMT)	2% VMT reduction	4% VMT reduction	14% increase in VMT (2010-2014)[18]
Incorporate renewable fuels into transportation sector	E10 and biodiesel at 2010 level[19]	–	52 million gallons
Improve standard efficiency of in-use vehicles[20]	25 mpg cars 18 mpg LT[21]	30 mpg cars 22 mpg LT	30 mpg cars 23 mpg LT
Accelerate the deployment of EVs and related infrastructure	4K EV sales (10K on road)	10K EV sales (40K on road)	1K EV sales (3,400 on road[22])
Ground transportation fuel use of 496 MGY in 2010	**–**	**–**	**521 MGY in 2014 (5% increase)**

[16] The term "electric vehicle" (EV) includes battery electric (BEV) and plug-in hybrid electric (PHEV) vehicles; this definition is commonly used in existing legislation (Hawaii State Legislature, 2009) and plans (HCEI, 2011) in Hawaii. The term "electric drive vehicle" (sometimes abbreviated "edrive") typically includes hydrogen fuel cell electric vehicles (FCEV) in addition to BEV and PHEV.

[17] Dash (–) indicates no interim target

[18] Hawaii DOT's statewide estimates of VMT were 10,111 million in 2010 and 11,570 million in 2014.

[19] Roughly 40 MGY for ethanol and 1 MGY for biodiesel. Source: DBEDT (2011). Biofuels Study Final Report to the Legislature In Accordance with Act 203, Session Laws of Hawaii, 2011.

[20] The vehicle efficiency figures reported in this table reflect the average fuel economy of cars and light trucks operating in Hawaii based on estimates of fuel use and VMT by vehicle type from Argonne National Laboratory's VISION model, adapted for Hawaii by the ICCT. These average fuel economy estimates for specific vehicle types differ by definition from the statewide average of all vehicle types that is estimated in DBEDT's Data Book (which includes heavy-duty trucks and buses in its calculation of average vehicle fuel economy).

[21] Light trucks (LT) include pickups, light commercial vans, and sport utility vehicles.

[22] As of March 2015. Source: DBEDT (2015a). Monthly Energy Trends. Retrieved from http://dbedt.hawaii.gov/economic/energy-trends-2/

The next several sections take a more detailed look at recent progress in Hawaii on each of the four strategies covered in the *HCEI Road Map 2011 Edition*.

A. Reduce Vehicle Miles Traveled

Between 1984 and 2013, the average number of vehicle-miles traveled per vehicle in Hawaii remained remarkably consistent at just over 9,000 annually (DBEDT, 2014). During this period, the State saw a 37%[23] increase in both population and the number of vehicles per capita, which combined have resulted in an 86% increase in total VMT. Growing VMT is a key driver of energy consumption for ground transportation, and the *HCEI Road Map 2011 Edition* identified VMT reduction as a core strategy toward meeting the State's clean energy goals for ground transportation.

The authors of the *HCEI Road Map 2011 Edition* identified VMT reduction as an area in which the State has "direct control" in comparison to other factors such as vehicle choices offered by auto manufacturers and international oil prices[24]. While it is true that the State – in collaboration with local governments – could take actions that significantly reduce statewide VMT over the long term, in the ICCT's view the State has relatively little direct control over changes in VMT from year to year. Whereas the *HCEI Road Map 2011 Edition* strategies for vehicle efficiency, electrification, and biofuels hinge on technology development and deployment, VMT strategies rely on influencing individual travel decisions and housing choices through a combination of transportation and land use planning, pricing measures, and travel demand management. This complex relationship between individual travel decisions and government policies contributes to the uncertainty associated with quantifying the impacts of such policies (Section F).

The *HCEI Road Map 2011 Edition* establishes quantitative goals to reduce the total number VMT statewide compared to the year 2010. These incremental goals are equivalent to a 2% reduction in 2015, 4% in 2020, and 10% in 2030. When these goals were set, VMT had stayed relatively flat for several years as a result of the 2007-2009 recession. From 2010 to 2013, VMT increased quickly as the economy recovered (Figure 4). As shown in Table 4, the increase in VMT after 2010 means that statewide VMT would need to decline 14% to meet the 2015 target, and 20% to meet the 2030 target. Coupled with a projected 14% increase in statewide population by DBEDT[25], per-capita VMT would need to decline 29% from 2014 levels to meet the 2030 VMT reduction target.

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[23] Change in vehicles per capita estimated from de facto population and registered motor vehicles. Source: DBEDT (2015). State of Hawaii Data Book Time Series. Retrieved 7 May 2015 from http://dbedt.hawaii.gov/economic/databook/data_book_time_series/

[24] Hawaii Clean Energy Initiative (HCEI) (2011). *HCEI Road Map, 2011 Edition*. Page 17. Retrieved from http://www.hawaiicleanenergyinitiative.org/about/.

[25] DBEDT (2015). Population and Economic Projections for the State of Hawaii to 2040. Retrieved from http://dbedt.hawaii.gov/economic/economic-forecast/2040-long-range-forecast/

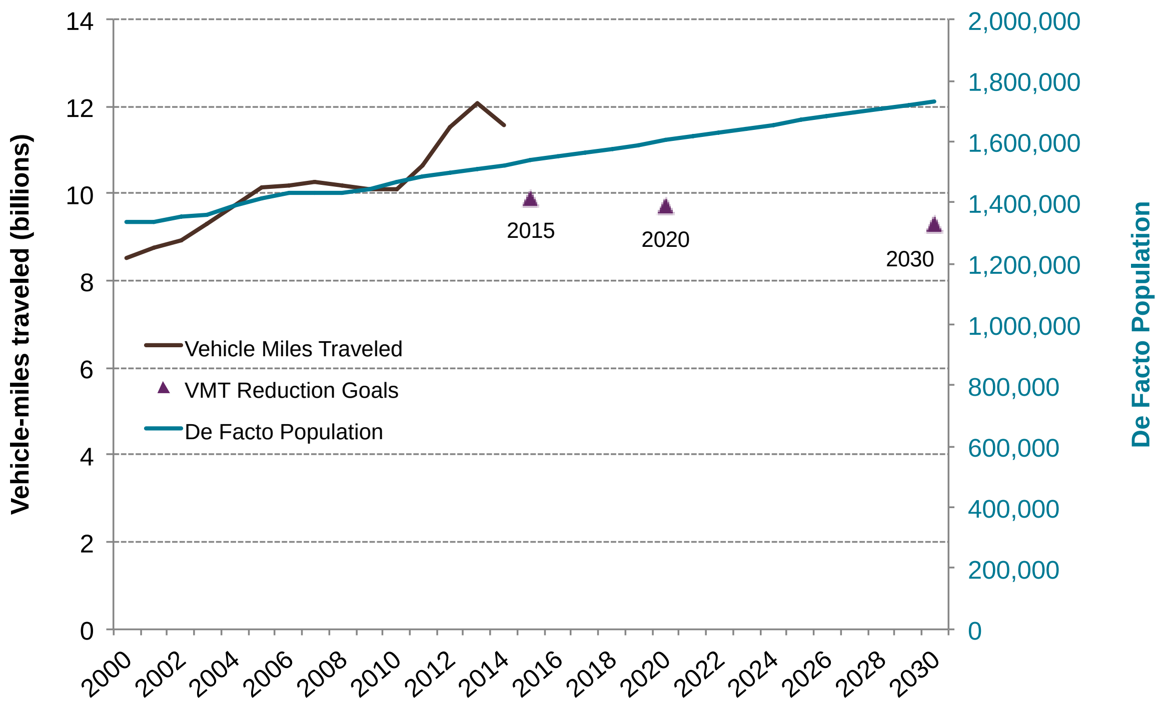

Figure 4. Trends in statewide population and vehicle-miles traveled

Table 4. Comparison of *HCEI Road Map 2011 Edition* goals with trends in VMT and population

Indicator	Historical 2010	Historical 2014	Goals 2015	Goals 2020	Goals 2030
VMT (billion)	10.11	11.57	9.91	9.71	9.30
Percent change from 2010	-	14%	-2%	-4%	-8%
Percent change from 2014	-	-	-14%	-16%	-20%
De facto population (million)	1.47	1.52	1.54	1.60	1.73
Population change from 2010	-	4%	5%	9%	18%
Population change from 2014	-	-	1%	5%	14%
VMT per capita	6882	7596	6438	6051	5370
VMT per capita change from 2010	-	10%	-6%	-12%	-22%
VMT per capita change from 2014	-	-	-15%	-20%	-29%

Data sources: VMT (DBEDT Monthly Energy Data), Population (DBEDT 2040 long-range forecast)

Target in *HCEI Roadmap 2011 Edition*

B. Incorporate Renewable Fuels into Transportation Sector

The renewable fuels strategy in the *HCEI Road Map 2011 Edition* focused on increasing the volume of ethanol and biodiesel consumed in the transportation sector. The near-term biofuels target could be met through ethanol imports to offset federal Renewable

Fuels Standard (RFS) requirements[26] to blend 10 percent ethanol into motor gasoline. Currently, nearly 3 million gallons a year of biodiesel is produced from waste products in Hawaii, and testing is underway to produce biodiesel from agricultural crops. The long-term target of 150 MGY by 2030, however, is much more aggressive. Biofuels were assumed to make up the remainder of the 70% reduction by 2030 after accounting for other strategies; however, limited local availability of agricultural land and the current cost-effectiveness of producing this volume of biofuels create barriers to achieving this target.

C. Improve Vehicle Efficiency

Of the four *HCEI Road Map 2011 Edition* strategies, the outlook for vehicle efficiency has improved the most since 2010 as a result of federal CAFE/GHG rules established by the US EPA and NHTSA for new passenger vehicles for model years 2012-2016 and 2017-2025, and for new heavy-duty vehicles model years 2014-2018. These standards are expected to reduce the fuel consumption of new passenger vehicles by 42 percent from 2010-2025, and by 7-20 percent for heavy-duty vehicles from 2010-2017.[27] Presently, the fleet average efficiency for cars and light trucks is estimated to have met the HCEI Road Map's 2020 target based on the ICCT's fleet turnover analysis using Argonne National Laboratory's VISION model[28]. Hawaii's vehicle fleet is expected to meet the efficiency targets through 2030 in the absence of action at the state level.

D. Accelerate the Deployment of EVs and Related Infrastructure

In the past several years, the State of Hawaii has made significant investments in enabling infrastructure for EVs. Now, there are 160 public charging stations (364 ports) across Hawaii, and Hawaii is among the leading states nationwide in terms of the share of EVs sold[29]. With just over 1,000 EVs added statewide in the last year[30], the 2015 EV

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[26] As of December 31, 2015, Act 161, SLH 2015 (SB 717 SD2 HD1 CD1), the State ethanol blending mandate, which dictates a statewide 10% ethanol blending requirement, will be repealed. The repeal's effects on state ethanol consumption is unclear at this time.

[27] TransportPolicy.net (2015). "US Light-duty Fuel Economy and GHG." ICCT and DieselNet. Retrieved from http://transportpolicy.net/index.php?title=US:_Light-duty:_Fuel_Economy_and_GHG

[28] ICCT (2014). Modified version of VISION model adapted for Hawaii. VISION 2013 AEO Base Case ©COPYRIGHT 2004 UCHICAGO ARGONNE, LLC. VISION model available from http://www.transportation.anl.gov/modeling_simulation/VISION/

[29] Jin, Searle, and Lutsey (2014). Evaluation of State-Level U.S. Electric Vehicle Incentives. The International Council on Clean Transportation. Retrieved from http://www.theicct.org/evaluation-state-level-us-electric-vehicle-incentives

[30] According to DBEDT monthly energy trends, there were 1,020 more EVs registered in Hawaii in March 2015 than in March 2014, suggesting annual EV sales of at least that number. Source: DBEDT (2015a). Monthly Energy Trends. Retrieved from http://dbedt.hawaii.gov/economic/energy-trends-2/

goals of 4,000 in sales and 10,000 on the road are unlikely to be met; however, the overall trend (Figure 5) is encouraging and indicates meaningful progress has been made by statewide actions[31].

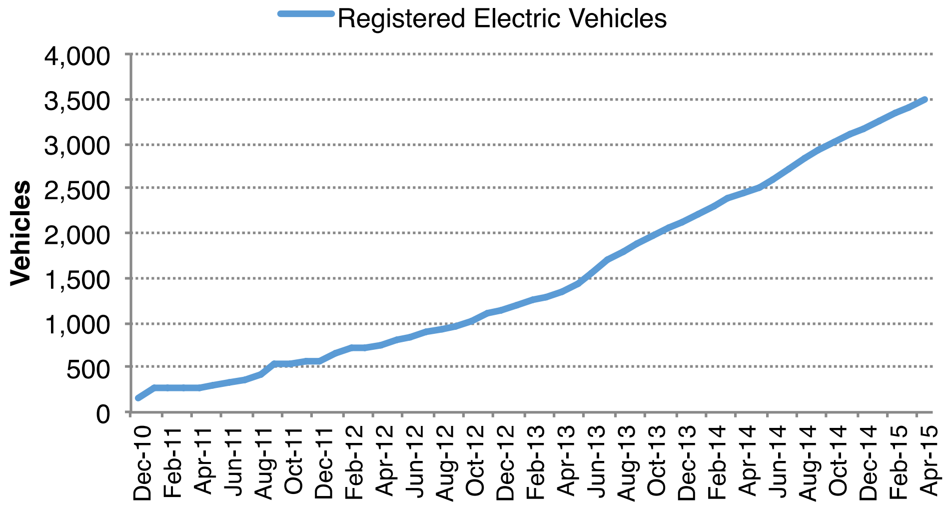

Figure 5. Registered electric vehicles in Hawaii[32]

III. Master List of Tactics

In its extensive series of publications on *Transportation Energy Futures*, the US Department of Energy recognizes the need for combined strategies to reach transportation petroleum and emissions reduction goals, including measures to improve vehicle efficiency, reduce travel demand, and switch to alternative fuels and electric-drive vehicles[33]. The ICCT's evaluation of progress since the *HCEI Road Map 2011 Edition* determined that this need for a combined approach applies not only at the federal level, but in Hawaii as well (Section I.C).

Based on a broad survey of the literature and consultations with stakeholders (VI.A; VI.C), the ICCT compiled an initial master list of tactics deemed feasible for inclusion in the HCEI transportation energy analysis. This list was updated and expanded as feedback was received from stakeholders.

The following master list includes all tactics and enabling actions considered, organized by sector (Table 5). The first column provides a description of the tactic, and footnotes provide additional detail where necessary. Column two indicates whether each tactic

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[31] Ibid.

[32] DBEDT (2015a). Monthly Energy Trends. Retrieved from http://dbedt.hawaii.gov/economic/energy-trends-2/

[33] US DOE (2013). "Transportation Energy Futures Study Points to Deep Cuts in Petroleum and Emissions." Retrieved from http://www1.eere.energy.gov/analysis/transportationenergyfutures/pdfs/tef_snapshot.pdf

was evaluated in the quantitative and qualitative analysis. Tactics were selected for evaluation based on availability of baseline data, likely impact on petroleum use statewide, and clear link between policy and petroleum impacts. Some of the tactics that were not evaluated (column five) may very well be worthy of consideration. For these tactics, either additional baseline data may be needed in order to facilitate analysis (VI.E), the tactic may need to be better defined and linked to a potential policy action[34], or additional funding may needed to commission a targeted study of sufficient depth.

The third column indicates existing or pending actions that should be coordinated with the recommendations developed in this report. Such actions are currently undergoing planning, implementation, or revision. The fourth column indicates enabling actions that could reduce petroleum consumption indirectly by supporting other tactics. Enabling actions are described in more detail in Section V.C.

[34] For example, a tactic to promote ridesharing/taxi services such as Lyft and Uber was not evaluated since there is not yet a clear link between these services and petroleum reductions: in particular, there are concerns that such services may compete with public transport instead of reducing driving, and additional evidence would need to be collected in order to characterize this as a petroleum saving action.

Table 5. Master list of tactics

Tactic	Evaluated	Existing / Pending	Enabling Action	Not Evaluated
General	0	0	7	0
Leverage rental car fees to finance clean transportation programs[a]			x	
Increase barrel tax to fund government actions to support clean energy			x	
Leverage federal grants for clean surface transportation			x	
Better data collection, validation, and sharing across government agencies[b]			x	
Public environmental education to promote awareness of State and County programs			x	
Baseline projections of transportation energy demand			x	
Establish performance metrics for planning agencies to measure and report progress[c]			x	
Vehicle Efficiency	8	2	0	5
Procure EVs and efficient vehicles for public fleets	x	x		
Federal vehicle fuel economy standards	x			
Feebates for vehicle fuel efficiency	x			
Green freight	x			
Replacement tires	x			
Vehicle retirement incentives for low-income groups	x			
High efficiency taxi program	x			
Rental car efficiency program	x			
Better enforcement of existing vehicle idling restrictions		x		x
Encourage use of fuel economy labels for used car sales				x
Hybrid, alternative fuel, or electric-drive public transit buses and shuttles[d]				x
Government motor pool fleet lease vs. own				x
Improve the efficiency of tour bus fleets[e]				x
Vehicle-miles traveled (VMT)	12	8	8	14
Legislative VMT reduction target			x	
Replace LOS metric with VMT			x	
Transit-oriented development	x	X		
Expand infrastructure for alternative transportation modes (biking, walking, and transit)	x	X		
Increased gasoline and diesel taxation	x			
VMT pricing program	x			
Price parking to recoup costs and promote alternative modes	x			
Carsharing for public fleets	x			
Dedicated parking for carsharing	x			
Commuter benefits legislation	x	X		
Support Transportation Demand Management (TDM) by large employers	x		x	
Multimodal public safety campaign			x	
Promote intelligent transportation systems			x	
Telecommuting by public employees and large employers	x			
Flexible scheduling for work and classes	x			
Statewide policy to promote roundabouts				x
Bus priority lanes to improve travel times				x
Secure state support and funding of bikeshare programs	x	X		
Clarify legality of using tax increment financing for infrastructure projects				x
Utilize EPA state revolving loan funds to improve existing water infrastructure				x
Estimate maximum rail system capacity (HRTP) and formulate TOD plans meet capacity		X		x
State and local government collaboration to develop state lands near rail stations				x
Consider residential density and distance to work as determinants of transport activity				x
Transportation Alternatives Program to support multi-modal transportation options				x
Expand statewide public transportation[f]		X		x
Improve efficiency of school trips and reduce associated traffic congestion[g]				x
Promote Peer-to-Peer carsharing				x
Promote ridesharing/taxi services (e.g. Lyft, Uber)				x
Promote Vanpool services		X		x
Tour bus fleets[h]				x
Island-specific mode share goals for bicycling, walking, and transit			x	
Support an interdepartmental group to connect transit, walking, and bicycling facilities		X	x	
Incorporate health sector goals for active transportation into local planning decisions			x	

Tactic	Evaluated	Existing / Pending	Enabling Action	Not Evaluated
Electric-drive vehicles	4	6	10	7
Procurement of government FCEVs				x
Provide incentives for private FCEVs				x
Encourage commercial vehicle operators to replace diesel ICEs with FCEVs				x
Define FCEVs as electric-drive vehicles and offer the same benefits as plug-in EVs		X	x	
Leverage federal grants for FCEVs			x	
Designate a lead hydrogen authority to implement State programs			x	
Support the development of economically viable hydrogen fueling infrastructure	x	X		
Standardize codes and permitting to ensure safe operation of hydrogen facilities			x	
Pilot demand-responsive hydrogen electrolysis facilities			x	
State rebates for electric-drive vehicles	x			
Conduct targeted outreach about the benefits of EVs		X	x	
EV rental prioritization for state & county employees	x			
Extend time-of-use and EV charging rates to all EV customers	x	X		
Pilot demand-responsive EV charging and vehicle-to-grid technology			x	
Promote multi-unit dwelling charging with regulatory and fiscal incentives			x	
Promote workplace charging with regulatory and fiscal incentives			x	
Enforce or penalize non-compliance with EV parking requirements		X	x	
Promote electric bicycles				x
Promote deployment of non-road EVs and FCEVs (e.g. forklifts)				x
Expand statewide network of fast-charging stations		X		x
Promote electric buses				x
Alternative Fuels[i]	4	1	1	4
Support establishment of local cellulosic biofuel industry and ongoing biofuel production	x			
Support establishment of local sugarcane ethanol industry and ongoing production	x			
Continue existing local production of biodiesel from waste fat	x			
Support the consumption of CNG and LNG in vehicles	x			
Promote drop-in jet fuels				x
Create a statewide inventory of waste-to-fuels resources			x	
Procure locally produced biofuels for existing government fleets		X		x
Promote locally produced biodiesel from agricultural crops				x
Promote biodiesel in marine applications				x
Biodiesel blending mandate				x
Biodiesel education in local universities				x
Aviation	6	0	0	0
Financial support for winglet retrofits	x			
Financial support for aircraft fleet renewal	x			
Apply the barrel tax or an equivalent tax to aviation fuels sold in Hawaii	x			
Fuel efficiency-based landing charges	x			
Airport infrastructure support	x			
Consumer information such as airline fuel efficiency ranking	x			
Marine	4	1	0	2
Slow steaming	x			
Propeller polishing and hull cleaning	x			
Increase bunker taxes under the barrel tax	x			
Onshore power	x			
State and private sector development and re-development of Harbor facilities in Hawaii		X		x
Promote interisland passenger travel by water instead of by air				x

[a] Could be supported by the US EPA's Environmental Education Grants.

[b] Needed to establish a robust baseline, evaluate the potential impacts of policy actions, and monitor progress toward established goals. Data needs include sales and total registrations of electric-drive vehicles, vehicle usage of state and county agencies, and estimated vehicle-miles traveled and fuel consumption by passenger and commercial vehicles.

[c] Such metrics could include miles of sidewalk and bike facilities constructed, transit ridership, average efficiency of passenger and commercial vehicles, average efficiency of government fleets, sales share of

electric-drive vehicles, average price of electricity used to charge EVs, volume and cost per unit of domestic alternative fuel production (biodiesel, CNG, hydrogen), electric-drive share of government fleets, average efficiency aircraft (per revenue passenger-mile) and marine vessels (per tonne-mile or passenger-mile).

[d] Could be funded through DOT's TIGER program.

[e] Requires collection of baseline data on tour bus capital and operating costs, age, efficiency, and vehicle activity.

[f] Includes increases in public transport service, especially on Oahu, the Big Island, Kauai and Maui. This tactic was evaluated in conjunction with TOD plans. Could also include improvements in bus efficiency such as hybrids, alternative fuel buses, although these were not evaluated.

[g] Includes tactics to help reduce VMT for schools and associated traffic: for example, more school buses, university shuttles, buses for private schools, officially organized carpool programs (similar to the BayArea's 511 RideMatch), and safe routes to schools. Tactics could also target improving the efficiency and emissions performance of school buses (e.g. hybrids, alternative fuels, advanced emission control technologies).

[h] Targeting specific fleets to reduce petroleum via alternative fuels, hybrids, and trip optimization (using intelligent transportation tools such as GPS).

[i] As a complement to tactics that promote the local production of biofuels, government agencies could provide incentives for procurement of locally produced biofuels for existing government fleets.

IV. Qualitative and Quantitative Evaluation of Tactics

The ICCT conducted a qualitative and quantitative evaluation of potential petroleum reduction tactics using a standardized format. Tactics were organized by sub-sector (e.g. Vehicle Efficiency) and strategy, and evaluated on the basis of benefits, costs, local economic benefits, environmental and lifecycle emissions benefits, social acceptability, and likelihood of implementation. Tactics were also categorized according to their likely implementation schedule.

Strategy: A high-level plan to reduce petroleum use from transportation in Hawaii.

Tactic: A specific policy or action that could support the implementation of a strategy. Each strategy has one or more associated tactics. For some strategies, multiple interrelated tactics are evaluated as a package. Some tactics may be considered "enabling" in that they enable other actions that will reduce petroleum use. Unless otherwise specified, all evaluated tactics are presented as options rather than recommendations. Recommendations with respect to all tactics and strategies will be summarized in a separate section.

Context: For each tactic or set of tactics, this section may include background and history on the design of a program and/or policy, examples of similar measures implemented elsewhere (e.g. in other U.S. states), and the current status of a measure in Hawaii.

Approach: This section describes one or more actions that Hawaii could take toward the development of the identified tactic(s).

Assumptions: These items include key policy assumptions and data inputs used to evaluate one or more tactics. These assumptions could be refined in the future as better data become available or policy options are modified.

Benefits: This section provides an estimate of the level of petroleum reduction (measured in million gallons of gasoline-equivalent per year, or MGY) that could be realized in 2030 assuming successful implementation of the tactic(s) according to the assumptions listed. In some cases where data are unavailable or there exists a high degree of uncertainty regarding policy impacts, a range may be given instead. The potential benefits listed for each tactic are not directly additive, since there may be some overlap with other tactics. Other non-petroleum benefits are discussed in the sections for "local economy" and "lifecycle emissions benefits."

Costs: This section includes an assessment of the cost or cost-effectiveness of the tactic(s) considered. In some cases, the outcome of whether an action is worthwhile depends on the current baseline; that is, an action may have significant costs but still cost less than what would have occurred otherwise. This section attempts to capture the most important costs to consumers, taxpayers, and the government. Where applicable, it includes a discussion of who stands to pay versus who stands to benefit from implementation.

Local economy: This criterion is intended to capture qualitatively the expected impacts on local jobs and investments. Actions that create jobs, utilize local energy resources, improve Hawaii's balance of trade, or bring additional dollars into the state's economy are rated favorably.

Social acceptability: Evaluates the extent to which the public or special interest groups may support or oppose the implementation of the tactic(s) considered.

Lifecycle emissions benefits: Evaluates the extent to which greenhouse gas emissions will be reduced by the implementation of the tactic(s). In many cases, lifecycle emissions benefits scale with the expected level of petroleum reduction. Pertains to benefits rather than actual emissions: for example, "High" would indicate high emissions benefits.

Schedule: Evaluates the timeframe for implementation, market uptake of relevant technologies, and assessment of the timing of petroleum reduction benefits. Schedules can be rated "Near-term" (1-2 years), "Medium-term" (3-5 years), or "Long-term" (6-10 years). While many tactics will continue to generate benefits long after they have been fully implemented, this criterion focuses on the time until implementation.

Likelihood of implementation: This criterion assesses the likelihood that the tactic(s) considered could be successfully implemented in Hawaii if an attempt were made by a public agency, legislative representative, or other stakeholder group. This evaluation attempts to take into account potential benefits, costs, and social acceptability, noting that the stringency of the tactic(s) may affect the likelihood of implementation. Tactics rated "Low" are unlikely to be implemented in Hawaii in the absence of major developments in Hawaii's administrative and political environment. Tactics rated "Medium" are moderately likely to be implemented if supported by relevant agencies and stakeholders. Finally, tactics rated "High" are very likely to be implemented if supported by relevant agencies and stakeholders.

All tactics were evaluated in isolation compared to the baseline. While this approach gives equal treatment to each tactic, there are several potential interactions among tactics that could influence the benefits when implemented together.

1. Increases in the cost of gasoline and diesel to consumers could increase the cost effectiveness and potential impact of the other evaluated tactics (i.e. by making conventional fuels and driving more expensive, respectively), such as those promoting electric-drive vehicles or aimed at reducing VMT.

2. The petroleum reduction benefits of tactics targeting vehicle efficiency and VMT may not be strictly additive if they apply to the same vehicles. For example, vehicle fuel economy standards may slightly lessen the benefits of reducing VMT from new vehicles, since less fuel is consumed per vehicle-mile traveled.

3. The *HCEI Road Map 2011 Edition* identified two issues related to the interaction between VMT measures and the other strategies: first, that limiting VMT reduces the savings of measures such as vehicle efficiency, and second, that improving vehicle efficiency reduces the cost of travel and could result in increased travel by owners of more-efficient vehicles. With respect to the first observation, it is important to note that VMT reductions do not necessarily decrease the cost effectiveness or payback periods of improved efficiency or electric-drive vehicles, especially if complementary VMT reduction measures encourage households to own fewer cars (such that per-capita VMT declines faster than per-vehicle VMT).

A. Vehicle efficiency

A.1 New fleet efficiency

A.1.1) Procure EVs and efficient vehicles for public fleets

Context: Last updated in 2010, Hawaii's vehicle procurement guidelines[35] require State and County agencies to follow a strict hierarchy when leasing or purchasing light-duty motor vehicles that are not covered by federal procurement rules (VI.F): 1) EV or PHEV; 2) Hydrogen FCEV; 3) Alternative fuel vehicle[36]; 4) Hybrid electric vehicle; 5) Fuel economy leader[37]. There are several salient issues with the current hierarchy: 1) the procurement policy does not include safeguards to ensure that flex fuel vehicles (e.g. capable of running on E85 or gasoline) actually operate with the alternative fuel; 2) there are a significant number of hybrid electric and conventional diesel/gasoline options that have better fuel economy than available flex fuel or CNG options, but the procurement guidelines may prevent agencies from choosing these more efficient options; 3) additional fuel savings could be realized by re-defining fuel economy leaders as the top one-tenth of their class (as opposed to the top one-fifth) or as best in class[38]; 4) even though electric-drive vehicles (EVs, PHEVs, and hydrogen FCEVs) are ranked higher than alternative fuel vehicles in the hierarchy, data on government vehicle fleets[39] indicate that most new vehicle acquisitions are not electric-drive.
Approach: Revise statewide vehicle procurement guidelines[40] to strengthen requirements for when agencies should choose electric-drive options, and ensure that alternative or conventional fuel vehicles are the most energy-efficient option (an example of a possible amendment for vehicle procurement is described below). The state government could strengthen requirements for electric-drive vehicles by defining strict criteria for when an agency must choose an electric-drive option: for example, public agencies could be directed to input vehicle operating requirements into a calculator that compares the cumulative cost of ownership for electric-drive, alternative fuel, and efficient conventional vehicle options. Such a calculator could be developed using Hawaii-specific fuel prices and populated with fuel economy data for specific

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[35] Hawaii State Energy Office (2014). "Vehicle Purchasing Guidelines." Retrieved from http://energy.hawaii.gov/lead-by-example/programsachieving-efficiencylead-by-examplevehicle-purchasing-guidelines

[36] Alternative fuels are defined as alcohol fuels, mixtures containing eighty-five per cent or more by volume of alcohols with gasoline or other fuels, natural gas, liquefied petroleum gas, hydrogen, biodiesel, mixtures containing twenty per cent or more by volume of biodiesel with diesel or other fuels, other fuels derived from biological materials, and electricity provided by off-board energy sources.

[37] Fuel economy leaders are defined as vehicles identified by the United States Environmental Protection Agency as being in the top one-fifth of the most energy-efficient vehicles in their class.

[38] US DOE & US EPA (2015). "2015 Most and Least Efficient Vehicles." FuelEconomy.gov. Retrieved 18 Feb 2015 from http://www.fueleconomy.gov/feg/best-worst.shtml.

[39] DBEDT (2015). "Lead By Example - State of Hawaiʻi Agencies' Energy Initiatives - FY 2013-2014." *Report to the 2015 Hawaiʻi State Legislature*.

[40] Note that this tactic would only apply to fleets that are subject to SPO vehicle procurement guidelines.

vehicles models from the US DOE and US EPA[41]. Agencies could be required to choose the electric-drive vehicle option as long as the cumulative cost of ownership is within a specified dollar or percentage premium compared to the fuel economy leader option[42]. Requiring the comparison of vehicle options using a cumulative cost of ownership calculator could also ensure that agencies make cost effective decisions that are also aligned with the State's goals to reduce petroleum use and promote energy-efficient vehicle technologies. For example, the procedure for vehicle procurement may be amended as follows:

1) Input vehicle class (e.g. midsize car, pickup) into the cost of ownership calculator.
2) Input operating requirements (i.e. annual mileage, maximum daily mileage).
3) Calculator estimates total cost of ownership for available EV, hydrogen FCEV, and fuel-efficient models.
4) The State sets a threshold value (e.g. $5,000). As long as the incremental total cost of ownership for EV or hydrogen option (compared to the fuel-efficient option) is less than this threshold value, agencies are directed to choose the EV or hydrogen vehicle; otherwise, agencies are permitted to choose the fuel-efficient option (which may also be an alternative fuel vehicle).

Assumptions:

- 11,243 light-duty vehicles were licensed to State and County agencies in 2014; 12.3% of these were flex fuel, 1.5% hybrid, 85.9% conventional gasoline/diesel, 0.3% other.
- State and County vehicles assumed to travel 8,719 miles annually, equivalent to the statewide average for passenger vehicles[43].
- Under business as usual, the average in-use fuel economy of ICE and flex fuel vehicles reaches 32 mpg by 2030; 46 mpg for hybrids (roughly 95th percentile based on MY2014).
- With a change to procurement rules favoring efficient hybrids over flex fuel, 80% of State and County vehicles are assumed to reach hybrid fuel economy levels by 2030.

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[41] For fuel economy data, ibid. The US DOE has developed a cumulative cost of ownership calculator for alternative fuel vehicles that takes into account capital, operating, maintenance, fuel, and financing costs. Such a tool could be adapted for use by public agencies in Hawaii. Source: US DOE & NREL (2013). "Vehicle Cost Calculator." Retrieved 18 Feb 2015 from http://www.afdc.energy.gov/calc/

[42] For example, if the cumulative cost of ownership over 15 years were $80,000 for the most efficient gasoline model, agencies could be directed to choose an electric-drive vehicle instead as long as the cumulative cost of ownership is within $8,000 or 10%. This threshold could be adjusted over time depending on the effective level of premium the State is willing to pay to reduce petroleum imports and lead by example by acquiring electric-drive vehicles. In some cases, the cumulative cost of electric-drive vehicles could be lower than for fuel economy leaders, resulting in long-term cost savings to public agencies.

[43] State of Hawaii Department of Transportation (2015). Worksheet for VMT estimate 2014. Prepared 28 Jan 2015.

Table 6. Example capital and fuel costs of gasoline, hybrid, and EV models[44]

Model	Efficiency	MSRP including federal EV tax credit	Fuel cost ($/year)	Capital and fuel cost (15 years)
Chevy Malibu	25 MPG	$22,465	$1,396	$36,955
Toyota Prius	50 MPG	$24,200	$696	$31,424
Nissan LEAF	30 kWh/100 miles	$21,510	$523[45]	$26,939

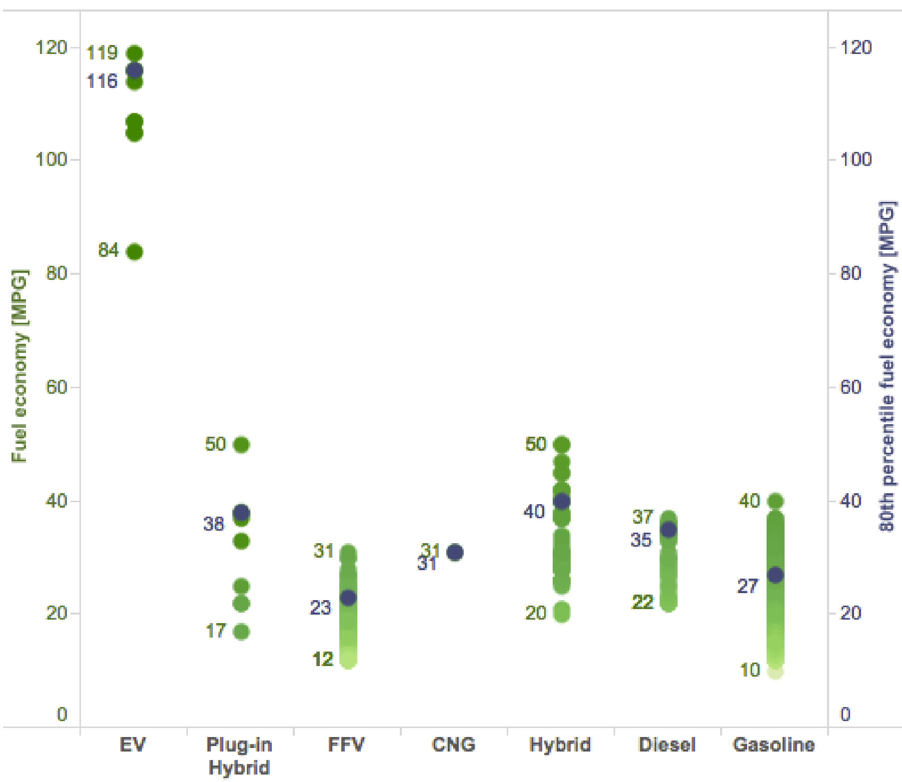

Figure 6. Fuel economy of new model year 2014 light-duty vehicles[46]

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[44] While this example compares MSRP, incremental costs would vary based on actual vehicle options and purchase prices. Costs over 15 years are discounted at a rate of 5 percent.

[45] Assuming an electricity price of $0.20 per kWh, roughly equivalent to Hawaiian Electric's rates for off-peak Schedule TOU EV ($0.209 per kWh) and Schedule J ($0.209 per kWh) in June 2015. Actual electricity rates vary by month.

Source: Hawaiian Electric Company, Inc. (2015). Current Monthly Effective Rates (June 2015). Retrieved 10 Jun 2015 from http://www.hawaiianelectric.com/heco/Residential/Electric-Rates/Effective-Rates-Summary-for-Hawaiian-Electric,-Maui-Electric-and-Hawaii-Electric-Light-Company

[46] Fuel economy data from: US EPA (2014). MPG data for all 1984-2014 vehicles. Available from http://www.fueleconomy.gov/feg/download.shtml

Benefits[47]: 0.7 MGY. Benefits could range from 0.4-1.0 MGY depending on efficiency level of new and existing vehicles. Even greater benefits may be achievable if the State sets a high cost threshold for electric-drive vehicles.

Costs: Net costs to government agencies depend on the cumulative cost of ownership of vehicles currently being purchased compared to that of electric-drive vehicles and fuel economy leaders. In some cases, electric-drive vehicles and fuel economy leaders may have lower cumulative costs of ownership than the vehicles currently being purchased, which could result in net savings over the lifetime of these vehicles. For example, an agency with the option to purchase a 2015 Chevrolet Malibu, Toyota Prius, or Nissan LEAF could save $5,500 with the Prius or $10,000 with the LEAF over 15 years (Table 6)[48].

Local economy: Shifting to electric-drive and energy-efficient vehicles could keep dollars that would have been spent on imported petroleum products within the state, allowing these dollars to be invested in the state's economy. The local economic benefits of electric-drive vehicles will likely increase as a greater share of electricity in Hawaii is generated using locally available energy resources.

Social acceptability: Medium. Social acceptability can be improved if agencies are provided with a locally relevant, up-to-date and user-friendly tool that streamlines the decision-making process and safeguards agencies from a significant increase in staff time or the cumulative cost of vehicle ownership.

Lifecycle emissions benefits: Medium. Lifecycle benefits depend on the extent to which vehicle choices are improved. Electric-drive vehicles will have lower fuel lifecycle GHG emissions over time as the share of renewable energy sources increases in the power sector (as required by the State Renewable Portfolio Standard).

Schedule: Near-term. The choices of new vehicles purchased or leased by public agencies could be influenced shortly after procurement guidelines are updated.

Likelihood of implementation: Medium. In 2015, legislation was introduced to amend the State's vehicle procurement requirements to favor hydrogen fuel cell vehicles over EVs[49]. Though this legislation did not pass, it signals that there is interest within the legislature to amend the procurement requirements to better align with the State's renewable energy goals.

A.1.2) Federal vehicle fuel economy standards

Context: USEPA and NHTSA[50] have adopted fuel efficiency and GHG standards for LDVs model years (MY) 2017-2025, and for HDVs MY 2014-2018[51]. The federal

[47] The potential benefits listed for each tactic are not directly additive, since there may be some overlap with other tactics. A consolidated estimate of potential fuel savings will be given later on.

[48] The choice of vehicle models shown in the table is for illustrative purposes only. Actual vehicle model choices available to government agencies will depend on vehicle operating requirements.

[49] HB 887, SB 1052, HB 1104, HB 1289, and SB 1053.

[50] National Highway Traffic Safety Administration

[51] TransportPolicy.net (2015). "US Light-duty Fuel Economy and GHG." ICCT and DieselNet. Retrieved from http://transportpolicy.net/index.php?title=US:_Light-duty:_Fuel_Economy_and_GHG

government is also currently developing Phase 2 standards for HDVs that would extend beyond MY 2019. California has also previously adopted its own fuel efficiency standards that go beyond federal requirements, and several other states have aligned with California. CARB has called for 5% annual reductions in fuel use of new LDVs and HDVs through 2025 and beyond.

Approach: Coordinate with California and the federal government to encourage the development of new fuel economy standards for new light- and heavy-duty vehicles model years 2026 to 2030.

Assumptions:

- The baseline includes adopted standards for LDVs MY2017-2025, HDVs MY2014-2018, and the Phase 2 HDV standards under development.
- New standards could reduce fuel use of new LDVs by 5% per year, and HDVs by 3.5% per year, from 2026-2030.
- VMT increases[52] with projected[53] population growth; sales in 2030 are assumed to be 40% higher than in 2010.

Benefits: 16 MGY in 2030

Costs: EPA estimates that the latest federal standards for LDVs MY2017-2025 will result in fuel savings that pay back the incremental cost of efficient technology within 4 years[54]. The standards for HDVs MY2014-2018 will result in payback periods of less than 3 years[55]. Subsequent standards may cost somewhat more per vehicle in today's dollars as 'low-hanging fruit' are captured in earlier standards; however the costs could come down over time as technologies improve. Lower annual mileage in Hawaii can be expected to increase, whereas higher fuel prices can be expected to decrease, the length of payback periods relative to those estimated for federal standards.

Local economy: N/A

Social acceptability: High; consumers have more efficient vehicle purchase options.

Lifecycle emissions benefits: High; standards target fuel and GHGs.

Schedule: Long-term; new standards would likely apply to MY 2026 vehicles.

Likelihood of implementation: Medium. Hawaii does not have authority to implement its own fuel economy standards; however, if California develops standards for the 2026-2030 timeframe, Hawaii could align with these. Alternatively, Hawaii legislators could encourage adoption of federal CAFE and GHG requirements for the 2026-2030 period.

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[52] As of May 2014, FHWA forecasts that nationwide VMT will increase at roughly the same rate as population, meaning that per-capita VMT is expected to remain relatively flat through 2030. Source: FHWA (2014). FHWA Forecasts of Vehicle Miles Traveled (VMT): May 2014. Retrieved from http://www.fhwa.dot.gov/policyinformation/tables/vmt/vmt_forecast_sum.pdf

[53] DBEDT (2015). Population and economic projections for the state of Hawaii to 2040. Retrieved from http://dbedt.hawaii.gov/economic/economic-forecast/2040-long-range-forecast/

[54] National Highway Traffic Safety Administration (NHTSA) (2012). NHTSA and EPA Propose to Extend the National Program to Improve Fuel Economy and Greenhouse Gases for Passenger Cars and Light Trucks. Retrieved from http://www.nhtsa.gov/fuel-economy

[55] Khan, S. (2013). Fuel Consumption of New Heavy-Duty Vehicles Can Be Reduced by More than One-Third by 2025. Retrieved from http://www.aceee.org/blog/2013/09/fuel-consumption-new-heavy-duty-vehic

A.1.3) Feebates for vehicle fuel efficiency

Context: Feebate programs[56] impose fees on purchases of less efficient vehicles and offer rebates for efficient vehicles; such programs are based on fuel use or carbon dioxide emissions and set a pivot point that determines the level at which vehicles receive no incentive, along with a slope that determines the magnitude of the financial incentive. Feebates have been implemented internationally in France, Belgium, and Austria, among others, while similar tax-only programs have been implemented in the US, Germany, and Ireland. The Gas Guzzler Tax[57] in the US applies to less than 3% of vehicle sales, and for this reason it has been considered a relatively "weak" program in terms of impacts on manufacturer and consumer choices. California has considered implementing a feebate program as a complement or replacement to the State's GHG standards. Additionally, in the 1990s several other US states considered feebates, including Connecticut, Maryland, Maine, Massachusetts, and Arizona; however, these states may have chosen to implement feebates due to potential legal challenges from the federal government[58]. In 2007, Canada implemented a Green Levy[59] excise tax on fuel-inefficient passenger vehicles; this tax was initially augmented by an ecoAUTO program[60] that offered rebates to buyers of new fuel-efficient vehicles.
Approach: Hawaii could apply either a revenue-neutral feebate or a vehicle sales tax linearly based on fuel consumption in order to promote sales of more efficient vehicles. Such a program could improve the efficiency of Hawaii's new vehicle fleet beyond the average fuel economy and GHG requirements of federal standards. Fees could be applied either at the dealer (point-of-sale) or manufacturer level. While it is somewhat irrelevant where the fee is applied (since fees applied to manufacturers could be passed on to consumers in the purchase price), the effect of the feebate on consumer choices

[56] German, J. & Meszler, D. (2010). Best Practices for Feebate Program Design and Implementation. The International Council on Clean Transportation. Retrieved from http://www.theicct.org/best-practices-feebate-program-design-and-implementation

[57] US EPA (2013). Gas Guzzler Tax. Accessed 30 Dec 2014 at http://www.epa.gov/fueleconomy/guzzler/

[58] Mims & Hauenstein (2008) explain that a state feebate based on GHG emissions could encounter legal challenges from the USEPA related to its authority to regulate GHG emissions under the Clean Air Act; however, they find no such issue would apply to a feebate based on fuel consumption: "The CAA is only relevant for feebates that are based on GHG emissions, as the EPA does not regulate fuel economy standards. It may be difficult for states to enact a feebate based on GHG emissions instead of a gallons per mile metric due to EPA's denial of California's CAA waiver; however, as the feebate is an incentive mechanism, not an emissions standard, states may still be able to pass a GHG feebate policy."

Mims, N. & Hauenstein, H. (2008). "Feebates - A Legislative Option to Encourage Continuous Improvements to Automobile Efficiency." Rocky Mountain Institute. p. 34. Retrieved from http://www.rmi.org/cms/Download.aspx?id=5096&file=Feebate_final.pdf&title=Feebates%3A+a+Legislative+Option+to+Encourage+Continuous+Improvements+to+Automobile+Efficiency

[59] Canada Revenue Agency (2013). Excise Taxes and Special Levies Memoranda. Accessed 30 Dec 2014 at http://www.cra-arc.gc.ca/E/pub/et/x3-1/x3-1-e.html

[60] Employment and Social Development Canada (2011). Evaluation of the ecoAUTO Rebate Program - June 2011. Accessed 30 Dec 2014 at http://www.esdc.gc.ca/eng/publications/evaluations/service_canada/2011/june.shtml

could be greater if consumers know the fee or rebate associated each vehicle option (for example, if it is included on a fuel economy label or as a line item at the dealer).
Assumptions:

- The feebate program under consideration would start in 2017 and continue to 2030.
- A study[61] of a range of feebate options for California estimated a 6-7% reduction[62] in new LDV GHG emissions following implementation of a $20/g/mi feebate in CA and several other opt-in states. Assuming the feebate did not increase in stringency over time, the impact on new LDV GHG emissions was estimated at 1-2% in 2025.
- An equivalent feebate program implemented in Hawaii along with several other US states is assumed to reduce new LDV GHG emissions by 6-7% in 2016 and 1-2% in 2025.

Benefits: 7.1-10.4 MGY. Impacts outside this range could occur under a program with differing stringency or breadth.
Costs: The program could be revenue-neutral (zero net cost) to the government or result in tax revenue (if a tax-only program). Consumers who purchase less efficient vehicles than average would pay fees up to several hundred or several thousand dollars depending on program stringency; consumers purchasing more efficient vehicles would receive commensurate rebates[63]. A range of statewide feebate options for California were estimated to cost -$100 to -$140 per ton CO_2 (as a GHG mitigation strategy)[64], indicating that the fuel saved by the feebate program would more than fully offset the cost of implementation.
Local economy: N/A
Social acceptability: Medium. A feebate program could be seen as a new tax even if it is designed to be revenue neutral; however, a feebate could be designed to impose no net costs to taxpayers, since some buyers would pay a fee and others would receive a rebate. Such a feebate could also be framed as a fiscally responsible support for electric-drive vehicles. Conversely, a tax-only strategy could increase the net tax burden on consumers unless it were offset by a reduction in fees elsewhere. Both program options would likely be opposed by potential buyers and sellers of vehicles that are less fuel-efficient than average (for example, sports cars or pickup trucks).
Lifecycle emissions benefits: Moderate to high depending on program stringency. If Hawaii were the only state to implement a feebate program, the effect on new LDV GHG emissions would be smaller than that of a program implemented nationwide or

[61] Bunch, D. & Greene, D. (2011). Potential design, implementation, and benefits of a feebate program for new passenger vehicles in California. University of California Davis. Retrieved from http://www.arb.ca.gov/research/single-project.php?row_id=64833

[62] Based on a starting point of 300 gCO2/mi and reductions of 5-20 gCO2/mi. Source: Bunch, D. & Greene, D. (2011). Potential design, implementation, and benefits of a feebate program for new passenger vehicles in California. Figure 9.5 Change in New Light-duty Vehicle Adjusted Emissions Rates in California with Geographical Expansion of Feebate Scope. University of California Davis. Retrieved from http://www.arb.ca.gov/research/apr/past/08-312revised.pdf

[63] For example, if a feebate were set at $20/g/mi with a pivot point of 354 g/mi (25 MPG), a vehicle that gets 443 g/mi (20 MPG) would be assessed a fee of $1780, but a vehicle that gets 268 g/mi (33 MPG) would be awarded a rebate of $1720.

[64] Ibid.

across several states. Additionally, a steeper slope (e.g. $30/g/mi) would have a greater impact on new LDV GHG emissions.

Schedule: Medium-term; it would likely take 2-5 years to design a feebate program for Hawaii. Such a program would benefit from a targeted study to evaluate the optimal slope and pivot point, as well as expected impacts.

Likelihood of implementation: Moderately low. Public education will also be important to ensure that consumers understand the benefits of the program.

A.2 In-use fleet efficiency

A.2.1) Green freight

Context: SmartWay Transport Partnership[65] is a voluntary public-private partnership between the US EPA and freight operators with the aim of reducing freight costs and emissions through improved vehicle technology and operations. The program has been operational since 2004, and to date only 5 truck carriers[66] in Hawaii have joined the SmartWay Transport Partnership. One of the core strategies of SmartWay is to verify the benefits of fuel efficient 'green freight' technologies such as low- rolling resistance tires, auxiliary power units, and improved aerodynamic technologies. US EPA encourages government agencies and NGOs to become affiliates that commit to promoting participation in SmartWay[67]. In 2015, EPA recognized the North Central Texas Council of Governments (NCTCOG) and Wisconsin Clean Cities, among others, for their participation as SmartWay affiliates.

Approach: NGOs and government agencies in Hawaii could become SmartWay affiliates. Affiliates could conduct education and outreach to freight carriers operating in Hawaii to encourage participation in the US EPA's SmartWay Transport Partnership.

Assumptions:

- Three fuel-saving technologies for Class 7 & Class 8 trucks: 0.6% reduction in fuel use with automatic tire inflation[68]; 5% for aerodynamics[69]; 3% for low rolling resistance tires[70].

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[65] US EPA (2014). About SmartWay. Accessed 30 Dec 2014 at http://www.epa.gov/smartway/about/index.htm

[66] DHX - Dependable Hawaiian Express – Big Island, Inc; DHX - Dependable Hawaiian Express Oahu; DHX - Maui; Hawaii Transfer Company Ltd.; Island Movers, Inc.

US EPA (2014). Partner and Affiliate Lists. Accessed 30 Dec 2014 at http://www.epa.gov/smartway/about/partnerlists.htm

[67] US EPA (2015). SmartWay for Supporters. Accessed 1 Jun 2015 at http://www.epa.gov/smartwayshipper/forsupporters/index.htm

[68] US EPA (2009). Automatic Tire Inflation Systems: A Glance at Clean Freight Strategies. EPA-420-F-09-033. Retrieved from http://www.epa.gov/smartway/forpartners/documents/trucks/techsheets-truck/420f09033.pdf

[69] US EPA (2014). SmartWay Technology. Accessed 30 Dec 2014 at http://epa.gov/smartway/forpartners/technology.htm

[70] Ibid.

- These green freight technologies are assumed to be applied to Class 7 & Class 8 trucks statewide, which are projected to consume an estimated 13 MGY in 2030[71].

Benefits: 1.1 MGY in 2030. Limited statewide data on the level of vehicle activity and fuel use by freight truck carrier -- as well as the total number of carriers -- in Hawaii makes it difficult to determine the potential benefits of expanding the application of green freight technologies in Hawaii[72].
Costs: SmartWay estimates fuel-saving technologies will pay back the investment within 1-3 years[73]. Higher fuel costs in Hawaii would decrease, while shorter annual mileage would increase, the estimated payback period for technologies on trucks operating in Hawaii.
Local economy: Small increase in jobs for technology installation.
Social acceptability: High; improved efficiency of freight trucks results in lower goods prices for consumers.
Lifecycle emissions benefits: Moderately low; road freight accounts for a relatively small share of transportation energy use in Hawaii.
Schedule: Near-term; the U.S. SmartWay Transport Partnership has already been operational for over a decade. Government agencies or NGOs in Hawaii could become affiliates and support the existing partnership.
Likelihood of implementation: Medium; collecting statewide data on freight carrier activity and fuel use could support the promotion of green freight activities.

A.2.2) Replacement tires

Context: New vehicles are typically sold with low rolling resistance tires; however, after a few years, vehicles are often equipped with replacement tires that have higher rolling resistance and thus reduce the fuel economy of the vehicle. In 2003, a working group for the Hawaii Energy Policy Forum recommended[74] several measures to reduce transportation energy use in Hawaii, including the promotion of low rolling resistance tires and regular tire inflation. That same year, California adopted Assembly Bill 844, which required the California Energy Commission to establish minimum efficiency standards for replacement tires as well as a consumer information program[75]. In 2014, the White House announced a goal for the National Highway Traffic Safety

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[71] ICCT (2014). Modified version of VISION model adapted for Hawaii. VISION 2013 AEO Base Case ©COPYRIGHT 2004 UCHICAGO ARGONNE, LLC. VISION model available from http://www.transportation.anl.gov/modeling_simulation/VISION/

[72] The State could collaborate with the USEPA to determine

[73] US EPA (2010). National Clean Diesel Campaign. EPA-420-F-10-016. Retrieved from http://nepis.epa.gov/Exe/ZyPDF.cgi/P100ABQS.PDF?Dockey=P100ABQS.PDF

[74] Working Group on Efficiency of the Hawaii Energy Policy Forum (2003). Opportunities for Improving Access to Energy Efficiency. Retrieved from http://www.hawaiienergypolicy.hawaii.edu/programs-initiatives/other/_downloads/energy-summit-2003-wg-efficiency.pdf

[75] California Energy Commission (2014). Fuel-Efficient Tire Program. Accessed 30 Dec 2014 at http://www.energy.ca.gov/tires/index.html

Administration (NHTSA) to finalize a federal program focused on providing consumers with the information they need to identify and purchase efficient replacement tires[76].
Approach: Hawaii could improve the efficiency of light-duty vehicles statewide by establishing a consumer information program to promote the purchase of fuel efficient replacement tires. Such a program could complement a national program that is expected to take effect in 2017[77].
Assumptions:

- According to a special report by the Transportation Research Board (TRB)[78], a 10% reduction in rolling resistance typically associated with low rolling resistance tires can reduce fuel consumption of light-duty vehicles by 1-2%.
- LDVs in Hawaii are forecast to consume 340 MGY in 2030 after the implementation of GHG standards for LDVs MY2017-2025.
- Since vehicles less than a few years old will already have low rolling resistance tires, a program encouraging consumers to choose efficient replacement tires is assumed to reduce fuel consumption of the light-duty fleet by up to 1%, assuming roughly half of LDVs on the road are affected.

Benefits: Up to 3.4 MGY in 2030. NHTSA estimates that if 10% of aftermarket replacement tire purchases were affected by a national consumer information scheme, the resulting benefits would be 72 MGY nationally.
Costs: The program would result in small savings per vehicle that pay off any incremental costs well within several years of operation. The US DOT estimates that proper maintenance and low rolling resistance tires can save drivers up to $80 per year[79]. Inconclusive data on the incremental costs of low rolling resistance tires prevents estimation of a definitive payback period[80].
Local economy: N/A
Social acceptability: Low to medium. Minimum requirements for replacement tires would yield direct savings to consumers; public education could increase acceptability if tires are known to be safe.
Lifecycle emissions benefits: Medium if applied statewide. Depends on the number of affected vehicles.

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[76] The White House Office of the Press Secretary (2014). Fact Sheet: Increasing Safety and Efficiency while Saving Money at the Pump. Retrieved from http://www.whitehouse.gov/the-press-office/2014/12/09/fact-sheet-increasing-safety-and-efficiency-while-saving-money-pump

[77] Reuters (2014). "White House rolls out tire safety, efficiency program with NASCAR." Automotive News. Retrieved from http://www.autonews.com/article/20141210/OEM05/141219982/white-house-rolls-out-tire-safety-efficiency-program-with-nascar

[78] Transportation Research Board (2006). Tires and Passenger Vehicle Fuel Economy. TRB Special Report 286. Retrieved from http://onlinepubs.trb.org/onlinepubs/sr/sr286.pdf

[79] US DOT (2014). Be TireWise: Save money at the pump, increase efficiency, and protect your safety. Retrieved from http://www.whitehouse.gov/sites/default/files/docs/tire_report_final.pdf

[80] Sharpe, B., May, D., Oliver, B., and Mansour, H. (2015). Costs and adoption rates of fuel-saving technologies for trailers in the Canadian on-road freight sector. The International Council on Clean Transportation. Retrieved from http://www.theicct.org/sites/default/files/publications/ICCT_Canada-trailers_20150209.pdf

Schedule: Near-term; a consumer information program could be developed with relatively little effort; however, standards would take much longer to develop.
Likelihood of implementation: Medium. In addition to effects of a consumer information program, minimum tire efficiency standards could ensure improvements in replacement tire efficiency[81]; however, such standards could be more challenging to implement than a voluntary program.

A.3 Fleet renewal

A.3.1) Vehicle retirement incentives for low-income groups

Context: As a result of federal fuel economy standards, new cars and light trucks are substantially more efficient than older vehicles, and this differential will likely increase through at least 2025 as a result of recently adopted MY 2017-2025 standards. Low-income households (defined as households earning less than 225% of the federal poverty threshold) are more likely to own older, less-efficient used vehicles, which tend to have substantially higher fuel costs than new, efficient vehicles. Several states including California[82] and Texas[83] offer financial incentives to scrap older, high-emitting, and less-efficient vehicles in order to reduce emissions of local air pollutants or GHGs. Recent legislation in California has directed the Air Resources Board (ARB) to increase the benefits of the State's voluntary programs for low-income households[84].
Approach: Hawaii could offer a combination of financial incentives (for example rebates or low-interest loans) to allow low-income households[85] to retire old vehicles and purchase newer, more-efficient ones. A rebate of $2500 is evaluated here based on a similar program in California. Such a program would benefit from requirements to: 1) ensure that new vehicles are significantly more efficient than the vehicles they replace; 2) scale the level of financial incentive with expected fuel savings; 3) ensure that eligible vehicles are driven enough to warrant incentives for retirement; and 4) offer flexibility to buy an efficient replacement vehicle or use alternative transportation modes.
Assumptions:

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[81] Pike, E. (2011). Tire Energy Efficiency. The International Council on Clean Transportation. Retrieved from http://www.theicct.org/tire-energy-efficiency

[82] CARB (2014). Enhanced Fleet Modernization Program - Car Scrap. Accessed 30 Dec 2014 at http://www.arb.ca.gov/msprog/aqip/efmp/efmp.htm

[83] Texas State Senate (2007). SB-12 Low-income vehicle repair assistance, retrofit, and accelerated vehicle retirement program. Retrieved from
http://www.legis.state.tx.us/tlodocs/80R/billtext/html/SB00012F.htm

[84] California State Senate (2013). SB-459 Vehicle retirement: low-income motor vehicle owners. Retrieved from http://leginfo.legislature.ca.gov/faces/billVersionsCompareClient.xhtml

[85] Eligibility for California's program is limited to households that qualify as low-income, meaning earnings are equal to 225% of the federal poverty guidelines. According to separate federal guidelines for Hawaii, qualifying low-income households (earning up 225% of poverty guidelines) could earn up to $30,487 for a single family household, adding $10,755 for each additional person.

U.S. Department of Health and Human Services (2015). 2015 Poverty Guidelines. Retrieved 29 May 2015 from http://aspe.hhs.gov/poverty/15poverty.cfm#thresholds

- California's Enhanced Fleet Modernization Program is funded by a $1 surcharge on vehicle registrations, amounting to roughly $30 million per year[86]. A comparable surcharge in Hawaii would amount to $1.3 million per year. Assuming a $2,500 incentive per vehicle, such a program could fund 520 replacements per year.
- Program implemented starting in 2016 and continuing to 2030.
- 51-57% of scrapped vehicles are cars (based on the current sales mix), with light trucks accounting for the remainder.
- The program is not assumed to change the overall vehicle stock or level of vehicle activity, although benefits would be increased to the extent that participants drive less after retiring their vehicle. While some low-income households will purchase newer used vehicles, a new vehicle is assumed to be purchased somewhere up the line so that the total vehicle stock does not change.
- The average fuel economy of scrapped vehicles is 13 years behind the average fuel economy of replacement vehicles.
- Gasoline price of $3.50 a gallon based on the average Hawaii statewide price in December 2014[87].

Benefits: 1.1 MGY in 2030, based on a funding level that allows for 520 replacements per year.
Costs: The CA program, if applied to Hawaii, could cost $1.3 million per year based on a surcharge of $1 for each vehicle registration. The number of vehicle rebates could be adjusted upward or downward from CA's program depending on the surcharge assessed. Annual fuel savings to program participants could exceed annual program costs within 3 years, with total benefits increasing over time along with the cumulative number of vehicles replaced.
Local economy: N/A
Social acceptability: Medium. At a very small cost to vehicle owners ($1 per vehicle registration in CA's program), the program could make transportation more affordable for low-income households[88].
Lifecycle emissions benefits: Emission reductions would scale with fuel savings.
Schedule: Medium-term; such a program would have to be carefully designed and regularly evaluated to ensure effective use of public funds.
Likelihood of implementation: Medium. A $1 vehicle registration surcharge could allow a pilot program with minimal risk; after measuring the effectiveness of the program, the funding level could be expanded based on proven benefits.

A.3.2) High efficiency taxis

Context: While taxis comprise a small share of the total passenger vehicle fleet, they tend to be driven much more than private vehicles on an annual basis. At least one taxi

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[86] CARB (2013). Staff Report: Enhanced Fleet Modernization Program Assessment. Retrieved from http://www.arb.ca.gov/msprog/aqip/EFMP_Update_Staff_Report_November_2013.pdf

[87] HawaiiGasPrices.com (2014). Average Prices by State. Accessed 30 Dec 2014 at http://www.hawaiigasprices.com/Prices_Nationally.aspx

[88] For example, a household replacing a car that gets 20 MPG with one that gets 35 MPG could save $650 per year (assuming 8719 miles driven and a price of $3.50 per gallon gasoline).

company in Hawaii, EcoCab, operates a fully hybrid fleet[89]; however, there seems to be significant additional potential to increase the hybrid share of taxi fleets statewide[90]. In 2008, the City of San Francisco passed a Green Taxi Ordinance that required average per-vehicle taxi emissions be reduced to 20% below 1990 levels[91]; this program also provided Clean Air Taxi Grant incentives to support the replacement of private fleets[92]. By 2012, over 90% of the 1,432 vehicle taxi fleet consisted of hybrid and CNG vehicles; this shift allowed a 10% reduction in GHG emissions amid a 74% increase in the number of taxis[93]. Similar programs have been implemented in Boston and San Diego in 2009 and 2011, respectively; these programs have included subsidies or tax credits for hybrids along with priority at airport taxi stands[94]. Following these successful efforts, Hawaii's Senate adopted a resolution in 2013 requesting that the Department of Transportation adopt rules promoting efficient hybrid taxis at Honolulu International Airport[95].

Approach: Consistent with Senate Resolution 144, the State could coordinate with City & County governments to develop a program that targets GHG emission reductions from taxi fleets by offering financial incentives to replace inefficient vehicles with efficient hybrids. The benefits of such a program depend on the efficiency of the existing taxi fleet, for which there is limited publicly available data[96].

Assumptions:

- Incentives equivalent to $2,000 per vehicle to support the replacement of private taxi fleets[97]. This incentive is half the level offered under San Diego's program[98].
- Roughly 1,800 taxis operate statewide in Hawaii[99]

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[89] EcoCabHawaii.com (2014). Accessed 30 Dec 2014 at http://ecocabhawaii.com/

[90] Mendoza, J. (2013). EcoCab motoring green fleet. Hawaii News Now. Retrieved from http://www.hawaiinewsnow.com/story/22380690/ecocab-motoring-green-fleet

[91] City & County of San Francisco Office of the Mayor (2012). San Francisco Taxis Surpass Emissions Goal. Retrieved from http://www.sfmayor.org/?page=684

[92] Fiset, Gary (2014). SF's Taxis Can Help You Go Green. Retrieved from http://www.sfmta.com/about-sfmta/blog/sf%E2%80%99s-taxis-can-help-you-go-green

[93] City & County of San Francisco Office of the Mayor (2012). San Francisco Taxis Surpass Emissions Goal. Retrieved from http://www.sfmayor.org/?page=684

[94] HI SR144 | 2013 | Regular Session. (2013, June 07). LegiScan. Retrieved January 06, 2015, from http://legiscan.com/HI/bill/SR144/2013

[95] Ibid.

[96] Data that would be needed to conduct a refined analysis include: the number of taxi registrations, annual distance driven and fuel consumed, model year, and resale value for each vehicle type.

[97] City & County of San Francisco Office of the Mayor (2012). "San Francisco Taxis Surpass Emissions Goal." Retrieved from http://www.sfmayor.org/?page=684

[98] San Diego County (2015). "San Diego offers incentives for alternative fuel taxicabs." NGVJournal. Retrieved from http://www.ngvjournal.com/san-diego-offers-incentives-for-alternative-fuel-taxis

[99] DBEDT (2012). Section 18 – Transportation. 2012 State of Hawaii Data Book Individual Tables and Updates. Retrieved from http://dbedt.hawaii.gov/economic/databook/2012-individual/_18/

- Assuming taxis in Hawaii are driven a similar distance as those in San Francisco, California, implementation of similar programs could yield similar reductions in GHG emissions and fuel use.
- Gasoline prices are about 30% higher in Hawaii than in California[100].
- San Francisco's programs save taxi operators an estimated $11 million in fuel costs each year, equivalent to 2.9 MGY[101]

Benefits: Assuming Hawaii improved the efficiency of its taxi fleet to a similar extent as in San Francisco, such a program could save 3.6 MGY in 2030. Benefits could be greater if similar programs were developed to improve the efficiency of other fleets, such as public shuttles, buses, and government vehicles.
Costs: Assuming the fleet conversion could be achieved with a fleet regulation and supporting incentive, the program cost could be up to $3.6 million. Annual fuel savings could reach up to $15 million once the program is fully implemented. San Francisco's program is funded by slightly higher fees for taxi drivers to take out a vehicle; however, taxi drivers and companies benefit from fuel costs that are roughly half that of non-hybrids, as well as reduced costs for brake repairs[102].
Local economy: Medium; taxi operators could see net increases in daily income.
Social acceptability: Medium; depends on successful coordination with taxi owners and operations.
Lifecycle emissions benefits: Medium; depends on how many taxis are already hybrids and annual vehicle mileage.
Schedule: Medium-term; while successful policies have already been implemented elsewhere, implementation of a voluntary program in Hawaii would require coordination with taxi owners and operators to determine appropriate incentives and ensure a high participation rate.
Likelihood of implementation: Moderately high. Higher likelihood if replacement incentives and fares align with industry interests.

A.3.3) Rental car efficiency program

Context: Since 2005, the State of Washington has required State employees to request and use fuel efficient, low emission vehicles when renting from a commercial vendor[103]. While Hawaii could implement a similar policy to improve the efficiency of rental vehicle trips taken by State employees, there is also potential for the State to offer financial incentives to replace less efficient rental cars. There is currently very limited publicly

[100] HawaiiGasPrices.com (2014). Average Prices by State. Accessed 30 Dec 2014 at http://www.hawaiigasprices.com/Prices_Nationally.aspx

[101] Addison, J. (2012). San Francisco Doubles Taxi Fleet while Cutting Gasoline Use in Half. Retrieved from http://www.cleanfleetreport.com/san-francisco-hybrid-taxis/

[102] City & County of San Francisco Office of the Mayor (2012). San Francisco Taxis Surpass Emissions Goal. Retrieved from http://www.sfmayor.org/?page=684

[103] Governor of Washington (2005). Executive Order 05-01. Retrieved from http://www.governor.wa.gov/office/execorders/eoarchive/eo_05-01.pdf

available data[104] on rental car fleets in Hawaii[105]; however, an online review of available rental vehicle choices indicated there is significant room for improving the efficiency of Hawaii's rental car fleet.

Approach: Hawaii could pursue a regulatory, financial incentive, or combined approach to support the modernization of rental car fleets statewide. Such a program could target the replacement of less efficient rental cars with those meeting federal fuel economy standards for new vehicles.

Assumptions:

- In 2014, there were 2.07 million rental cars in the US[106]; Hawaii has 0.48% of the population in the US; if Hawaii had the same number of rental cars per capita as in other states, there would be just under 10,000 rental cars statewide.
- Assuming a successful combination of financial incentives and supporting regulations resulted in the hybridization of 8,605 vehicles (85% of the hypothetical rental fleet).
- Rental cars are assumed to be driven an average of 50 miles a day – about half the estimated national average[107] for rental cars and roughly twice the length of the typical commute[108] in Hawaii – and rented 25 days per month[109], equivalent to 15,000 miles annually.
- Since rental cars tend to be newer than average, these are assumed to have fuel economy about 10% better than the state average of 23 mpg for LDVs (25.3 mpg).
- These are assumed to be replaced with vehicles meeting the 2016 federal fuel economy standards of roughly 35 mpg[110].

Benefits: 1.4 MGY once the program is fully implemented.

Costs: Similar to a high efficiency taxi incentive program, financial incentives of up to $2,000 per vehicle may be sufficient to encourage replacement of less efficient vehicles. Drivers of rental cars could save an average of $575 in fuel costs per vehicle each year[111]. Regulations of rental car fleets would have lower direct costs to government but may have lower social acceptability. While it is unclear to what extent rental car

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[104] Data that would be needed to conduct a refined analysis include: the number of rental car registrations, annual distance driven and fuel consumed, model year, and resale value for each vehicle type.

[105] Additional data may become available through the Consolidated Rental Car Facility (CONRAC).

[106] Auto Rental News (2014). U.S. Rental Car Market. Fact Book 2015. http://www.autorentalnews.com/fileviewer/2015.aspx

[107] Schalberg, J. (2010). Unlimited Miles or Mileage Caps. Retrieved from http://www.autorentalnews.com/channel/rental-operations/article/story/2010/06/unlimited-miles-or-mileage-caps.aspx

[108] NREL (2013). Hawai'i's EVolution. Retrieved from http://energy.gov/sites/prod/files/2014/05/f15/53667.pdf

[109] Schalberg, J. (2010). Unlimited Miles or Mileage Caps. Retrieved from http://www.autorentalnews.com/channel/rental-operations/article/story/2010/06/unlimited-miles-or-mileage-caps.aspx

[110] TransportPolicy.net (2015). "US Light-duty Fuel Economy and GHG." ICCT and DieselNet. Retrieved from http://transportpolicy.net/index.php?title=US:_Light-duty:_Fuel_Economy_and_GHG

[111] Assuming 15000 miles driven and a price of $3.50 per gallon gasoline.

companies would pass along the costs of purchasing more-efficient vehicles to consumers, drivers of more efficient rental cars would save money on fuel.
Local economy: Low. To the extent that visitors save fuel with more-efficient rental vehicles, they may spend more on other goods and services during their visit; however, the extent of this possible behavior change would need to be further investigated.
Social acceptability: Medium; rental car companies may have concerns about the cost of vehicle replacement; financial incentives may mitigate such concerns. Such a measure could reduce the environmental impacts of tourism associated with car rental and fuel use.
Lifecycle emissions benefits: Low; accelerated rate of fleet turnover could reduce fuel consumption and GHG emissions.
Schedule: Medium; effectiveness of a voluntary program is contingent on designing an appropriate incentive that encourages participation by rental car companies.
Likelihood of implementation: Medium; program may have limited social acceptability based on costs; however, if structured appropriately, rental companies and visitors could benefit[112]. Likelihood of implementation could be improved if rental car companies or other fleet operators are engaged through the National Clean Fleets Partnership under the U.S. DOE's Clean Cities program[113].

B. Vehicle-miles traveled

B.1 Adopt performance measures

This section considers two performance measures to improve transportation planning at the state and local levels: 1) the adoption of a legislative target to reduce VMT, and 2) replacing the Level of Service (LOS) metric that is currently used in environmental impact assessments of infrastructure projects with VMT.

B.1.1) Legislative VMT reduction target

B.1.2) Replace LOS metric with VMT

Context: During the first stakeholder meeting on November 13, 2014, the most common concern expressed by VMT stakeholders was a need for a binding goal that would require coordination across government agencies and facilitate cooperation with

[112] For example, financial incentives for rental cars could be financed through an increase in the rental car surcharge. This way, vehicle renters would save money on fuel for rental cars, and some of these savings would go to pay for improvements to rental car efficiency.

[113] U.S. DOE (2014). National Clean Fleets Partnership. Clean Cities Program. Retrieved from cleancities.energy.gov/publications

non-government groups[114]. While such a goal could take the form of mandatory reductions in greenhouse gas emissions or energy consumption in the transportation sector, the idea that received the strongest support was a legislatively binding target to reduce statewide VMT, coupled with island-specific targets to increase the share of trips taken by bicycling, walking, and public transit. Legislation requiring VMT reductions has been adopted in five US states[115]. Stakeholders expressed a desire for better coordination with and support from HIDOT, especially relating to issues of financing and planning infrastructure for transportation alternatives such as bicycling, walking, and public transit. In 2015, HIDOT has initiated quarterly sustainable transportation forum meetings to facilitate such coordination.

The Level of Service (LOS) metric has been widely applied in the United States by state DOTs and planning practitioners to evaluate the potential impact of transportation projects. LOS is a measure of the vehicle throughput for an intersection or roadway; however, it typically does not capture any improvements made to service alternative modes. For this reason, relying on LOS to evaluate the impacts of potential transportation projects create significant barriers to projects that would reduce VMT by promoting bicycling, pedestrian, and public transit use, as well as urban infill development[116]. Recent legislation adopted in California[117] has set a precedent for using VMT instead of LOS to evaluate and promote multimodal transportation projects that are consistent with California's commitment to reduce VMT as well as transportation energy use and emissions.

Approach:

- Hawaii's legislature could request that relevant State agencies coordinate with Counties to develop targets to reduce VMT and increase the share of trips taken by bicycling, walking, and public transit. Such targets should take into account household travel behavior patterns and potential land use changes[118] to ensure that targets are realistic and sufficiently stringent. Once developed, these targets could be adopted as legally binding to formally align support across State and County agencies, especially the State DOT. Such targets have been adopted in five US states[119].

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114 Bandivadekar, A., Miller, J., Searle, S., Lloyd, A., Glick, M., Sparlin, K., Larson, M., Viray, L., Chin, J. (2014). DBEDT and ICCT. Retrieved from http://www.hawaiicleanenergyinitiative.org/storage/pdfs/TransWorkshop_Summary.pdf

115 New York, Massachusetts, Oregon, Washington, and Vermont. Source: American Council for an Energy-Efficient Economy. (2014). Executive Summary, 2014 State Energy Efficiency Scorecard. Retrieved from http://www.aceee.org/state-policy/scorecard

116 Newton, D. and Curry, M. (2014). California Has Officially Ditched Car-Centric ‘Level of Service’. Streetsblog LA. Accessed 28 Jan 2015 at http://la.streetsblog.org/2014/08/07/california-has-officially-ditched-car-centric-level-of-service/

117 CA SB743 (2013, Sep 27). Environmental quality: transit oriented infill projects, judicial review streamlining for environmental leadership development projects, and entertainment and sports center in the City of Sacramento. California Legislative Information. Retrieved 27 Jan 2015, from http://leginfo.legislature.ca.gov/

118 For example, U.S. census data and travel demand models maintained by local MPOs.

119 New York, Massachusetts, Oregon, Washington, and Vermont. Source: American Council for an Energy-Efficient Economy. (2014). Executive Summary, 2014 State Energy Efficiency Scorecard. Retrieved from http://www.aceee.org/state-policy/scorecard

- Replace the Level of Service (LOS) measurement of vehicle flow currently used in environmental impact assessments for potential infrastructure projects with VMT.

Assumptions: Enabling.
Benefits: Enabling.
Costs: Low. These enabling actions would have no direct costs to the government; however, to the extent that public agencies are to be tasked with developing feasible targets for VMT reduction and mode share of alternative transportation, and monitoring progress toward these targets, allocating additional resources[120] to these agencies to conduct analysis and gather data would significantly improve the likelihood of success.
Local economy: Medium. These actions would enable the expansion of transit, walking, and bicycling infrastructure, all of which would generate temporary construction jobs. These actions could also enable the creation of permanent jobs for the operation of public transportation. In the long term, increased agency commitment to VMT reduction could facilitate a broader set of positive economic impacts, including benefits to public health from increased physical activity, less time lost to traffic congestion, and lower transportation costs for Hawaii's residents.
Social acceptability: Medium. Targets to reduce VMT and promote transportation alternatives – as well as replacing LOS with VMT – could benefit from a focus on ensuring the availability of transportation options and reducing congestion in the long-term as opposed to imposing limitations on driving.
Lifecycle emissions benefits: Enabling.
Schedule: Near-term. While all three tactics could be adopted within the next several years, these tactics would enable many further actions that reduce VMT and petroleum use over the long-term.
Likelihood of implementation: Medium. Both tactics could require participation from the legislature.

B.2 Improve transportation infrastructure and land use planning

Coordinating the provision of transportation infrastructure with improved land use planning (such as transit-oriented development) is essential to reduce the need for travel and allow use of public transit, walking, and bicycling. While this section considers some of the near-term impacts of tactics to promote TOD and expand infrastructure for transportation alternatives, these measures will play a critical role in determining the long-term need for travel and associated energy demand for road transportation in Hawaii.

B.2.1) Transit-oriented development

B.2.2) Expand infrastructure for bicycling, walking, and public transit

Context: The State of Hawaii has identified transit-oriented development (TOD) as a "means of implementing 'smart growth' development patterns that support quality of life, preserve the natural environment, provide a range of housing choices for residents, and

[120] For example, hiring one or more full-time staff in each relevant agency.

encourage walking, biking, and mass transit"[121]. After major mass transit projects were approved in the City & County of Honolulu, the City Council adopted an ordinance requiring the creation of neighborhood TOD plans to support the rezoning of parcels within two thousand feet of a transit station[122]. According to the City Council, these TOD plans should promote mixed use, high density development; reduce or remove minimum off-street parking requirements; include affordable housing and encourage public-private partnerships; and promote public transit use, walking, and bicycling[123]. In addition to local planning authorities, State DOTs have taken an active role in implementing TOD programs and policies in California, Florida, Maryland, Massachusetts, New Jersey, Pennsylvania, and Washington, D.C.[124]

Approach: There are many actions that Hawaii could take to advance transit-oriented development and expand infrastructure for bicycling, walking, and public transit. These actions include: identifying public lands near planned and existing transit stations for redevelopment; aligning travel demand management (TDM) and land use planning efforts to fully utilize transit system capacity; ensuring the availability of funding for infrastructure improvements related to TOD; and implementing existing state and local plans for bicycling, pedestrian, and transit facilities in coordination with neighborhood TOD plans[125]. The approach taken in this analysis is to use the example of Kauai's Multimodal Transportation Plan, which includes integrated transportation and land use planning as well as significant increases in multimodal transportation infrastructure, as the basis for assessing the potential impacts of similar actions statewide.

Assumptions:

Research into transportation and land use planning has identified important relationships between land use indicators – such as residential density, distance to transit, and differentiation of land uses – and travel behavior. Selected results of these studies are given below to put the estimated benefits for Hawaii into context:

- Doubling residential density can reduce VMT of affected households by 4% to 19%[126].

[121] State of Hawaii Office of Planning (2012). "Leveraging State Agency Involvement in Transit-Oriented Development to Strengthen Hawaii's Economy." Prepared by Strategic Economics, Inc. and Smart Growth America. Retrieved from http://planning.hawaii.gov/wp-content/uploads/2013/04/HI-State-TOD-Strategies-Final-Report-FINAL.pdf

[122] City & County of Honolulu City Council. "Ordinance 09-04: Relating to transit-oriented development." Retrieved from http://www4.honolulu.gov/docushare/dsweb/Get/Document-86893/4108c6sr.pdf

[123] Ibid.

[124] Cambridge Systematics, Inc. (2006). The Role of State DOTs in Support of Transit-Oriented Development (TOD). AASHTO. Retrieved from http://www.fta.dot.gov/documents/Project_25-25_Task_20_final_report.pdf

[125] Additional enabling actions to support VMT reduction are described in Section V.C.2.

[126] Boarnet, M., and Handy, S. (2014). Impacts of Residential Density on Passenger Vehicle Use and Greenhouse Gas Emissions. USC and UC Davis. Retrieved from http://www.arb.ca.gov/cc/sb375/policies/density/residential_density_brief.pdf

- Reducing the distance to transit by one mile can reduce VMT of affected households by 1% to 6%[127].
- Increasing the differentiation of land uses by 10% can reduce VMT by 1% to 17%[128].

Potential statewide impacts of TOD planning and expanded investments in multimodal infrastructure are based on Kauai's Multimodal Transportation Plan[129]:

- Kauai's Multimodal Transportation Plan estimates a "preferred" scenario could reduce fuel consumption by 4 MGY in 2035 in Kauai County alone[130]. The reduction in fuel use achievable by avoiding the need for VMT to grow is estimated to be roughly equivalent to the fuel savings expected from improved fleetwide fuel efficiency. Considering Kauai County accounts for less than 6% of Hawaii's statewide population[131], the long-term potential reduction in statewide fuel consumption is very high.
- Assuming the benefits of avoided VMT in Kauai's plan are equivalent to 2 MGY in 2035, actions of similar magnitude statewide could reduce fuel consumption by roughly 33 MGY in 2035.
- Assuming benefits scale evenly over time gives a statewide estimate of 23 MGY in 2030, equivalent to a 7% reduction in passenger vehicle VMT compared to a scenario in which VMT grows at the same rate as statewide population. These benefits are within the range cited in a U.S. DOT Report to Congress, which concluded land use strategies could reduce U.S. light-duty vehicle GHG emissions by 2.5% to 7.8% by 2030, with about twice the level of benefit by 2050[132].

Benefits: Up to 23 MGY in 2030. This magnitude is to be expected, since Kauai County's plan includes large-scale improvements to walking, bicycling, and transit infrastructure and service, as well as improvements in land use. These benefits are consistent with roughly a 7% reduction in statewide VMT by passenger cars and light trucks in 2030 compared to the current trend.
Costs: From a fiscal perspective, implementing TOD can be expected to increase tax revenues related to development and property ownership, and reduce the cost of building and maintaining roads. A study of TOD scenarios in Honolulu estimated that

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[127] Tal, G., Boarnet, M., and Handy, S. (2013). Policy Brief on the Impacts of Transit Access (Distance to Transit) Based on a Review of the Empirical Literature. Retrieved from http://www.arb.ca.gov/cc/sb375/policies/transitaccess/transit_access_brief120313.pdf

[128] Based on an entropy scale in which 0 indicates no differentiation of land use and 1 indicates maximum differentiation. Source: Spears, S., Boarnet, M., Handy, S., and Rodier, C., (2014). Impacts of Land-Use Mix on Passenger Vehicle Use and Greenhouse Gas Emissions. Retrieved from http://arb.ca.gov/cc/sb375/policies/mix/lu-mix_brief.pdf

[129] Kauai County (2012). Kauaʻi Multimodal Land Transportation Plan. Retrieved from http://movekauai.net/

[130] Kauai County (2012). Kauaʻi Multimodal Land Transportation Plan. Retrieved from http://movekauai.net/

[131] Based on de facto population. Source: DBEDT (2015). Population and economic projections for the state of Hawaii to 2040. Retrieved from http://dbedt.hawaii.gov/economic/economic-forecast/2040-long-range-forecast/

[132] U.S. DOT (2010). Transportation's Role in Reducing U.S. Greenhouse Gas Emissions. Washington, DC: U.S. Department of Transportation. Retrieved from http://ntl.bts.gov/lib/32000/32700/32779/DOT_Climate_Change_Report_-_April_2010_-_Volume_1_and_2.pdf

compared to a business-as-usual scenario, TOD strategies that concentrate the growth of housing and jobs in transit corridors could save the average household living on Oahu $2,450 to $3,000 in transportation, home energy, and water costs by 2050, with roughly double the savings for new households[133]. Potential transportation infrastructure costs are already accounted for in various state and county transportation plans such as Oahu MPO's 2035 Regional Transportation Plan; however in some cases these plans identify a funding gap for planned infrastructure projects[134]. Lastly, since land use strategies reduce the cost of travel, the U.S. DOT has estimated that the net cost of these strategies is negative once operating savings are taken into account[135].

Local economy: High. Successful TOD plans can increase investment from public and private sources and improve the economic competitiveness of affected areas as well as saving travel time and expenditures[136].

Social acceptability: High. Planning for TOD involves a high degree of participation from neighborhoods to ensure that community transitions preserve the unique characteristics of each neighborhood, improve access to employment, schools, and other destinations, and reduce household travel costs[137]. For example, during public workshops held in 2012 to support Kauai County's Multimodal Transportation Plan, 88% of public participants indicated that the County should work to implement its "preferred" scenario (including a rapid expansion of bus service) instead of a baseline scenario (e.g. "business-as-usual" trends)[138].

Lifecycle emissions benefits: High. Not only can TOD have significant, long-term, direct benefits in terms of reduced private vehicle travel and petroleum use, but it can enable the preservation of agricultural land[139].

Schedule: Long-term. Expansion of TOD could have significant impacts on the long-term need for travel by enabling a greater share of the population to live close to work, school, and other destinations; however, due to the time required to design TOD plans

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[133] Calthorpe Associates (2013). "Honolulu Transit Oriented Development Study Scenarios." Retrieved from http://www.calthorpe.com/Honolulu_TOD_Study

[134] OMPO (2011). Oahu Regional Transportation Plan 2035. Retrieved from http://www.oahumpo.org/plans-and-programs/oahu-regional-transportation-plan-ortp/

[135] U.S. DOT (2010). Transportation's Role in Reducing U.S. Greenhouse Gas Emissions. Washington, DC: U.S. Department of Transportation. Retrieved from http://ntl.bts.gov/lib/32000/32700/32779/DOT_Climate_Change_Report_-_April_2010_-_Volume_1_and_2.pdf

[136] State of Hawaii Office of Planning (2012). "Leveraging State Agency Involvement in Transit-Oriented Development to Strengthen Hawaii's Economy." Prepared by Strategic Economics, Inc. and Smart Growth America. Retrieved from http://planning.hawaii.gov/wp-content/uploads/2013/04/HI-State-TOD-Strategies-Final-Report-FINAL.pdf

[137] City & County of Honolulu City Council. "Ordinance 09-04: Relating to transit-oriented development." Retrieved from http://www4.honolulu.gov/docushare/dsweb/Get/Document-86893/4108c6sr.pdf

[138] Kauai County (2012). Kaua'i Multimodal Land Transportation Plan. Retrieved from http://movekauai.net/

[139] State of Hawaii Office of Planning (2012). "Leveraging State Agency Involvement in Transit-Oriented Development to Strengthen Hawaii's Economy." Prepared by Strategic Economics, Inc. and Smart Growth America. Retrieved from http://planning.hawaii.gov/wp-content/uploads/2013/04/HI-State-TOD-Strategies-Final-Report-FINAL.pdf

and permit and build new developments and transportation networks, it could take a decade or more before the bulk of these benefits are realized.
Likelihood of implementation: High. Many of Honolulu's neighborhood TOD plans have already been developed, and other local governments such as Kauai County have developed plans to integrate land use and transportation planning[140]. Certain public investments (such as improvements to sewer capacity and multimodal transportation networks) can improve TOD incentives for private developers and ensure that land use changes are accompanied with appropriate transportation options.

B.3 Finance transportation alternatives with pricing measures and applications for federal funding[141]

B.3.1) Gasoline and diesel taxation

Context: Together with surcharges on motor vehicle registrations and vehicle rentals, fuel taxes are a major source of revenue for the State Highway Fund, and the primary source of revenue for County Highway Funds in Hawaii[142]. Even as the need to maintain and improve transportation infrastructure in Hawaii is increasing[143], total revenues from fuel taxes have remained essentially unchanged since fiscal year 2005, at about $160 million per year[144]. At the national level, the Congressional Budget Office estimates that total revenues to the Highway Trust Fund could decline 21 percent over the next 30 years as a result of increasing vehicle efficiency[145]. In view of the State's goal to significantly reduce the use of petroleum fuels in transportation by 2030, raising enough tax revenue to make necessary infrastructure investments will entail some combination of increased tax rates on fuel consumption, vehicle surcharges, or other fees (e.g. congestion or road user charges).
As of 2014, federal, state, and county gasoline taxes in Hawaii totaled $0.44 to $0.52 per gallon[146]. This combined tax rate is low compared to gasoline taxes in the European

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[140] Kauai County (2012). Kauaʻi Multimodal Land Transportation Plan. Retrieved from http://movekauai.net/

[141] This tactic was discussed during the stakeholder meeting on June 17, 2015.

[142] State of Hawaii Department of Taxation (2014). Annual Report 2013-2014. Retrieved from http://files.hawaii.gov/tax/stats/stats/annual/14annrpt.pdf

[143] Trip (2014). Key Facts about Hawaii’s Surface Transportation System and Federal Funding. Retrieved from http://www.tripnet.org/docs/Fact_Sheet_HI.pdf

[144] Includes State and County fuel taxes. Source: State of Hawaii Department of Taxation (2014). Annual Report 2013-2014. Retrieved from http://files.hawaii.gov/tax/stats/stats/annual/14annrpt.pdf

[145] Congressional Budget Office (2012). "How Would Proposed Fuel Economy Standards Affect the Highway Trust Fund?" Retrieved Apr 9 2015 from http://www.cbo.gov/publication/43198

[146] Tax rates vary by county in Hawaii. The federal tax rate is 18.4 cents per gallon. Source: Circella, G., Handy, S., & Boarnet, M. (2014). Impacts of Gas Price on Passenger Vehicle Use and Greenhouse Gas Emissions. California Air Resource Board. Retrieved from http://www.arb.ca.gov/cc/sb375/policies/gasprice/gasprice_brief.pdf

Union, which range from $1.84 to $3.84 per gallon[147]. Consumption of gasoline and diesel in motor vehicles have substantial externalities that are not typically reflected in the market price: these impacts include energy security, air pollution, traffic accidents, and traffic congestion (the latter two apply to all driving, not just gasoline and diesel vehicles). Because demand for gasoline is relatively inelastic in the short term, economists tend to regard gasoline taxes as an economically efficient means of raising tax revenue. While the comparatively higher gasoline tax rates in the European Union serve to internalize these factors, such taxes in the United States do not reflect the full social costs of gasoline consumption. A recent study of the optimal gasoline tax in California estimated a tax rate of $1.37 per gallon, with $0.85 to correct for negative externalities and $0.52 based on the comparative economic efficiency of taxing gasoline as opposed to other consumption goods[148].

Approach: While gasoline and diesel fuels account for the vast majority of petroleum used for on-road transportation in Hawaii, the prices of these fuels currently do not reflect their full social costs. Based on the estimated optimal gasoline tax in California ($1.37 per gallon) and the general level of fuel taxes applied in the European Union, the State of Hawaii could increase the tax rate on gasoline and diesel fuels by up to $0.85 per gallon to account for their full social costs and increase the cost competitiveness of technologies that use alternative fuels, especially biofuels, electricity, and hydrogen. Such an increase would result in a total State tax rate of $1.02 per gallon. While the use of diesel fuel can have greater impacts on air pollution than gasoline, in this analysis the same tax increase is applied to both gasoline and diesel fuels. Such action could raise much-needed revenue for transportation infrastructure investments in a manner that is consistent with the State's priorities to reduce petroleum imports, improve the efficiency of passenger and freight transportation, and promote alternative fuels.

Assumptions:

- Gasoline and diesel fuels sold for highway use are currently taxed at the same rate in Hawaii; applying the same rate to both fuels is preferable to avoid creating an artificial incentive to shift to gasoline or diesel vehicles.
- Hawaii's combined federal, state, and county taxes almost exactly equal the estimated optimal tax rate based on the economic efficiency of taxing inelastic consumption goods ($0.52 per gallon). The State tax rate of $0.17 per gallon could be increased by up to 400%, or $0.85 per gallon, to fully account for the negative social externalities of fuel consumption. Such an increase would result in a total State tax rate of $1.02 per gallon.

Hawaii's state tax rate is 17 cents per gallon, and County tax rates range from 8.8 to 16.5 cents per gallon gasoline. Source: State of Hawaii Department of Taxation (2014). Annual Report 2013-2014. Retrieved from http://files.hawaii.gov/tax/stats/stats/annual/14annrpt.pdf

[147] Circella, G., Handy, S., & Boarnet, M. (2014). Impacts of Gas Price on Passenger Vehicle Use and Greenhouse Gas Emissions. California Air Resource Board. Retrieved from http://www.arb.ca.gov/cc/sb375/policies/gasprice/gasprice_brief.pdf

[148] Lin, C.-Y. Cynthia & Prince, Lea (2009). "The optimal gas tax for California." *Energy Policy*, Elsevier, vol. 37(12), pages 5173-5183, December. Retrieved from http://www.des.ucdavis.edu/faculty/Lin/gas_tax_paper.pdf

- In accordance with the State's efforts to encourage alternative fuels, lower tax rates are applied to ethanol, biodiesel, LPG, LNG, and CNG[149]. Maintaining a lower tax rate for domestically produced biofuels could provide a significant financial incentive for these fuels compared to gasoline and diesel; this incentive could be increased by raising the tax rate for gasoline and diesel, but not for domestically produced biofuels.
- Estimates of the long-term elasticity of gasoline use to price are typically -0.2 to -0.3[150], meaning that a 10% increase in gasoline prices would reduce gasoline use by 2-3%. In this analysis, an average long-term elasticity of -0.25 is applied to gasoline and diesel fuels. Diesel fuels account for only a small portion of total diesel and gasoline demand; therefore, applying a different elasticity for diesel would have only a small effect on the total estimated change in fuel demand.

Benefits: Based on the long-term elasticity of gasoline and diesel to fuel price, increasing State tax rates to account for the full social cost of these fuels could reduce gasoline demand by 26 MGY and highway diesel demand by 2.1 MGY compared to the statewide demand for these fuels in 2014.

Costs: An $0.85 per gallon increase in the State tax rate for gasoline and highway diesel fuels could increase net fuel tax revenues by $418 million per year, accounting for the additional revenue from the increased rate ($422 million based on 2014 fuel consumption) and the lost revenue from reduced fuel demand ($4.8 million based on a long-term price elasticity of -0.25). For consumers, an $0.85 per gallon increase in the gasoline tax might bring the price of gasoline from $3.50 to $4.35 per gallon -- note that using a fixed tax amount per gallon avoids the potential issue of an alternative percentage-based tax, which would increase when gasoline prices are high and decrease when they are low (increasing the volatility of fuel prices). For an average driver (8,719 miles per year), increasing the gasoline tax by $0.85 per gallon could increase fuel costs by $150 to $300 per year, assuming vehicle fuel economy of 50 mpg and 25 mpg, respectively. These costs translate to 1.7 to 3.4 cents per mile driven.

Local economy: Statewide, operators of vehicles fueled by gasoline and diesel could pay an additional $418 million in fuel taxes each year (an average of roughly $312 per vehicle registered in Hawaii). The increase in fuel tax rates could incentivize changes in technology, vehicle operations, and travel behavior that would save $130 million in fuel costs each year (based on the long-term price elasticity of gasoline). Assuming that the additional State tax revenues ($418 million per year) are reinvested in Hawaii's economy or used to reduce other taxes, the net benefits to Hawaii's taxpayers could amount to $101 million from reduced petroleum imports. For further discussion of recommendations for mitigating the potential for economic hardship associated with increased fuel tax rates, see the following sections on social acceptability and likelihood of implementation.

Social acceptability: Medium. The social acceptability of significantly increasing fuel taxes will vary significantly across interest groups and hinge critically on allocating tax revenues to ensure that low-income and rural residents are not disproportionately

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[149] State of Hawaii Department of Taxation (2014). Annual Report 2013-2014. Retrieved from http://files.hawaii.gov/tax/stats/stats/annual/14annrpt.pdf

[150] Circella, G., Handy, S., & Boarnet, M. (2014). Impacts of Gas Price on Passenger Vehicle Use and Greenhouse Gas Emissions. California Air Resource Board. Retrieved from http://www.arb.ca.gov/cc/sb375/policies/gasprice/gasprice_brief.pdf

affected by increased fuel prices. This could be accomplished by dedicating a significant share of revenues to be spent as cash rebates for low-income households (preserving the incentive to reduce fuel use without harming equity), targeted subsidies to purchase efficient vehicles or use public transit, as well as expansion of public transportation service and system-wide improvements to bicycling and walking infrastructure. Social acceptability could also be significantly improved by starting with a small increase in the tax rate that scales over time, giving consumers and commercial vehicle operators ample time to take cost-effective fuel saving actions.

Lifecycle emissions benefits: High. Lifecycle emission benefits will be greater to the extent that consumers reduce fuel use by purchasing more-efficient vehicles, reducing unnecessary trips, carpooling, using alternative transportation modes, and making long-term decisions to live close to work, school, and other destinations. Lifecycle emission benefits would be lower if gasoline demand were offset by an increase in imports of first-generation bioethanol, which can have similar lifecycle emissions to gasoline.

Schedule: Near-term to long-term. The tax rate on gasoline and diesel fuels could be increased within two years by appropriate legislative action; however, to minimize adverse economic impacts of a sudden large price increase, such legislation could increase the tax rate steadily over several years (e.g., increasing 10 cents per gallon each year).

Likelihood of implementation: Low. Current conditions do not justify a ranking of “Medium” as it would have to be supported by relevant agencies and stakeholders. However, there is a need to address funding of critical transportation infrastructure given that reducing petroleum consumption consequently reduces transportation funding, which currently primarily supported via gas and diesel taxation. Increasing the statewide tax rate on gasoline and highway diesel could finance much-needed improvements to transportation infrastructure within a short period of time. Adverse social and economic impacts could be minimized by setting a long-term plan for steady tax rate increases that gives consumers and commercial vehicle operators lead time to take cost-effective fuel saving actions. However, education and outreach on the issue of transportation infrastructure funding will be required to ultimately gain support from relevant agencies and stakeholders to address transportation funding.

B.3.2) VMT pricing program

- Distance-based pricing
- Cordon pricing

Context: VMT pricing programs to fund transportation systems have been considered in several U.S. states, including Vermont and Oregon[151]. Such programs could serve as a replacement or addition to state fuel taxes or vehicle registration taxes and fees. The State of Hawaii levies an annual fee for motor vehicle registration as well as a tax based on vehicle weight. The State also levies a surcharge of $3 per day on rental vehicles, a separate surcharge and registration fee for tour vehicles, and a new surcharge of $0.25

[151] US DOE (2014). "State Fees as Transportation Funding Alternatives." Retrieved Apr 9 2015 from http://www.afdc.energy.gov/bulletins/technology_bulletin_2014_03_10.html

per half hour on car-sharing vehicles. In FY2014, these motor vehicle taxes and fees totaled $168.7 million in revenue for the State Highway Fund[152]. While daily rental vehicle charges are somewhat correlated with vehicle usage and fuel taxes are directly linked to fuel consumption, annual registration taxes and fees are insensitive to vehicle mileage and fuel consumption. There is a rationale that users making greater use of the roads and especially those driving on congested roadways should contribute more to the maintenance and improvement of the transportation network. Converting the State's fixed annual registration taxes and fees to a variable charge based on either 1) total distance traveled (distance-based pricing) or 2) distance traveled within a specific area (cordon pricing) could improve the matching of road usage with the amount paid by each user into the State Highway Fund. In addition to improving the economic efficiency of revenue generation for the State Highway Fund, such a conversion could have additional benefits in the form of reduced vehicle-miles traveled, less traffic congestion[153], and reduced fuel consumption.

Approach: The State of Hawaii could replace fixed annual vehicle registration taxes and fees with a variable charge based on 1) total distance traveled or 2) distance traveled within a specific area. The first option, distance-based pricing, would apply to vehicle travel on all roadways throughout the state. Such a charge could be collected at the time of annual vehicle registration and be measured based on the change in odometer reading from the previous year. For distance-based pricing, the primary change from the current fixed-fee system would be that the annual charge is the product of a set rate (cents per mile) and mileage traveled. This rate could vary based on vehicle weight, since heavier vehicles tend to cause more wear and tear to roads. The second option, cordon pricing, could apply a charge only to vehicles entering a designated area, even varying the charge by time of day to reduce congestion during peak hours; such a charge could be levied using electronic toll collection devices[154]. Option 1 (distance-based pricing) is evaluated here; it would involve converting existing vehicle registration taxes and fees to a 1.1 cent per mile charge[155].

Assumptions:

- While a cordon pricing system could have added benefits in terms of reduced traffic congestion, such a system could be more challenging to design and implement statewide across several islands. To improve the transparency of underlying assumptions and results, the distance-based option is evaluated here.
- While no mandatory VMT pricing programs are in effect in the United States, Oregon's Department of Transportation has demonstrated the feasibility of VMT pricing through

[152] Includes motor vehicle and rental vehicle taxes and fees. Source: State of Hawaii Department of Taxation (2014). Annual Report 2013-2014. Retrieved from http://files.hawaii.gov/tax/stats/stats/annual/14annrpt.pdf

[153] Downs, A. (1992). Stuck in Traffic. Washington, D.C.: The Brookings Institution.

[154] For example, FasTrak is an electronic toll collection system that has been implemented for toll bridges in the San Francisco Bay Area. Source: FasTrak (2012). General FAQs. Retrieved from https://www.bayareafastrak.org/en/support/faq_general.shtml

[155] For example, driving 8.6 miles from Honolulu International Airport to Waikiki would incur a VMT fee of 8.6*1.1=9.5 cents (as part of the charge assessed on an annual basis).

several pilot programs, including one in 2007 and a second in 2012-2013[156]. A study of Oregon's 2007 program found that levying an average VMT fee of 1.2 cents per mile reduced VMT of affected drivers by 11 percent[157]; however, since this VMT charge replaced an equivalent gasoline tax for affected drivers, it cannot easily be used as the basis for the elasticity of VMT to a per-mile charge.

- Cordon pricing schemes have been estimated to reduce VMT by 0.21 to 0.31 percent for a given 1 percent price increase in Singapore[158], and 0.70 to 0.86 percent for a given 1 percent price increase in Stockholm[159]. In the absence of studies directly estimating the elasticity of VMT for distance-based pricing schemes, the effects of a VMT charge in Hawaii were estimated using a long-term elasticity of -0.5, indicating that a 1 percent price increase would reduce VMT by 0.5 percent.
- Motor vehicle taxes and fees total $125.9 million in FY2014[160]. Based on the estimate 11.6 billion VMT traveled statewide in 2014[161], a VMT charge of 1.1 cents per mile would generate equivalent revenue.
- In 2014, the average cost of vehicle ownership in Hawaii was $0.49[162] per VMT. This rate is comparable to the federal GSA's reimbursement rate of $0.575 per mile for travel in privately owned vehicles[163]. Household savings from reduced VMT were estimated using the average cost of vehicle ownership per VMT, which is intended to reflect the amortized cost of purchasing, operating, and maintaining a private vehicle.
- In 2013, the average fuel economy of all vehicles in Hawaii was 23.1 mpg[164].

Benefits: 5.6 MGY based on 2013/2014 data. Converting existing vehicle registration taxes and fees to a 1.1 cent per mile charge could reduce total statewide VMT by an estimated 1.12 percent, or 130 million miles.

Costs: No net impacts to State tax revenues. Vehicle registration taxes and fees averaged $94 per vehicle in 2014[165]. Road users who drive less than average would

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[156] Oregon Department of Transportation (2014). Road Usage Charge Pilot Program 2013 & Per-Mile Charge Policy in Oregon. Retrieved from http://www.oregon.gov/ODOT/HWY/RUFPP/Pages/rucpp.aspx

[157] Rufolo, A., & Kimpel, T. (2008). Responses to Oregon’s Experiment in Road Pricing. Transportation Research Record: Journal of the Transportation Research Board, 2079, 1–7. doi:10.3141/2079-01

[158] Olszewski, Piotr (2007). Singapore Motorisation Restraint and Its Implications on Travel Behaviour and Urban Sustainability. Transportation 34(3): 319–35

[159] Börjesson, M., Eliasson, J., Hugosson, M. B., & Brundell-Freij, K. (2012). The Stockholm congestion charges—5 years on. Effects, acceptability and lessons learnt. Transport Policy, 20, 1-12.

[160] Excludes rental vehicle fees. Source: State of Hawaii Department of Taxation (2014). Annual Report 2013-2014. Retrieved from http://files.hawaii.gov/tax/stats/stats/annual/14annrpt.pdf

[161] State of Hawaii Department of Transportation (2015). Worksheet for VMT estimate 2014. Prepared 28 Jan 2015.

[162] Derived from data on household auto ownership costs and VMT. Source: Center for Neighborhood Technology (2012). H&T Affordability Index. Retrieved from http://htaindex.cnt.org/

[163] U.S. General Services Administration (2014). Privately Owned Vehicle (POV) Mileage Reimbursement Rates. Accessed 20 Feb 2015 at http://www.gsa.gov/portal/content/100715

[164] DBEDT (2014). "Section 18: Transportation." 2013 State of Hawaii Data Book. Retrieved from http://dbedt.hawaii.gov/economic/databook/db2013/

[165] Estimated from 2014 tax revenues and total number of vehicles registered. Source: State of Hawaii Department of Taxation (2014). Annual Report 2013-2014. Retrieved from http://files.hawaii.gov/tax/stats/stats/annual/14annrpt.pdf

pay less than this amount, while those who drive more than average would pay more (for example, someone driving 15,000 miles per year would pay $165). If switching to a VMT-based charge reduced total VMT consistent with an elasticity of -0.5, the average vehicle would be driven roughly 100 miles less, saving about $47 annually in amortized transportation costs.

Local economy: To the extent that a VMT-based charge reduces vehicle travel and fuel use, the charge would keep more dollars in the State's economy as a result of reduced petroleum imports.

Social acceptability: Medium. Replacing fixed vehicle registration fees and taxes with a distance-based charge would reward users for driving less; however, as with an increased tax rate on gasoline and highway diesel fuels, rural residents who rely on driving to get to work, school, and other destinations could be disproportionately affected by a road user charge based on VMT. Negative impacts on rural residents could be mitigated by providing a fixed rebate to rural residents – preserving the incentive to drive less – or applying a lower per-mile rate to vehicles registered in counties with less traffic congestion. Such differentiation would need to be approached carefully to avoid creating an artificial incentive to register vehicles or develop additional housing in rural areas. A distance-based charge would not necessarily impact tourism, since rental car companies would pay the charge for their registered vehicles on an annual basis, and a VMT charge of 1.1 cents per mile is very small compared to rental car rates (for example, less than $1 for driving 90 miles compared to perhaps $50 to rent a car for a day).

Lifecycle emissions benefits: Assuming the same VMT rate were applied to all vehicle technologies, the benefits of such a charge would scale with reduced VMT and fuel use.

Schedule: Medium-term. While Oregon has conducted multiple pilot programs, a distance-based road user charge has yet to be piloted in Hawaii. Carrying out a successful pilot study could lay the groundwork for implementation of a mandatory statewide scheme a few years later.

Likelihood of implementation: Low to Medium. A distance-based charge would ensure that all users contribute to the maintenance and improvement of Hawaii's transportation network; however, since such a charge has not yet been piloted in Hawaii or implemented at full-scale within the U.S., implementing such a charge would require strong support from Hawaii DOT and other stakeholders.

B.3.3) Price parking to recoup costs and promote alternative modes

- Workplace parking cash-out programs
- Adaptive pricing for public parking

Context: Downtown Honolulu has been ranked the most expensive location in the U.S. for parking, with rates averaging $42 per day. These rates are no surprise considering that constructing a parking structure can cost $20,000 to $50,000 per space, and even more for condominiums and apartment buildings where parking spaces compete with residences for rentable space[166]. In other areas of Hawaii where parking charges may be low or nonexistent, the costs of providing parking facilities may be built into the cost of housing, workplaces, or the price of goods and services. Parking pricing measures can be designed to recuperate the cost of providing parking, ensure adequate availability to potential users, reduce vehicle-miles traveled by private vehicles, and encourage alternate transportation modes. Such measures can include charging or offering a cash-out option for workplace parking, requiring residential parking permits, reducing minimum parking requirements, differentiating between short- and long-term parking, and implementing adaptive pricing programs[167]. While some of these measures may increase or decrease existing parking charges, others put a price on parking that would otherwise be paid for through indirect means.

Approach: While market rates for parking in Downtown Honolulu are very high, workplace parking outside of this area may often be offered to employees free of charge or at discounted rates, effectively subsidizing the cost of private vehicle travel. State and County governments could encourage workplaces to offer a cash-out option for employees who commute by public transit, walking, bicycling, or vanpooling rather than driving. Additionally, County governments could implement an adaptive parking pricing program to ensure availability of public parking and reduce excess driving associated with searching for parking.

Assumptions:

- Studies of parking cash-out programs in Southern California estimated a 12% average reduction in VMT at employers who offered cash-out options for employee parking, with a range of 5% to 24[168].
- San Francisco's SFpark program provides a case study of how adaptive pricing can be utilized to improve parking availability, save time that would otherwise be spent searching for parking, mitigate peak-hour congestion, and reduce VMT. A pilot study of SFpark found that 30% fewer vehicle-miles were traveled in pilot areas after the introduction of adaptive pricing[169].

Benefits: 5-24% reduction in VMT and fuel use by participating employers. Adaptive pricing could result in a 30% VMT reduction in affected areas, with slightly greater fuel benefits as a result of increased travel speeds. These estimates cannot be converted to petroleum reductions (MGY) without better baseline data on employer parking

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[166] Kain, M. (2013). "Why Is Honolulu Parking so Expensive?" Honolulu Magazine. Accessed 5 Mar 2015 at http://www.honolulumagazine.com/Honolulu-Magazine/February-2013/Parking-in-Paradise/Why-Is-Honolulu-Parking-so-Expensive/

[167] Spears, S., Boarnet, M., and Handy, S. (2014). Impacts of Parking Pricing and Parking Management on Passenger Vehicle Use and Greenhouse Gas Emissions. UC Irvine, USC, and UC Davis. Retrieved from http://www.arb.ca.gov/cc/sb375/policies/pricing/parking_pricing_brief.pdf

[168] A study of cash-out programs at eight firms covering 1,694 employees estimated annual fuel savings of 26 gallons of gasoline per employee, or 44,000 gallons per year in total.

Shoup, D. (1997). Evaluating the Effects of Cashing Out Employer-Paid Parking: Eight CaseStudies. *Transport Policy* 4(4), 201-216. Retrieved from http://shoup.bol.ucla.edu/EvaluatingCashOut.pdf

[169] SFMTA (2014). SFpark Pilot Project Evaluation Summary. Retrieved from http://sfpark.org/wp-content/uploads/2014/06/SFpark_Eval_Summary_2014.pdf

subsidies, commuting patterns at these employers, and the volume of vehicle traffic in areas that could be targeted for adaptive parking pricing.

Costs: No direct costs to the state. Since employers already pay to subsidize parking, offering a cash-out option would not inherently increase costs. Some employers may opt to reduce net subsidies for commuting, while others might increase. An evaluation of eight parking cash-out programs in California estimated a benefit-to-cost ratio of 4 to 1, accounting for reductions in drive-alone commuting costs and associated air pollution[170]. In the California parking cash-out study, the monthly commuting subsidy per employee increased an average of only $2, with the change in subsidy per employee ranging from $70 less to $33 more depending on employer choices[171]. San Francisco's adaptive parking pricing program resulted in a net increase in parking revenues, as well as reductions in traffic congestion and VMT[172].

Local economy: Medium. Employees who cash out subsidized parking would have additional funds to spend on alternative commute modes or other goods and services. Some temporary jobs would be created to install an adaptive pricing program; additional permanent jobs would be created to monitor the program and maintain associated equipment.

Social acceptability: Medium to high. Some smaller employers with shared use parking lots may have difficulty operationalizing a parking cash-out option; initial cash-out requirements could focus on large employers to establish feasibility and cost effectiveness in Hawaii. In addition to ensuring availability of parking spaces, an adaptive pricing program could make it more convenient for drivers to pay for parking and improve traffic speeds for private vehicles and public transit.

Lifecycle emissions benefits: By adjusting parking pricing to ensure a minimum availability of parking spaces, adaptive pricing programs can reduce the extent to which drivers need to cruise looking for a parking space. In the case of San Francisco's SFpark, adaptive pricing was estimated to reduce cruising by 50% relative to blocks without adaptive pricing[173].

Schedule: Medium-term. To the extent that neither option has undergone recent discussion in Hawaii, it would likely take several years to initiate discussions with relevant stakeholders, build knowledge of these options, and move toward implementation.

Likelihood of implementation: Medium. To improve the likelihood of implementation, Hawaii could draw on the experience of California, which has required certain

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[170] Shoup, D. (1997). Evaluating the Effects of Cashing Out Employer-Paid Parking: Eight CaseStudies. *Transport Policy* 4(4), 201-216. Retrieved from http://shoup.bol.ucla.edu/EvaluatingCashOut.pdf

[171] Costs are likely in 1997 USD. Source: Shoup, D. (1997). Evaluating the Effects of Cashing Out Employer-Paid Parking: Eight CaseStudies. *Transport Policy* 4(4), 201-216. Retrieved from http://shoup.bol.ucla.edu/EvaluatingCashOut.pdf

[172] SFMTA (2014). SFpark Pilot Project Evaluation Summary. Retrieved from http://sfpark.org/wp-content/uploads/2014/06/SFpark_Eval_Summary_2014.pdf

[173] Millard-Ball, A., Weinberger, R.R. & Hampshire, R.C. (2014). Is the curb 80% full or 20% empty? Assessing the impacts of San Francisco's parking pricing experiment. *Transportation Research Part A* 63, 76-92.

employers to offer a parking cash-out option since the 1990s[174], as well as San Francisco's SFpark adaptive pricing program[175].

B.4 Promote carsharing programs

B.4.1) Carsharing for public fleets

Context: The U.S. General Services Administration (GSA) is implementing a pilot program to help federal agencies optimize their use of vehicles and reduce the costs of owning and maintaining their vehicle fleets. Similarly, municipalities throughout the U.S.[176] are increasingly taking advantage of carsharing services to reduce the cost of providing work vehicle access to government employees. Third-party carsharing services such as Zipcar's FastFleet and Zipcar for government have allowed government employees to easily access vehicles when needed, as well as providing public administrators the ability to track and manage vehicle use, mileage, and costs. While plug-in hybrid and battery-electric vehicles have higher purchase prices than conventional vehicles, the cost of these vehicles can be paid back over time with savings in maintenance and fuel costs. PHEV and BEV technologies could be especially effective for use in carsharing programs, since high daily utilization rates could accelerate the payback for these vehicles.

Approach: Hawaii's State and County governments could implement carsharing programs for public fleets, making use of highly efficient vehicles and EVs to substantially improve the average fuel economy of work trips taken by public employees. By enabling better administrative oversight of employee work trips, carsharing for public fleets could also reduce VMT.

Assumptions:

- Chicago implemented a carsharing program for government employees in 2011. As a result of the program, the city was able to reduce its fleet from 1,000 to 650 vehicles (equivalent to a 35% reduction) and save $7 million over three years[177].
- Carsharing for public fleets could be combined with fleet renewal efforts for public fleets, including scrappage of older, less efficient vehicles and consolidation of mileage on high-efficiency vehicles.

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[174] CARB (2011). California's Parking Cash-Out Law. Accessed 6 Mar 2015 at http://www.arb.ca.gov/planning/tsaq/cashout/cashout.htm

[175] SFMTA (2014). SFpark Pilot Project Evaluation Summary. Retrieved from http://sfpark.org/wp-content/uploads/2014/06/SFpark_Eval_Summary_2014.pdf

[176] As of 2014, these municipalities included Boston; Chicago; Houston; New York; Philadelphia; Portland, Oregon and Washington, D.C. Source: Zipcar (2014). "U.S. General Services Administration Selects Zipcar for Car Sharing Program in Boston, Chicago, New York City and Washington, D.C." GlobeNewswire, Inc. Accessed 6 Mar 2015 at http://globenewswire.com/news-release/2014/10/03/670608/10101191/en/U-S-General-Services-Administration-Selects-Zipcar-for-Car-Sharing-Program-in-Boston-Chicago-New-York-City-and-Washington-D-C.html

[177] Grass, M. (2014). "How Big Cities Are Saving Big Bucks With Car Sharing." National Journal Group, Inc. Accessed 6 Mar 2015 at http://www.govexec.com/state-local/2014/07/car-sharing-chicago-zipcar-indianapolis-blueindy/88141/

- 11,243 light-duty vehicles were licensed to State and County agencies in 2014. Assuming statewide implementation of carsharing services for State and County vehicles, if Hawaii were able to reduce its government vehicle fleets by a similar share as Chicago (35%), it could reduce its fleet by about 3,935 vehicles.
- Scaling Chicago's cost savings over three years based on the size of its vehicle fleet (1,000) compared to state and county vehicles in Hawaii (11,243) indicates potential cost savings of $78.7 million over three years, equivalent to $20,000 for each vehicle no longer needed as a result of improved vehicle utilization.
- Assuming State and County vehicles get an average of 32 mpg and could be replaced by vehicle travel in hybrids and EVs, the reduction in fuel consumption could range from 0.4 to 1.2 MGY depending on the share of travel in hybrids vs. EVs (or PHEVs).

Benefits: 0.3 to 1.1 MGY; 0.7 MGY if 50% of affected mileage were traveled on electric-drive.
Costs: Potential cost savings of $78.7 million over three years, equivalent to $20,000 for each vehicle no longer needed as a result of improved vehicle utilization. The full costs savings to State and County governments in Hawaii would depend on the extent to which carsharing programs are implemented among government agencies, as well as the fuel economy and operating characteristics of replaced vehicles. Fuel savings may be internalized by the carsharing company depending on the nature of the carsharing agreement.
Local economy: Some permanent jobs could be added at carsharing companies to provide program services and maintain vehicles; however, it is unclear to what extent these jobs would replace current vehicle maintenance positions.
Social acceptability: High. Implementing carsharing programs for State and County agencies could result in more efficient use of public funds in addition to furthering clean energy and environmental priorities. While some employees at State and County agencies may oppose increased oversight of work trips, the program could also result in net time savings and productivity benefits by providing employees with easy access to vehicles.
Lifecycle emissions benefits: Medium. Benefits would scale with fuel savings and depend on the share of travel in hybrids and EVs. Emissions benefits of traveling in EVs would increase over time as the grid becomes cleaner.
Schedule: Near- to Medium-term. It could take anywhere from one to five years to analyze the vehicle needs of public agencies, identify a carsharing service provider, negotiate a contract, and implement a program.
Likelihood of implementation: Medium. While there is significant potential for cost savings, implementing a carsharing program across all State and County agencies may encounter coordination difficulties. One means of improving the likelihood of implementation may be for a sizeable agency at the state, county, or city level to pilot carsharing for its vehicle fleet and pave the way for implementation in other agencies.

B.4.2) Dedicated parking for carsharing

Context: Carsharing services can make more efficient use of limited public parking facilities and reduce the number of vehicles needed to provide mobility to car users. As electric-drive and autonomous vehicle technologies continue develop, there is potential for carsharing services to substantially transform and reduce the petroleum intensity of private vehicle travel in the long-term[178]. In the near-term, municipalities can take actions to promote carsharing options and enable significant reductions in VMT. EV carsharing programs are becoming increasingly popular, with programs underway in U.S.[179], France, and China[180].

As of June 2015, a proposed City and County of Honolulu Bill 24 (2015)[181] would allow 50 off-street municipal stalls to be dedicated for carshare.

Approach: The State could encourage local governments in Hawaii to dedicate additional parking for carsharing programs. Priority dedication of facilities or reduced parking decal rates could be offered for EV carsharing fleets.

Assumptions:

- Carsharing services can significantly reduce congestion and energy use. Certain studies have found that each carshare vehicle can replace an estimated 9 to 13 private cars, reduce overall driving of participants by 27% to 56%, and increase rates of walking, bicycling, and utilization of public transit[182]. A study of North American carshare programs implemented over ten years estimate an average VMT reduction among carsharing participants of 44%[183].
- Each carshare vehicle is assumed to replace 10 private cars (near the lower end of the cited range of 9 to 13 private cars replaced by each carshare vehicle).
- Every 1,000 dedicated parking spaces or decals might be expected to add the same number of carshare vehicles, which could replace 10,000 private cars based on the assumption of 10 private cars replaced per carshare vehicle.

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178 Fagnant, D., and Kockelman, K. (2014). The Travel and Environmental Implications of Shared Autonomous Vehicles, Using Agent-Based Model Scenarios. *Transportation Research Part C*, Vol 40 (2014): 1-13. Retrieved from http://www.ce.utexas.edu/prof/kockelman/public_html/TRB14SAVenergy_emissions.pdf

179 BlueIndy (2014). "BlueIndy, a car sharing service in Indianapolis." Accessed 6 Mar 2015 at http://www.blue-indy.com/

180 Feng, S., Huang, W., Wang, J., Wang, M., and Zha, J. (2015). "Low-carbon City and New-type Urbanization: Proceedings of Chinese Low-carbon City Development International Conference." *Environmental Science and Engineering / Environmental Science*. Accessed 6 Mar 2015 at https://books.google.com/books?id=04xnBgAAQBAJ&dq=survey+of+ev+carsharing+programs&source=gbs_navlinks_s

181 Proposed City and County of Honolulu Bill 24 (2015), has subsequently been passed by City Council, and has been transmitted to the Mayor. http://www4.honolulu.gov/docushare/dsweb/Get/Document-163462/BILL024(15).htm

182 Dutzik, T., Madsen, T. and Baxandall, P. (2013). A New Way to Go: The Transportation Apps and Vehicle-Sharing Tools that Are Giving More Americans the Freedom to Drive Less. U.S. PIRG Education Fund & Frontier Group. Retrieved from http://washpirgfoundation.org/sites/pirg/files/reports/A%20New%20Way%20to%20Go%20vUS1_1.pdf

183 Shaheen, S., Cohen, A., and Chung, M. (2009). *Transportation Research Record: Journal of the Transportation Research Board*, No. 2110, Transportation Research Board of the National Academies, Washington, D.C., 2009, pp. 35–44. DOI: 10.3141/2110-05. Retrieved from http://www.rmi.org/Content/Files/North%20American%20Carsharing%20-%2010%20Year%20Retrospective.pdf

- The range of benefits is based on the reduction in VMT assuming that the fuel economy of replaced vehicles ranges from 23 mpg (the state average for all vehicles) to 32 mpg (the average for new light-duty vehicles in 2014)[184].

Benefits: 1.2 to 1.7 MGY, with an average of 1.4 MGY in the near-term[185]. Additional fuel savings could result if a significant share of new carshare vehicles are EVs.
Costs: Since the State government levies a surcharge of $0.25 per hour on carsharing vehicles[186], increasing the provision of carsharing services would increase revenues to the State from this surcharge. Local governments would recoup the cost of providing parking through fees charged to carsharing organizations. Studies of carsharing programs have estimated average cost savings to users in the range of $154 to $435 per month[187]. Net savings consider reductions in private vehicle travel costs including VMT and fuel use, as well as fees paid to carsharing organizations.
Local economy: Medium. Jobs added at carsharing companies, and to maintain vehicles.
Social acceptability: High. Carsharing services can enable greater use of public transit, walking, and bicycling while retaining consumer access to mobility when needed. Since carsharing organizations (and users) would compensate local governments for the cost of parking, these programs would not require subsidies from non-participants.
Lifecycle emissions benefits: Medium based on fuel savings. EV carsharing vehicles could increase lifecycle emission benefits; in general, the benefits of EVs will further increase as the grid becomes cleaner. Additional benefits could result from decreased congestion and increased use of alternative transportation modes.
Schedule: Near-term. There are already several carsharing organizations active[188,189] in Hawaii, and provision of additional parking facilities could increase the scale of existing programs.
Likelihood of implementation: High. Recent changes to the state carsharing surcharge and the City and County of Honolulu's rules to enable dedicated parking for carsharing indicate a high level of stakeholder interest in expanding carsharing programs.

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[184] ICCT (2014). Modified version of VISION model adapted for Hawaii. VISION 2013 AEO Base Case ©COPYRIGHT 2004 UCHICAGO ARGONNE, LLC. VISION model available from http://www.transportation.anl.gov/modeling_simulation/VISION/

[185] Additional research is recommended to collect data on travel behavior of local carsharing participants (before and after joining a carsharing program), and apply this data to improve estimates of potential reductions in VMT and fuel use associated with expanding carsharing programs statewide.

[186] Hawaii Revised Statutes (2015). Section 251-2.5. Car-sharing vehicle surcharge tax. Retrieved from http://www.capitol.hawaii.gov/hrscurrent/Vol04_Ch0201-0257/HRS0251/HRS_0251-0002_0005.htm

[187] Ibid.

[188] Moriki, D. (2015). "Car sharing network Zipcar rolls out first Hawaii fleet in Waikiki." Retrieved from http://www.bizjournals.com/pacific/blog/morning_call/2015/05/car-sharing-network-zipcar-rolls-out-first-hawaii.html

[189] Honolulu Clean Cities (2015). "Car Sharing." Retrieved May 29, 2015 from http://honolulucleancities.org/vmt-reduction/car-sharing/

B.5 Secure state support and funding of bikeshare programs

B.5.1) Bikeshare system in urban Honolulu

The City and County of Honolulu funded a study, conducted by Nelson Nygaard, to evaluate bikeshare in Honolulu; this Honolulu Bikeshare Organizational Study, released by the City and County of Honolulu's Department of Planning and Permitting in June 2014[190], outlines the costs and benefits of a bikeshare program. Due to limited time for analysis of petroleum reduction tactics, the ICCT did not perform its own evaluation of the potential costs and benefits of bikeshare programs in Hawaii. The bikeshare evaluation, shown below, has been provided by Bikeshare Hawaii and covers the urban Honolulu system. Additional costs and benefits would occur if bikeshare expands beyond urban Honolulu to other communities in the City and County of Honolulu, Hawaii County, Kauai County and Maui County.

Context: Bikeshare is a low-cost, flexible public transportation service that provides on-demand access to a network of publically accessible bicycles. Bikeshare provides an option for people to make point-to-point trips and generally accommodate shorter trips that replace less efficient auto and transit trips (trip lengths average between one and three miles). There are over 30 bikeshare systems operating throughout the United States and at least 100 more systems being planned. The City and County of Honolulu completed a bikeshare feasibility study in 2014 and the recommendation was to move forward in creating a bikeshare system. As a result, Bikeshare Hawaii was created. It is a not-for-profit 501(c)3 organization aiming to launch and manage bikeshare in the State of Hawaii. Bikeshare Hawaii is seeking public and private funding to launch operations and is designed to maintain and grow system coverage through revenue generated by its customers. Bikeshare Hawaii is currently supported by Ulupono Initiative, Hawaii Pacific University, the State of Hawaii and the City and County of Honolulu, and the U.S. EPA and is actively seeking other partnerships.
Approach: Bikeshare Hawaii could implement bikeshare in Honolulu and throughout the State of Hawaii, with support from public and private partners. Encouraging the use of bicycles for short trips will support a multi-modal transportation system, help ease traffic, promote fitness, create business for retailers, reduce our dependence on fossil fuels and reduce VMT[191].
Benefits: The recommended initial service area encompasses an area spanning from Honolulu's Chinatown district to Waikiki — bounded by the H1 freeway, but extending up to UH Manoa and Makiki. The proposed initial number of bicycles deployed is at least 1,676 and the proposed number of stations is at least 183. Based on the projected ridership for this initial phase of Bikeshare in urban Honolulu, the following benefits are estimated:
Health Benefits: 141-173 million calories and 45,000 pounds of fat burned each year the equivalent of 566,000-692,000 hamburgers annually. Bikeshare presents an opportunity

[190] http://www.honoluludpp.org/Portals/0/pdfs/NewsRelease/HonoluluBikeshareOrgStudyJune2014.pdf

[191] Source & Assumptions: City & County of Honolulu's "Honolulu Bikeshare Organizational Study, Published June 2014" posted on Bikesharehawaii.org/about.

for health activity that could be supported by a multimodal public safety campaign (Section V.C.2.1).
Environmental/ Energy: 4.3 million in potential annual VMT savings[192], 3.9-4.3 million estimated pounds of carbon saved annually
Economic: 33-36 new jobs created directly by bike share operations, $195,000-$255,000 net increase in retail spending near stations (conservative estimate), $2.5 million in potential annual savings from reduced driving and use of fossil fuels.
Costs: The optimal density scenario described above will likely have a one-time capital cost of between $9.2-11.8 million depending on the specific system requirements and technologies employed. Although no decision has been made about equipment, these costs are based on the selected bikeshare vendor providing 7-speed bicycles. Anticipated annual operating costs generally consist of operations facilities and equipment, general, administrative, and operations staff, administrative and maintenance activity, and IT, website, and other communication-related costs. Planning-level costs for Honolulu's optimal initial phase implementation scenarios is estimated to cost: $3.2 million per year but should be covered by user fees and sponsorship support.
Local Economy: Two permanent jobs have already been created by bikeshare and additional permanent jobs could be added to provide program services and maintain bicycles. All of these jobs are new jobs and not replacement jobs since bikeshare is new to Hawaii.
Social acceptability: High. Implementing bikeshare programs in Hawaii has already gained a lot of public agency, private, non-profit and general public support. In comparison with other public transit systems and transportation infrastructure, bikeshare is inexpensive, straightforward, and can benefit residents and tourists at a very low cost to users.
Lifecycle emission benefits: High. Bicycles do not use any fossil fuels and instead run off of human power, leading to an overall more sustainable and healthier community. There are zero emissions from bicycles. Rebalancing bikeshare systems sometimes requires trucks to move bicycles from full stations to empty stations. Truck rebalancing is common but not the only possible way to rebalance the system and Hawaii has the opportunity to reduce lifecycle emissions even more by using innovative solutions such as user incentive apps.
Schedule: Bikeshare is planned to be launched in 2016, but this launch is contingent upon enough funding being secured.
Likelihood of Implementation: High if funding is secured. For the initial service area, station siting, permitting, the RFP are all currently underway. The likelihood of system expansion is also high. There is interest from various communities outside of urban Honolulu on Oahu and on the outer islands. More public funding would pave the way for timely implementation.

[192] The ICCT estimates a reduction of 4.3 million VMT would save 0.14 MGY in 2030 based on an assumption of 30 mpg for the average passenger car.

B.6 Manage travel demand

B.6.1) Commuter benefits legislation

B.6.2) Support TDM by large employers

Context: The federal government offers a tax incentive to all employers and employees to encourage commuting by alternative modes, including public transit, vanpooling, and bicycling[193]. These commuter benefits can take the form of a pre-tax deduction, subsidy, or direct employer provision of vanpooling or shuttle services to employees. While these commuter benefits can result in monetary savings for both employers and employees, not all employers take advantage of these options. In 2015, several legislative proposals were introduced in Hawaii related to commuter benefits: one bill would allow counties to offer up to three commuter benefit options to their employees[194], and another would give counties authority to require that other employers offer specified commuter benefits[195].

Approach: Similar to legislation proposed[196] in 2015, Hawaii could require public and private employers to offer commuter benefit options that take full advantage of the existing federal tax incentives for commuting by alternative modes. In addition to participation in the federal program, the State could support additional TDM programs, for example in public agencies or at the University of Hawaii.

Assumptions:

- A U.S. DOT Report to Congress concluded that "widespread employer outreach and alternative mode support" could reduce LDV GHG emissions by 0.2-1.1% in 2030[197].
- With current policies, LDVs in Hawaii are projected to consume 328 MGY in 2030[198]. Assuming a constant GHG intensity of petroleum fuels, a 0.2-1.1% reduction in projected LDV fuel use translates to 0.7 to 3.6 MGY.

Benefits: 0.7 to 3.6 MGY in 2030.

Costs: Hawaii Energy Policy Forum (HEPF) estimates that for an employee who spends $60 per month on a bus pass, taking advantage of the federal commuter benefits could save the employee $225 per year in wage and payroll taxes, and save

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[193] Internal Revenue Service (2014). Fringe Benefit Guide. Office of Federal, State, and Local Governments. Retrieved from http://www.irs.gov/pub/irs-pdf/p5137.pdf

[194] HB1503 (2015). Relating to the Commuter Benefits Program. Retrieved 5 Mar 2015 from http://www.capitol.hawaii.gov/measure_indiv.aspx?billtype=HB&billnumber=1503

[195] HB1010 (2015). Relating to the Commuter Benefits Program. Retrieved 5 Mar 2015 from http://www.capitol.hawaii.gov/measure_indiv.aspx?billtype=HB&billnumber=1010&year=2015

[196] Proposed legislation, HB 1010, relating to commuter benefits program, has subsequently been passed into law, and is now known as Act 205

[197] U.S. DOT (2010). Transportation's Role in Reducing U.S. Greenhouse Gas Emissions. Washington, DC: U.S. Department of Transportation. Retrieved from http://ntl.bts.gov/lib/32000/32700/32779/DOT_Climate_Change_Report_-_April_2010_-_Volume_1_and_2.pdf

[198] ICCT (2014). Modified version of VISION model adapted for Hawaii. VISION 2013 AEO Base Case ©COPYRIGHT 2004 UCHICAGO ARGONNE, LLC. VISION model available from http://www.transportation.anl.gov/modeling_simulation/VISION/

the employer $55 per year in payroll taxes[199]. In this case, these benefits would come at no cost to the employer or the employee. In other cases where employees change their commuting behavior in response to these benefits, additional savings could result from reduced costs of private vehicle travel.

Local economy: Taking advantage of federal tax benefits would keep additional tax revenues in Hawaii, allowing this money to be spent locally on alternative transportation modes or other goods and services. To the extent that some employers opt to provide direct vanpooling or shuttle services to their employees, these services could create permanent jobs.

Social acceptability: High. Employees would benefit from tax benefits or direct subsidies that offset their commute costs. Some employers may object to mandatory requirements.

Lifecycle emissions benefits: Low. Emissions benefits would scale with the level of employer participation and the extent to which employees change commuting behavior as a result of being offered benefits.

Schedule: Near-term to medium-term. Commuter benefit options could be required within a year or two with supporting legislation. Supporting for TDM for large employers could take slightly longer than commuter benefit programs, allowing time for employers to conduct surveys of employee travel and design and implement TDM programs.

Likelihood of implementation: High. Commuter benefits legislation would take advantage of existing federal tax benefits, and there is already proposed legislation that would allow counties to require that employers offer commuter benefit options.

B.6.3) Telecommuting by public employees and other large employers

B.6.4) Flexible work and class scheduling

Context: Telecommuting or working from home can be a valuable option for employees that also reduces the time and travel costs associated with commuting to work. While some employees telecommute exclusively, others may do so less frequently, for example one day per week. The American Community Survey estimates that 4.5% of Hawaii's commuters work from home[200]. Aside from telecommuting, flexible work and class scheduling for employees and students can both reduce the need for travel and mitigate congestion by shifting travel to off-peak hours. One example of flexible work scheduling is the compressed work week (CWW): two commonly used CWW schedules are 40 hours worked over 4 days (4/40) and 80 hours worked over 9 days. Hawaii's Department of Human Resources Development piloted a 4/40 CWW schedule in 2009; however, the results of this pilot were not readily available.

Approach: Hawaii's state and county governments could encourage public employees to telecommute or use CWW schedules. For example, supervisors could offer interested employees the option to work one day a week from home or switch to a CWW schedule. Similarly, the State could encourage public education institutions such as the University

[199] Hawaii Energy Policy Forum (HEPF) (2015). "Commuter Benefits for Employers & Employees."

[200] U.S. Census Bureau (2009-2013). 5-Year American Community Survey. Retrieved 5 Mar 2015 from http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk

of Hawaii to offer increased scheduling of evening or remote classes to reduce the need for travel during peak times. Since timing and location of classes can affect the productivity of both faculty and students, additional research would be needed to assess the potential impacts of these changes before evaluating a specific policy.

Assumptions:

- Government employees account for 21% of workers in Hawaii[201].
- A U.S. DOT Report to Congress estimated that doubling telecommuting from current levels could reduce LDV GHG emissions by 0.9-1.2% in 2030[202].
- Similarly, the U.S. DOT report estimated that changing 75% of government employees over to compressed work weeks could reduce LDV GHG emissions by 0.3% in 2030[203].
- With current policies, LDVs in Hawaii are projected to consume 328 MGY in 2030[204]. Assuming a constant GHG intensity of petroleum fuels, a 1.2-1.5% reduction in projected LDV fuel use from telecommuting and CWW schedules translates to 3.9 to 4.9 MGY.

Benefits: 3.9 to 4.9 MGY in 2030.

Costs: Both measures could reduce commuting costs of affected individuals and save travel time. Telecommuting could add costs for enabling technology; these costs could range from negligible for certain roles to cost-prohibitive for others. CWW schedules or shifted class schedules could increase facility operating costs by extending the time that facilities are in use.

Local economy: Low. Both measures could reduce congestion, resulting in less travel time wasted. These impacts would scale based on the level of voluntary participation.

Social acceptability: Medium. Voluntary programs that give employees and students the option to telecommute or otherwise increase flexibility of scheduling could be well received. Some public agencies may find it difficult to maintain productivity with telecommuting or flexible scheduling; similarly, some faculty or students may object to increased scheduling of evening classes.

Lifecycle emissions benefits: Medium. Lifecycle emission benefits scale with fuel savings based on the level of voluntary participation.

Schedule: Near-term. Participation could also be expected to increase over time as employers and employees increasingly adapt to telecommuting and flexible work schedule options.

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[201] Ibid.

[202] U.S. DOT (2010). Transportation’s Role in Reducing U.S. Greenhouse Gas Emissions. Washington, DC: U.S. Department of Transportation. Retrieved from http://ntl.bts.gov/lib/32000/32700/32779/DOT_Climate_Change_Report_-_April_2010_-_Volume_1_and_2.pdf

[203] Ibid.

[204] ICCT (2014). Modified version of VISION model adapted for Hawaii. VISION 2013 AEO Base Case ©COPYRIGHT 2004 UCHICAGO ARGONNE, LLC. VISION model available from http://www.transportation.anl.gov/modeling_simulation/VISION/

Likelihood of implementation: Medium. Telecommuting was recommended as a critical action in the 2011 edition of the HCEI Road Map, indicating there may be potential to revive interest in the measure[205].

C. Electric-drive vehicles

In January 2015, the Hawaii State Energy Office convened a charrette on electric-drive vehicles[206], with the aim of generating a set of actionable steps that can be realistically implemented in Hawaii in support of the State's clean energy goals. 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. 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 electric vehicles and fuels as well as policies and regulations to remove market barriers and accelerate the uptake of these technologies. The charrette presentations and discussions produced a number of actions that Hawaii's State and County governments could take to enable increased uptake of electric-drive technologies, as well as policies that would directly support sales of hydrogen fuel cell and electric vehicles and the development of hydrogen fueling and charging infrastructure and networks. The proceedings and outcomes of this charrette were summarized in a February 2015 publication[207]. In this section, these actions are further evaluated in terms of their potential benefits, costs, social acceptability, and likelihood of implementation.

C.1 Accelerate deployment of hydrogen fuel cell vehicles

C.1.1) Procurement of government FCEVs

C.1.2) Provide incentives for private passenger FCEVs

C.1.3) Encourage commercial vehicle operators to replace diesel ICEs with FCEVs

Context: As of September 2014, out of the roughly 500 hydrogen fuel cell vehicles (FCEVs) operating in the U.S., 45 vehicles were active or planned in the State of

[205] Hawaii Clean Energy Initiative (HCEI) (2011). HCEI Road Map, 2011 Edition. p.33. Retrieved from http://www.hawaiicleanenergyinitiative.org/about/

[206] Including hydrogen fuel cell (FCEV) and plug-in electric vehicles (PEV).

[207] Lloyd, A., Miller, J., Glick, M., Yunker, C., Sparlin, K., Larson, M., Viray, L., & Chin, J. (2015). "Summary of the Hydrogen Fuel Cell and Battery Electric Vehicle Stakeholder Charrette: Expanding Hawaii's Clean Transportation Solutions." The International Council on Clean Transportation (ICCT) and Hawaii Department of Business, Economic Development, and Tourism (DBEDT).

Hawaii.[208] Hydrogen vehicles can have significant benefits compared to electric vehicles, including extended range and reduced refueling time. The potential to expand the market adoption of FCEVs depends on numerous factors, including specific vehicle characteristics and operating patterns, changes in technology and fuel costs over time, the availability of public and private financing mechanisms and funding sources, and social and commercial acceptability of a new technology and fuel system. In particular, FCEVs differ from EVs in that they require the development of a totally new hydrogen production and fueling system. While many potential EV customers have the option to charge vehicles overnight using standard electricity outlets, there is no such option for FCEVs. This section describes several measures that could promote hydrogen fuel cell vehicles themselves. The following section focuses on critical infrastructure needs to support the introduction of these vehicles.

- <u>Procurement of government FCEVs.</u> Hydrogen fuel is not yet commercially available in Hawaii, posing a major barrier to uptake of private passenger and commercial FCEVs. Until hydrogen fuel is commercially available (see Section C.2), federal, state, and local governments may be better positioned to expand the deployment of FCEVs and hydrogen fueling infrastructure in Hawaii. The US DOE is in the process of demonstrating and commercializing FCEVs for a number of vehicle types[209], and there is additional potential to demonstrate viability and identify the most efficient pathways by conducting pilot programs for FCEVs in Hawaii. Out of the 45 active and planned FCEVs in Hawaii, 40 are passenger vehicles, most of which are operated by the Department of Defense[210].
- <u>Provide incentives for private passenger FCEVs.</u> Several incentives are currently offered to operators of EVs, 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 for individuals or companies that purchase or lease FCEVs. For example, California offers a $5,000 rebate for the purchase of FCEVs[211]. While passenger cars and light trucks are likely to be the primary target for such incentives, other vehicle types such as scooters, golf carts, and small utility vehicles could be candidates as well. These incentives could encourage market uptake of consumer FCEV models once fueling facilities are in place. Over the next several years, consumer models of FCEVs are expected to become commercially available[212]: for example,

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[208] US DOE (2014). Inventory of U.S. Over-the-Road Hydrogen-Powered Vehicles. Hydrogen Analysis Resource Center. Retrieved from http://hydrogen.pnl.gov/hydrogen-data/inventory-us-over-road-hydrogen-powered-vehicles

[209] US DOE, HNEI, and HCATT (2014, Draft). Fuel Cell Electric Vehicle and Hydrogen Fueling Infrastructure Implementation Plan For Hawai'i (HIP).

[210] US DOE (2014). Inventory of U.S. Over-the-Road Hydrogen-Powered Vehicles. Hydrogen Analysis Resource Center. Retrieved from http://hydrogen.pnl.gov/hydrogen-data/inventory-us-over-road-hydrogen-powered-vehicles

[211] Center for Sustainable Energy (2015). "Clean Vehicle Rebate Project." Retrieved from http://energycenter.org/clean-vehicle-rebate-project

[212] Lloyd, A., Miller, J., Glick, M., Yunker, C., Sparlin, K., Larson, M., Viray, L., and Chin, J. (2015). Hydrogen Fuel Cell & Battery Electric Vehicle Stakeholder Charrette Summary Report. ICCT and DBEDT. Retrieved from http://www.hawaiicleanenergyinitiative.org/storage/pdfs/E-driveCharretteSummary_2.27.2015.pdf

Toyota plans to release the Mirai FCEV in 2015 as a 2016 model[213]. For more details on state rebates for electric-drive vehicles, see Section C.3.1).

- Encourage commercial vehicle operators to replace diesel vehicles with FCEVs. While EVs have been more extensively commercialized, especially for passenger cars, hydrogen fuel cell technologies are particularly well suited to certain medium- and heavy-duty applications due to extended range and fuel system durability[214]. Several types of commercial vehicles that could be targeted for replacement with FCEVs include airport ground equipment and shuttles, forklifts (which are already used commercially and are cost effective), postal delivery trucks, refrigerated container trucks, and public buses. Hydrogen fuel cell models are already available for some vehicle types such as buses, while others are anticipated to become commercially available within several years. On-board hydrogen systems on train cars could also potentially offer a lower cost of operation than electrified light rail[215]; however such systems are still at an early stage and need to be further evaluated.

Approach: Not evaluated.
Hydrogen FCEVs and fuels are not yet commercially available in Hawaii; however, Hawaii could build on the experiences of leaders in the deployment of hydrogen FCEVs, production, and fueling infrastructure such as California, Germany, Japan, and Korea. While FCEV models are available for specific vehicle types such as passenger cars and buses, additional investigation will be needed to assess the impacts of specific policy actions to promote the deployment FCEVs. A government-led push in collaboration with the private sector could potentially demonstrate the technical practicality and economic feasibility of deploying these systems in Hawaii.
Assumptions: None
Benefits: Not evaluated.
Costs: Due to their earlier stage of commercialization, the economic challenges of hydrogen FCEVs are currently greater than for EVs. A study of the transition to electric-drive vehicles in California, other states that have adopted California's vehicle emissions standards, and the rest of the U.S. found that the initial costs of government investments in electric-drive vehicles and infrastructure pay for themselves many times over in long-term private and societal benefits[216]. These findings indicate that the costs of piloting hydrogen FCEVs and fueling infrastructure in Hawaii would have medium to high near-term costs, but potentially significant long-term benefits to the extent that they facilitate the commercialization of FCEVs in Hawaii.

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[213] As of May 2015, the Mirai has a posted MSRP of $57,500.

Toyota Motor Sales, USA, Inc. (2015). "The Toyota FCV." Retrieved from http://www.toyota.com/mirai/fcv.html

[214] Hill, P., and Penev, M. (2014). Hydrogen Fueling Station in Honolulu, Hawaii Feasibility Analysis. INL and NREL. Retrieved from http://energy.gov/sites/prod/files/2014/08/f18/fcto_h2_fueling_station_honolulu_feasibility_analysis.pdf

[215] LRTA (2015). "Is hydrogen the holy grail for off wire operation?" Retrieved from http://www.applrguk.co.uk/media/files/027-029_TAUT1501_TIG-M3pdf

[216] Greene, D., Park, S., and Liu, C. (2013). "Analyzing the Transition to Electric Drive in California." Final Report to The International Council on Clean Transportation. Retrieved from http://www.theicct.org/analyzing-transition-electric-drive-california

Though hydrogen vehicles and fuels require financial support in the near-term, a study by the National Academy of Sciences estimates that the long-run costs for hydrogen fuel cell passenger cars could converge to the cost of ICE cars between 2030 and 2040 if FCEVs achieve full-scale commercial production[217]. If demonstration programs and early commercialization efforts are successful, the government could reduce direct subsidies in later years as FCEVs become increasingly cost-competitive with conventionally fueled vehicles.

Local economy: Not evaluated.

Social acceptability: Not evaluated.

Lifecycle emissions benefits: Not evaluated.

Schedule: Not evaluated.

Likelihood of implementation: Not evaluated.

C.2 Accelerate deployment of hydrogen fueling infrastructure

C.2.1) Support the development of economically viable fueling infrastructure

Context: Widespread deployment of EVs and hydrogen FCEVs will require investments in new infrastructure, including fast-charging stations for EVs and hydrogen production and fueling infrastructure for FCEVs. A 2014 NREL study estimates that the per-mile cost of BEVs and hydrogen FCEVs will be comparable in 2025, taking into account retail fueling infrastructure, vehicle costs, and vehicle efficiency[218]. Many U.S. states and countries such as Germany, Japan, and Korea have already recognized the need to lead the development of hydrogen production and fueling infrastructure to enable the uptake of FCEVs[219]. California has already committed $20 million per year for ten years to support the development of 100 hydrogen fueling stations throughout the state[220]. By the end of 2015, California ARB expects 51 hydrogen stations to be operational, providing up to 9,400 kg of hydrogen per day[221]. In 2013, governors of eight states signed an MOU[222] to take specific actions to accelerate the market uptake of zero-

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[217] National Academy of Sciences (2013). Transitions to Alternative Vehicles and Fuels. p.98. Retrieved from http://www.nap.edu/openbook.php?record_id=18264&page=98

[218] Costs were estimated for a generic urban city. Source: Melaina, M., Sun, Y., Bush, B. (2014). Retail Infrastructure Costs Comparison for Hydrogen and Electricity for Light-Duty Vehicles. National Renewable Energy Laboratory (NREL). Retrieved 26 Jun 2015 from http://www.nrel.gov/docs/fy14osti/60944.pdf

[219] Lloyd, A., Miller, J., Glick, M., Yunker, C., Sparlin, K., Larson, M., Viray, L., and Chin, J. (2015). Hydrogen Fuel Cell & Battery Electric Vehicle Stakeholder Charrette Summary Report. ICCT and DBEDT. Retrieved from http://www.hawaiicleanenergyinitiative.org/storage/pdfs/E-driveCharretteSummary_2.27.2015.pdf

[220] Pursuant to Assembly Bill 8. Source: California Air Resources Board (ARB) (2014). Annual Evaluation of Fuel Cell Electric Vehicle Deployment and Hydrogen Fuel Station Network Development. Retrieved from http://www.arb.ca.gov/msprog/zevprog/ab8/ab8_report_final_june2014.pdf

[221] Ibid.

[222] CA, CT, MD, MA, NY, OR, RI, and VT (2013). State Zero-Emission Vehicle Programs - Memorandum of Understanding. Retrieved from http://arb.ca.gov/newsrel/2013/8s_zev_mou.pdf

emission vehicles (ZEV) and support the development of associated fueling infrastructure. In 2015, Northeast Electrochemical Energy Storage Cluster (NEESC) released plans to deploy 10,800 FCEVs, 640 hydrogen fuel cell buses, and 110 hydrogen fueling stations in eight states in the Northeast region[223].

Approach: Hawaii could build upon the experience of other states to support the development of hydrogen fueling infrastructure. Many of these actions are identified in the MOU signed by governors of eight states in 2013[224], as well as reports by California ARB and NEESC. Since FCEVs cannot operate in the absence of locally available hydrogen fuel (e.g. FCEVs operating on Oahu would require hydrogen fuel availability on the island), the approach taken for vehicles should be closely coordinated with the development of necessary fueling infrastructure. A 2014 draft report by the US DOE, HNEI, and HCATT included the development of a coordinated plan to deploy hydrogen vehicles and fuels in Hawaii, with a focus on Oahu and the Big Island[225]. The report also provided a detailed assessment of the proposed plan, which serves as the basis for this analysis. The next phase of this plan would be implementation, as discussed during the charrette on electric-drive vehicles[226]. Achieving the benefits of this plan would require the joint deployment of vehicles and fuels. In addition to government-led deployment of vehicles and fuels, public-private partnerships could support the development of hydrogen fueling stations, for example to make use of plentiful renewable energy resources on the Big Island. Additional enabling actions that would support the development of hydrogen fueling infrastructure are described in Section V.C.

Assumptions:

The plan developed by US DOE, HNEI, and HCATT includes pilot programs for light-duty vehicles, para-transit buses, delivery trucks, refuse trucks, baggage tow tractors, and full-size buses. The following table indicates the number of vehicles and expected hydrogen fueling demand assuming full implementation of the pilot programs in the 2016-2020 timeframe[227].

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[223] These plans were supported by the US Small Business Administration (SBA) and produced with input from government agencies and industry representatives. Source: Green Car Congress (2015). "NEESC releases 2015 hydrogen & fuel cell development plans for eight Northeastern states; power generation and transportation." Retrieved 4 Mar 2015 from http://www.greencarcongress.com/2015/02/20150220-neesc.html

[224] CA, CT, MD, MA, NY, OR, RI, and VT (2013). State Zero-Emission Vehicle Programs - Memorandum of Understanding. Retrieved from http://arb.ca.gov/newsrel/2013/8s_zev_mou.pdf

[225] US DOE, HNEI, and HCATT (2014, Draft). Fuel Cell Electric Vehicle and Hydrogen Fueling Infrastructure Implementation Plan For Hawai'i (HIP).

[226] Lloyd, A., Miller, J., Glick, M., Yunker, C., Sparlin, K., Larson, M., Viray, L., & Chin, J. (2015). "Summary of the Hydrogen Fuel Cell and Battery Electric Vehicle Stakeholder Charrette: Expanding Hawaii's Clean Transportation Solutions." The International Council on Clean Transportation (ICCT) and Hawaii Department of Business, Economic Development, and Tourism (DBEDT).

[227] Ibid.

Table 7. Assumed number of FCEVs and fuel demand for pilot programs (US DOE, HNEI, & HCATT; 2014)[228]

FUEL CELL TECHNOLOGY	NUMBER OF UNITS	H2 FUELING DEMAND (KG/DAY)
Light Duty FCEVs	80	40
Plug-In Para-transit Bus Pilot	25	100
Plug-In Delivery Truck Pilot	10	50
Plug-In Refuse Truck Pilot	7	63
Baggage Tow Tractor Pilot	10	60
Fuel Cell Bus Pilot	4	84
Total	**137**	**397**

In addition to the number of vehicles and total hydrogen fueling demand, the following assumptions were made:

- While 1 kg hydrogen has about the same energy content as one gallon of gasoline[229], hydrogen FCEVs tend to be much more energy efficient than ICE or hybrid vehicles[230]. As result, each kg of hydrogen produced could reduce several gallons of gasoline consumed.
- Electricity cost is a major determinant of the cost of hydrogen production through electrolysis. The cost of high volume hydrogen production using electrolysis has been estimated at $4.00 to $5.80 per kg assuming an electricity price of less than $0.07 per kWh[231].
- An analysis by NREL and INL of the planned hydrogen station at Fort Armstrong (one of the stations considered in the plan developed by US DOE, HNEI, and HCATT) estimated that hydrogen would need to be sold for $13.00 per kg in order to recuperate the capital, operating, and maintenance costs of the facility. This price was estimated to be equivalent to a gasoline price of $3.90 per gallon, assuming 80 mpgge for a FCEV and 24 mpg for an ICE.[232]

Benefits: 0.265 MGY by 2020 for the pilot program of 137 vehicles on Oahu and the Big Island[233]. These fuel savings would require hydrogen facilities capable of producing and delivering a combined 397 kg hydrogen per day[234]. Since FCEVs are substantially more efficient than ICEs, about 2 gallons of gasoline would be saved for each kg of hydrogen produced.

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[228] Ibid.

[229] US DOE (2015). Energy Equivalency of Fuels (LHV). Hydrogen Analysis Resource Center. Retrieved from http://hydrogen.pnl.gov/hydrogen-data/hydrogen-properties

[230] For example by a factor of 2: Lloyd, A., Miller, J., Glick, M., Yunker, C., Sparlin, K., Larson, M., Viray, L., and Chin, J. (2015). Hydrogen Fuel Cell & Battery Electric Vehicle Stakeholder Charrette Summary Report. ICCT and DBEDT. Retrieved from http://www.hawaiicleanenergyinitiative.org/storage/pdfs/E-driveCharretteSummary_2.27.2015.pdf

[231] Ainscough, C., Peterson, D., and Miller, E. (2014). H2 Production Cost From PEM Electrolysis. US DOE.

[232] Hill, P., and Penev, M. (2014). Hydrogen Fueling Station in Honolulu, Hawaii Feasibility Analysis. INL and NREL. Retrieved from http://energy.gov/sites/prod/files/2014/08/f18/fcto_h2_fueling_station_honolulu_feasibility_analysis.pdf

[233] Ibid.

[234] Ibid.

Costs: The cost competitiveness of hydrogen fuel is dependent on several factors, including the efficiency of the FCEV and comparison vehicle, as well as prices of electricity for electrolysis and the gasoline or diesel fuels that hydrogen would displace. At $3.90 per gallon gasoline, US DOE's Hydrogen Threshold Cost Calculator estimates that $13 per kg for hydrogen could be competitive assuming NREL and INL's estimates of FCEV and ICE efficiency[235]. As with tactics to promote EVs, actions that reduce the cost of electricity for hydrogen production (e.g., demand response), streamline the permitting and safe operation of hydrogen fueling stations, or increases in the cost for gasoline and diesel fuels would significantly improve the cost competitiveness of hydrogen fuels and vehicles.

The draft study by US DOE, HNEI, and HCATT did not include final cost estimates for the FCEVs that will make use of the hydrogen produced. Government agencies would likely need to support the procurement of these vehicles, potentially with the assistance of federal grants (Section V.C.3.1).

Local economy: Medium. Some jobs would be created with the installation and maintenance of hydrogen fueling infrastructure and maintenance of FCEVs; the number of jobs could roughly scale with the number of stations constructed and vehicles procured. Since electrolysis produces medical grade oxygen in addition to hydrogen, monetizing this revenue stream could reduce the net costs of hydrogen production[236].

Social acceptability: Medium. Developing commercially accessible hydrogen fueling infrastructure could increase consumer choices as FCEVs become increasingly available. To the extent that new hydrogen stations will require the support of taxpayer funds, public outreach and education will be especially important to demonstrate current technical feasibility and safety, as well as long-term economic viability of hydrogen FCEVs in Hawaii.

Lifecycle emissions benefits: Low. Lifecycle emissions benefits will be greater to the extent that hydrogen production facilities use electricity generated from renewable sources (as with the proposed Fort Armstrong station). These benefits will increase over time as demand-responsive hydrogen production facilities enable a greater share of renewable sources to be integrated into the electricity grid. While the first several hydrogen stations will likely reduce only a small absolute level of petroleum use relative to the amount consumed for transportation statewide, these and other actions could help to bring about the widespread use of hydrogen for transportation in Hawaii, with much greater long-term energy and lifecycle emissions benefits.

Schedule: Near-term and long-term. The plan developed by US DOE, HNEI, and HCATT could demonstrate the near-term technical feasibility of operating hydrogen fueling stations and FCEVs in Hawaii. To the extent that this demonstration plan results in other actions that encourage the development of hydrogen fuels and vehicles throughout the state, it could have large-scale long-term impacts on petroleum use in transportation.

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[235] US DOE (2015). Hydrogen Threshold Cost Calculator. Retrieved 3 Mar 2015 from http://hydrogen.pnl.gov/tools/hydrogen-threshold-cost-calculator

[236] Lloyd, A., Miller, J., Glick, M., Yunker, C., Sparlin, K., Larson, M., Viray, L., and Chin, J. (2015). Hydrogen Fuel Cell & Battery Electric Vehicle Stakeholder Charrette Summary Report. ICCT and DBEDT. Retrieved from http://www.hawaiicleanenergyinitiative.org/storage/pdfs/E-driveCharretteSummary_2.27.2015.pdf

Likelihood of implementation: Medium. Significant efforts have been underway for several years to formulate and evaluate the demonstration plan developed by US DOE, HNEI, and HCATT. At a workshop focused on electric-drive vehicles in January 2015, local stakeholders formulated a set of actionable steps to move toward the implementation of the plan, with an initial focus on the hydrogen production and fueling station at Fort Armstrong[237].

In addition, a number of proposed legislative initiatives relating to hydrogen vehicles and fuels indicate that there is potential interest in bringing such a plan to fruition. Supportive legislative action could also provide a positive signal to the private sector concerning the potential to commercialize hydrogen vehicles and fuels in Hawaii. Given that FCEV buses have already been deployed in several areas in the U.S.[238], expanding the number of FCEV buses in Hawaii could provide an early guarantee for local hydrogen demand.

C.3 Accelerate deployment of electric vehicles

C.3.1) State rebates for new electric vehicles

Context: According to surveys of consumers in the U.S., vehicle purchase price is the most significant factor in determining whether a consumer will buy an electric vehicle (EV)[239] or an internal combustion engine (ICE) vehicle; while some consumers are willing to pay more in exchange for expected fuel savings or non-fiscal benefits, minimizing the differential between EV and ICE purchase price is one of the most important factors to enable mass uptake of EVs[240]. Since consumers face significant uncertainty regarding future fuel prices, and to a lesser extent, electricity rates and driving behavior, subsidies that guarantee immediate benefits could significantly increase the attractiveness of EVs to the general population. The federal government offers a tax credit of up to $7,500 to reduce the price differential between EVs and ICEs. Many states (including Colorado, Illinois, Louisiana, and California) offer an additional tax credit or rebate of $2,000-$6,000 to further increase the attractiveness of EVs compared to ICEs. As a result, several of these states with significant state-level

[237] Lloyd, A., Miller, J., Glick, M., Yunker, C., Sparlin, K., Larson, M., Viray, L., and Chin, J. (2015). Hydrogen Fuel Cell & Battery Electric Vehicle Stakeholder Charrette Summary Report. ICCT and DBEDT. Retrieved from http://www.hawaiicleanenergyinitiative.org/storage/pdfs/E-driveCharretteSummary_2.27.2015.pdf

[238] Lloyd, A., Miller, J., Glick, M., Yunker, C., Sparlin, K., Larson, M., Viray, L., and Chin, J. (2015). Hydrogen Fuel Cell & Battery Electric Vehicle Stakeholder Charrette Summary Report. ICCT and DBEDT. Retrieved from http://www.hawaiicleanenergyinitiative.org/storage/pdfs/E-driveCharretteSummary_2.27.2015.pdf

[239] The term "EV" encompasses battery electric (BEV), plug-in hybrid electric (PHEV), and neighborhood electric (NEV) vehicles. Most of the analysis uses assumptions relating to BEVs, since these have had the highest sales among EV types.

[240] Deloitte Touche Tohmatsu Ltd (2010). “Gaining Traction: A Customer View of Electric Vehicle Mass Adoption in the U.S. Automotive Market.”

rebates have EV market shares that are roughly 2-4 times[241] the national average[242]. While Hawaii has one of the highest rates[243] of EV sales without offering an incentive, the state could accelerate the rate of EV uptake with the addition of such an incentive. An advantage of offering a rebate instead of a tax incentive is that the rebate can be processed within a few weeks of the vehicle purchase, whereas a tax incentive can take until after the end of the tax year to reach the EV buyer.

Approach: To accelerate a rapid market uptake of EVs, Hawaii could offer a fiscal incentive (e.g. $2,000) for EV purchases that brings the price differential between EVs and ICEs to well within the range of expected fuel savings, providing consumers with certainty that choosing an EV will result in a lower total cost of ownership than an ICE. Combined with the federal tax credit, a state rebate could effectively make it cheaper to purchase an EV than a conventional ICE vehicle.

Assumptions:

- In addition to fuel savings, EVs are estimated to have lower maintenance costs than ICEs. While this analysis conservatively only considers the fuel savings of EVs, reduced maintenance costs can be expected to further reduce the total cost of ownership of EVs compared to ICEs[244].
- The fuel savings of EVs are sensitive to several key factors, including the price of gasoline, the price of electricity, and the fuel economy of the comparison ICE vehicle. Figure 7 shows the effect of gasoline prices on EV fuel savings over 15 years for four different electricity rates, assuming a discount (or interest) rate of 5%.
- EV fueling costs were estimated for a Nissan LEAF, consuming 29 kWh/100 miles, compared with the estimated cost of fueling a new gasoline-powered car that gets 36 mpg[245]. The benefits of an EV would be greater if compared to a less efficient conventional vehicle (for example, the statewide average of 23 mpg for all vehicles[246]).

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[241] Jin, Searle, and Lutsey (2014). Evaluation of State-Level U.S. Electric Vehicle Incentives. The International Council on Clean Transportation. Retrieved from http://www.theicct.org/evaluation-state-level-us-electric-vehicle-incentives

[242] 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

[243] Jin, Searle, and Lutsey (2014). Evaluation of State-Level U.S. Electric Vehicle Incentives. The International Council on Clean Transportation. Retrieved from http://www.theicct.org/evaluation-state-level-us-electric-vehicle-incentives

[244] Sunderland, F. (2012). Electric car repair bill 35% less than combustion car. Retrieved 3 Mar 2015 from http://www.thegreencarwebsite.co.uk/blog/index.php/2012/11/27/electric-car-repair-bill-35-less-than-combustion-car/

[245] US EIA (2015). "Light-Duty Vehicle Miles per Gallon by Technology Type, Reference Case." *Annual Energy Outlook 2014*. Retrieved from http://www.eia.gov/oiaf/aeo/tablebrowser/

[246] DBEDT (2014). "Section 18: Transportation." 2013 State of Hawaii Data Book. Retrieved from http://dbedt.hawaii.gov/economic/databook/db2013/

- Assuming a $7,500 federal tax credit[247], a $29,010 Nissan LEAF[248] (the top-selling EV model in Hawaii) would cost $1,510 more than an average compact car costing $20,000[249].

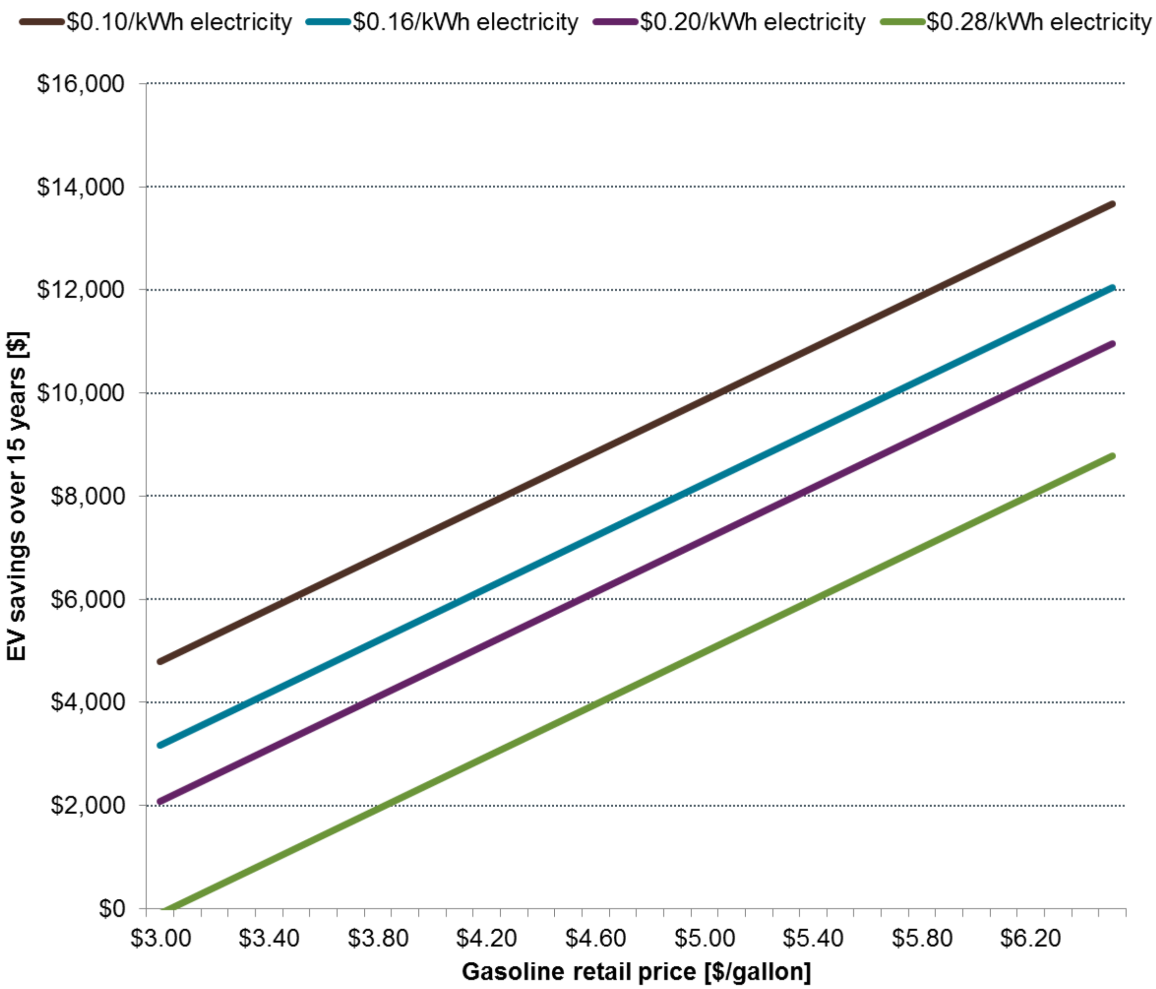

Figure 7. Sensitivity of EV fuel savings over 15 years to gasoline prices and electricity rates

Benefits: An average EV could save 242 gallons gasoline per year (assuming the additional electricity used to power that EV is renewable) compared to a compact car that gets 36 mpg. The number of vehicle purchases affected depends on numerous factors, including the level of state fiscal incentive, time-of-use (TOU) electricity rates,

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[247] U.S. DOE & U.S. EPA (2015). Federal Tax Credits for Electric Vehicles. Accessed 26 Feb 2015 at http://www.fueleconomy.gov/feg/taxevb.shtml

[248] California Plug-in Electric Vehicle Collaborative (2015). "Vehicles." Accessed 26 Feb 2015 at http://driveclean.ca.gov/pev/Costs/Vehicles.php

[249] Kelley Blue Book Co. (2014). Compact Car Buyer's Guide. Accessed 26 Feb 2015 at http://www.kbb.com/car-news/all-the-latest/best-compact-cars/2000010127/

non-fiscal incentives, and the availability of residential, workplace, and commercial charging.

Costs: Costs to the State would be equal to the number of EVs sold times the rebate offered per vehicle. For example, a program funded at $10 million could provide a $2,000 rebate to 5,000 EV buyers. California's rebate program is funded at a fixed level, and rebates are no longer given after the fund is exhausted -- this mechanism can control costs to the State while still providing an incentive to potential EV owners. As shown in Figure 7, at a gasoline price of $4.00 per gallon, an EV could return $2,000 to $7,000 in fuel savings over 15 years. Slightly higher gasoline prices that have been observed in recent years (such as $4.60 in April 2012) could increase these savings to $4,000 to $9,000.

Local economy: High. As with other EV-related tactics, expanded market uptake of EVs would reduce petroleum imports and increase utilization of local energy resources. The existence of a $7,500 federal tax credit means that a smaller state rebate that encourages sales of EVs could bring federal tax dollars to the state, since more EV buyers would be taking advantage of the federal tax credit. Additionally, an economic jobs assessment[250] in California - which currently offers financial incentives for the purchase of EVs and FCEVs - have found that each dollar in fuel savings allows an increase in consumer spending that creates 16 times as many jobs throughout the economy, with especially large benefits to low-income groups.

Social acceptability: Medium. 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[251].

Lifecycle emissions benefits: As with other EV-related tactics, lifecycle emissions benefits depend on the share of renewable electricity used to charge EVs, which will increase over time in accordance with the Renewable Portfolio Standard for utilities. Expanded adoption of EVs would have additional environmental benefits including reductions in road noise, air pollution, and water pollution.

Schedule: Near-term. Fiscal incentives for electric-drive vehicles could be implemented within a year or two; such incentives are expected to be especially effective in the near-term while there remains a price differential between EVs and ICEs, and a much larger price differential between FCEVs and ICEs.

Likelihood of implementation: Medium. In the near-term, fiscal incentives would require taxpayer funds (see costs section), whereas the benefits of these incentives will occur over several years as EVs become increasingly commercialized in Hawaii. Likelihood of implementation could be improved if incentives are targeted to improve access to EVs for low- and middle-income households.

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[250] Roland-Holst, D. (2012). Plug-in Electric Vehicle Deployment in California: An Economic Jobs Assessment. University of California, Berkeley.

[251] CA SB1275 (2014, Sep 21). Vehicle retirement and replacement: Charge Ahead California Initiative. California Legislative Information. Retrieved 27 Jan 2015, from http://leginfo.legislature.ca.gov/

While the analysis focused on the payback of EVs, hydrogen FCEVs should be considered for fiscal incentives as well, since these have zero tailpipe emissions and align with clean energy goals. A study of the transition to electric-drive vehicles in California, other states that have adopted California's vehicle emissions standards, and the rest of the U.S. found that the initial costs of electric-drive vehicle subsidies pay for themselves many times over in private and societal benefits (e.g. public health, GHG reduction, energy security)[252].

C.3.2) EV rental prioritization for state & county employees

Context: 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 have comparable daily rates as conventional vehicles but yield fuel savings for renters. The Hawaii State Procurement Office maintains a contract with rental car companies for state and county employees to rent vehicles for work purposes; this contract includes negotiated daily rates for rental cars by vehicle type[253].

Approach: The State could modify or supplement its contract with rental car companies to prioritize rentals of EVs, as well as efficient hybrids and fuel economy leaders (a softer approach would be to ensure rental car companies provide the option to rent EVs). EV models could be especially prioritized for trips within the range of a single charge or on routes with access to fast charging stations.

Assumptions:

- From June to November 2014, state and county employees rented about 6,800 cars for a total of 11,000 days[254], driving an estimated 1.2 million miles.
- Assuming an average fuel economy ranging from 25 mpg to 35 mpg, these rental car trips consumed 35,000 to 49,000 gallons of gasoline-equivalent over a six month period, or roughly 70,000 to 100,000 gallons per year.
- As shown in Figure 8, 60% of vehicle rentals and an estimated 35% of rental vehicle-miles traveled by state and local agencies had an average daily mileage under 80 miles, within the range of most EVs available in 2015[255]. Benefits were estimated assuming these rentals were EVs rather than ICE vehicles.

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[252] Greene, D., Park, S., and Liu, C. (2013). "Analyzing the Transition to Electric Drive in California." Final Report to The International Council on Clean Transportation. Retrieved from http://www.theicct.org/analyzing-transition-electric-drive-california

[253] Hawaii State Procurement Office (2014). Commercial Car Rental Services - Statewide. Retrieved from http://spo.hawaii.gov

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

[255] Schaal, Eric (2015). "The 10 Electric Vehicles With the Longest Driving Range." The Cheat Sheet. Retrieved 2 Mar 2015 from http://wallstcheatsheet.com/automobiles/top-10-electric-vehicles-with-the-longest-driving-range.html

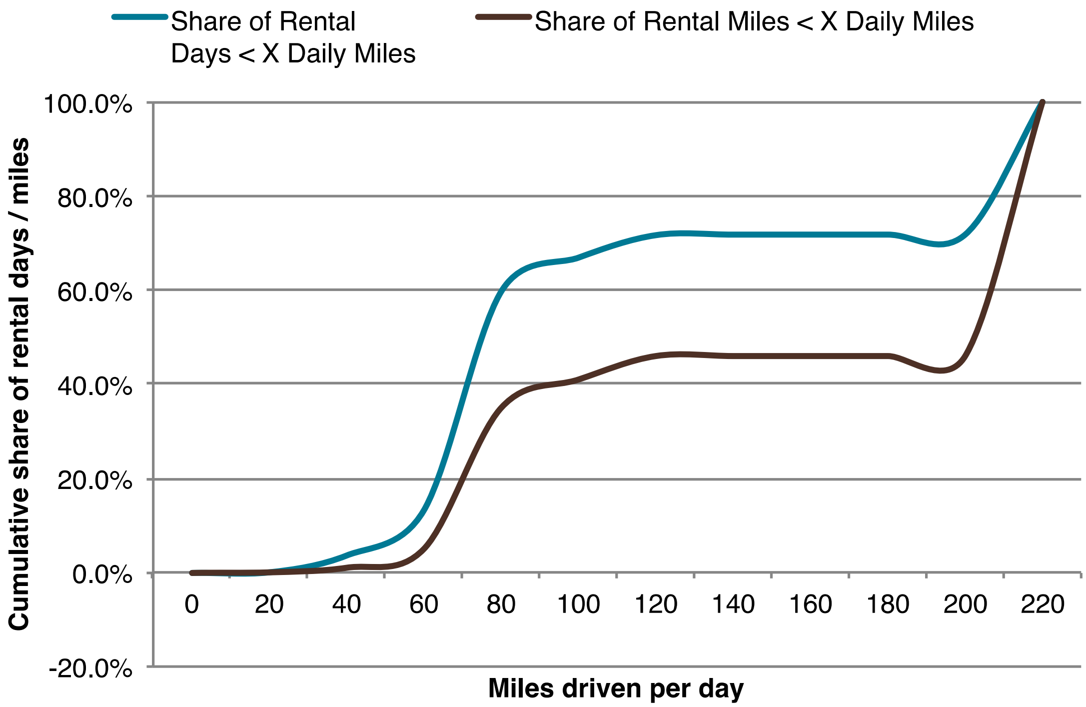

Figure 8. Share of rental days and miles driven by average daily mileage

Benefits: 0.024 to 0.034 MGY. The total level of fuel savings depends on the share of vehicle rentals and miles traveled that are driven with EVs instead of ICEs, as well as the fuel economy of ICEs. Petroleum reduction ranges from 45,000 to 63,000 gallons per year assuming an ICE fuel economy ranging from 25 to 35 mpg. Benefits could be greater if EVs were also used for trips with longer daily mileage by making use of fast charging stations. The share of rental trips that could be covered by EVs will likely increase as the range of available EV models increases.

Costs: If EVs and hybrid vehicles can be offered at comparable daily rates as conventional ICE vehicles, directing public employees to choose EVs whenever possible could reduce petroleum use and increase the number of EVs in rental car fleets at minimal or no incremental cost to the State (a softer approach would be to encourage rather than require EV selection). Additional data on EV rental rates would be needed from rental car companies in order to provide a more concrete estimate of incremental costs, if any.

Local economy: As with other EV-related tactics, expanding the utilization of EVs would reduce petroleum imports and increase utilization of local energy resources.

Social acceptability: Medium. State or local employees may have concerns about the range of available EV models and availability of fast-charging stations for longer trips. EV requirements or prioritization would benefit from targeted outreach to public employees about the technology and operating characteristics of EVs. As at least one rental car company has expressed interest in expanding its EV fleet, there may be opportunity for collaboration between the State and rental car companies for outreach to the public and employees of state and local agencies.

Lifecycle emissions benefits: As with other EV-related tactics, lifecycle emissions benefits depend on the share of renewable electricity used to charge EVs, which will increase over time in accordance with the Renewable Portfolio Standard for utilities. Expanded use of EVs (instead of conventional ICEs) would have additional environmental benefits including reductions in road noise, air pollution, and water pollution. The program may also indirectly encourage private EV sales by familiarizing public agency employees with EVs; however, this potential benefit would require additional investigation.

Schedule: Near- to medium-term. Changes to procurement rules could likely be made within a year or two; however, it may take longer for rental car companies to expand the selection of EV models in their fleets and confirm daily rental rates for these vehicles.

Likelihood of implementation: High. Changes to rental vehicle procurement rules would be broadly consistent with the State's guidelines for new vehicle purchases. Given interest from at least one major rental car company, the measure seems to be a viable, potentially cost-effective means for the public sector to demonstrate leadership in meeting the State's clean energy goals.

C.4 Reduce the cost of electricity for electric vehicle charging

C.4.1) Extend residential and commercial pilot rates for time-of-use and EV-charging to all EV operators[256]

C.4.2) Pilot demand-responsive and vehicle-to-grid technologies (not currently quantifiable)

Context: The electricity rates charged by utilities have a significant impact on the amount of money saved by EV operators compared to conventionally fueled vehicles. Lowering the cost of electricity used to charge EVs can provide a significant monetary incentive for consumers to purchase EVs. Tactics that lower the cost of electricity for EVs include innovative demand-responsive technologies that automatically charge when electricity is cheapest; vehicle-to-grid models that provide a financial return to EV owners in exchange for using their vehicles as a grid resource[257]; price signals from utilities in the form of differentiated time-of-use (TOU) rates, and combining EVs with renewable electricity generation such as solar PV.

In September 2014, Hawaii's Public Utilities Commission extended HECO's existing four-year EV pilot rates program through October 2015[258]. Under the existing pilot program, Hawaiian Electric, Maui Electric and Hawaii Electric Light Company offer lower off-peak EV charging rates (TOU EV) and separate EV electricity rates (EV-R and EV-C) to up to 1,000 customers on Oahu, 300 on Maui, and 300 on Hawaii[259]. Released in July 2014, HECO's Final Report on EV Pilot Rates recommends replacing the EV pilot rates with identical standard rates effective through 2020, including Schedule TOU EV, EV-R, and EV-C[260]. The report also concludes that EV pilot rates have influenced further adoption of EVs, shifted EV charging to the off-peak period, provided customers with bill savings, and supported the State's goal of greater adoption of EVs. In response to HECO's Final Report, DBEDT submitted comments to the PUC with ten recommendations for HECO, notably: development of a daytime EV TOU pilot rate that helps match customers' electricity demand to renewable electricity supply[261]; improving education regarding EV rates[262]; and conducting outreach to EV dealers[263].

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[256] Includes those who own, lease, or otherwise operate an electric vehicle.

[257] Corey D. White, K. Max Zhang (2011). Using vehicle-to-grid technology for frequency regulation and peak-load reduction. *Journal of Power Sources*. Volume 196, Issue 8, 15 April 2011, Pages 3972-3980, ISSN 0378-7753, http://dx.doi.org/10.1016/j.jpowsour.2010.11.010

[258] Public Utilities Commission of the State of Hawaii (2014). Transmittal No. 14-07.

[259] 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/

[260] HECO (2014). EV Final Report. July 31, 2014.

[261] DBEDT (2014). Protest/Comments of DBEDT on HECO's Transmittal No. 14-07. September 15, 2014.

[262] Ibid.

[263] Ibid.

Approach: With annual sales of about 1,000 new EVs and roughly 3,000 EVs operating statewide as of 2014[264], there is a need to transition from pilot programs to those that extend the benefits of off-peak and daytime time-of-use charging[265] to all existing and new EV customers[266]. This analysis evaluates the costs and benefits of purchasing an EV compared to a compact gasoline-powered car, taking into account the effect of electricity rates on EV cost effectiveness. Demand-responsive and vehicle-to-grid technologies could not be quantitatively evaluated at this time due to limited application in Hawaii; however, these technologies are recommended for further investigation due to their potential to support integration of EVs and renewable electricity generation.

Assumptions:

- Figure 9 illustrates the effect of electricity rates on annual fuel savings to an EV owners, as well as the time it takes to payback the incremental cost of an EV compared to a conventional gasoline passenger vehicle. Payback periods are estimated using a discount rate of 5%.
- For the payback periods and annual savings shown in the following figure, all EV electricity is assumed to be charged at the rate on the x-axis. In actually, most EVs will likely charge during several different periods, with corresponding changes in TOU rates. To the extent that a new daytime charging rate schedule allowed for a greater share of EV charging at "off-peak" rate levels, such a program could encourage EVs and offer greater savings to EV customers than the current TOU EV or EV-R rate.
- Assuming a $7,500 federal tax credit[267], a $29,010 Nissan LEAF[268] (the top-selling EV model in Hawaii) would cost $1,510 more than an average compact car costing $20,000[269].
- EV fueling costs were estimated for a Nissan LEAF, consuming 29 kWh/100 miles[270], compared with the estimated cost of fueling a new gasoline-powered car that gets 36

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[264] DBEDT (2014). Monthly Energy Trends. Retrieved from http://dbedt.hawaii.gov/economic/energy-trends-2/

[265] In August, 2015 The Hawaiian Electric Companies asked the Hawaii Public Utilities Commission to approve discount EV charging rates in a new TOU program. The new rates aim to promote EV use by fostering more use of excess electricity generated by rooftop solar systems during the middle of the day.

[266] For example, customers of SDG&E (in San Diego, CA) who own EVs can opt into an EV TOU rate. Source: San Diego Gas & Electricity Company (2015). "EV Rates." Accessed 25 Mar 2015 at http://www.sdge.com/clean-energy/ev-rates

[267] U.S. DOE & U.S. EPA (2015). Federal Tax Credits for Electric Vehicles. Accessed 26 Feb 2015 at http://www.fueleconomy.gov/feg/taxevb.shtml

[268] California Plug-in Electric Vehicle Collaborative (2015). "Vehicles." Accessed 26 Feb 2015 at http://driveclean.ca.gov/pev/Costs/Vehicles.php

[269] Kelley Blue Book Co. (2014). Compact Car Buyer's Guide. Accessed 26 Feb 2015 at http://www.kbb.com/car-news/all-the-latest/best-compact-cars/2000010127/

[270] Note that real-world energy use could be higher depending on driving conditions and driver behavior. The value of 29 kWh/100 miles is based on the official EPA rating.

mpg[271]. The benefits of an EV would be greater if compared to a less efficient conventional vehicle (for example, the statewide average of 23 mpg for all vehicles[272]).

- The price of gasoline is a significant determinant of payback periods and annual savings for EVs. Figure 9 assumes a medium-term gasoline cost of $4.00 per gallon.
- Validation: HECO estimates that an EV operating on Oahu could save 10 cents per mile compared to a mid-size gasoline-powered sedan. Assuming 8,700 annual vehicle-miles traveled, these savings amount to $870, which falls well within the range shown in Figure 9[273].

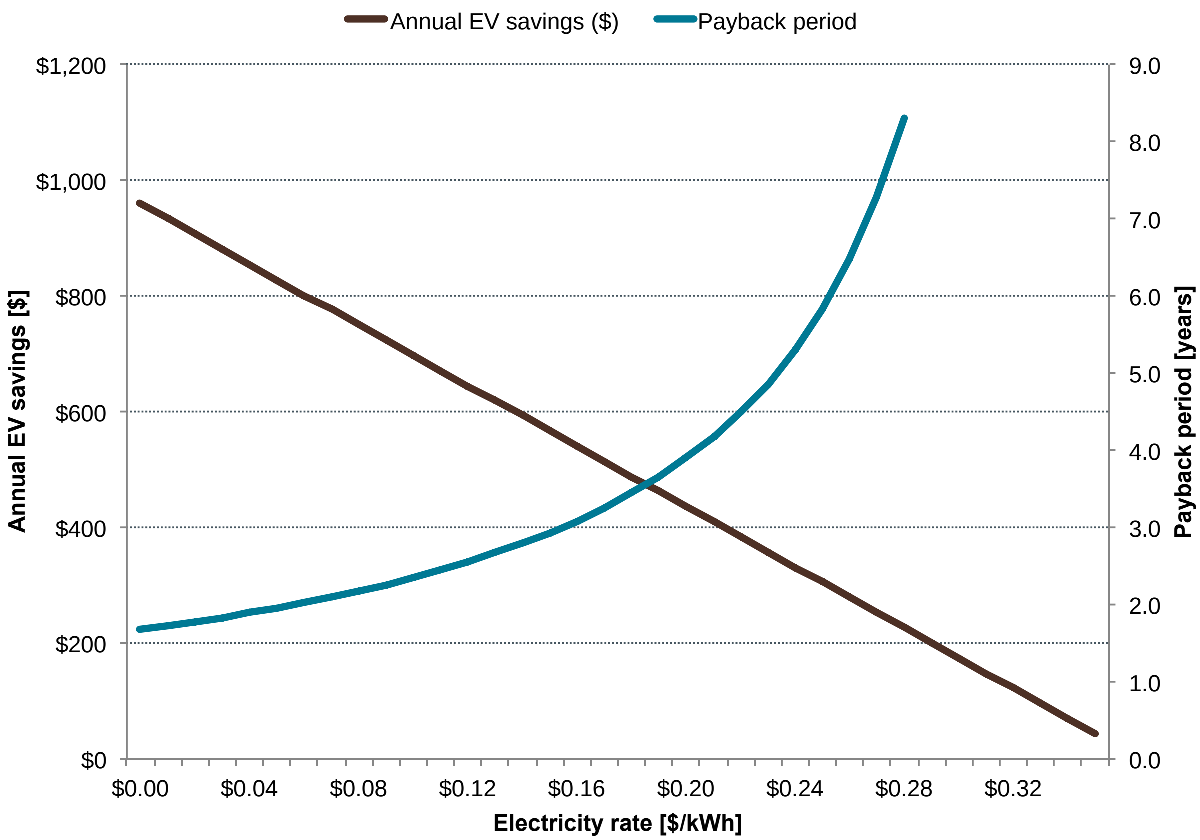

Figure 9. Annual fuel savings and payback period of a representative EV by electricity rate, assuming $4/gallon gasoline

Benefits: An average EV could save 242 gallons gasoline per year (assuming no petroleum used to generate electricity for the EV) compared to a compact car that gets 36 mpg. The number of vehicle purchases affected depends on numerous factors, including electricity rates, incremental technology costs, non-fiscal incentives, and availability of residential, workplace, and commercial charging.

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271 US EIA (2015). "Light-Duty Vehicle Miles per Gallon by Technology Type, Reference Case." *Annual Energy Outlook 2014*. Retrieved from http://www.eia.gov/oiaf/aeo/tablebrowser/

272 DBEDT (2014). "Section 18: Transportation." 2013 State of Hawaii Data Book. Retrieved from http://dbedt.hawaii.gov/economic/databook/db2013/

273 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/

Costs: A study of transportation electrification in California found that by shifting electricity demand to off-peak hours, TOU rates for EVs can reduce costs to both EV owners and utilities, with spillover benefits for utility customers who do not own EVs[274]. As shown in Figure 9, the off-peak TOU rate for schedule EV-R could save EV owners about $700 in fuel costs per year compared to a compact car that gets 36 mpg. Conversely, EV owners paying the average residential or commercial rate might save about $100 to $200 per year. So, extending the EV-R pilot rate to all EV owners could save each prospective EV owner an additional $500 to $600 per year, substantially shortening the time it takes to pay off the incremental vehicle cost.

Local economy: Expanding the number of EVs on the road would reduce petroleum imports and allow increased utilization of local energy resources. In addition to the direct financial benefits of fuel savings, switching from gasoline as a transportation fuel to electricity could reduce vulnerability of consumers to fuel price volatility, making monthly household costs more predictable and increasing financial stability[275].

Social acceptability: High. Residents of Hawaii could benefit from lower fuel bills with adoption of EVs. Encouraging EVs to charge when electricity costs less to produce could save utilities on electricity generation costs; some of these savings could be passed on to consumers as lower electricity rates. EVs equipped with demand responsive technologies could also help utilities meet an increased Renewable Portfolio Standard (RPS)[276].

Lifecycle emissions benefits: Lifecycle emissions benefits depend on the share of renewable electricity used to charge EVs; while this share will increase over time along with the Renewable Portfolio Standard, emissions benefits could be accelerated if EVs are adopted concurrently with renewable electricity generation systems. Expanded adoption of EVs would have additional environmental benefits including reductions in road noise, air pollution, and water pollution.

Schedule: Near-term. Utility rate schedules could be revised within one or two years, and permitted PV systems could be installed within this timeframe as well. The deployment of demand-responsive and vehicle-to-grid technologies may take several more years to allow time for demonstrating technical feasibility and developing financially viable utility rate schedules.

Likelihood of implementation: Medium. HECO already has several pilot programs for residential and commercial charging; if these pilots prove to be financially and technically viable, these could be extended to all EV owners.

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[274] ICF International (2014). "Phase 2: Grid Impacts." California Transportation Electrification Assessment. p.17. Retrieved from http://www.caletc.com/wp-content/uploads/2014/10/CalETC_TEA_Phase_2_Final_10-23-14.pdf

[275] National Conference of State Legislatures (2014). State Efforts Promote Hybrid and Electric Vehicles. Retrieved 2 Mar 2015 from http://www.ncsl.org/research/energy/state-electric-vehicle-incentives-state-chart.aspx

[276] David B. Richardson (2013). Electric vehicles and the electric grid: A review of modeling approaches, Impacts, and renewable energy integration. *Renewable and Sustainable Energy Reviews*. Volume 19, March 2013, Pages 247-254, ISSN 1364-0321, http://dx.doi.org/10.1016/j.rser.2012.11.042.

C.5 Expand electric vehicle charging infrastructure

Affordable and easily accessible slow and fast charging infrastructure could accelerate the adoption of EVs.

C.5.1) Promote charging systems in multi-unit dwellings

C.5.2) Promote charging systems in workplaces

Context: Multi-unit dwellings (MUDs) and workplaces have been identified by local stakeholders 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 multi-unit dwellings (MUDs)[277]. Such residences can be challenging environments for EV charging due to transformer load capacity, 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 guarantees owners of parking spaces in MUDs the right to install an EV charging system on or near their space, and restricts private entities from assessing a charge on such systems other than reimbursement for electricity[278]; however, this legislation does not guarantee the right of renters to install charging systems, nor does it provide a mechanism for charging systems that are shared among multiple units. Recent legislation[279] establishes a working group to "examine the issues regarding requests to the board of directors of an association of apartment owners, condominium association, cooperative housing corporation, or planned community association for the installation of electric vehicle charging system."[280] In addition, the Hawaiian Electric Companies are installing public DC fast chargers under an approved pilot, Schedule EV-U. One of the objectives of this pilot is to provide DC fast charging for MUD tenants.

Approach: A simple way to address charging shortfalls in new MUDs and workplaces could be to update building codes and ensure that 220-volt outlets are provided to

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[277] 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

[278] Hawaii Revised Statutes Section 196-2.5. Retrieved from http://capitol.hawaii.gov/hrscurrent/Vol03_Ch0121-0200D/HRS0196/HRS_0196-0007_0005.htm

[279] Proposed legislation, SB 1316, relating to electric vehicles, has subsequently been passed into law, and is now known as Act 164

[280] Ibid.

charge electric vehicles[281]. The State could also offer a rebate[282] to offset the costs of purchasing and installing EV charging systems in MUDs and workplaces; such rebates or grants have been offered in several U.S. states, including Colorado, Connecticut, and Florida[283]. In addition to charging systems located in MUDs and workplaces, publicly accessible fast charging stations (including those offered by private companies[284]) could allow EV owners to charge their vehicle quickly at a location other than home or the workplace. Such stations can also serve to reduce range anxiety and enable longer trips.

Assumptions: None.

Benefits: Not currently assessed. If up to 38 percent of housing units in Hawaii are MUDs, increasing the availability of EV charging systems in MUDs could enable roughly one-third of households to own EVs that otherwise may not. Additional data on the current level of charging availability and cost of providing different kinds of charging in MUDs and at workplaces could enable quantitative analysis.

Costs: Not currently assessed. Offering rebates or tax credits for charging infrastructure could cost several hundred to several thousand dollars per EV; however, additional data on the costs of purchasing and installing charging facilities in MUDs and at workplaces would be needed for a refined analysis of this measure.

Local economy: Some jobs could be created for the installation of EV chargers. As with other EV-related tactics, expanding the utilization of EVs could reduce petroleum imports and increase utilization of local energy resources.

Social acceptability: Medium. Some building managers and residential associations may oppose legislation that restricts their authority to approve or deny requests for installation of charging systems; others may welcome fiscal incentives to install EV charging infrastructure, especially if these facilities are seen as increasing the appeal of the property to tenants or prospective buyers.

Lifecycle emissions benefits: Not currently assessed.

Schedule: Near-term to long-term. Modifications to building codes would result in long-term changes in the availability of EV charging. In the near term, pending legislation or potential charging rebates could increase the number of public EV charging systems and dedicated parking spaces, as well as make it easier for residents of MUDs to access EV charging facilities at home.

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[281] Lloyd, A., Miller, J., Glick, M., Yunker, C., Sparlin, K., Larson, M., Viray, L., & Chin, J. (2015). “Summary of the Hydrogen Fuel Cell and Battery Electric Vehicle Stakeholder Charrette: Expanding Hawaii's Clean Transportation Solutions.” The International Council on Clean Transportation (ICCT) and Hawaii Department of Business, Economic Development, and Tourism (DBEDT).

[282] 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.

[283] PlugIncentives (2014). List of U.S. Electric Vehicle and EVSE Incentives by State. Retrieved from https://www.plugincentives.com/blog/list-us-electric-vehicle-and-evse-incentives-state

[284] For example, ChargePoint, Inc.

Likelihood of implementation: State and County governments could make use of DOE's Plug-In Electric Vehicle Readiness Scorecard[285] to evaluate and track progress toward community EV readiness, including MUD and workplace charging installation.

[285] U.S. DOE (2014). Plug-In Electric Vehicle Readiness Scorecard. Available from https://www.afdc.energy.gov/pev-readiness

D. Promoting Alternative Fuels

D.1 Cellulosic biofuel

D.1.1) Support establishment of local cellulosic biofuel industry and ongoing biofuel production.

Context: Cellulosic biofuel is ethanol, drop-in diesel or gasoline, or other types of transport fuel made from cellulosic plant material such as wood, leaves, or sugarcane bagasse. The federal government requires increasing use of cellulosic biofuel in road transportation to 2022 through the Renewable Fuel Standard. California incentives use low carbon cellulosic biofuel through its Low Carbon Fuel Standard.

Approach: Hawaii may be able to produce up to 24 MGY ethanol (or other fuel types like renewable gasoline[286]) if all 72 thousand acres of current pasture and idle cropland were repurposed to energy crop production[287]. In addition, Hawaii could potentially produce 4 MGY cellulosic biofuel from municipal solid waste.

Fulfilling this strategy would require a high level of policy support from the state of Hawaii:

a) providing feedstock price support to incentivize livestock farmers and holders of idle land to switch to energy crop production;
b) direct investment in the construction of cellulosic biofuel facilities through grants or loan guarantees, likely at least $200 million needed;
c) effective policy support for production of cellulosic biofuel through a refundable tax credit, grants, or other direct financial support of $1 per gallon or more;[288]
d) investment in energy crop establishment and support for long-term off-take agreements between farmers and biorefineries;
e) support for long-term off-take agreements for renewable fuel supplied by Hawaii biorefineries (through e.g. DOD use). Steps may also be necessary to increase local fuel transport and storage capacity.

Assumptions:

1. Energy crop potential is based on 2007 areas of pasture and idle cropland (72 thousand acres) as reported by USDA's Economic Research Service.[289]

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[286] Ethanol, biodiesel, and drop-in renewable gasoline and renewable diesel can all be produced from cellulosic feedstocks. Fewer gallons of biodiesel, drop-in renewable gasoline and renewable diesel would be produced from the same amount of feedstock compared to ethanol, as these fuels have a higher energy density.

[287] http://www.ers.usda.gov/data-products/major-land-uses.aspx#.VCGDzitdXEs

[288] Direct financial support for production is necessary as well as financial support for facility construction. USDOE has financially supported the construction of several cellulosic biofuels that were thereafter unable to produce biofuel cost competitively and ceased production, despite RFS support. The federal $1.00 per gallon non-refundable tax credit was insufficient in addressing this problem because cellulosic biofuel companies generally do not have a positive tax liability for the first few years of production (http://www.theicct.org/addressing-investment-risk-biofuels).

[289] http://www.ers.usda.gov/data-products/major-land-uses.aspx#.VCGDzitdXEs

2. An average yield of 10 tons per hectare (4 tons per acre[290]) was assumed for poplar and Eucalyptus grown on marginal land (it is assumed that the identified area of pasture and idle land is currently unused for crop production because it is lower-yielding than land still in production[291]).
3. A conversion efficiency of 0.25 tons ethanol per ton biomass was assumed (personal communication with cellulosic industry representative).
4. Construction costs are based on an estimate of $200 million in construction costs for a cellulosic biorefinery with 21.7 MGY capacity and assuming two such biorefineries are constructed.

Benefits: 24 MGY biofuel (ethanol equivalent), displacing 16 MGY gasoline.[292]
Costs: This tactic would require a considerable amount of financial support, including at least $200 million in funding by the state for establishment of production capacity and at minimum a continual $1/gallon tax credit for producers to offset the additional costs of land, water, maintenance, etc.
Local economy: This tactic would promote job creation in feedstock cultivation, harvest, and transport, and in biorefinery construction and operation.
Social acceptability: High. Consumers would have access to environmentally clean fuel; however, local biofuel production could compete with food production for limited agricultural land.
Lifecycle emissions benefits: An estimated 5% reduction in GHG intensity of Hawaii's transportation fuel mix.[293]
Schedule: Medium term.
Likelihood of implementation: Low. This measure would require ongoing government financial support on the order of $1 per gallon over the cost of wholesale conventional gasoline, plus initial investment costs on the order of $200 million.

D.2 Sugarcane ethanol

D.2.1) Support establishment of local sugarcane ethanol industry and ongoing ethanol production

Context: The federal government requires consumption of biofuel to 2022 through the Renewable Fuel Standard – to date the majority of this mandate has been met with

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[290] from http://onlinelibrary.wiley.com/doi/10.1111/gcbb.12141/abstract

[291] Malins, Searle & Baral. (2014) A Guide for the Perplexed to the Indirect Effects of Biofuel Production. Washington, DC: The International Council on Clean Transportation. Available at: http://www.theicct.org/guide-perplexed-indirect-effects-biofuels-production

[292] Pacific Biodiesel submitted comments suggesting that there may be a potential to produce up to 50 million gallons of biodiesel from crops economically, if by-products could be sold as animal feed.

[293] GHG intensity values were taken from ARB Lookup Table 6 (http://www.arb.ca.gov/fuels/lcfs/121409lcfs_lutables.pdf) for sugarcane ethanol and waste biodiesel, and from RFS (http://www.gpo.gov/fdsys/pkg/FR-2010-03-26/pdf/2010-3851.pdf) for cellulosic ethanol from energy crops (using average value for switchgrass ethanol) and MSW cellulosic ethanol (using average value for corn residue). For these calculations, it is assumed that total transport fuel consumption in 2030 will be similar to 2012.

ethanol, including sugarcane ethanol. Sugarcane ethanol is also incentivized by California's Low Carbon Fuel Standard as a relatively low carbon fuel.
As of May 2015, there are a number of state policy incentives to promote the production of ethanol, including in particular the ethanol production incentive (income tax credit up to 30% until 2017) and the ethanol fuel blend standard (E10)[294].
Approach: Hawaii could produce up to 49 MGY sugarcane ethanol on repurposed pasture and idle cropland[295]. A suite of policy actions would be necessary to incentivize production of sugarcane ethanol in Hawaii, including investment in sugarcane establishment or price support for domestically produced sugar, increased price support (such as increasing the value of the ethanol production tax credit) and possibly financial support for the construction of ethanol facilities. Policy steps needed for this strategy include:

a) providing sugar price support to incentivize livestock farmers and holders of idle land to switch to sugarcane production;
b) investment in sugarcane establishment, including repairing irrigation infrastructure and sugar terminals, and support for long-term off-take agreements between farmers and biorefineries;
c) grants, loan guarantees, or other direct financial support for the construction of ethanol facilities;
d) price support for biofuel production, such an increased ethanol producer's tax credit or blending mandate; and
e) support for long-term off-take agreements for renewable fuel supplied by Hawaii biorefineries (through e.g. military or Navy use). Local fuel transport and storage capacity may also need to be increased.

Assumptions:

1. Energy crop potential is based on 2007 areas of pasture and idle cropland (72 thousand acres) as reported by USDA's Economic Research Service.[296]
2. Typical average yield of 86.9 tons per harvested acre of sugarcane in Hawaii in 2005,[297] or 43.4 tons per acre per year (sugarcane is Hawaii is grown on a two year cycle) multiplied by 80% to account for lower yields on marginal land (see footnote 2).
3. A conversion efficiency of 19.5 gallons ethanol per ton sugarcane was used.[298]

Benefits: 49 MGY ethanol, displacing 33 MGY gasoline.
Costs: According to USDA data, sugarcane is more expensive to produce in Hawaii than in other states in the US, and sugar from sugarcane is more expensive to produce

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[294] As of December 31, 2015, Act 161, SLH 2015 (SB 717 SD2 HD1 CD1), the State ethanol blending mandate, which dictates a statewide 10% ethanol blending requirement, will be repealed. The repeal's effects on state ethanol consumption is unclear at this time.

[295] Note that these are the same 72K acres used in the cellulosic scenario. This land could be used either for cellulosic feedstock or for sugarcane.

[296] USDA Economic Research Service: http://www.ers.usda.gov/data-products/major-land-uses.aspx#.VCGDzitdXEs

[297] USDA (2006). The Economic Feasibility of Ethanol Production From Sugarcane in the United States. Available at: http://www.usda.gov/oce/reports/energy/EthanolSugarFeasibilityReport3.pdf

[298] Ibid.

than that from corn or sugar beet. Largely because of this, sugarcane ethanol in Hawaii would cost around $3.86 per volumetric gallon to produce wholesale[299]. If capital costs from constructing ethanol facilities were added to this,[300] the price per volumetric gallon would be $4.40 ($6.43 per gallon on an energy equivalent basis). This is $2.64 per gallon[301] more than wholesale imported ethanol and a price premium of $3.24 over wholesale conventional gasoline (E10[302]) on an energy equivalent basis. To achieve the total potential volume of 49 MGY sugarcane ethanol identified above would require a total annualized level of price support of around $100 million each year from the state. These estimates do not take into account the expired federal tax credit for ethanol production or price support from Renewable Identification Numbers in the RFS program.[303]

Local economy: This tactic would promote job creation in feedstock cultivation, harvest, and transport, and in biorefinery construction and operation.

Social acceptability: Medium. This tactic would revitalize Hawaii's sugarcane industry but would have some local negative environmental impacts such as increased water usage, fertilizer runoff, and biodiversity impacts.

Lifecycle emissions benefits: Estimated 2% reduction in GHG intensity of Hawaii's transportation fuel mix

Schedule: Medium term.

Likelihood of implementation: Low. This measure would require ongoing government financial support on the order of $3.24 per gallon over the cost of wholesale conventional gasoline.

D.3 Biodiesel from waste fat

D.3.1) Continue existing production of biodiesel from waste fat.

Context: Biodiesel from waste fat is currently produced by Pacific Biodiesel at a facility with a production capacity of 5.5 MGY.

Approach: No policy action. The biodiesel produced by Pacific Biodiesel is assumed to already utilize the locally available supply of waste fat, estimated at 3 MGY. Low carbon feedstock availability (waste fats) is a limiting factor to significant further expansion of

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[299] Calculated from the following data in USDA (2006; http://www.usda.gov/oce/reports/energy/EthanolSugarFeasibilityReport3.pdf) with costs adjusted to 2012 dollars to facilitate comparison with recent fuel price data: ethanol yield, sugarcane production economic costs per acre, sugarcane yield, feedstock processing cost, sugar yield, and ethanol facility capital costs. All values except ethanol yield and facility cost are specific to sugar production in Hawaii.

[300] Annualized over 20 years (USDA, 2006).

[301] Gasoline equivalent gallon.

[302] The price differential between wholesale and retail gasoline in the US has typically been around $0.77 recently (http://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_nus_w.htm); this differential was applied to retail gasoline price in Hawaii. (http://www.eia.gov/state/seds/data.cfm?incfile=/state/seds/sep_sum/html/rank_pr_mg.html&sid=US).

[303] Renewable Identification Number (RIN) prices are highly volatile and are typically highly discounted by biofuel investors for that reason (http://www.theicct.org/addressing-investment-risk-biofuels).

this pathway. Importing additional vegetable oil into the state for use in biodiesel would likely require financial support from the state.
Assumptions: Current waste fat availability in Hawaii[304], which is similar to per capita production of waste-based biodiesel as on a national level in 2012.[305] Waste oils are a relatively inelastic source and future availability of this feedstock is not likely to significantly increase.
Benefits: 3 MGY biodiesel, displacing around 3 MGY diesel.
Costs: None.
Local economy: None.
Social acceptability: High. Consumers have access to small amounts of low carbon biofuel with no added taxpayer cost.
Lifecycle emissions benefits: Estimated 0.4% reduction in GHG intensity of Hawaii's transportation fuel mix.
Schedule: Immediate.
Likelihood of implementation: This tactic requires no further policy action.

D.4 Compressed and liquefied natural gas

D.4.1) Support the consumption of CNG and LNG in vehicles

Context: Hawaii Gas currently produces synthetic natural gas from naphtha that is produced at one of Hawaii's refineries. Hawaii Gas began importing LNG in ISO containers to use as backup fuel starting in 2013. Hawaii Gas is developing a scale-able LNG solution that could accommodate additional volumes of LNG to supply multiple end-uses, including the ground and marine transportation market.
Approach: Support LNG supply solution, establishment of LNG or CNG fueling stations and purchases of LNG and CNG vehicles.
Assumptions: None.
Benefits: Potential replacement of the portion of petroleum fuels used for ground transport fleet vehicles, airport and harbor specialized vehicles and marine transport. If supplies are more readily available in the future this tactic will require further evaluation as there is sufficient evidence in the public domain regarding the emissions and cost reduction benefits of CNG[306].

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304 (Pacific Biodiesel, personal communication)

305 EIA (2014). Monthly Biodiesel Production Report. Available at: http://www.eia.gov/biofuels/biodiesel/production/

306 Other programs, such as those at the Port of Los Angeles' Clean Truck Program and the San Francisco International Airport's Clean Vehicle Policy have shown great promise in reducing emissions and reducing petroleum use from foreign sources. Further analysis would also include the marine transport market including Matson, Pasha, Foss, Tote and luxury cruise ships.

Costs: Potential fuel cost savings.[307] Cost of $250,000-$700,000 per CNG fueling station. CNG/LNG refueling stations are generally more expensive than conventional gasoline or diesel stations, but are less expensive than hydrogen fueling stations.
Local economy: A limited number of jobs would be supported in the establishment and operation of the LNG terminal facility and in fueling station installation.
Social acceptability: Medium. Consumers would have more fueling options, but this tactic would not reduce fuel imports.
Lifecycle emissions benefits: Unclear. Using natural gas instead of petroleum reduces lifecycle greenhouse gas emissions if gas leakage is minimal. Because of the high global warming potential of methane, even low rates of leakage could result in an increase in greenhouse gas emissions compared to gasoline.
Schedule: Medium term.
Likelihood of implementation: Low. Current market conditions do not justify a ranking of Medium however conditions need to be monitored as supply solutions are being developed. Efforts to seek increased amount of LNG imports to Hawaii, as well as potential growth in transportation segments will largely be driven by potential for environmental compliance through reduced emissions and cost savings.

E. Aviation

E.1 Improve aircraft fuel efficiency

E.1.1) Financial support for retrofits (blended winglets)

Context: Over the long-term, fuel consumption in the aviation sector is largely determined by the rate at which fuel-efficient technologies are developed and deployed in new aircraft designs. The fuel efficiency of new aircraft is estimated to have improved by about 1.5% annually from 1960 to 2008[308], with diminishing gains in recent years due in part to a lack of new designs. Over shorter time scales, fuel consumption can be reduced through the retrofit of technologies such as wingtip devices and performance improvement packages (PIP) for engines. To date, winglets have predominately been adopted in response to market forces alone but barriers to their deployment do exist.
Approach: The State could create a new state program to partially or fully subsidize the adoption of wingtip devices by airlines servicing Hawaii airports. Winglets would reduce the consumption of fuel uplifted on departing flights, and therefore reduce State petroleum dependence. Fuel consumed would be reduced the most on long haul flights,

[307] FGE (2012) report for HNEI: "Liquefied Natural Gas for Hawaii: Policy, Economic, and Technical Questions" and Hawaiian Electric Power Supply Improvement Plan, submitted to the Public Utilities Commission Aug 26, 2014.

[308] Rutherford, D.; Zeinali, M. "Efficiency Trends for New Commercial Jet Aircraft: 1960 to 2008." International Council on Clean Transportation. November 2009.

and winglets are not universally applicable to all aircraft types, limiting their application to certain aircraft types (e.g. 717 and A330).

Assumptions:

- Using year 2013 as an example, total aviation fuel consumption per year in Hawaii is ~228 million gallons[309]
- The current penetration rate of winglets for airlines flying out of Hawaii airports 41%[310]
- Aircraft retrofitted with winglets will result in a 3% fuel burn reduction[311]
- The sale price of installing winglets is about ~$1 million per aircraft,[312] which with a 45% discount rate[313] would amount to an actual retrofit cost of $550,000 per aircraft.
- Assume an average retrofit age of 8 years (the average age of the Hawaiian Airlines fleet in 2013)[314]
- Assume average usage after retrofit of 10 years
- Aircraft activity hours by aircraft age is based on the average single aisle aircraft
- Fuel price assumed to be $2.23/gallon.[315]

Benefits: 4 MGY jet fuel saved in all of Hawaii if non-retrofitted aircraft flying out of Hawaii (59% estimated) were retrofitted with winglets, assuming that winglets provide 3% fuel savings.

Costs: Payback period is typically 1.5-3 years. Fuel savings from winglets could effectively save 4 cents per gallon of jet fuel over a 10-year period, assuming a $550,000 retrofit cost per aircraft and 3% fuel savings from winglets. For an airline such as Hawaiian Airlines, which in 2013 had only 8 winglet aircraft (B767-300ER)[316], the total upfront cost to retrofit the rest of its fleet (35 aircraft) is estimated to be about 19 million USD.

Local economy: Minimal.

Social acceptability: High. Wingtip devices can provide significant reduction in aircraft emissions as well as noise.

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[309] DBEDT Monthly Energy Data (2014).

[310] This was calculated as the RPM-weighted average of winglet penetration rates for the top five carriers flying out of Hawaii and includes Hawaiian Airlines, United Airlines, Delta Air Lines, Alaska Airlines, and American Airlines. Fleets data was obtained from Ascend Online Fleets (2014).

[311] Boeing (2009). Blended Winglets Improve Performance. Retrieved from http://www.boeing.com/commercial/aeromagazine/articles/qtr_03_09/article_03_1.html

[312] Chicago Tribune (2014). Winglets go a long way to give airlines fuel savings. Retrieved from http://articles.chicagotribune.com/2014-03-04/business/ct-airline-winglets-0302-biz-20140304_1_fuel-savings-jet-fuel-southwest-airlines

[313] Michaels, D. The Secret Price of a Jetliner. Retrieved from http://www.wsj.com/articles/SB10001424052702303649504577494862829051078

[314] Ascend Online Fleets (2014). http://www.ascendworldwide.com/what-we-do/ascend-data/aircraft-airline-data/ascend-online-fleets.html

[315] Based on EIA's Short-Term Energy Outlook for average jet fuel price in 2016. http://www.eia.gov/forecasts/steo/tables/?tableNumber=8#

[316] Ascend Online Fleets (2014). http://www.ascendworldwide.com/what-we-do/ascend-data/aircraft-airline-data/ascend-online-fleets.html

Lifecycle emissions benefits: Medium. In particular, longer flights will experience greater reductions in emissions with winglet retrofits.
Schedule: Medium term, allowing time to design and implement a new program.
Likelihood of implementation: Medium. Currently about 40% of passenger miles flown out of Hawaiian airports are on aircraft with wingtip devices.[317]

E.1.2) Financial support for fleet renewal

Context: Aircraft have long operational lives, being flown for 20 to 30 years depending on type, often by multiple owners and lessors. Over the long-term, fuel consumption in the aviation sector is largely determined by the rate at which fuel efficient technology are developed and deployed in new aircraft designs, but over short and medium terms fuel consumption could be reduced by speeding up the rate of fleet renewal. This approach could be especially effective over the next 5 years due to relatively faster improvements in new aircraft expected due to an influx of new project aircraft (e.g. A320neo, 737 MAX, A350 777x, etc.). Fuel efficiency gains, and operational cost reductions, would need to be weighed against upfront capital costs and losses associated with the premature sale of flyable aircraft.
Approach: The State could partially subsidize the purchase of new aircraft replacing older, less efficient models used on Hawaiian routes. Alternatively, the State could help airlines obtain financing for new aircraft purchases.
Assumptions:

- A single Airbus A320ceo aircraft is retired early and sold, and immediately replaced with an A320neo, which provides 14% fuel burn reduction
- Parameters: A320ceo cost = ~$40 million; A320neo cost = ~$50 million; depreciation rate of aircraft = 6%; discount rate = 9%; fuel cost = $2.23 per gallon
- Aircraft activity hours by aircraft age is for the average single aisle aircraft[318]
- Retirement age ranges from 10 to 20 years
- Time horizon for comparison is 15 years, the estimated aircraft ownership time

Benefits: Moderately low. 0.08-0.2 MGY jet fuel saved per aircraft (varies depending on the retirement age of the current aircraft)
Costs: High. Retiring a single airplane early and replacing it with a more efficient one will cost approximately $1.2 to $1.5 per gallon jet fuel over a 15-year time period.
Local economy: N/A.
Social acceptability: High. Airlines including Hawaiian Airlines have implemented fleet renewal programs to some extent.[319] Ongoing fleet renewal plans are expected to lower

[317] U.S. DOT Bureau of Transportation Statistics (2014); Ascend Online Fleets (2014).

[318] Refinement of Projected Aviation Energy Use and Related Characteristics. Consultant report to Argonne National Laboratory, October 31, 2012.

[319] Hawaiian Airlines (2011). Hawaiian Adding 5 More A330s by 2015. Retrieved from http://investor.hawaiianairlines.com/phoenix.zhtml?c=82818&p=irol-newsArticle&ID=1631515

the average fleet age of airlines in 2020 serving the Hawaiian market, especially for American Airlines.[320]
Lifecycle emissions benefits: Moderately low. New aircraft types are expected to provide fuel savings on the order of 20% compared to today's aircraft.[321]
Schedule: Medium term, allowing time to design and implement a new program.
Likelihood of implementation: Low. Early retirement is unlikely to be cost effective for many airlines. Subsidies may be viewed as disadvantaging early movers that have already invested in fuel efficiency. Furthermore, given existing large production backlogs for established manufacturers it may not be possible for airlines to gain delivery slots for new purchases in the near-term.

E.2 Provide economic incentives to reduce airline fuel consumption

E.2.1) Increase the barrel tax

Context: Transportation demand management is a well-established strategy for surface transport; it has attracted less attention for other transport modes like aviation. Because aviation demand is relatively elastic, an increase in fuel price driven by an expansion of the barrel tax would constrain demand by increasing ticket prices. Fewer flights would reduce overall fuel consumption, although with anticipated impacts on Hawaii's tourism industry.
Approach: Increase the barrel tax by a set amount or percent. Expected impacts would be dominated by demand effects, although some long-term supply response in the form of increased demand for more fuel efficient aircraft might also be anticipated (not modeled here). Evading a fuel tax increase in Hawaii through tankering (carriage of cheaper fuel on inbound flights) should be low given the high fuel penalty that would be incurred tankering fuel from the mainland US or internationally and due to lack of alternative airports for diversion of tourists visiting Hawaii.
Assumptions:

- Long-term elasticity of demand of about 2 for aviation
- Fuel accounts for 30% of operating costs
- $0.20 per gallon tax rate
- Fuel cost = $2.23 per gallon
- Using year 2013 as an example, total aviation fuel consumption per year in Hawaii is ~228 million gallons[322]

Benefits: About 12 MGY[323].
Costs: N/A.

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[320] International Council on Clean Transportation (2014). U.S. airline fleets due for renewal. www.theicct.org/blogs/staff/us-airline-fleets-due-renewal

[321] Airbus (2015). A320 Family. Retrieved from http://www.airbus.com/aircraftfamilies/passengeraircraft/a320family/spotlight-on-a320neo/

[322] DBEDT Monthly Energy Data (2014).

[323] Typically aviation elasticities of demand are about 2. At fuel at 30% of operating costs a 10% fuel price increase due to $0.20/gallon tax would reduce demand by about 6%.

Local economy: Potentially negative impact on tourism.
Social acceptability: Low. Impacts on tourism are likely to be unpopular given that sector's importance to Hawaii's economy.
Lifecycle emissions benefits: High. Reduced aviation demand would also reduce non-CO_2 climate impacts of aviation, including NOx and aviation induced cloudiness (AIC).
Schedule: Near-term. This measure could be implemented with a legislative bill similar to HB 822, which was proposed in 2011 but was not adopted at that time.
Likelihood of implementation: Low. Impacts on tourism due to fewer visitors to Hawaii would be expected, although partially mitigated by reduced outward travel by residents, keeping more dollars local. An increase in the barrel tax could reduce fuel imports, relatively reducing the benefits of reduced fuel consumption on outbound flights.

E.3 Improve airline operating efficiency

E.3.1) Fuel efficiency-based landing charges

Context: Operational fees such as landing charges and en route fees are an important contributor to airline operational costs and offer a vehicle for providing economic incentives for cleaner and/or quieter aircraft. Airports in Europe have experience with levying landing fees differentiated by the certified noise levels and NOx emissions of incoming aircraft, providing an incentive for the purchase of aircraft with improved environmental performance. In 2013, the International Civil Aviation Organization (ICAO) developed a CO_2 (fuel efficiency) certification requirement for new aircraft that will eventually allow the fuel efficiency of new aircraft types to be benchmarked and compared to another for the first time under a policy mechanism.
Approach: Hawaii's airports could alter their landing fee structure to increase fees for less fuel efficient aircraft while offering reductions for more efficient aircraft. Overall fees collected could remain constant ("revenue neutral"), although the system would need to be revisited over time to ensure that adequate funds are raised even as fleetwide fuel efficiency improves. The system could lead to the diversion of more efficient aircraft to Hawaii airports rather than incremental demand for more fuel efficient aircraft, although in each case local fuel consumption would be reduced. Fuel efficiency-based landing charges would be a pioneering policy with no implementation track-record; furthermore, it may take some years to generate the necessary CO_2 certified data for some aircraft models, limiting the applicability of this measure in the short term.
Assumptions: None[324].
Benefits: Low (not quantified).
Costs: N/A.
Local economy: N/A (if revenue neutral).
Social acceptability: Medium. Economic incentives for more fuel efficient aircraft are likely to be supported publicly, particularly if they are revenue neutral and would not otherwise impact travel demand.
Lifecycle emissions benefits: Low.

[324] Quantitative analysis could not be conducted under the scope of this project.

Schedule: Medium term, allowing time to design and implement a new program.
Likelihood of implementation: Low. Would require implementing a completely new policy in Hawaii, potentially to significant industry opposition.

E.4 Reduce aircraft fuel consumption

E.4.1) Airport infrastructure support

Context: Airplanes typically use auxiliary power units (APUs) and occasionally idle main engines to provide electricity and air conditioning while at gate. APUs are relatively inefficient and can have high criteria pollutant emissions. An alternative is the use of ground power and preconditioned air while at gate, reducing fuel consumption and local air pollution. Ground power is being promoted at various airports but additional economic incentives could speed its adoption in Hawaii.
Approach: The State could subsidize infrastructure to support ground power and preconditioned air at Hawaii airports. Currently Honolulu (HNL) is wired for ground power at each gate, while Kahului (OGG) is for some, and Lihue (Kauai) and Hilo (Big Island) are not. However, those gates provide 90 KVA, whereas most airlines require a minimum of 180 KVA. Airports would need to undergo a complete electrical system overhaul to support the use of ground power. Pre-conditioned air units (60 amps/unit) at gates could also be installed to reduce APU usage.
Assumptions:

- All Hawaii airport departing flights (~360,000) in 2013[325]
- Auxiliary power unit (APU) on time before departure for an aircraft is about 15 minutes[326]
- Estimated gate delay (therefore APU usage time) is about 4 minutes per flight[327]
- Cost to install an electric gate and install and connect pre-conditioned air unit for parked aircraft is at least $150,000[328]
- Assume that 25% of operations at Hawaii airports have switched from APU to electricity usage at gates already.

Benefits: About 3 MGY jet fuel saved for all Hawaii flight operations, assuming all aircraft switch from APU usage to electricity at gates.
Costs: The payback period is estimated to be about 2-4 years. It is estimated that Hawaii's largest airport, HNL, would save about 39,000 gallons of fuel, or about $116,000 in fuel costs, per gate per year using electric power instead of APU. Note that

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[325] U.S. DOT Bureau of Transportation Statistics (2014). Form 41 via Data Base Products, Inc.

[326] Airways New Zealand. Reducing use of APU. Retrieved from http://www.airways.co.nz/aspire/_content/apu.asp

[327] Based on flights from HNL and OGG airports in 2013. Source: Federal Aviation Administration Aviation System Performance Metrics (FAA ASPM, 2014). Retrieved from https://aspm.faa.gov/.

[328] Based on installation of funding provided for installation of 12 electric gates and installation and connection of 7 pre-conditioned air units at the Dallas-Fort Worth International Airport. Source: FAA (2014). FAA Awards $10.2 Million in Environmental Grant to Airports. Retrieved from http://www.faa.gov/news/press_releases/news_story.cfm?newsId=17614.

Hawaii airports are not eligible for support from the FAA Voluntary Airport Low Emissions (VALE) program.[329]
Local economy: Minimal.
Social acceptability: High. Combined climate and air quality benefits are likely to generate popular support for this tactic.
Lifecycle emissions benefits: Low.
Schedule: Medium term, allowing time to design and implement a new program.
Likelihood of implementation: High. Many airports have implemented and continue to implement ground power and pre-conditioned air units already. Federal grants are also provided by the FAA to support airport sustainability programs.

E.4.2) Consumer information such as airline fuel efficiency ranking

Context: Despite growing concern about climate change, there is surprisingly little information available to the traveling public about the relative fuel efficiency and therefore carbon intensity of airlines, particularly at the route level. Research has suggested that there is a relatively stable gap of about 26% between the most and least-fuel efficient carriers serving the US domestic market[330]. Providing additional information about relative fuel efficiency to travelers, particularly for individual flights at the point of purchase, could potentially steer existing demand to more efficient airlines, routes, and/or flights, creating a new mid- to long-term incentive for fuel efficiency.
Approach: The State could mandate the reporting of fuel use and aviation demand (revenue passenger miles, revenue ton miles, and departures) for commercial flights to and from Hawaiian airports. It could then disseminate that data to travelers in an appropriate format in order to guide more efficient consumer decisions.
Assumptions:

- Total aviation fuel consumption in Hawaii was ~228 million gallons in 2013
- An average 7% variation in airline fuel consumption rate between airlines flying out of Hawaii[331]
- Consumer information assumed to close 10% of the efficiency gap on flights.

Benefits: 2 MGY jet fuel.
Costs: Difficult to assess; depends on administrative costs of collecting, compiling, and disseminating data.
Local economy: N/A.
Social acceptability: Medium. Public information on airline fuel efficiency is minimal but desired by consumers seeking green flying options.

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[329] FAA (2012). Voluntary Airport Low Emissions (VALE) program. Retrieved from http://www.faa.gov/airports/environmental/vale/

[330] Kwan, I., & Rutherford, D. (2014). U.S. domestic airline fuel efficiency ranking, 2013. The International Council on Clean Transportation. Retrieved from http://www.theicct.org/us-domestic-airline-fuel-efficiency-ranking-2013

[331] Assuming 45% belly freight load factor; calculated based on the excess pound fuel to provide one ton-mile compared to the most fuel-efficient airline on the HNL-NRT route, which is the route with the largest share of RPMs for flights out of HNL airport in 2013 (Data Base Products, 2014).

Lifecycle emissions benefits: Low.
Schedule: Medium term, allowing time to design and implement a new program.
Likelihood of implementation: High. Information on airline fuel efficiencies is available already exists and will continue to be made more accessible to consumers.

F. Marine

F.1 Operational optimization

F.1.1) Slow steaming

Context: The speed and the energy consumption of marine diesel engines follow a cubic function, meaning that for a given voyage a 10% speed reduction leads to 27% less energy use (1-(1-10%)^3 = 27%) by the main engine. Taking into account longer time to complete a voyage and extra ships to cover the lost frequency, ship owners can conserve 9% of energy by slowing down their ships 10% from the design speed.[332] Slow steaming has been used by ports in California to reduce port-wide air emissions and greenhouse gases (GHGs). For example, the Port of Los Angeles (POLA) adopted a vessel speed reduction incentive program in 2008, which provides compliant vessel operators a discount equivalent to 15% of the first day of dockage per vessel. Additionally, since January 2005 the Port of Long Beach (POLB) has implemented a Green Flag program that provides incentives for the observance of a voluntary speed limit of 12 knots within 40 nm of Point Fermin (near the entrance to the Harbor). Carrier lines that achieve a 90% or better compliance rate in a 12–month period are eligible for a 15% reduced dockage rate (Green Rate) in the following year. From January 2008, the Long Beach Board of Harbor Commissioners expanded the slowdown zone to 40 nm for additional pollution reductions.
Approach: The State could encourage Port Hawaii to implement a speed reduction program for ocean-going vessels (OGVs) that visit the port. The program would provide owners of OGVs that reduce their speed to 12 knots within 40 nautical miles of the port area with a 15% dockage rate discount. If desired, the Harbors Division could initially opt for a less stringent program, such as 80% compliance rate to be eligible for the discount or a smaller speed reduction zone of 20 nautical miles, and gradually ramp up the stringency over time. The state government will refund the Harbors Division the paid discount, in recognition that the effort contributes to the State's goals to reduce the petroleum use and promote energy-efficient technologies and operational strategies.
Assumptions:

- The cargo throughput of POLB and Port of Honolulu was 80 and 14 million tonnes, respectively in 2008.[333]

[332] Corbett et al (2009). The effectiveness and costs of speed reductions on emissions from international shipping. Transportation Research Part D.

[333] American Association of Port Authorities “Port Industry Statistics” http://www.aapa-ports.org/Industry/content.cfm?ItemNumber=900

- Energy savings and incentive costs at Port Hawaii would be comparable to that at the POLB, scaled according to their relative throughput.[334].
- Between 2008 and 2020, ship activities visiting Port of Honolulu will grow by 5% per year.[335]

Benefits: 0.8 MGY. Benefits may vary, depending on the real energy consumption from OGVs visiting Port of Honolulu.
Costs: Estimated at $0.6 million annually. This analysis assumes the State will cover the cost of all foregone revenue that the Harbors Division incurs under this program.
Local economy: We expect negligible impact on the state economy. Shipping companies may have to adjust their schedules by up to two hours, because it takes a little longer to deliver cargo to Hawaii, but the negative impact will be very limited.
Social acceptability: High. Social acceptability can be improved if state government works with the Harbors Division to analyze ship energy use when visiting Port Hawaii with a locally relevant, up-to-date, and user-friendly tool that streamlines the inventory-building process for future update.
Lifecycle emissions benefits: High. Slow steaming does not require alternative energy. The only concern might be that ships may speed up outside of the slow steaming zone to keep up with the requirement at speed reduction zone, leading to more energy consumption. However, in the medium term we expect shipping companies will adjust their schedule to account for the more time from new speed reduction zone, avoiding the speed up effect.
Schedule: Medium-term, allowing time to organize and establish a system to monitor the compliance of the program as well as facilitate the incentive payment.
Likelihood of implementation: Medium. Since this tactic does not involve a regulatory mandate, the only barrier is the willingness and the capacity to take the action. Early consultations with the maritime industry will be necessary to determine the feasibility of this strategy, since shippers tend to optimize speed for delivery schedules. State funding would be needed in order to provide financial incentives for speed reduction. Additionally, Hawaii DOT has noted the need for additional staff to monitor compliance under such a program. As an alternative to the assessed program, increased taxes on fossil fuels could provide additional incentive for maritime operators to conserve fuel.

F.1.2) Propeller polishing and hull cleaning

Context: Cleaning and polishing propeller surfaces can reduce roughness by reducing accumulated organic materials that increase trailing turbulence on ships and the frictional losses across the propeller. Hull cleaning (usually through mechanical brushing, by divers or automated systems) effectively removes marine biological growth between dry-dockings. This reduces frictional resistance and, therefore, increases

[334] For example, slow steaming reduced fuel consumption by 8.3 thousand tonnes for ships visiting POLB by 2008, respectively (Ross and Associates Environmental Consulting, 2009). Furthermore, PoLB paid out $1.6 million as an incentive to ships for complying with the slow steaming voluntary program (Faber et al 2010).

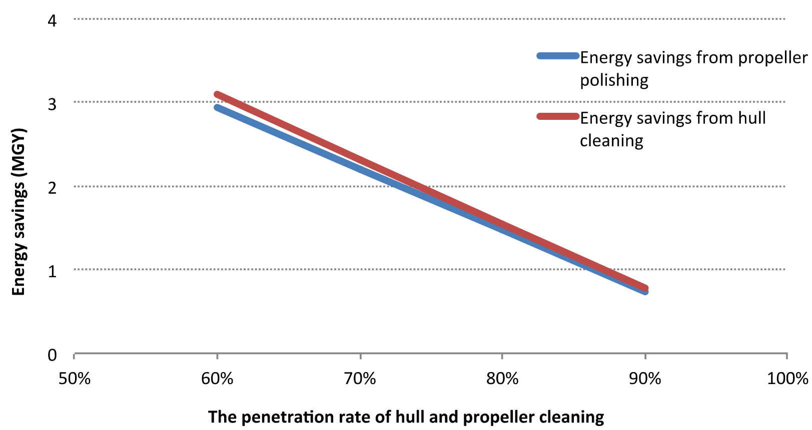
[335] Environmental Protection Agency (2009) “Emission Control Area Application to the International Maritime Organization”

energy efficiency. Both measures are part of regular maintenance for OGVs and small boats, and can be finished during the dry dock period, eliminating the cost of the lost service when ships have to be taken out of regular business. There is evidence that some ship owners do not regularly polish ships' propellers and clean their hulls, leading to the unnecessary loss of energy use.[336]

Approach: Encourage the business of propeller polishing and hull cleaning in the state of Hawaii by providing fiscal incentives to train technicians specialized in providing these services. Raise the awareness of the benefit of regular maintenance of ships to the general public.

Assumptions:

- Total fuel sales to OGVs from Hawaii reached 100 thousand tonnes by 2013.[337]
- Diesel and gasoline consumption from smaller boats was 2,680 thousand gallons in 2013. [338]
- Between 2013 and 2020, bunker sales for ships visiting Port of Honolulu will grow by 5% per year.[339]
- Propeller polishing will reduce energy consumption by 3% to 8%; hull cleaning will reduce energy consumption by 1%-10%. [340]
- The cost of propeller polishing and hull cleaning are about $22,000 to $24,000 and 75,000 to 112,000, respectively, for OGVs each time.[341]
- 60% of ship owners regularly polish the propeller and clean the hulls of their ships. Figure 2 shows the energy savings when current adoption rates range between 60% and 90% (Figure 2).



[336] IMarEST (2011) "Marginal abatement costs and cost-effectiveness of energy-efficiency measures"

[337] Energy Information Administration (2014) "Hawaii total adjusted distillate sales to vessel bunker consumers" http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=KD0VABSHI1&f=A

[338] Hawaii DBEDT "Research and Economic Analysis Division"

[339] Environmental Protection Agency (2009) "Emission Control Area Application to the International Maritime Organization"

[340] ICCT (2010) "Reducing Greenhouse Gases from shipping"

[341] Ibid.

Figure 10. The energy savings versus the percentage of ship owners who have already adopted propeller polishing and hull cleaning

Benefits: 6.0 MGY. Benefits range from 1.5 MGY to 6.0 MGY depending on the current adoption of propeller polishing and hull cleaning practices (Figure 10). No study to date has evaluated the adoption rate of these two maintenance measures, but anecdotal evidence points to fairly prevailing adoption of them, evidenced by the number of propeller polishing and hull cleaning shops in Hawaii.
Costs: Low. Net costs to government agencies are the incentives to stimulate local propeller polishing and hull cleaning businesses as well as the campaign to raise the awareness of the benefits of these maintenance measures. To the extent that additional dry dock shops are needed to facilitate propeller polishing and hull cleaning operations, such shops could require a substantial investment in terms of equipment and expertise.
Local economy: There would be net benefit to the state economy, as more shops that work on propeller polishing and hull cleaning are set up and running.
Social acceptability: Medium. Propeller polishing and hull cleaning have already been practiced in many shops in Hawaii. Expanding the business to cover most of the vessel fleet will not create new social concerns for the business.
Lifecycle emissions benefits: High. Propeller polishing and hull cleaning are unlikely to be operated with high energy demand. However, there are concerns of local water pollution when ships clean propellers during the dry dock in Hawaii.
Schedule: Medium-term. Prior to implementation, the State would need to evaluate the share of ship owners who have already regularly done the propeller polishing and hull cleaning in order to assess the effectiveness of this tactic.
Likelihood of implementation: Medium. Several State agencies, including Hawaii DOT, Harbors Division; the Department of Land and Natural Resources; and the Department of Health are in the process of evaluating the impact of propeller polishing and hull cleaning on water quality. These studies should be taken into account when considering implementation of the evaluated program.

F.2 Provide economic incentives to reduce marine fuel consumption

F.2.1) Increase bunker taxes under the barrel tax

Context: The high price of fuel will dampen energy demand, especially in shipping where vessels typically purchase bunker fuels[342] at ports where the price of the fuel is low and carry the fuel in their tanks when visiting other ports. In early 2000s, the bunker price in Hawaii was lower than surrounding ports, leading to a gradual increase in bunker sales from Hawaii that peaked between 2006 and 2007. The price advantage subsided as the bunker price from Hawaii pared back the difference between other ports, and bunker sales from Hawaii subsequently declined (Figure 1). Living standards on the island did not decrease as a result; in other words, higher bunker price, which

[342] Bunker fuel is a fraction obtained from petroleum distillation, either as a distillate (Marine Gas Oil or Marine Diesel Oil) or a residue (Heavy Fuel Oil).

curtails demand for bunkers in Hawaii, will not discourage ships visiting Hawaii and negatively influence the local economy.

Approach: Raise the fuel price by $30 per tonne through the inclusion of bunker fuels in an expanded barrel tax.

Assumptions:

- The bunker price is $700 per tonne by 2020.[343] A $30 per tonne surcharge raises the price by 4%.
- A 1% increase in the price of bunker fuel will reduce the bunker demand by 0.14%.[344]
- Total fuel sales to OGVs from Hawaii reached 100 thousand tonnes by 2013.[345]
- Between 2013 and 2020, ship activities visiting Port of Honolulu will grow by 5% per year.[346]
- Less fuel sales will not create adverse impact on ship transportation supply.

Benefits: 0.9 MGY in reduced local fuel consumption; however, in the absence of fuel saving measures, this fuel would likely be purchased outside of Hawaii. The reduction in local fuel consumption would depend on the elasticity of fuel sales to fuel price.

Costs: The state government will earn net revenues through the bunker fees.

Local economy: There would no negative impact on the state economy. Historical evidence suggests that the quality of life will not be impacted when the bunker sales dropped substantially, as witnessed after 2007. Ships will bunker in other ports and carry sufficient amount of fuels when they visit Hawaii.

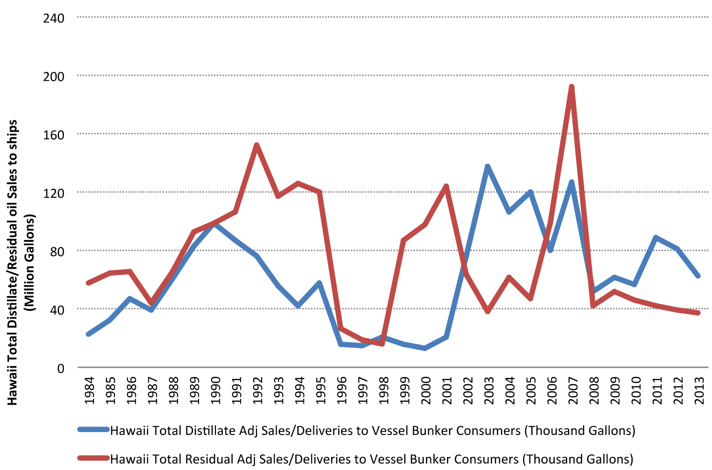


Figure 11 The fluctuation of bunker sales in the past three decades (data source: EIA)

343 ICCT (2011). “Reducing Greenhouse Gas Emissions from ships”

344 The elasticity is calculated based on three studies: CE Delft (2011). “Research to assess impacts on developing countries of measures to address emissions in the international aviation and shipping sectors”; Swedish Maritime Administration (2009) “Consequences of the IMO’s maritime sulfur fuel regulation”; and Kalli et al (2009). “A study on the impacts of the new IMO regulations and transportation costs”

345 Energy Information Administration (2014). “Hawaii total adjusted distillate sales to vessel bunker consumers” http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=KD0VABSHI1&f=A

346 Environmental Protection Agency (2009). “Emission Control Area Application to the International Maritime Organization”

Social acceptability: Low. There is a common social avoidance to fees that are commonly viewed as equivalent to tax.
Lifecycle emissions benefits: No benefit. Ships are expected to bunker and carry more fuel when they visit Hawaii. The extra weight may lead to a trivial increase in energy consumption.
Schedule: Medium-term. It will require some time for the government to analyze and implement the proposal, especially if it faces public resistance.
Likelihood of implementation: Low. There is currently no discussion within the government about expanding the barrel tax to include bunker fuels.

F.3 Promote the use of alternative energy for marine vessels

F.3.1) Onshore power

Context: Onshore power enables ships at the hoteling mode to use shore-side electricity to power electric systems onboard, such as lighting, ventilation, communication, cargo pumps, and other critical equipment, while turning off their auxiliary engines. These ships can be hooked up to onshore power supplies, so that ships' operations can proceed uninterrupted, while eliminating diesel emissions resulting from auxiliary engines. The electricity comes from the local power grid through a substation at the port and is plugged to the specialized power connectors in the onshore power system on the ship. Onshore power has been installed in more than ten ports worldwide, mostly in North America, Europe, and most recently in China.[347] The California Air Resources Board (ARB), for example, required ships in Los Angeles, Long Beach, Oakland, San Diego, San Francisco, and Hueneme to use shore power or equivalent control technique(s) to reduce at-berth emissions by 80% by 2020.[348] Since there is no other practical equivalent technology commercially available, shore power is likely the technology that most ships will employ in compliance with the ARB regulation. The main benefit of using shore power is to benefit local air quality. Emissions at berth will be replaced by emissions from electricity generation to provide the onshore power, which are both lower in emissions and occurs further away from residential areas. This is particularly true if onshore electricity is provided by renewables that has close to zero carbon footprint.
Approach: Collaborate with Port Hawaii to build an onshore power system that would enable OGVs to be connected with onshore electricity while ships are in the hoteling mode.
Assumptions:

- OGVs consumed about 6.7 thousand tonnes of marine bunkers in POLB in 2011.[349]

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[347] WPCI (2015). "Ports using OPS." Accessed 4 Mar 2015 at http://www.ops.wpci.nl/ops-installed/ports-using-ops/

[348] http://www.arb.ca.gov/ports/shorepower/finalregulation.pdf

[349] Port of Long Beach (2012). "Port of Long Beach Inventory"

- Between 2008 and 2020, ship activities visiting Port of Honolulu will grow by 5% per year.[350]
- Costs include shore-side infrastructure cost, terminal retrofit cost, terminal operating and maintenance cost as well as ship-side infrastructure costs. Data come from ENVIRON[351] and ARB.[352] The lifetime of the infrastructure is 15 years; the discount rate is 4%; it takes 3 years to build the infrastructure (2017-2020). The infrastructure will be up and running in 2020.
- Estimated energy consumption for ships at berth in Port of Honolulu is based on the energy consumption for OGVs at berth in POLB and the relative cargo throughputs between POLB and Port of Honolulu.[353]
- About 25% of energy will be generated by renewables in Hawaii by 2020.[354]
- State electricity price is $0.30 kWh[355]

Benefits: 0.1 MGY. Benefits may vary, depending on the real penetration rate of the renewable energy in Hawaii in 2020. In 2012 Hawaii used petroleum to generate about 70% of use electricity, reducing the effectiveness of shore power as a petroleum reduction strategy.
Costs: The cost will be very high because of the need of building onshore and shipside electricity infrastructure and the fact that many materials essential to building the infrastructure have to be shipped from other states.
Local economy: Heavy investment in infrastructure may stimulate local economy.
Social acceptability: Medium. The low energy reduction potential and high cost may dampen the social acceptability to the onshore electricity project. Conversely, associated air quality benefits will increase public support for this tactic.
Lifecycle emissions benefits: Low. Roughly 25% of fossil energy would be replaced by 2020. While CO_2 benefits scale with fuel savings, providing onshore power would result in a significant reduction of local air pollutants. Lifecycle emissions benefits would increase over time as the electricity grid is powered by an increasing share of renewable sources.
Schedule: Long-term. Planning and building onshore power requires time, as witnessed in California's experience.
Likelihood of implementation: Low. There is current no discussion about the onshore power project in Hawaii. This evaluation drew upon data from onshore power projects in California and local electricity rates in Hawaii. Future in-depth evaluations of onshore power in Hawaii should consider existing technologies on an island-by-island basis, taking into account differences in cost-effectiveness for cruise ships and container

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350 Environmental Protection Agency (2009). "Emission Control Area Application to the International Maritime Organization"

351 ENVIRON (2004). "Cold Ironing Cost Effectiveness Study"

352 CARB (2007). "Regulations to Reduce Emissions from Diesel Auxiliary Engines on Ocean-Going Vessels while At-Berth at a California Port"

353 The cargo throughput of POLB and Port of Honolulu were 80 million tonnes and 14 million tonnes, respectively in 2008. Source: American Association of Port Authorities "Port Industry Statistics" http://www.aapa-ports.org/Industry/content.cfm?ItemNumber=900

354 DBEDT (2014). Hawaii Energy Facts & Figures, May 2014.

355 Ibid.

ships. Additionally, further consultations with the maritime industry will be needed to determine the capacity of current vessels to connect to onshore power if available.

V. Recommendations

A. Criteria Ranking Methodology

Petroleum reduction tactics were ranked based on the criteria identified in the quantitative and qualitative assessment. Tactics were separated into five categories:

1. **PRIMARY TARGET**. Such tactics have the potential to reduce transportation petroleum use by more than one million gallons of gasoline equivalent per year in 2030. The societal benefits of these tactics are estimated to outweigh the total costs to the government and taxpayers. To be recommended, these tactics must also score a rating of "medium" or better in terms of social acceptability and likelihood of implementation. It is recommended that the State implement these high priority tactics as soon as feasible.

2. **SECONDARY TARGET**. Such tactics have the potential to reduce transportation petroleum use, but likely by fewer than one million gallons of gasoline equivalent per year in 2030. The overall benefits to society of these tactics are estimated – or are likely to – outweigh the total costs to the government and taxpayers. To be recommended, these tactics must also score a rating of "medium" or better in terms of social acceptability and likelihood of implementation. These tactics would be worthwhile provided they do not displace resources for primary tactics.

3. **MONITOR FOR CHANGES IN CONDITIONS**. These tactics are not a priority target for implementation in Hawaii based on current conditions. They may lack a definite petroleum benefit, have societal costs that likely exceed the benefits, or score a rating of "low" on social acceptability or likelihood of implementation. It is possible that some of these tactics could become cost effective and suitable for implementation in the future, especially once primary and secondary tactics have been implemented in Hawaii.

4. **CONDUCT ADDITIONAL RESEARCH**. These tactics may be worthwhile; however additional research and data collection are needed to determine the best path forward. These tactics may require additional data on the current baseline, potential policy impacts, or costs. Tactics that were rated "low" on social acceptability or likelihood of implementation may become more viable with public engagement, follow-up surveys, availability of new evidence, or commitment from key implementing agencies.

5. **NOT EVALUATED**. These tactics were not evaluated due to insufficient baseline data or unclear policy definition, or were not prioritized in consideration of limited project timing and resources. Other tactics that could enable reductions in petroleum consumption by supporting the implementation of other tactics were evaluated qualitatively or simply included in the master list based on their priority (Section III).

The criteria that determine the categorization of tactics are summarized in Table 8.

Table 8. Criteria for ranking petroleum reduction tactics

<table>
<tr><th>Criterion</th><th>Primary Target</th><th>Secondary Target</th><th>Monitor for Changes</th><th>Conduct additional research</th></tr>
<tr><td>Petroleum reduction benefits</td><td>Greater than or equal to 1 MGY in 2030
and</td><td>Less than 1 MGY in 2030
and</td><td>No petroleum benefit
or</td><td rowspan="4">Requires one or more of the following in order to make a determination:
- More data on the current baseline and/or potential policy impacts
- Additional cost data
- Public engagement or surveys
- Additional evidence to gain support from key agencies</td></tr>
<tr><td>Cost effectiveness</td><td>Societal benefits exceed costs
and</td><td>Societal benefits likely exceed costs
and</td><td>Societal costs likely exceed benefits
or</td></tr>
<tr><td>Social acceptability</td><td>Medium or better
and</td><td>Medium or better
and</td><td>Low social acceptability
or</td></tr>
<tr><td>Likelihood of implementation</td><td>Medium or better</td><td>Medium or better</td><td>Low likelihood of implementation</td></tr>
</table>

These criteria were applied to the list of evaluated tactics to generate a transparent ranking of petroleum reduction tactics (Section B).

B. Recommended Tactics and Implementation Schedule

This section lists the recommendation for each of the 37 evaluated tactics according to the criteria ranking methodology described in the preceding section. The description of each recommended tactic includes a short section on potential implementation schedule (timeline). Estimated impacts of the recommended tactics in 2030 are covered in Section V.D. Potential funding sources for implementation and next steps in the overall process are covered in Section V.E and Section V.F, respectively.

Table 9 lists the ranking of each evaluated tactic, categorized by sub-sector. In total, 22 tactics were recommended as primary or secondary targets, 11 are listed as monitor for changes in conditions, and 4 require additional research in order to make a determination.

Table 9. List of Tactic Recommendations by Sub-Sector

Sub-sector Tactic	PRIMARY TARGET	SECONDARY TARGET	MONITOR FOR CHANGES	CONDUCT ADDITIONAL RESEARCH
Vehicle Efficiency	**2**	**4**	**2**	**–**
FEDERAL VEHICLE FUEL ECONOMY STANDARDS	✓			
HIGH EFFICIENCY TAXIS	✓			
PROCURE EVS AND EFFICIENT VEHICLES for public fleets		✓		
GREEN FREIGHT		✓		
Vehicle RETIREMENT INCENTIVES for low-income groups		✓		
RENTAL CAR EFFICIENCY program		✓		
FEEBATES for vehicle fuel efficiency			✓	
REPLACEMENT TIRES			✓	
Vehicle-Miles Traveled	**6**	**3**	**2**	**1**
TRANSIT-ORIENTED DEVELOPMENT	✓			
Infrastructure for ALTERNATIVE TRANSPORTATION (biking, walking,	✓			
GASOLINE AND DIESEL TAXATION			✓	
CARSHARING FOR PUBLIC FLEETS	✓			
Dedicated PARKING FOR CARSHARING	✓			
Secure state support and funding of BIKESHARE PROGRAMS		✓		
COMMUTER BENEFITS LEGISLATION	✓			
Support of TDM BY LARGE EMPLOYERS	✓			
TELECOMMUTING by public employees and large employers		✓		
FLEXIBLE SCHEDULING for work and classes		✓		
VMT PRICING PROGRAM			✓	
PRICE PARKING to recoup costs and promote alternative modes				✓
Electric-Drive Vehicles	**–**	**3**	**–**	**2**
State REBATES FOR ELECTRIC-DRIVE vehicles		✓		
EV RENTAL PRIORITIZATION for state & county employees		✓		
Time-of-use and EV CHARGING RATES		✓		
Promote government, private, and commercial HYDROGEN FCEVs				✓
Support economically viable HYDROGEN FUELING INFRASTRUCTURE				✓
Alternative Fuels	**–**	**–**	**3**	**–**
CELLULOSIC BIOFUEL			✓	
SUGARCANE ETHANOL			✓	
Support the consumption of CNG AND LNG in vehicles			✓	
Aviation	**2**	**–**	**3**	**1**
Financial support for WINGLET RETROFITS	✓			
AIRPORT INFRASTRUCTURE support	✓			
Financial support for AIRCRAFT FLEET RENEWAL			✓	
Include aviation fuels in the BARREL TAX			✓	
Fuel efficiency-based LANDING CHARGES			✓	
CONSUMER INFORMATION such as airline fuel efficiency ranking				✓
Marine	**–**	**2**	**2**	**–**
SLOW STEAMING		✓		
PROPELLER POLISHING and hull cleaning		✓		
Increase BUNKER TAXES under the barrel tax			✓	
ONSHORE POWER			✓	
Total of all six sub-sectors (38 tactics)	**10**	**12**	**12**	**4**

The following sections summarize the tactics in each recommendation category. The underlying quantitative and qualitative evaluation can be found starting at the page number provided for each tactic.

B.1 Primary Target (10 tactics)

Vehicle Efficiency

1. FEDERAL VEHICLE FUEL ECONOMY STANDARDS (page 34)

The federal government has adopted fuel efficiency and GHG standards for LDVs MY2017-2025, for HDVs MY2014-2018, and is currently developing Phase 2 standards for HDVs that would extend beyond MY2019. California's Air Resource Board has called for 5% annual reductions in fuel use of new LDVs and HDVs through 2025 and beyond. Hawaii could coordinate with California and the federal government to encourage the development of efficiency standards for new light- and heavy-duty vehicles model years 2026 to 2030.

Schedule: Long-term; new standards would likely apply to MY 2026 vehicles.

2. HIGH EFFICIENCY TAXIS (page 42)

While taxis comprise a small share of the total passenger vehicle fleet, they tend to be driven much more than private vehicles on an annual basis. At least one taxi company in Hawaii operates a fully hybrid fleet, and there could be additional potential to increase the hybrid share of taxi fleets statewide. Consistent with Senate Resolution 144, the State could coordinate with City & County governments to develop a program that targets GHG emission reductions from taxi fleets by offering financial incentives to replace inefficient vehicles with efficient hybrids. An early action toward such a program should involve collecting baseline data on taxis operating in Hawaii.

Schedule: Medium-term starting now; while successful policies have already been implemented elsewhere, implementation of a voluntary program in Hawaii would require coordination with taxi owners and operators to determine appropriate incentives and ensure a high participation rate.

Vehicle-Miles Traveled

3. TRANSIT-ORIENTED DEVELOPMENT (page 48)

Transit-oriented development, which includes mixed use, high density development near public transit stations, can reduce the need for travel and promote walking, bicycling, and use of public transit. Expansion of TOD could have significant impacts on the long-term need for travel by enabling a greater share of the population to live close to work, school, and other destinations. Actions to support TOD could include identifying public lands near planned and existing transit stations for redevelopment; aligning travel demand management (TDM) and land use planning efforts to fully utilize planned Honolulu Rail Transit Project (HRTP) capacity; and ensuring the availability of funding for infrastructure improvements related to TOD. This measure was evaluated in conjunction with expanded infrastructure for alternative transportation modes.

Schedule: Long-term starting now. Expansion of TOD could have significant impacts on the long-term need for travel by enabling a greater share of the population to live close to work, school, and other destinations; however, due to the time required to design TOD plans and permit and build new developments and transportation networks, it could take a decade or more before the bulk of these benefits are realized.

4. Infrastructure for ALTERNATIVE TRANSPORTATION (biking, walking, transit) (page 48)

Alternative transportation modes include public transit, walking, and bicycling. Potential statewide impacts of TOD planning and expanded investments in multimodal infrastructure were evaluated together based on Kauai's Multimodal Transportation Plan. This tactic would involve implementing existing state and local plans for bicycling, pedestrian, and transit facilities in coordination with neighborhood TOD plans.

Schedule: Near and long-term. Planned infrastructure for alternative transportation modes could be completed within 2-5 years; new infrastructure for public transit could take longer, with most of the impacts on travel demand likely occurring after infrastructure improvements have been completed.

5. CARSHARING FOR PUBLIC FLEETS (page 61)

The U.S. GSA is implementing a pilot program to help federal agencies optimize their use of vehicles and reduce the costs of owning and maintaining their vehicle fleets. Similarly, municipalities throughout the U.S. are increasingly taking advantage of carsharing (also called motor pool) services to reduce the cost of providing work vehicle access to government employees. Hawaii's State and County governments could implement carsharing programs for public fleets that reduce the number of vehicles needed to provide a given level of service by making vehicles available to government employees on-demand instead of providing each agency with a fixed number of vehicles. By consolidating travel to a smaller number of vehicles, carsharing could allow State and County governments to quickly shift travel to efficient or electric vehicles. Additionally, such a program could promote transparency in the use of public funds for government vehicle travel.

Schedule: Near- to Medium-term. It could take anywhere from one to five years to analyze the vehicle needs of public agencies, identify a carsharing service provider, negotiate a contract, and implement a program.

6. Dedicated PARKING FOR CARSHARING (page 62)

Carsharing services can make more efficient use of limited public parking facilities and reduce the number of vehicles needed to provide mobility to car users. As electric-drive and autonomous vehicle technologies continue develop, there is potential for carsharing services to substantially transform and reduce the petroleum intensity of private vehicle travel in the long-term. The State could encourage local governments in Hawaii to dedicate additional parking for carsharing programs. Priority dedication of facilities or reduced parking decal rates could be offered for EV carsharing fleets.

Schedule: Near-term. There are already several carsharing organizations active in Hawaii[356,357], and provision of additional parking facilities could increase the scale of existing programs.

7. COMMUTER BENEFITS LEGISLATION (page 67)

The federal government offers a tax incentive to employers and employees to encourage commuting by alternative modes, including public transit, vanpooling, and bicycling. While these commuter benefits can result in monetary savings for both employers and employees, not all employers take advantage of these options. In 2015, several legislative proposals were introduced in Hawaii related to commuter benefits: one bill would allow counties to offer up to three commuter benefit options to their employees, and another would give counties authority to require that other employers offer specified commuter benefits. Beyond legislation proposed in 2015, Hawaii could require public and private employers to offer commuter benefit options that take full advantage of the existing federal tax incentives for commuting by alternative modes.

Schedule: Near-term. Commuter benefit options could be required within a year or two with supporting legislation.

8. Support of TDM BY LARGE EMPLOYERS (page 67)

This tactic was evaluated in conjunction with the tactic for commuter benefits legislation. As a complementary action to encouraging participation in the federal program, the State could directly support additional TDM programs, for example at government agencies or at the University of Hawaii. Such actions could include expanding the availability of workplace showers, secure bicycle parking, and other benefits related to alternative commute modes.

Schedule: Medium-term. Supporting TDM programs for large employers could take slightly longer than commuter benefit programs, allowing time for employers to conduct surveys of employee travel and design and implement TDM programs.

Aviation

9. Financial support for WINGLET RETROFITS (page 96)

Over the long-term, fuel consumption in the aviation sector is largely determined by the rate at which fuel-efficient technologies are developed and deployed in new aircraft

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[356] Moriki, D. (2015). "Car sharing network Zipcar rolls out first Hawaii fleet in Waikiki." Retrieved from http://www.bizjournals.com/pacific/blog/morning_call/2015/05/car-sharing-network-zipcar-rolls-out-first-hawaii.html

[357] Honolulu Clean Cities (2015). "Car Sharing." Retrieved May 29, 2015 from http://honolulucleancities.org/vmt-reduction/car-sharing/

designs. Over shorter time scales, fuel consumption can be reduced through retrofit technologies such as wingtip devices and performance improvement packages for engines. The State could create a new state program to partially or fully subsidize the adoption of wingtip devices by airlines servicing Hawaii airports. Such winglets would reduce the consumption of fuel uplifted on flights departing from Hawaii.

Schedule: Medium term, allowing time to design and implement a new program.

10. AIRPORT INFRASTRUCTURE support (page 101)

Airplanes typically use auxiliary power units (APUs) and occasionally idle main engines to provide electricity and air conditioning while at gate. APUs are relatively inefficient and can have high criteria pollutant emissions. An alternative is the use of ground power and preconditioned air while at gate, reducing fuel consumption and local air pollution. Ground power is being promoted at various airports, but additional economic incentives could speed its adoption in Hawaii. The State could subsidize infrastructure to support ground power and preconditioned air at Hawaii airports. Currently Honolulu (HNL) is wired for ground power at each gate, while Kahului (OGG) is for some, and Lihue (Kauai) and Hilo (Big Island) are not. However, airports would need to undergo a complete electrical system overhaul to support the use of ground power. Pre-conditioned air units at gates could also be installed to reduce APU usage.

Schedule: Medium term, allowing time to design and implement a new program.

B.2 Secondary Target (12 tactics)

Vehicle Efficiency

1. PROCURE EVS AND EFFICIENT VEHICLES for public fleets (page 31)

Last updated in 2010, Hawaii's vehicle procurement guidelines[358] require State and County agencies to follow a strict hierarchy when leasing or purchasing light-duty motor vehicles that are not covered by federal procurement rules. This tactic would revise statewide vehicle procurement guidelines to strengthen requirements for when agencies should choose electric-drive options, as well as ensure that alternative or conventional fuel vehicles are the most energy-efficient option[359]. The revised guidelines could provide a total cost of ownership calculator that compares fuel and other costs of the most efficient vehicle choices for each technology in a given class; agencies could then be directed to choose an EV (or hydrogen fuel cell vehicle) if the lifetime cost difference is below an established threshold (e.g. $5,000), or the most efficient non-EV option. The

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[358] Hawaii State Energy Office (2014). "Vehicle Purchasing Guidelines." Retrieved from http://energy.hawaii.gov/lead-by-example/programsachieving-efficiencylead-by-examplevehicle-purchasing-guidelines

[359] While there are multiple potential pathways to improve the efficiency of public fleets (including a requirement for an increasing percent of vehicles to be zero-emission vehicles, or an in-use fuel economy target for public fleets), a change in Hawaii's vehicle procurement guidelines was evaluated and recommended since it requires only modification of an existing policy, which is likely to be easier to accomplish than drafting a brand new policy.

choices of new vehicles purchased or leased by public agencies could be influenced shortly after procurement guidelines are updated. Note that requiring procurement of EVs and efficient vehicles would combine very well with carsharing for public fleets, since mileage could be consolidated on new, more efficient vehicles, and EVs could be used for most trips within a normal operating range.

Schedule: Near-term. The choices of new vehicles purchased or leased by public agencies could be influenced shortly after procurement guidelines are updated.

2. GREEN FREIGHT (page 38)

SmartWay is a voluntary public-private partnership between the US EPA and freight operators with the aim of reducing freight costs and emissions through improved vehicle technology and operations. While the program has been operational since 2004, and to date only 5 truck carriers[360] in Hawaii have joined the partnership. There may be potential to provide incentives for additional truck carriers to join SmartWay and install fuel-saving technologies. For example, State or County agencies could encourage participation by preferring procurement from SmartWay-certified carriers. Counties could offer preferential delivery locations and access hours to SmartWay-certified carriers.

Schedule: Near-term; the U.S. SmartWay Transport Partnership has already been operational for over a decade, and participation could be promoted with changes to administrative or procurement rules.

3. Vehicle RETIREMENT INCENTIVES for low-income groups (page 41)

As a result of federal fuel economy standards, new cars and light trucks are substantially more efficient than older vehicles, and this differential will likely increase through at least 2025 as a result of recently adopted standards. Low-income households earning less than 225% of the federal poverty threshold[361] are more likely to own older, less-efficient used vehicles, which tend to have substantially higher operating costs than new, efficient vehicles. Hawaii could offer a rebate modeled after California's program that allows low-income households to retire old vehicles and purchase more efficient ones. Such a program would benefit from requirements to: 1) ensure that new vehicles are significantly more efficient than the vehicles they replace; 2) scale the level of financial incentive with expected fuel savings; 3) ensure that eligible vehicles are driven enough to warrant incentives for retirement; and 4) offer flexibility to buy an efficient replacement vehicle or use alternative transportation modes.

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[360] US EPA (2014). Partner and Affiliate Lists. Accessed 30 Dec 2014 at http://www.epa.gov/smartway/about/partnerlists.htm

[361] Eligibility for California's program is limited to households that qualify as low-income, meaning earnings are equal to 225% of the federal poverty guidelines. According to separate federal guidelines for Hawaii, qualifying low-income households (earning up 225% of poverty guidelines) could earn up to $30,487 for a single family household, adding $10,755 for each additional person.

U.S. Department of Health and Human Services (2015). 2015 Poverty Guidelines. Retrieved 29 May 2015 from http://aspe.hhs.gov/poverty/15poverty.cfm#thresholds

Schedule: Medium-term; such a program would have to be carefully designed and regularly evaluated to ensure effective use of public funds.

4. RENTAL CAR EFFICIENCY program (page 44)

Hawaii could support the modernization of rental car fleets statewide using a fiscal incentive, regulatory, or combined approach. Such a program could target the replacement of less efficient rental cars with those meeting federal fuel economy standards for new vehicles. An early step toward establishing such a program in Hawaii should involve developing a baseline statewide inventory of rental car fleets that includes vehicle efficiency, vehicle-miles traveled, purchase price, vehicle age, and remaining lifetime.

Schedule: Medium, allowing time to design and implement an appropriate incentive that encourages voluntary participation by rental car companies.

Vehicle-Miles Traveled

1. Secure state support and funding of BIKESHARE PROGRAMS (page 65)

Based on the evaluation provided by Bikeshare Hawaii, implementing a bike share program in urban Honolulu could reduce an estimated 0.14 MGY in 2030. While this magnitude is less than 1 MGY, additional costs and benefits would occur if bikeshare were expanded beyond urban Honolulu to other communities in the City and County of Honolulu, Hawaii County, Kauai County and Maui County.

Schedule: The initial deployment of bicycles in urban Honolulu is planned for 2016; however, this launch is contingent upon securing sufficient funding.

2. TELECOMMUTING by public employees and other large employers (page 68)

Telecommuting, or working from home, can be a valuable option for employees that also reduces the time and travel costs associated with commuting to work. While some employees telecommute exclusively, others may do so less frequently, for example one day per week. The American Community Survey estimates that 4.5% of Hawaii's commuters work from home. Telecommuting was recommended as a critical action in the 2011 edition of the HCEI Road Map, and there may be additional potential for Hawaii's state and county governments to lead by example by encouraging public employees to telecommute. For example, supervisors could offer interested employees the option to work one day a week from home provided that productivity is maintained.

Schedule: Near-term. Some employees could likely begin telecommuting shortly after receiving permission, while others may need to procure equipment before doing so. Participation could also be expected to increase over time as employers and employees increasingly adapt to telecommuting options.

3. Flexible scheduling for work and classes (page 68)

Flexible work and class scheduling for employees and students can both reduce the need for travel and mitigate congestion by shifting travel to off-peak hours. One example of flexible work scheduling is the compressed work week (CWW): two commonly used CWW schedules are 40 hours worked over 4 days (4/40) and 80 hours worked over 9 days. Hawaii's Department of Human Resources Development piloted a 4/40 CWW schedule in 2009; however, the results of this pilot were not readily available. Hawaii's state and county governments could give public employees the option to switch to CWW schedules; this option could be especially useful as a travel demand management tactic for positions that are not compatible with telecommuting.

Schedule: Near-term. Some employees could likely switch to flexible work schedules within a short time after receiving approval. Other departments may need additional time to restructure in order to support flexible work schedules.

Electric-Drive Vehicles

4. State Rebates for electric-drive vehicles (page 77)

According to surveys of consumers in the U.S., vehicle purchase price is the most important factor in determining whether a consumer will buy an electric vehicle (EV) or an internal combustion engine (ICE) vehicle. Hawaii could offer a fiscal incentive[362] (e.g. $2,000) that brings the price differential between EVs and ICEs to well within the range of expected fuel savings, providing consumers with certainty that choosing an EV will result in a lower total cost of ownership. Combined with the federal tax credit of $7,500, a state rebate could make it cheaper to purchase or lease an EV upfront than an ICE vehicle. Such a rebate could include limits on eligible household income or vehicle purchase price to boost effectiveness of the program and ensure that the benefits go to low- and middle-income households.

Schedule: Near-term. Fiscal incentives for electric-drive vehicles could be implemented within a year or two if funding is secured; such incentives are expected to be especially effective in the near-term while there remains a price differential between EVs and ICEs, and a much larger price differential between FCEVs and ICEs.

5. EV rental prioritization for state & county employees (page 81)

The Hawaii State Procurement Office maintains a contract with rental car companies for state and county employees to rent vehicles for work purposes; this contract includes negotiated daily rates for rental cars by vehicle type. The State could modify or

[362] A rebate could also be offered for the installation of home charging infrastructure; however, such a rebate would not be accessible to residents of multi-unit dwellings (see Section V.C.3.7). A vehicle purchase rebate has the advantage of applying to any sale of an EV, giving buyers flexibility to choose how they would like to charge their vehicle.

supplement its contract with rental car companies to prioritize[363] rentals of EVs, as well as 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. If EVs and hybrid vehicles can be offered at comparable daily rates as conventional ICE vehicles, directing public employees to choose EVs whenever possible could reduce petroleum use and increase the number of EVs in rental car fleets at minimal or no incremental cost to the State.

Schedule: Near- to medium-term. Changes to procurement rules could likely be made within a year or two; however, it may take longer for rental car companies to expand the selection of EV models in their fleets and confirm daily rental rates for these vehicles.

6. Time-of-use and EV CHARGING RATES (page 84)

In 2014, HECO recommended converting the current EV pilot rates to standard rates effective through 2020, including Schedule TOU EV, EV-R, and EV-C. HECO also concluded that EV pilot rates have influenced further adoption of EVs, shifted EV charging to the off-peak period, provided customers with bill savings, and supported the State's goal of greater adoption of EVs[364]. In response, DBEDT submitted comments to the PUC with ten recommendations notably: development of a daytime EV TOU pilot rate that helps match customers' electricity demand to renewable electricity supply; improving education regarding EV rates; and conducting outreach to EV dealers.

This tactic focuses on the impact of off-peak and daytime time-of-use charging for EV customers. Encouraging EVs to charge when electricity costs less to produce could save utilities on electricity generation costs; some of these savings could be passed on to consumers as lower electricity rates. EVs equipped with demand responsive technologies could also help utilities meet an increased Renewable Portfolio Standard (RPS).

Schedule: Near-term. Utility rate schedules could be revised within one or two years, and permitted PV systems could be installed within this timeframe as well. The deployment of demand-responsive and vehicle-to-grid technologies may take several more years to allow time for demonstrating technical feasibility and developing financially viable utility rate schedules.

Marine

7. SLOW STEAMING (page 103)

The speed and the energy consumption of marine diesel engines follow a cubic function, meaning that for a given voyage a 10% speed reduction leads to 27% less energy use. The State could encourage Port Hawaii to implement a speed reduction

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[363] At a minimum, a revised contract could allow rental car companies to offer hybrids and EVs to public employees at a negotiated rate. A follow-up tactic could involve directing employees to prioritize choice of rental vehicles based on fuel efficiency.

[364] HECO (2014). EV Final Report. July 31, 2014.

program for ocean-going vessels (OGVs) that visit the port. The program would provide owners of OGVs that reduce their speed to 12 knots within 40 nautical miles of the port area with a 15% dockage rate discount. If desired, the Harbors Division could initially opt for a less stringent program, such as 80% compliance rate to be eligible for the discount or a smaller speed reduction zone of 20 nautical miles, and gradually ramp up the stringency over time. The state government could refund the Harbors Division the paid discount in recognition that the effort contributes to the State's goals to reduce the petroleum use and promote energy-efficient technologies and operational strategies.

Schedule: Medium-term, allowing time to organize and establish a system to monitor the compliance of the program as well as facilitate the incentive payment.

8. PROPELLER POLISHING and hull cleaning (page 104)

Cleaning and polishing propeller surfaces can reduce trailing turbulence on ships and frictional losses across the propeller. Likewise, hull cleaning can reduce frictional resistance and increase energy efficiency. Both measures are part of regular maintenance for OGVs and small boats and can be finished during the dry dock period, eliminating the cost of the lost service when ships have to be taken out of regular business. There is evidence that some ship owners do not regularly polish ships' propellers and clean their hulls, leading to the unnecessary loss of energy use. The state government could encourage propeller polishing and hull cleaning by providing fiscal incentives to train technicians specialized in providing these services, and by conducting outreach to ship owners about the fuel benefits of regular ship maintenance.

Schedule: Medium-term. Prior to implementation, the State would need to evaluate the share of ship owners who have already regularly done the propeller polishing and hull cleaning in order to assess the effectiveness of this tactic.

B.3 Monitor for Changes in Conditions (12 tactics)

Seven tactics for on-road vehicles and five tactics for aviation and marine are listed as "monitor for changes in conditions" according to the criteria ranking methodology selected here. Inclusion of tactics in this category does not preclude their implementation in the State of Hawaii at a later date, especially after some of the priority items are implemented in the next 3-4 years. Since these tactics are not presently targeted, implementation schedules are not included in the following descriptions.

Vehicle Efficiency

1. FEEBATES for vehicle fuel efficiency (page 36)

Hawaii could apply either a revenue-neutral feebate or a vehicle sales tax linearly based on fuel consumption in order to promote sales of more efficient vehicles. Such a program could improve the efficiency of Hawaii's new vehicle fleet beyond the average fuel economy and GHG requirements of federal standards. Fees could be applied either at the dealer or manufacturer level. While this tactic was evaluated as a cost-effective means of improving the efficiency of new vehicles sold in Hawaii, it was rated with a low likelihood of implementation due to a limited precedent for state-level feebates in the

U.S. If, however, there were sufficient interest from local stakeholders, Hawaii could become a leader with a statewide feebate or sales tax based on new vehicle fuel consumption.

2. REPLACEMENT TIRES (page 39)

New vehicles are typically sold with low rolling resistance tires; however, after a few years, vehicles are often equipped with replacement tires that have higher rolling resistance and thus reduce the fuel economy of the vehicle. Hawaii could improve the efficiency of light-duty vehicles statewide by establishing a consumer information program and minimum tire efficiency standards to promote the purchase of fuel efficient replacement tires. Such a program could complement a national program that is expected to take effect in 2017. While a consumer information program could still be worthwhile, minimum tire efficiency standards were evaluated to have low to medium social acceptability, in part due to Hawaii's relatively small influence over the national tire market.

Vehicle-Miles Traveled

3. GASOLINE AND DIESEL TAXATION (page 52)

While gasoline and diesel fuels account for the vast majority of petroleum used for on-road transportation in Hawaii, the prices of these fuels currently do not reflect their full social costs. Based on the estimated optimal gasoline tax in California ($1.37 per gallon) and the general level of fuel taxes applied in the European Union, the State of Hawaii could increase the tax rate[365] on gasoline and diesel fuels by up to $0.85 per gallon to account for their full social costs and increase the cost competitiveness of technologies that use alternative fuels, especially biofuels[366], electricity, and hydrogen. Such action could raise much-needed revenue for transportation infrastructure investments[367] in a manner that is consistent with the State's priorities to reduce petroleum imports, improve the efficiency of passenger and freight transportation, and promote alternative fuels.

The social acceptability of this tactic will vary significantly across interest groups and hinges critically on allocating tax revenues to ensure that low-income and rural residents are not disproportionately affected. This could be accomplished by allocating a share of fuel tax revenues as cash rebates for low-income households, targeted subsidies to purchase efficient vehicles or use public transit. Additionally, increased fuel taxes could provide the funds necessary to expand public transportation service and improve bicycling and walking infrastructure. Social acceptability could also be improved by

[365] As of 2014, federal, state, and county gasoline taxes in Hawaii totaled $0.44 to $0.52 per gallon, with rates varying by county.

[366] Some tactics promoting bbiofuels were not presently recommended in part due to their higher cost relative to conventional gasoline and diesel fuel; however, increasing taxes on conventional fuels could make biofuels cost-competitive, reducing the need for government subsidy to expand production.

[367] An alternate or complementary policy to increasing fuel taxes would be to implement a road user charge; however, such a charge was evaluated with a low likelihood of implementation in Hawaii at present.

starting with a small increase in the tax rate that scales over time, giving consumers and commercial vehicle operators ample time to take cost-effective fuel saving actions.

Schedule: Near-term to long-term. The tax rate on gasoline and diesel fuels could be increased within two years by appropriate legislative action; however, to minimize adverse economic impacts of a sudden large price increase, such legislation could increase the tax rate steadily over several years: for example, increasing 5-10 cents per gallon each year.

4. VMT PRICING PROGRAM (page 55)

A statewide mileage-based road user charge could replace fixed vehicle registration taxes and fees, improving the matching of road usage with the amount paid by each user into the State Highway Fund. Such a charge could be collected at the time of annual vehicle registration and be measured based on the change in odometer reading from the previous year. The per-mile rate could vary based on vehicle weight, since heavier vehicles tend to cause more wear and tear to roads. This tactic was rated with a low likelihood of implementation since a mandatory road user charge has yet to implemented for all in-use vehicles in any U.S. state; however, as with feebates, Hawaii has an opportunity to be a leader if there is sufficient local interest in converting fixed vehicle registration taxes and fees into a variable mileage-based fee.

Alternative Fuels

5. CELLULOSIC BIOFUEL (page 91)

Cellulosic biofuel is ethanol, drop-in diesel or gasoline, or other types of transport fuel made from cellulosic plant material such as wood, leaves, or sugarcane bagasse. Hawaii may be able to produce up to 24 MGY ethanol if all 72 thousand acres of current pasture and idle cropland were repurposed to energy crop production. In addition, Hawaii could potentially produce 4 MGY cellulosic biofuel from municipal solid waste. This tactic has a low likelihood of implementation, since it would require ongoing government financial support on the order of $1 per gallon over the cost of wholesale conventional gasoline, plus initial investment costs on the order of $200 million. Should the costs of producing cellulosic biofuel decline in the future, there is potential for State-level action to support the displacement of petroleum fuels with cellulosic biofuel in Hawaii. As mentioned in the section on gasoline taxes, increasing the state tax rate on gasoline and diesel could increase the price competitiveness of biofuels without the need to spend public funds on direct biofuel subsidies.

6. SUGARCANE ETHANOL (page 92)

Hawaii currently has a number of state policy incentives to promote the production of ethanol, including in particular the ethanol production incentive (income tax credit up to 30% until 2017) and the ethanol fuel blend standard (E10)[368]. Hawaii could produce up to 49 MGY sugarcane ethanol on repurposed pasture and idle cropland. A suite of

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[368] As of December 31, 2015, Act 161, SLH 2015 (SB 717 SD2 HD1 CD1), the State ethanol blending mandate, which dictates a statewide 10% ethanol blending requirement, will be repealed. The repeal's effects on state ethanol consumption is unclear at this time.

policy actions would be necessary to incentivize production of sugarcane ethanol in Hawaii, including investment in sugarcane establishment or price support for domestically produced sugar, increased price support (such as increasing the value of the ethanol production tax credit) or increasing the ethanol blending mandate, and possibly financial support for the construction of ethanol facilities. This tactic has a low likelihood of implementation, since it would require ongoing government financial support on the order of $3.24 per gallon over the cost of wholesale conventional gasoline. As with cellulosic biofuel, should the costs of producing sugarcane ethanol decline in the future, there is potential for State-level action to support the displacement of petroleum fuels with sugarcane ethanol in Hawaii. As mentioned in the section on gasoline taxes, increasing the state tax rate on gasoline and diesel could increase the price competitiveness of biofuels without the need to spend public funds on direct biofuel subsidies.

7. Support the consumption of CNG AND LNG in vehicles (page 95)

Hawaii Gas currently produces synthetic natural gas from naphtha that is produced at Hawaii's refineries or imported, and has started to import ISO containers of LNG from California as backup. This syngas is utilized for electricity production. Use of natural gas in transportation is currently very limited in Hawaii. A consortium including Hawaii Electric Company and Hawaii Gas is seeking establishment of a LNG terminal facility to receive bulk shipments from LNG tankers or barges. This tactic would include establishing an LNG terminal facility to receive bulk shipments from LNG tankers or barges, and supporting the establishment of LNG or CNG fueling stations as well as purchases of LNG and CNG vehicles.

Aviation

8. Financial support for AIRCRAFT FLEET RENEWAL (page 98)

The State could partially subsidize the purchase of efficient new aircraft that replace older, less efficient models used on Hawaiian routes. Alternatively, the State could help airlines obtain financing for new aircraft purchases. This tactic has a low likelihood of implementation for several reasons. Early retirement is unlikely to be cost effective for many airlines, and subsidies may be viewed as disadvantaging early movers that have already invested in fuel efficiency. Furthermore, given existing large production backlogs for established manufacturers, it may not be possible for airlines to gain delivery slots for new purchases in the near-term.

9. Include aviation fuels in the BARREL TAX (page 99)

This tactic considers an increase in fuel taxes for aviation such as applying the barrel tax to aviation fuel; such a change was proposed by HB 822 in the 2011 legislative session but failed to pass. Because aviation demand is relatively elastic, an increase in fuel price driven by an expansion of the barrel tax would constrain demand somewhat by increasing ticket prices. Fewer flights would reduce overall fuel consumption, although with anticipated impacts on Hawaii's tourism industry. This tactic was rated low in terms of social acceptability, since potential impacts on tourism are likely to be unpopular given that sector's importance to the Hawaiian economy.

10. Fuel efficiency-based LANDING CHARGES (page 100)

Operational fees such as landing charges and en route fees are an important contributor to airline operational costs and offer a vehicle for providing economic incentives for cleaner and/or quieter aircraft. Hawaiian airports could alter their landing fee structure to increase fees for less fuel efficient aircraft while offering reductions for more efficient aircraft. The program could be designed to be revenue neutral, although the system would need to be revisited over time to ensure that adequate funds are raised as fleetwide fuel efficiency improves. While fuel efficiency-based landing charges could be a revenue-neutral mechanism to divert more efficient aircraft to Hawaii airports, such charges have not yet been successfully implemented anywhere in the U.S. This tactic has a low likelihood of implementation, since it would require implementing a completely new policy in Hawaii, potentially to significant industry opposition.

Marine

11. Increase BUNKER TAXES under the barrel tax (page 106)

This tactic includes an expansion of the barrel tax to include bunker fuels for marine vessels at a rate of $30 per tonne of fuel, equivalent to a 4% price increase. In the absence of additional fuel saving measures, this fuel would likely be purchased outside of Hawaii. This tactic has a low likelihood of implementation due to low potential social acceptance of a higher fuel tax, as well as little or no ongoing discussion in Hawaii about expanding the barrel tax to include bunker fuels.

12. ONSHORE POWER (page 108)

This tactic includes a collaboration between the State government and Port Hawaii to build an onshore power system that would enable ocean-going vessels to be powered with onshore electricity while ships are in hoteling mode. Such an investment would enable ships to use electricity from the local power grid to power electric systems onboard, such as lighting, ventilation, communication, cargo pumps, and other critical equipment, while turning off their auxiliary engines and eliminating diesel emissions from these engines. This tactic was rated low in terms of social acceptability due to low energy-saving potential and high cost; however, it should be re-evaluated if there is an increase in public interest in local air quality improvement.

B.4 Conduct Additional Research (4 tactics)

Three tactics for on-road vehicles and one tactic for aviation were categorized as requiring additional research in order to make a recommendation. Suggested research and data collection to support the evaluation of these tactics are summarized below. Additional data needs and research opportunities are identified in Section VI.E.

Vehicle-Miles Traveled

1. PRICE PARKING (page 58)

Collect baseline data on large employer parking subsidies, commuting patterns at these employers, and the volume of vehicle traffic in areas that could be targeted for adaptive parking pricing. Evaluate the potential impact on VMT and fuel use of employer parking cash-out programs and adaptive parking pricing in Hawaii. For information on existing parking pricing programs, Hawaii could draw on the experience of California, which has required certain employers to offer a parking cash-out option since the 1990s, as well as San Francisco's adaptive parking pricing program.

Electric-Drive Vehicles

2. HYDROGEN FCEVS (page 73)

Track commercial availability and costs of hydrogen FCEV models for passenger cars and for commercial vehicles such as postal delivery trucks, refrigerated container trucks, shuttles, public buses, airport ground equipment, and forklifts. Evaluate the cost-effectiveness of government, private, and commercial FCEVs compared to EVs, as well as vehicles that run on biofuels, CNG, LPG, and conventional fuels. Apply for federal funds to replace government and commercial diesel vehicles with hydrogen FCEVs.

3. HYDROGEN FUELING INFRASTRUCTURE (page 73)

Explore public-private partnership models for constructing and operating hydrogen production and fueling facilities on Oahu and the Big Island, leveraging federal and state funding to support the introduction of vehicles that make use of newly available hydrogen fuel, and supporting any private efforts to bring renewable hydrogen to Hawaii fueling stations. Pilot demand-responsive technologies in hydrogen production facilities and evaluate the impact on the cost of hydrogen production under different utility rate models. Coordinate with utilities to establish a low or negative rate for demand-responsive hydrogen production (e.g. using renewable electricity that would otherwise be curtailed) that benefits the utility and customers.

Aviation

4. CONSUMER INFORMATION (page 102)

Evaluate the administrative costs of collecting, compiling, and disseminating data on the relative fuel efficiency of airlines by route. Assess the extent to which providing this information to domestic and international travelers for individual flights at the point of purchase shifts demand to more efficient airlines, routes, and/or flights.

C. Enabling Actions

This section describes in more detail the enabling actions that are listed in the master list of petroleum reduction tactics (Table 10). Many of these actions have already undergone policy discussions, and some were identified as critical actions in the *HCEI Road Map 2011 Edition*.

Table 10. Enabling actions in master list of tactics

Tactic	Evaluated	Existing / Pending	Enabling Action	Not Evaluated
General				
Leverage rental car fees to finance clean transportation programs[x]			x	
Increase barrel tax to fund government actions to support clean energy			x	
Leverage federal grants for clean surface transportation			x	
Better data collection, validation, and sharing across government agencies[xi]			x	
Public environmental education to promote awareness of State and County programs			x	
Baseline projections of transportation energy demand			x	
Establish performance metrics for planning agencies to measure and report progress[xii]			x	
Vehicle-miles traveled (VMT)				
Legislative VMT reduction target[369]			x	
Replace LOS metric with VMT[370]			x	
Support Transportation Demand Management (TDM) by large employers[371]	x		x	
Multimodal public safety campaign			x	
Promote intelligent transportation systems			x	
Island-specific mode share goals for bicycling, walking, and transit			x	x
Support an interdepartmental group to connect transit, walking, and bicycling facilities		x	x	x
Incorporate health sector goals for active transportation into local planning decisions			x	x
Electric-drive vehicles				
Define FCEVs as electric-drive vehicles and offer the same benefits as plug-in EVs		x	x	
Leverage federal grants for FCEVs			x	
Designate a lead hydrogen authority to implement State programs			x	
Standardize codes and permitting to ensure safe operation of hydrogen facilities			x	
Pilot demand-responsive hydrogen electrolysis facilities			x	
Conduct targeted outreach about the benefits of EVs		x	x	
Pilot demand-responsive EV charging and vehicle-to-grid technology			x	
Promote multi-unit dwelling charging with regulatory and fiscal incentives			x	
Promote workplace charging with regulatory and fiscal incentives			x	
Enforce or penalize non-compliance with EV parking requirements		x	x	
Alternative Fuels[xiii]				
Create a statewide inventory of waste-to-fuels resources			x	x

369 Section IV.B.1.1)

370 Section IV.B.1.1)

371 Section IV.B.6.2)

C.1 General

C.1.1) Leverage rental car fees to fund transportation programs

Hawaii receives more than 8 million visitors each year[372], with many of these visitors 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[373]. 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, levying a green fee on car rentals to support the electrification of rental car fleets.

C.1.2) Increase barrel tax to fund government actions to support clean energy

State and County fuel taxes imposed on distributors brought in $166.8 million in revenue in fiscal year (FY) 2013[374]. An additional Environmental Response Tax of $1.05 per barrel of oil collected $27.2 million in FY 2013[375]. 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[376]. Due to its alignment with the petroleum-saving objective and relatively small impact on household costs, an increase in the barrel tax is recommended as a means of providing government agencies with the necessary resources to conduct additional research on identified tactics and implement other enabling actions that support petroleum-saving tactics.

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[372] DBEDT (2015). Quarterly Tourism Data. Visitor Statistics. Retrieved from http://dbedt.hawaii.gov/visitor/

[373] 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

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

[375] Ibid.

[376] Blue Planet Foundation (2015). Barrel Tax Disbursement. Retrieved from http://blueplanetfoundation.org/barrel-tax-disbursement.html

C.1.3) Leverage federal grants for clean surface transportation

Several federal programs[377] 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.

C.1.4) Better data collection and sharing across government agencies

Better data are needed to establish a robust baseline, evaluate the potential impacts of policy actions, and monitor progress toward established goals. Data needs include sales and total registrations of electric-drive vehicles, vehicle usage of state and county agencies, digitized and integrated registration data from DMV and HDOT, and estimated vehicle-miles traveled and fuel consumption by passenger and commercial vehicles (VI.E).

C.1.5) Public environmental education to promote awareness of State and County programs

Public education could promote awareness and enhance the impact of State and County environmental programs. Such education could potentially be supported by the US EPA's Environmental Education Grants. Such efforts could include educating freight carriers on the benefits of joining the US EPA SmartWay partnership, or educating utility customers on the benefits of owning an EV.

C.1.6) Baseline projections for transportation energy demand

The State of Hawaii could develop its own baseline projections for transportation energy demand, including on-road vehicles, rail, aviation, and marine sources. These projections would facilitate tracking of progress toward the State's clean energy goals as well as assist in identifying and evaluating potential petroleum reduction tactics. Such projections could be updated regularly as new transportation data becomes available.

C.1.7) Establish performance metrics for planning agencies to measure and report progress

Performance metrics are an important means of quantitatively evaluating progress toward policy goals. Hawaii's Healthy People 2020 Progress Tracker is a local example of an online platform for tracking and reporting such progress in the health sector. The *HCEI Road Map 2011 Edition* could serve as a starting point for identifying metrics for transportation: these could include VMT (estimated each year by Hawaii DOT), the

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[377] US EPA (2015). Funding Sources. National Clean Diesel Campaign. Retrieved from http://www.epa.gov/cleandiesel/grantfund.htm#epa

number of EVs (DBEDT), the volume of biofuels produced locally (not available), the average efficiency of new vehicles sold in Hawaii (data only available for purchase from private sources), and the share of commuters bicycling, walking, and taking public transport (the US Census Bureau's American Community Survey). This tactic would involve identifying, compiling, and making publicly available such performance metrics for specific clean transportation strategies. These metrics could give credit to policy makers and local partners for progress on clean transportation strategies, as well as regularly highlight areas where further action is needed.

C.2 Vehicle-Miles Traveled

C.2.1) Multimodal public safety campaign

In addition to direct State support for commuter benefit and TDM programs, State and County governments could partner with NGOs to educate drivers, bicyclists, and pedestrians and promote safe and efficient multimodal transportation[378]. In addition to reducing the number of traffic-related incidents, such programs could encourage drivers to switch to alternative transportation modes.

C.2.2) Promote intelligent transportation systems

Intelligent transportation systems encompass a very wide range of applications, from provision of consumer information about alternative transportation modes to optimization of traffic signals. While the definition of these systems is too broad to evaluate specific costs and benefits, such systems should be integrated into all measures related to travel demand. Funded by the US DOE and US Office of Naval Research, the Energy Excelerator program is well-positioned to connect innovative energy companies with opportunities to deploy intelligent transportation systems in Hawaii.

C.2.3) Island-specific mode share goals for bicycling, walking, and transit

A common concern expressed by stakeholders in the VMT sector was a need for a binding goal that would require coordination across government agencies and facilitate cooperation with non-government groups. While such a goal could take the form of mandatory reductions in greenhouse gas emissions or energy consumption in the transportation sector, a legislatively binding target to reduce statewide VMT received the strongest support (IV.B.1.1). Such legislation has been adopted in five US states[379] and could be supported with island-specific targets to increase the share of trips taken by bicycling, walking, and public transit.

[378] Multimodal public safety campaigns are underway in several US cities including Denver and New York City. In 2014, the US DOT published an action plan to reduce pedestrian and bicyclist fatalities.

[379] New York, Massachusetts, Oregon, Washington, and Vermont. Source: ACEEE (2014)

C.2.4) Support an interdepartmental group to connect transit, walking, and bicycling facilities

To facilitate transit-oriented development ahead of the HRTP, an interdepartmental group is already working "to ensure seamless, safe connections between transit stations, bus stops, streets and sidewalks, and major activity nodes, including wayfinding signs and fare integration."[380] This tactic would involve expanding this group or starting one to facilitate better coordination between the State DOT, MPOs, and County transportation planning departments, especially relating to issues of financing and planning infrastructure for transportation alternatives such as bicycling, walking, and public transit.

C.2.5) Incorporate health sector goals for active transportation into local planning decisions

As part of the Healthy People initiative by the U.S. Department of Health and Human Services[381], Hawaii's Department of Health has established 2020 goals for a list of health indicators[382], which includes several indicators for transportation (e.g. the share of commuters walking, bicycling, and taking public transportation). This tactic would involve formally incorporating these health goals into planning decisions made by the State DOT, as well as MPOs and County planning departments.

C.3 Electric-Drive Vehicles

C.3.1) Define FCEVs as electric-drive vehicles and offer the same benefits as plug-in EVs

Hydrogen fuel cell vehicles have not yet been deployed extensively in Hawaii: as of September 2014, there were 45 active and planned FCEVs in Hawaii, most of which are operated by the Department of Defense[383]. 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 were legislative proposals to define hydrogen FCEVs as electric-drive vehicles, and confer the benefits of electric vehicles as established in previous state and local government

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[380] City and County of Honolulu, Department of Planning and Permitting (2014). TOD Honolulu. Retrieved from http://www.honolulu.gov/rep/site/dpptod/dpptod_docs/TOD_Framework_-_FINAL_NEW_small.pdf

[381] U.S. Department of Health and Human Services (2015). "State and Territorial Healthy People Plans." Accessed 1 Jun 2015 at http://www.healthypeople.gov/2020/healthy-people-in-action/State-and-Territorial-Healthy-People-Plans

[382] State of Hawaii Department of Health (2015). Hawaii's Healthy People 2020 Progress Tracker. Accessed 1 Jun 2015 at http://www.hawaiihealthmatters.org/index.php?module=Trackers&func=display&tid=1003

[383] US DOE (2014). Inventory of U.S. Over-the-Road Hydrogen-Powered Vehicles. Hydrogen Analysis Resource Center. Retrieved from http://hydrogen.pnl.gov/hydrogen-data/inventory-us-over-road-hydrogen-powered-vehicles

policies[384]. In terms of energy and environmental impacts, hydrogen FCEVs can be treated 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.

C.3.1) Leverage federal grants for FCEVs

Several federal programs[385] 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.

C.3.2) Designate a lead hydrogen authority to implement State programs

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. In May 2015, HB 1296 designated the Hawaii Center for Advanced Transportation Technologies (HCATT) as the state hydrogen implementation coordinator.

C.3.3) Standardize codes and permitting to ensure safe operation of hydrogen facilities

In addition to direct financial incentives, the State of Hawaii could partner with the US DOE, industry, and NGOs to educate local legal and insurance industries on safety, codes, and standards for fueling facilities; this outreach could mitigate the legal barriers to developing such facilities and reduce cost of liability coverage for station operators. Updates to codes could be made with guidance from US DOE and leading states such as California[386]. Some exchanges between Hawaii and California have already taken place[387].

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[384] Hawaii State Legislature (2015). HB622. Retrieved from http://www.capitol.hawaii.gov/measure_indiv.aspx?billtype=HB&billnumber=622

[385] For example, US EPA's National Clean Diesel Campaign. Source: US EPA (2015). Funding Sources. National Clean Diesel Campaign. Retrieved from http://www.epa.gov/cleandiesel/grantfund.htm#epa

[386] Rivkin, C. (2014). Deployment of Hydrogen Infrastructure Module 3 Codes and Standards. Retrieved from http://cafcp.org/sites/files/3_Codes_and_Standards_2.pdf

[387] For additional details, see: Lloyd, A., Miller, J., Glick, M., Yunker, C., Sparlin, K., Larson, M., Viray, L., & Chin, J. (2015). "Summary of the Hydrogen Fuel Cell and Battery Electric Vehicle Stakeholder Charrette: Expanding Hawaii's Clean Transportation Solutions." The International Council on Clean Transportation (ICCT) and Hawaii Department of Business, Economic Development, and Tourism (DBEDT).

C.3.4) Pilot demand-responsive hydrogen electrolysis facilities

Electrolyzers can produce hydrogen and oxygen from water using electricity. The efficiency of electrolyzers has improved in recent years, and the amount of electricity needed to produce a given quantity of hydrogen is expected to further decline. With current technology, however, the cost of producing hydrogen in Hawaii 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. Of course, it is possible that developers may be able to produce low cost electricity from renewable sources in Hawaii, so that renewable hydrogen could be produced by electrolysis at competitive prices.

C.3.5) Conduct targeted outreach about the benefits of EVs

In addition to offering rebates themselves, consumer education is an important element of encouraging market uptake of EVs. 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. 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. However, 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[388] or auto dealers. Such a collaboration could include a built-in cost calculator[389] that considers the impact of federal and state financial incentives, as well as up-to-date information on actual electricity rates, EV costs, potential 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.

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[388] Would include the administrator of a public benefits fund if an EV or charging infrastructure rebate were implemented in Hawaii.

[389] For example, such a calculator could be similar to the Vehicle Cost Calculator developed by the US DOE Alternative Fuels Data Center, except with more pre-filled vehicle options and Hawaii-specific energy price data.

In March 2015, HECO launched an online EV savings estimator[390] that allows residential customers to input recent electricity bill data and see how much they could save with the EV TOU, EV-R, or Net Energy Metering rate (including rooftop solar) compared to the standard residential electricity rate. HECO's new savings estimator could serve as a first step toward an expanded automatic savings calculator.

C.3.6) Pilot demand-responsive EV charging and vehicle-to-grid technology

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. 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.

C.3.7) Promote multi-unit dwelling and workplace charging with regulatory and fiscal incentives

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. 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. Recent legislation establishes a working group to "examine the issues regarding requests to the board of directors of an association of apartment owners, condominium association, cooperative housing corporation, or planned community association for the installation of electric vehicle charging system."[391] 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.

[390] HECO (2015). Transmittal No. 14-07 - Quarterly Report. March 31, 2015.

[391] Proposed legislation, SB 1316, relating to electric vehicles, has subsequently been passed into law, and is now known as Act 164

The simplest solution put forth during the charrette was to update building codes to ensure that enough 220-volt outlets are available to charge electric vehicles at new MUDs and workplaces. The State could also offer a rebate 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. The State could also join the US DOE's EV Everywhere Workplace Charging Challenge. Aside from the capital and installation costs of charging systems[392], 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 Plug-In Electric Vehicle Readiness Scorecard to evaluate and track progress toward community EV readiness, including MUD and workplace charging installation.

C.3.8) Enforce or penalize non-compliance with EV parking requirements

Hawaii already requires that places of public accommodation with at least one hundred available parking spaces provide at least one parking space exclusively for EVs and equipped with an EV charging system[393]; however, the benefits of this legislation have been limited since not all facilities are in compliance[394]. Pending legislation could assess a charge for facilities that are still non-compliant with the EV parking and charging requirement. While enforcing these requirements could increase the availability of EV parking and charging facilities, it could incur costs to businesses and government agencies that operate large, publicly accessible parking facilities. Managers of non-compliant facilities would likely oppose a fee; however, EV drivers would benefit[395] from enforcement of these requirements.

C.4 Alternative Fuels

C.4.1) Create a statewide inventory of waste-to-fuels resources

There is currently limited data concerning the availability of waste feedstocks in the State of Hawaii. Collecting enough information to establish a statewide inventory could

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[392] For estimates of charging equipment costs, see: Agenbroad, J., & Holland, B. (2014). Pulling Back the Veil on EV Charging Station Costs. Retrieved June 20, 2014, from http://blog.rmi.org/blog_2014_04_29_pulling_back_ the_veil_on_ev_charging_station_costs

[393] Hawaii Revised Statutes Section 291-71. Retrieved from http://capitol.hawaii.gov/hrscurrent/Vol05_Ch0261-0319/HRS0291/HRS_0291-0071.htm

[394] HCEI (2015). "Senator wants to add teeth to Hawaii electric vehicle parking law with fines up to $20k." Retrieved May 29, 2015 from http://www.hawaiicleanenergyinitiative.org/senator-wants-to-add-teeth-to-hawaii-electric-vehicle-parking-law-with-fines-up-to-20k/

[395] Jin, Searle, and Lutsey (2014). Evaluation of State-Level U.S. Electric Vehicle Incentives. The International Council on Clean Transportation. Retrieved from http://www.theicct.org/evaluation-state-level-us-electric-vehicle-incentives

support policy efforts to ensure all viable waste resources are utilized effectively, either in transportation as liquid or gaseous fuels or in other sectors.

D. 2030 Impact of Recommended Tactics

D.1 Ground Transportation

Table 11 lists recommendations for tactics related to on-road vehicles. Based on the framework for categorization applied to the quantitative and qualitative assessment of petroleum reduction tactics, 19 tactics are targeted for on-road vehicles. Taken together, these recommended tactics could reduce petroleum use in 2030 by an estimated 81 to 86 MGY above and beyond the benefits of existing actions (e.g. HRTP).

Of the five tactics listed as "monitor for changes in conditions" for on-road vehicles, three were assessed as unlikely to be presently cost effective in Hawaii: these include additional State support of cellulosic biofuel, sugarcane ethanol, and CNG/LPG vehicles (Section B). The remaining three tactics – feebates, replacement tires, and VMT pricing programs – were estimated to be cost-effective; however, since these actions had received little discussion in Hawaii at the time of this analysis, they were assessed to have a relatively low likelihood of implementation. Future policy discussions that increase the likelihood of implementation should trigger re-evaluation of these actions.

Table 11. Recommended tactics for ground transportation

Recommendation Category **Sub-sector** Tactic	**Potential petroleum reduction in 2030 (MGY)**
PRIMARY TARGET *(8)*	**45 - 49 MGY**
Vehicle Efficiency	
• FEDERAL VEHICLE FUEL ECONOMY STANDARDS	16 MGY
• HIGH EFFICIENCY TAXIS	3.6 MGY
Vehicle-Miles Traveled	
• TRANSIT-ORIENTED DEVELOPMENT	23 MGY
• Infrastructure for ALTERNATIVE TRANSPORTATION modes	Included with above
• CARSHARING FOR PUBLIC FLEETS	0.3 to 1.1 MGY
• Dedicated PARKING FOR CARSHARING	1.2 to 1.7 MGY
• COMMUTER BENEFITS LEGISLATION	0.7 to 3.6 MGY
• Support of TDM BY LARGE EMPLOYERS	Included with above
SECONDARY TARGET *(10)*	**8 - 9 MGY**
Vehicle Efficiency	
• PROCURE EVS AND EFFICIENT VEHICLES for public fleets	0.4-1.0 MGY
• GREEN FREIGHT	1.1 MGY
• Vehicle RETIREMENT INCENTIVES for low-income groups	1.1 MGY
• RENTAL CAR EFFICIENCY program	1.4 MGY
Vehicle-Miles Traveled	
• TELECOMMUTING by public employees and large employers	3.9 to 4.9 MGY
• FLEXIBLE SCHEDULING for work and classes	Included with above
• Secure state support and funding of BIKESHARE PROGRAMS	0.14 MGY
Electric-Drive Vehicles	
• State REBATES FOR ELECTRIC-DRIVE vehicles	242 gallons per EV
• EV RENTAL PRIORITIZATION for state & county employees	0.024 to 0.034 MGY
• Time-of-use and EV CHARGING RATES	242 gallons per EV
Total recommended tactics for ground transportation	**–53-58 MGY**
MONITOR FOR CHANGES *(7)*	
Vehicle Efficiency	
• FEEBATES for vehicle fuel efficiency	**Efficiency & VMT** 46 MGY
• REPLACEMENT TIRES	
Vehicle-Miles Traveled	
• VMT PRICING PROGRAM	
• GASOLINE AND DIESEL TAXATION	**Alternative Fuels** > 33 MGY
Alternative Fuels	
• CELLULOSIC BIOFUEL	
• SUGARCANE ETHANOL	
• Support the consumption of CNG AND LNG in vehicles	
CONDUCT ADDITIONAL RESEARCH *(3)*	
Vehicle-Miles Traveled	
• PRICE PARKING to recoup costs and promote alternative modes	
Electric-Drive Vehicles	
• Promote government, private, and commercial HYDROGEN FCEVS	
• Support economically viable HYDROGEN FUELING INFRASTRUCTURE	

D.2 Aviation and Marine

Table 12 lists recommendations for tactics related to aviation and marine. Based on the framework for categorization applied to the quantitative and qualitative assessment of petroleum reduction tactics, four tactics are recommended with either high or low priority. Taken together, these recommended tactics could reduce petroleum use in 2030 by an estimated 9 to 14 MGY. Six tactics for aviation and marine were categorized as MONITOR FOR CHANGES or CONDUCT ADDITIONAL RESEARCH in large part due to low likelihood of implementation in Hawaii. For example, increasing the barrel tax, while an economically efficient means of taxing a commodity to internalize some of its external costs, does not seem to be a politically viable option in Hawaii unless there were accompanying provisions to ensure that the revenue is only spent on petroleum-saving policies and programs and not diverted to the general fund. If political or institutional developments in Hawaii were to allow for further consideration of these six tactics, implementing these actions as they were evaluated could reduce petroleum use in 2030 by an estimated 15 MGY.

In contrast to the approach taken for on-road vehicles, the ICCT did not project future energy use for aviation and marine due to limited availability of baseline data, the high share of aviation and marine activity attributed to international and trans-pacific passenger and freight travel (rather than domestic interisland travel), and prioritization of detailed analysis and forecasts for the on-road sector within a limited project scope.

Table 12. Recommended tactics for aviation and marine

Recommendation Category **Sub-sector** Tactic	**Potential petroleum reduction in 2030 (MGY)**
PRIMARY TARGET *(2 TACTICS)*	**7 MGY**
Aviation • Financial support for WINGLET RETROFITS • AIRPORT INFRASTRUCTURE support	 4 MGY 3 MGY
SECONDARY TARGET *(2 TACTICS)*	**2 - 7 MGY**
Marine • SLOW STEAMING • PROPELLER POLISHING and hull cleaning	 0.8 MGY 1.5 - 6 MGY
Total recommended tactics for aviation and marine	**9 - 14 MGY**
MONITOR FOR CHANGES *(5 TACTICS)*	**13 MGY**
Aviation • Financial support for AIRCRAFT FLEET RENEWAL • Increase the BARREL TAX • Fuel efficiency-based LANDING CHARGES **Marine** • Increase BUNKER TAXES under the barrel tax • ONSHORE POWER	 0.08 - 0.2 MGY 12 MGY Not quantified 0.9 MGY 0.1 MGY
CONDUCT ADDITIONAL RESEARCH *(1 TACTIC)*	**2 MGY**
Aviation • CONSUMER INFORMATION such as airline fuel efficiency ranking	 2 MGY

D.3 Impacts in Context of HCEI Clean Energy Target for Transportation

The *HCEI Road Map 2011 Edition* targeted a 70 percent reduction in petroleum use from ground transportation, equivalent to roughly 385 million gallons per year (MGY) against a baseline projection of 550 MGY in 2030. The 385 MGY target, while helpful to conceptualizing the magnitude of targeted petroleum reductions, does not directly allow tracking of progress over time since it is defined as a reduction from a changing baseline projection. To facilitate a comparison of progress in this analysis with the level of petroleum reduction targeted in 2011, the 385 MGY target can be reframed as a 165 MGY target for petroleum use of on-road vehicles in 2030[396] (Figure 12). Compared to actual petroleum use in the on-road sector in 2011, the HCEI energy target is equivalent to a 68% reduction in petroleum use[397].

For the Transportation Energy Analysis, the ICCT took into account recent developments at the federal, state, and county levels to construct a new baseline for on-road petroleum use in 2030. This baseline assumes:

- New vehicles sold in Hawaii meet federal fuel economy standards for light-duty vehicles through 2025, and GHG standards for heavy-duty vehicles through 2018. These standards will reduce the fuel use of new light-duty vehicles by about 33% and heavy-duty vehicles by 5% to 13% compared to 2010 models.
- Sales of electric vehicles increase to account for one in ten vehicles sold in 2030 (equivalent to 43,000 BEV and PHEVs on the road).
- Total vehicle-miles traveled increase in proportion to Hawaii's de facto population from 11.57 billion in 2014 to 13.40 billion in 2030 (assuming no change in per-capita VMT).
- Continuation of existing biofuel production and imports (including local production of 3 MGY biodiesel from waste fats).

As shown in Figure 12, the *Revised Baseline* (for the year 2030) estimated in this study reflects a marked improvement in projected on-road petroleum demand compared to the 2030 *Baseline* estimated in 2011 (equivalent to a 184 MGY[398] reduction in 2030). Potential savings with completion of the planned HRTP could reduce petroleum use by an additional 19 MGY (VI.B). Finally, implementing the recommended tactics for on-road vehicles as evaluated in this study could reduce petroleum use up to 58 MGY, bringing

[396] The initial projection of 550 MGY in 2030 minus the petroleum reduction target of 385 MGY (savings) amounts to 165 MGY in projected petroleum demand in 2030.

[397] The reduction in petroleum use by 2030 relative to 2011 can be calculated as follows: (511 - 165)/511 = 67.7%, rounded to 68%.

[398] The ICCT's *Revised Baseline* projection in 2030 is 184 MGY lower than the *Baseline* projection in the *HCEI Road Map 2011 Edition* as a result of including the impacts of federal fuel economy standards, sales of EVs, an increase in VMT proportional only to population growth, and continuation of existing biofuel production and imports. The 184 MGY difference cannot be broken down without access to the model used to create the 2011 *Baseline* projection.

the 2030 projected petroleum demand to 289 MGY. This potential level of petroleum demand represents a 43% reduction from 2011 levels, compared to the 68% reduction targeted in the *HCEI Road Map 2011 Edition*.[399]

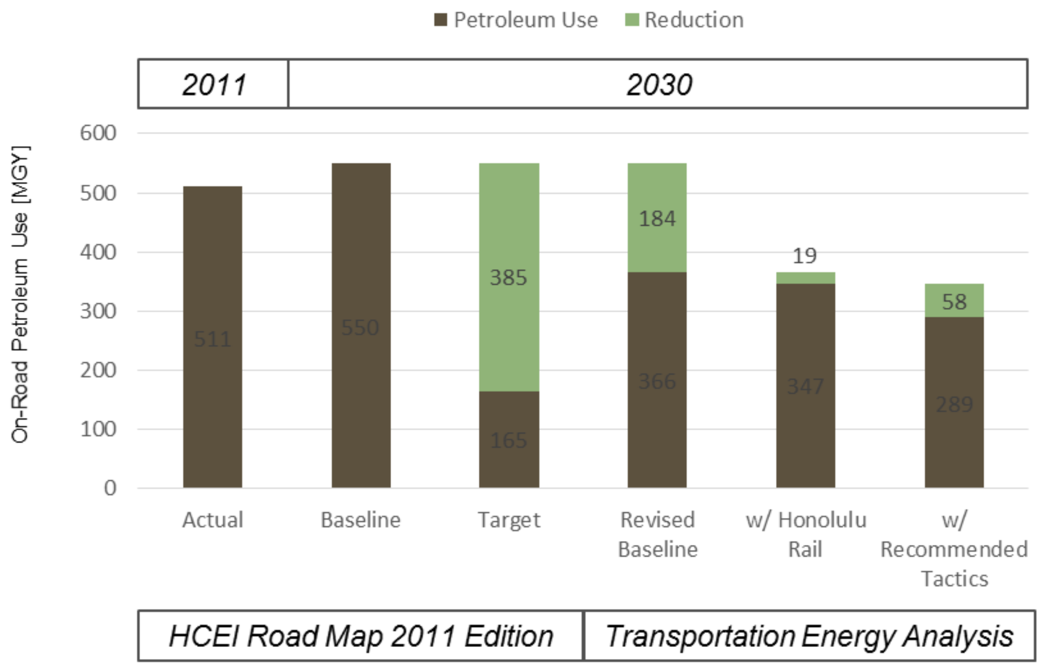

Figure 12. Comparison of HCEI Road Map Target with Transportation Energy Analysis

Table 13 summarizes the impact of the revised baseline and recommended tactics on the feasibility of meeting the 70% clean energy target for on-road vehicles. Since the tactics recommended in this study do not represent the maximum feasible reduction in petroleum use, it is very much a possibility that the State could explore and implement additional measures that reduce petroleum use by the 96 MGY needed to reach the 70% target for on-road vehicles.

[399] While petroleum is not the only fuel consumed by on-road vehicles, it is the basis for the transportation sector target established in the HCEI.

Table 13. Impact of recommended tactics on Hawaii's on-road petroleum demand

Study **Scenario** Target	**Fuels**	**Actual MGY in 2011**	**Projected MGY in 2030**	**Percent change 2011-2030**
HCEI Roadmap 2011 Edition				
Baseline petroleum demand for on-road vehicles	Petroleum	511*	550	8%
70% clean energy target for transportation (385 MGY)	Petroleum		- 385	
Targeted petroleum demand for on-road vehicles	Petroleum	511	165	-68%
Transportation Energy Analysis (this study)				
Baseline with adopted policies and current trends • Adopted federal fuel economy standards • EV sales reach 10% of total sales by 2030 • VMT grows with population • Continued production of biodiesel from waste fats	Petroleum	511	366	-28%
	Biofuels	35	34	
	Electricity & Hydrogen	< 1	4	
	Total	546	404	
Impact of planned HART**	Petroleum		-19	
Impact of recommended tactics for on-road vehicles	Petroleum		-58	
Potential petroleum demand for on-road vehicles	Petroleum	511	289	-43%
Remaining petroleum reduction to meet 70% target***	Petroleum		-124	

* Includes 466 MGY gasoline and 46 MGY diesel. Source: DBEDT Monthly Energy Trends.
** ICCT estimate. See Section VII.B for underlying assumptions.
*** Several tactics evaluated in this study are recommended for additional research, which could lead to realizing all or part of the additional petroleum reduction needed to meet the 70% target.
Red fill indicates on-road petroleum use (MGY) for a given scenario.

The *HCEI Road Map 2011 Edition* initially targeted on-road vehicles as a first step in reducing petroleum consumption; this analysis now also considers the aviation and marine sectors. While the State of Hawaii has limited ability to influence the activity of aircraft and marine vessels traveling to and from Hawaii, there are some concrete actions that the State can take to improve the energy efficiency of these modes. A first step to establishing a petroleum reduction goal for aviation and marine modes should involve constructing a set of baseline projections that the State government can use to evaluate the potential impacts of petroleum reduction tactics (Section V.C.1.6). Similar official projections could also be developed for ground transportation. In the meantime, this study identifies several recommended tactics to reduce petroleum use from aviation and marine. The potential impacts of these tactics are shown in context with recommended tactics for on-road vehicles in Figure 13.

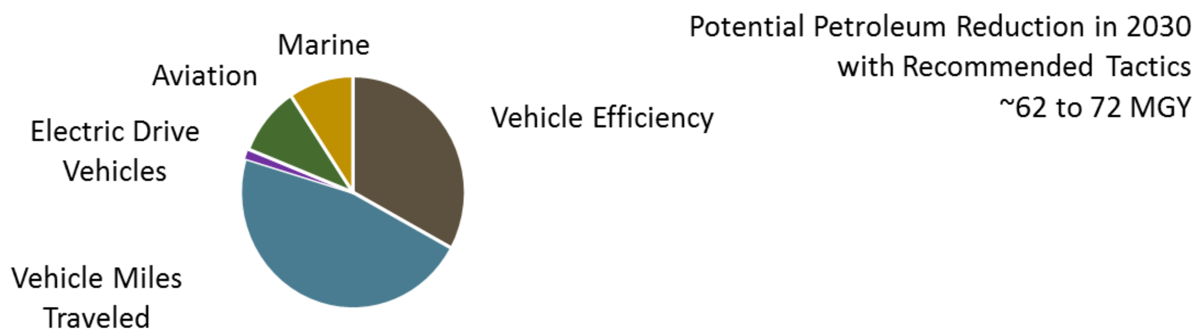

Figure 13. Potential petroleum reduction in 2030 with recommendations by sub-sector

The tactics recommended at present could reduce petroleum use by 62 to 72 million gallons of gasoline equivalent (MGY) in the year 2030 (Figure 13). While tactics targeting reductions in vehicle-miles traveled and improvements in road vehicle efficiency account for most of the quantified potential reduction, those targeting aviation and marine account for a non-trivial share (7% and 5%, respectively). It is worth noting that since electric-drive vehicles are already assumed to account for 10% of new vehicles sold in 2030 under the *Revised Baseline*, the petroleum reductions from these vehicles are already counted (along with adopted fuel economy standards) in the 184 MGY reduction compared to the former *Baseline* (Figure 12). As identified in the Recommendations, tactics promoting the further market uptake of electric-drive vehicles (including EVs and hydrogen fuel cell vehicles) have the potential to reduce petroleum use beyond what could be quantified in this analysis (starting page 70); these recommended tactics are also good candidates for additional analysis, since they are likely to be cost-effective and suitable for implementation in Hawaii.

E. Funding

Some of the recommended tactics may require additional funding resources in order to be implemented. Table 14 summarizes the resource requirements of these tactics, identifies relevant State and County plans, and suggests possible funding sources that could support implementation. The second column, *Government Funding Required*, indicates the extent to which implementing the tactic would incur costs to the government. For some tactics, the total costs to the government depend on the level of funding made available for the program (e.g. HIGH EFFICIENCY TAXIS). Some tactics do not require government funding, instead internalizing the costs to consumers who would also benefit from fuel-saving measures (e.g. FEDERAL VEHICLE FUEL ECONOMY STANDARDS); other tactics could generate tax revenue that could be used to fund other petroleum reduction tactics (e.g. GASOLINE AND DIESEL TAXATION). For tactics that would require government funding, the third column, *Budgeted*, indicates the extent to which funding is budgeted for these tactics in State or County planning documents. For partially or fully budgeted tactics, these plans are listed under *Relevant Plans*. Lastly, *Potential Funding* sources are identified for tactics that would require government funding, but which are not fully budgeted in existing planning documents. In some cases, potential funding sources already exist, whereas in other cases, generating revenue to implement a tactic may require new funding. Potential funding sources that either do not currently exist or that may need to be expanded (rather than simply changing allocation of existing funds) are indicated with an asterisk (*). For details on the cost or scale of evaluated tactics, see Section IV. While this analysis focuses on sources of government funding, partnerships between public agencies and private organizations could play a crucial role in supporting the development of certain tactics (for example, hydrogen infrastructure). Such projects would likely require additional research to determine a return on investment or estimate other economic impacts such as the number of jobs created.[400]

Of the tactics considered, gasoline and diesel taxes have perhaps the greatest potential to generate revenue that supports the implementation of other petroleum-saving measures, in particular, the development of infrastructure for alternative transport modes. Strengthened taxes on other fuels such as jet fuel and bunker fuel could raise revenue to implement recommended measures for aviation and marine modes, respectively. Other possible revenue-raising measures include barrel tax increases and road user charges; however, these measures could be especially difficult to implement unless taxpayers are assured that the funds will actually reduce petroleum dependence (and not be diverted to the general fund). Due to its alignment with the petroleum-saving objective and relatively small impact on household costs, an increase in the barrel tax may be justified as a means of providing government agencies with the necessary resources to conduct additional research on identified tactics and implement enabling actions that support other petroleum-saving tactics.

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[400] For an example of an economic jobs assessment for a potential energy-saving policy, see:

Roland-Holst, D. (2012). Plug-in Electric Vehicle Deployment in California: An Economic Jobs Assessment. University of California, Berkeley.

[x] Could be supported by the US EPA's Environmental Education Grants.

[xi] Needed to establish a robust baseline, evaluate the potential impacts of policy actions, and monitor progress toward established goals. Data needs include sales and total registrations of electric-drive vehicles, vehicle usage of state and county agencies, and estimated vehicle-miles traveled and fuel consumption by passenger and commercial vehicles.

[xii] Such metrics could include miles of sidewalk and bike facilities constructed, transit ridership, average efficiency of passenger and commercial vehicles, average efficiency of government fleets, sales share of electric-drive vehicles, average price of electricity used to charge EVs, volume and cost per unit of domestic alternative fuel production (biodiesel, CNG, hydrogen), electric-drive share of government fleets, average efficiency aircraft (per revenue passenger-mile) and marine vessels (per tonne-mile or passenger-mile).

[xiii] As a complement to tactics that promote the local production of biofuels, government agencies could provide incentives for procurement of locally produced biofuels for existing government fleets.

Table 14. Funding to support implementation of recommended tactics

TACTIC	GOVERNMENT FUNDING REQUIRED	BUDGETED	RELEVANT PLANS	POTENTIAL FUNDING
Vehicle efficiency				
Federal vehicle fuel economy standards	No	–	–	–
High efficiency taxis	$2,000 per taxi	No	–	- Daily taxi fees* - Congestion Mitigation and Air Quality Improvement (CMAQ) Program (FHWA) - Clean Cities (DOE)
Procure EVs and efficient vehicles for public fleets	Yes	Mostly	Agency vehicle procurement budgets	- CMAQ (FHWA) - Clean Cities (DOE)
Green freight	Administrative	No	–	- National Clean Diesel Campaign (NCDC) (EPA, includes DERA)
Vehicle retirement incentives for low-income groups	$2,500 per vehicle	No	–	- Vehicle registration surcharge* - CMAQ (FHWA) - Clean Cities (DOE)
Rental car efficiency program	$2,000 per rental car	No	–	- Rental car surcharge* - CMAQ (FHWA) - Clean Cities (DOE)
Vehicle-miles traveled				
Transit-oriented development and infrastructure for bicycling, walking, and public transit	Yes	Partially	- Statewide Transportation Improvement Plan - Honolulu Neighborhood TOD Plans - Oahu MPO Regional Transportation Plan - Kauai Multimodal Transportation Plan - County of Maui 2030 General Plan	- Gasoline and diesel taxes* - Transportation Alternatives Program (US DOT) - Partnership for Sustainable Communities (HUD, DOT, EPA) - Brownfields Cleanup Grants (EPA) - Smart Growth National Funding for Transportation - General Excise Tax (GET)
TACTIC	**GOVERNMENT FUNDING REQUIRED**	**BUDGETED**	**RELEVANT PLANS**	**POTENTIAL FUNDING**

Carsharing for public fleets	Yes	Yes	Agency vehicle procurement and operations budgets could be reallocated to a carsharing/motor pool system	–
Dedicated parking for carsharing	No	–	–	–
Commuter benefits legislation and support of TDM by large employers	No	–	–	–
Telecommuting by public employees and flexible work and class scheduling	No	–	–	–
Electric-drive vehicles				
State rebates for new electric vehicles	Yes			
EV rental prioritization for state & county employees	No	–	–	–
Time-of-use EV charging	No	–	–	–
Aviation				
Financial support for retrofits	Yes	No	–	Aviation fuel taxes*
Airport infrastructure support	Yes	No	–	- Voluntary Airport Low Emissions Program (VALE) (FAA) - Airport fees*
Marine				
Slow steaming	Yes	No	–	Bunker fuel taxes* Dockage fees*
Propeller polishing and hull cleaning	Yes	No	–	Bunker fuel taxes* Dockage fees*

2

F. Implementation

As stated in the Foreword (page 7), the Hawaii Clean Energy Initiative is fundamental to leading Hawaii to a clean and energy independent future. The actions recommended in this transportation-focused report are key tactics for the HCEI to consider. However, implementation is the key to accomplish the goals of the HCEI. This section will lay out the key ingredients necessary for successful implementation of the actions identified in Section V above.

With the conclusion of the Transportation Energy Analysis, the next step is for transportation and energy stakeholders to collaborate on an action plan framework and commit to carrying out specific actions.. To help inform our suggestions for such a framework, we can look to lessons learned from two successful approaches in California – the Climate Action Team created by Governor Schwarzenegger and the Zero Emissions Infrastructure “Czar” appointed by Governor Brown: the Climate Action Team delivered a report to Governor Schwarzenegger and the legislature which was turned into the AB32 legislation for dramatic reductions of GHGs. This achievement involved working with all stakeholders, including relevant state agencies, local government, the private sector, NGOs and the general public. The designated lead was the Secretary of the CalEPA[401]. The initiative taken by Governor Brown to solve the “chicken or the egg” challenge for electricity and hydrogen infrastructure has again demonstrated the vital role of Administration leadership in moving forward aggressive agendas. Some lessons learned from these examples which can be applied in Hawaii and the HCEI are:

- The number one priority is to identify the responsible persons and Agency for implementation of the plan. To be successful, support for the plan would be needed from the Governor, legislature and key agencies including DBEDT, Hawaii Department of Transportation and City and County Governments.
- The recommendations must have the backing of the Governor and the legislature. One approach would be for this report to be used to create an Action Plan to be submitted to the Governor and the legislature. This action plan will embody the recommendations included in this report.
- Should the step of creating an Action Plan be deemed unnecessary, the next step would be to proceed with the implementation of individual tactics recommended in this report.

There are several considerations that should be taken into account in the interpretation of the recommendations in this report. First, the recommended petroleum reduction tactics are not intended to be a definitive plan for the next 15 years, since these recommendations do not include all potentially beneficial actions – instead, they highlight a set of cost-effective, feasible actions that could advance Hawaii's clean energy goals for transportation. There remains a need for additional research and

[401] California Environmental Protection Agency (CalEPA) (2006). Climate Action Team Report to Governor Schwarzenegger and the California Legislature. Available from http://www.climatechange.ca.gov/climate_action_team/reports/

collection of baseline data (VI.E) to enable the evaluation of tactics that could not be considered within the timeframe of this project, as well as to refine the analysis of evaluated tactics. In addition, considering the extent to which Hawaii's transportation sector and policy environment have changed in the past 3-4 years, it is recommended that this plan be re-evaluated after the same amount of time in order to check overall progress and identify new policy options or those for which cost-effectiveness or likelihood of implementation has changed. For example, electric-drive vehicles are becoming increasingly competitive with conventional vehicles in terms of cost and range, and new technologies such as autonomous vehicles and driver assistive technologies could make their way into the market within the next several years.

Some of the petroleum reduction tactics and enabling actions that are recommended and evaluated in this report may already include the details necessary to support implementation; however, other tactics will require additional data collection, research on potential impacts, or refinement of the policy design before they can be implemented.

Suggested next steps for each of the recommended tactics are as follows.

- Develop a plan with the additional details for implementation, including refined policy design, implementation schedule, explanation of costs and benefits, and funding considerations (if applicable).
- Implement any enabling actions that are necessary for the success of the tactic (for example, setting binding VMT reduction goals that align objectives across state and county agencies).
- Incorporate the work in the transportation sector within a comprehensive energy road map. The road map must take into account the interdependencies throughout Hawaii's energy ecosystem to identify requirements and innovations necessary to achieve state policy goals including achieving 100% renewable energy in the electric sector.
- For each tactic, designate a lead agency and a coordinator[402] that will be responsible for taking it toward implementation. This designation should ideally come from the Administration or the Legislature in order to ensure accountability to fulfill this responsibility. Critical functions of this role include developing a detailed implementation plan which includes the following steps:
    - Collect baseline data to support evaluation of impacts;
    - Commission research as needed to support policy development;
    - Engage with all stakeholders whose support is needed for implementation;
    - Conducting the education and public outreach to ensure social acceptability;
    - Monitor performance to demonstrate impacts once the tactic has been implemented.

Based on these suggestions, HSEO plans to oversee development of a draft implementation framework for the identified tactics in collaboration with key government agencies and stakeholders. HSEO will hold a follow up meeting in September 2015 in

[402] Recommended tactics will require inter-agency and private sector collaboration, in addition to clearly defined roles and responsibilities.

which the draft implementation framework will be vetted by stakeholders[403]. Specific items include:

- Tactic leads
- Framework for leads to measure and report on tactic progress
- Method for socializing plan, results and resource requirements to key stakeholders including the Administration, legislature and State and County agencies in order to secure sustained support and necessary resources for implementation
- Process to update analyzed tactics for changes in market conditions and incorporate additional tactics into the energy in transportation roadmap

It is expected that tactic leads with support of their working groups will present tactic specific implementation plans by the end of the 4th Quarter of 2015.

[403] During the stakeholder meeting on June 17, 2015, the Hawaii State Energy Office announced plans to establish and participate in inclusive working groups to move individual or like tactics toward implementation. In response, Hawaii DOT invited participants to take part in a forum to discuss and implement a suite of coordinated tactics to secure adequate statewide funding for transportation in a manner that is consistent with Hawaii's clean energy goals.

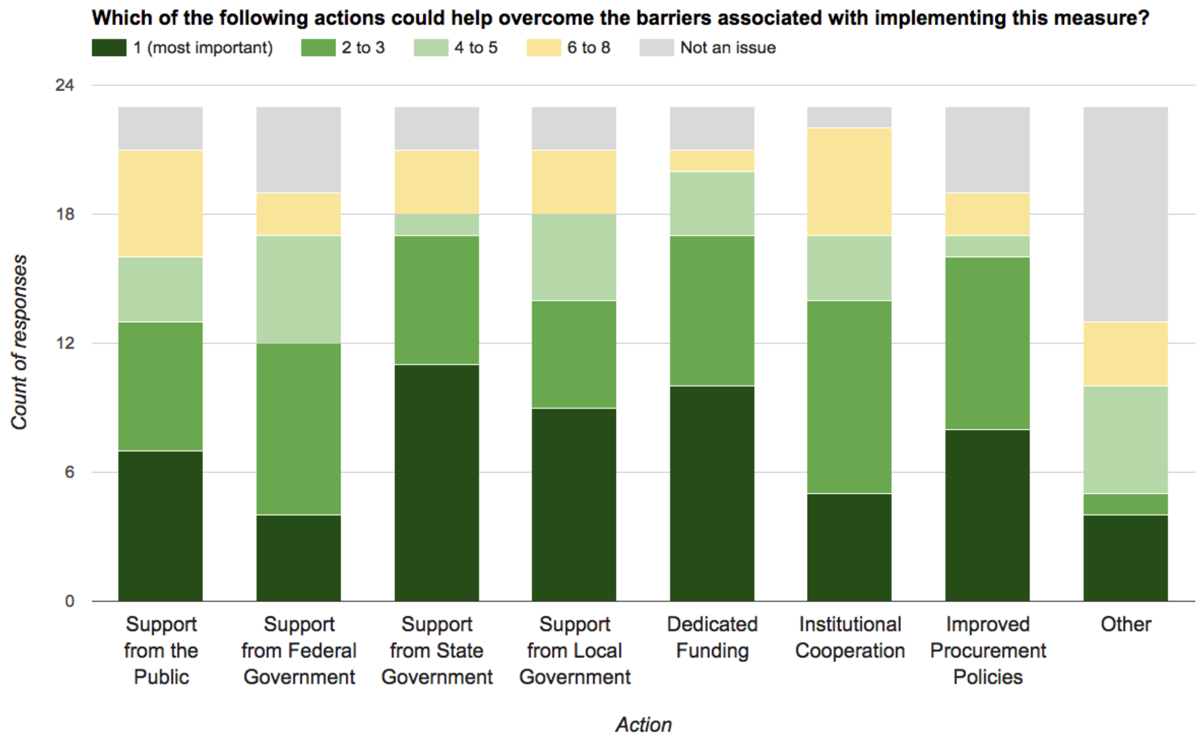
VI. Appendix

A. Transportation Stakeholder Survey

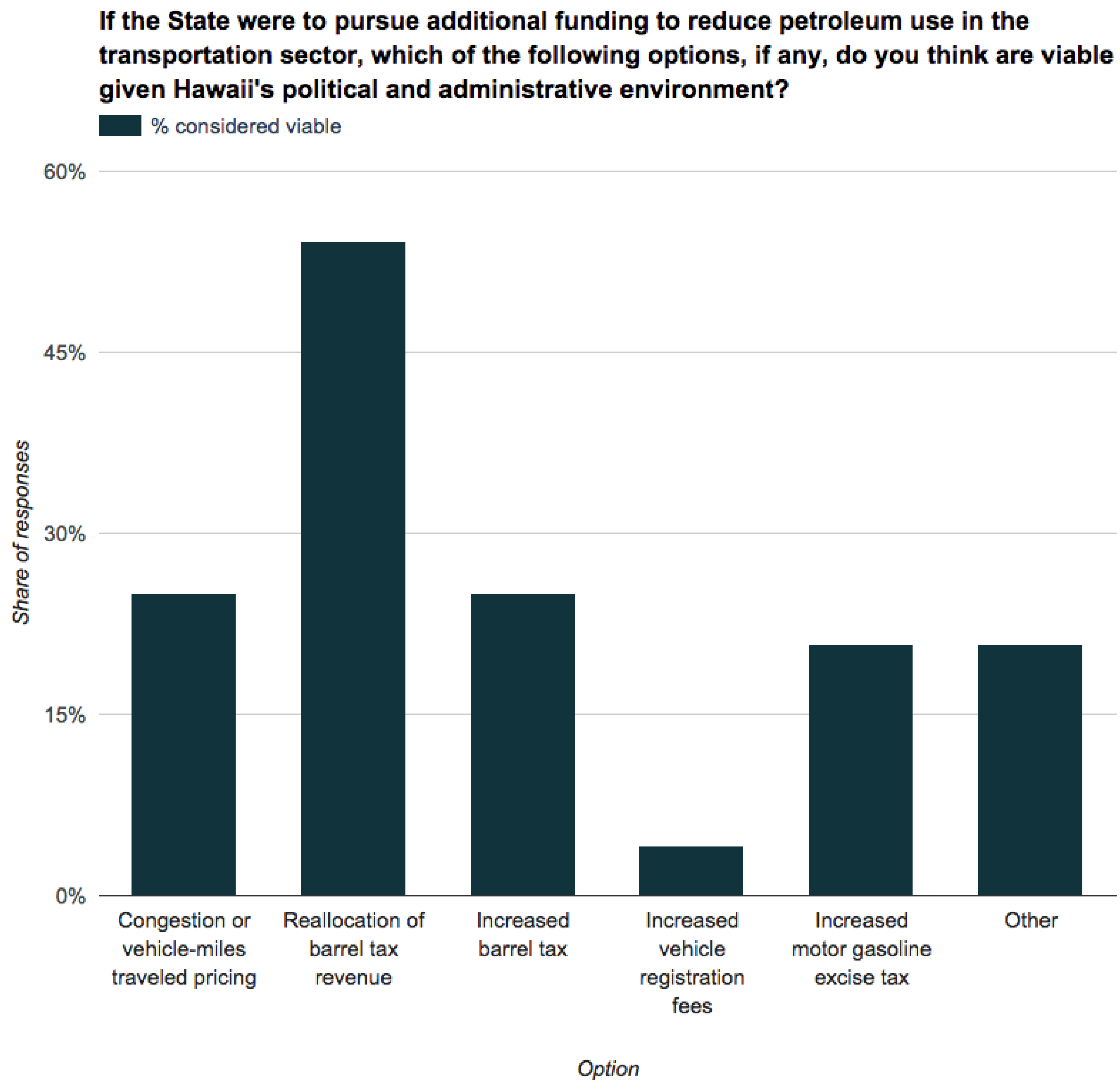
In advance of the workshop on November 13, 2014, the ICCT conducted phone interviews with over 40 stakeholders to gather insights on recent progress, relevant data, suggested policy options, and future outlook. All stakeholders were encouraged to submit written comments, relevant data, and specific policy proposals to the State Energy Office as well as the ICCT. To augment the feedback received from stakeholders during phone and in-person interviews and from written comments, the ICCT conducted an online survey of stakeholder opinions on HCEI strategies and tactics for the transportation sector. The results of this survey were considered in the ICCT's compilation and evaluation of petroleum reduction tactics. This section includes a summary of survey results, selected quotes from survey responses, and a copy of the survey instrument.

A.1 Summary of survey results

Respondents were asked to specify a transportation-related petroleum reduction measure that they would like to see considered in a revised HCEI (Q1). Following this question, respondents were asked to rank actions that could help overcome barriers to implementing this measure (Q2). Of the eight options given, *Support from State Government* and *Dedicated Funding* were the highest ranked actions. Additionally, *Improved Procurement Policies* and *Institutional Cooperation,* as well as support from the *Federal Government*, *Local Government*, and the *Public* were identified as important actions (ranking 1, 2, or 3 on an 8-point scale). These results highlight the potential for the Hawaii Clean Energy Initiative to coordinate support across government institutions, engage the public, and identify funding to support the implementation of petroleum reduction measures.



Respondents were also asked to rate the viability of options for raising revenue to fund petroleum reductions in the transportation sector (Q4). While over half of respondents rated reallocating the barrel tax as viable, no other revenue options were ranked as viable by more than one in four respondents (including increasing the barrel tax). These results indicate that any effort to raise additional revenue for transportation could prove challenging in Hawaii; however, considering the importance of dedicated funding (as indicated by respondents in Q2), revenue options could be made more viable by dedicating funding for measures that advance the State's clean energy priorities, including: reducing petroleum imports, mitigating congestion, promoting alternative transportation modes, and limiting air, noise, and water pollution from transportation sources.



A.2 Selected quotes from survey responses

Electric-drive vehicles:

- "It is clear factors such as customer incentives, tax credits, technology awareness, first responder training, government support for infrastructure, etc. made EV's successful in Hawaii."
- "Key near-term barriers for hydrogen are lack of investment in H2 production infrastructure, lack of private sector partnership, and lack of utility operations to allow for rapid scaling up of renewable hydrogen production capability."

On Managing travel demand:

- “HDOT and OMPO should participate in Transportation Alternatives Program (TAP).”
- “Statewide pedestrian master plan sounds great, not sure about implementation.”
- “Hawaii not doing much in assertive way to encourage VMT reduction.”
- “Could use roundabouts more effectively than problematic lights.”
- “Embrace multimodal rather than car-centric transportation.”

Marine:

- “80% of everything is imported and 98% of that 80% initially goes through [Port Hawaii].”
- “Shore power for cargo ships is viable, but likely not for passenger ships.”

Biofuels:

- “Main challenges for producing biofuel in Hawaii are lack of access to cheap feedstocks like woodchips and low land availability.”
- “It is important that the State fleets use renewable energy. Private industry is leading the way, the State should try to catch up.”

Miscellaneous:

- “Take the testbed concept that we're promoting in the electricity space and implement it in transportation too!”
- “Fuel is the third leading cost factor for us – reducing fuel consumption will allow us to improve service.”
- “Everyone wants a piece of the barrel tax.”
- “The elephant in the room that nobody talks about is the rail.”

A.3 Survey instrument

Hawaii Clean Energy Initiative: Transportation Charrette

The purpose of this survey is to gather initial feedback from participants in the Transportation Charrette to support the development of a revised transportation plan under the Hawaii Clean Energy Initiative, which aims to achieve deep reductions in petroleum use in the State of Hawaii. Aggregated results of this survey will be presented at the first stakeholder meeting, held on November 13, 2014. Your personal responses to the survey will be kept confidential.

Background

The Hawaii State Energy Office has contracted The International Council on Clean Transportation (ICCT) to assist in conducting a Hawaii Transportation Industry Analysis. The objective of this project is to provide assessments, analysis, and recommendations in order to develop a clean transportation plan under a revised Hawaii Clean Energy Initiative ("HCEI 2.0"). 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 under the current plan. As part of the Transportation Charrette, ICCT will offer for consideration a new set of transportation options, goals and timeline to reduce petroleum-based fuels in the transportation sector including aviation, ground and marine transportation.

* Required

About you

We are asking you to fill in this survey as you have been identified as a key expert on Hawaii transportation issues. Your personal responses to the survey will not be disclosed, and will not be considered as official views of your department or organization. We ask that you provide us with a bit of information about yourself for the purposes of transparency and follow-up.

Name *

Organization *

One transportation-related measure for consideration in HCEI 2.0

1. What is one specific transportation-related measure that you would like to see considered in a revised HCEI? *

Please choose one measure you'd like to elaborate on. There will be opportunity to suggest multiple measures during the Charrette.

2. Which of the following actions could help overcome the barriers associated with implementing this measure? *

Please rank actions in order of importance, selecting the rightmost option if not an issue. 1 = most important; 8 = least important.

	1	2	3	4	5	6	7	8	Not an issue
Support from the Public									
Institutional Cooperation									
Other									
Improved Procurement Policies									
Support from Federal Government									
Support from Local Government									
Support from State Government									
Dedicated Funding									

3. Please elaborate on one action that you assigned a rank of high importance to overcoming barriers to implementation.

If the identified transportation measure would benefit from support of a specific agency within government, please indicate. There will be opportunity to discuss additional actions and measures during the Charrette.

Funding to reduce petroleum use in the transportation sector

4. If the State were to pursue additional funding to reduce petroleum use in the transportation sector, which of the following options, if any, do you think are viable given Hawaii's political and administrative environment?

We're interested in your personal view about the feasibility of each option. Responses will not be considered as official views of your department or organization.

- ☐ Increased vehicle registration fees
- ☐ Congestion or vehicle-miles traveled pricing
- ☐ Increased barrel tax
- ☐ Increased motor gasoline excise tax
- ☐ Reallocation of barrel tax revenue
- ☐ Other: ________

Please feel free to add any clarifications or comments that you would like us to consider.

Answering this question is entirely optional.

Submit

B. Potential Petroleum Benefits of Honolulu Rail Transit Project

According to the latest official estimates, the Honolulu Rail Transit Project (HRTP) is scheduled to begin operation in 2018. In the Transportation Energy Analysis, the HRTP is treated as an existing policy/program. The ICCT estimated the potential petroleum benefits of the HRTP based on projected ridership and rail system capacity retrieved from the Honolulu Authority for Rapid Transportation (HART) website: http://honolulutransit.org/rail-system-guide/facts-and-figures.aspx. These assumptions and calculations are summarized in the following table. In summary, the HRTP could reduce gasoline consumption by 14 to 19 MGY in 2030 depending on the level of ridership[404].

Table 15. Potential Petroleum Benefits of the Honolulu Rail Transit Project

Technical Potential at Full Capacity (Source: ICCT)	**Value**	**Unit**
1. Maximum trip distance	20	miles
2. Trains at maximum capacity	800	passengers per train
3. Peak hours @ 6 hours per day, 12 trains per hour, 5 days per week	360	peak trains per week
4. Off-peak trains @ 20 hours per day (weekends), 14 hours per day (weekdays), 6 trains per hour	660	off-peak trains per week
5. Total weekly trains = peak plus off-peak	1,020	trains per week
6. Weekly passengers carried = trains per week * passengers per train	816,000	passengers carried per week
7. Maximum passenger-miles per week = passengers * max distance	16,320,000	passenger-miles per week
8. Maximum passenger-miles per year	848,640,000	passenger-miles per year
9. Passengers per vehicle	1.5	passengers per vehicle
10. Maximum VMT reduction	565,760,000	VMT per year
11. Average passenger car fuel economy	30	mpg
Gasoline saved in 2030: maximum ridership estimates based on technical potential	**19**	**MGY**
Ridership in 2030 (Source: HART)	**Value**	**Unit**

[404] In its 2010 Environmental Impact Statement, HART estimated the HRTP would reduce VMT by 186.6 million in 2030. Assuming an average passenger car fuel economy of 30 mpg, this VMT reduction would translate to petroleum savings of 6.2 MGY in 2030. In response to stakeholder concerns that the EIS ridership estimate had to be conservative and therefore did not consider the maximum potential of the HRTP, the ICCT developed the ridership estimates described in this appendix, which are based on a higher capacity utilization rate than the 2010 EIS.

Source: HART (2010). Honolulu High-Capacity Transit Corridor Project Environmental Impact Statement. Table 3-14, page 3-31.

1. 119,600 weekday passenger trips by 2030	119,600	weekday passenger trips
2. Weekday passenger-miles = weekday passenger trips * max distance	2,392,000	weekday passenger-miles
3. Weekdays per year = 5 * 52	260	weekdays per year
4. Passenger-miles per year	621,920,000	passenger-miles per year
5. Passengers per vehicle	1.5	passengers per vehicle
6. Maximum VMT reduction	414,613,333	VMT per year
7. Average passenger car fuel economy	30	mpg
Gasoline saved in 2030: HART ridership	**14**	**MGY**

C. Stakeholder Phone Interviews

The following 40 stakeholders were interviewed by phone in advance of the workshop on November 13, 2014[405]. An additional 158 stakeholders could not be interviewed in advance but were invited to participate in the workshop.

Table 16. List of stakeholders interviewed

First	Last	Organization
Kawakahi K.	Amina	PACOM/DOD
Leo	Asuncion	State of Hawaii, Office of Planning
Steve	Barker	Airlines for America
Robin	Campaniano	Hawaii Clean Energy Initiative c/o CGI Technologies
Richard	Carlin	Office of Naval Research
David	Cepala	Envergent
Makena	Coffman	University of Hawaii Manoa Department of Urban and Regional Planning
Bruce	Coppa	Governor Abercrombie Chief of Staff
Kerry	Drake	USEPA Region 9
Mitch	Ewan	Hawaii Natural Energy Institute
Elizabeth	Fischer	USDOT, Hawaii Division
Mark	Garrity	City & County of Honolulu
Greg	Gaug	Ulupono Initiative
Brian	Gibson	Oahu Metropolitan Planning Association (OMPO)
Matt	Gonser	University of Hawai'i Sea Grant College - Community Planning and Design
Dale	Hahn	Office of U.S. Senator Schatz
Lee	Jakeway	HC&S
JoAnne	Johnson-Winer	County of Maui - Maui Bus
Maurice	Kaya	PICHTR - Energy Excelerator
Ken	Kelly	National Renewable Energy Lab
Kelly	King	Pacific Biodiesel & Sustainable Biodiesel Alliance
Jackie	Kozak Thiel	Department of Land and Natural Resources
Shem	Lawlor	City & County of Honolulu (subsequently Blue Planet / Honolulu Clean Cities)
Jeremy	Lee	County Transportation Agency
Dawn	Lippert	Energy Excelerator, (and Chair of Hawaii Clean Energy Initiative)
Jason	Maga	Aircraft Service International Group
Celia	Mahikoa	County of Kauai
Aki	Marceau	Honolulu Authority for Rapid Transportation
Joel	Matsunaga	Hawai'i Bioenergy
Roger	Morton	City & County of Honolulu TheBus and TheHandi-Van
Rob	Myrben	Airlines for America
Gary	North	Hawaii Harbors Users Group & Partners
Stan	Osserman	Hawaii Center for Advanced Transportation Technologies
Harrison	Rue	City & County of Honolulu
Joelle	Simonpietri	PACOM/DOD
Mayela	Sosa	USDOT, Hawaii Division
Dan	Szeezil	Envergent
Marc	Takamori	County of Maui
Richard	Wallsgrove	Blue Planet Foundation
Asia	Yeary	USEPA Region 9

[405] This list does not include employees at the Hawaii State Energy Office who participated in the Transportation Energy Analysis project: Mark Glick, Chris Yunker, Margaret Larson, Kym Sparlin, Lynda Viray, Jonathan Chin, and Julie Yunker.

D. VMT Tactics Worksheet

During the workshop on November 13, 2014, the ICCT gathered feedback from stakeholders on the list of VMT tactics to be considered, and revised this list based on the feedback provided. A copy of this worksheet is included below.

Breakout Session 1 – Managing Travel Demand
Moderators: Asia Yeary (US EPA) and Josh Miller (ICCT)
Rapporteur: Margaret Larson (DBEDT)

Name:
Organization:

As identified in an analysis of transportation sector energy trends, meeting Hawaii's clean energy goals for transportation would require progress on several fronts, including vehicle efficiency, alternative fuels, and management of travel demand. In Hawaii, an average of one gallon of gasoline is saved for every 23 miles not driven. This session will explore barriers and opportunities for reducing travel demand. The following list of tactics has been compiled based on conversations with several dozen transportation experts in Hawaii. This list will serve as a template for discussion of the feasibility and potential impacts of possible intervention tactics.

Disclaimer: Inclusion of a tactic on this list does not constitute endorsement by the Hawaii State Energy Office or by the ICCT.

Measure	**Feasibility**	**Agency with authority**	**Funding availability**	**Cost effective**	**Magnitude of VMT benefit**	**Co-benefits relative to VMT benefit**
Please fill out this template during the discussion of VMT tactics. If you're not sure about an answer, it's fine to leave blank. If you'd like a copy for your records, write your name and we'll send you a scanned copy after the workshop.	1 - High 2 - Medium 3 - Low	List agency with authority to implement. If multiple, rank in order of likelihood.	1 - Fully 2 - Partially 3 - Not funded X - Not needed	1 - Yes 2 - No X - No cost	1 - High 2 - Medium 3 - Low	1 - Greater 2 - Similar 3 - Less
Traffic operations and management						
Support an interdepartmental group to coordinate connections between transit, walking, and bicycling facilities.						
Statewide policy to promote roundabouts.						
Bus priority lanes to improve travel times.						
Partner with private sector to pilot intelligent transportation systems.						
Carsharing						
Explore carsharing options for public fleets.						
Allow dedicated parking for carsharing.						
Prioritizing transportation projects						
Consider multimodal and safety impacts of projects instead of vehicle flow alone.						
Incorporate health sector active transportation goals into local planning decisions.						
Secure resources to fully implement existing plans						
Statewide Pedestrian Master Plan.						
Statewide Bicycling Master Plan.						
County and MPO multimodal, pedestrian, and bicycling plans.						
County neighborhood TOD plans.						
Other travel demand management (TDM)						
Public education campaign to improve safety and compliance of drivers and bicyclists.						
Secure state support, funding of bikesharing.						
Commuter benefit program to encourage transportation alternatives.						
Increase government support of TDM programs at University of Hawaii campuses.						
Lead by example to encourage telecommuting among state and local employees.						

Measure (continued)	Feasibility	Agency with authority	Funding availability	Cost effective	Magnitude of VMT benefit	Co-benefits relative to VMT benefit
Transportation financing						
Designate administrator(s) and execute a competitive application process for the Transportation Alternatives Program (TAP).						
Increase motor gasoline excise tax and dedicate funding for transportation alternatives.						
Reallocate vehicle registration fees and taxes to fund transportation alternatives.						
Price congested highways during peak hours.						
Price annual vehicle-miles traveled.						
Increase parking fees and expand use of smart parking programs.						
Strengthen capacity of State and local agencies to apply for federal funding (e.g. HUD-DOT-EPA, and TIGER).						
Transit-oriented development (TOD)						
Clarify legality of using tax increment financing for infrastructure projects under the State Constitution.						
Utilize EPA drinking water and wastewater state revolving loan funds (SRFs) to improve existing infrastructure and capacity in conjunction with EPA consent decree plans.						
Estimate maximum rail system capacity and formulate TOD plans to meet capacity.						
State and local government collaborate to identify and develop state lands near rail stations.						
Consider residential density and distance to work as key determinants of transport activity.						
Metropolitan Planning Organizations (MPOs)						
Modify Oahu MPO charter to give Policy Committee final decision-making authority for Transportation Improvement Plans.						
Improve State DOT and MPO capacity to ensure compliance with environmental regulations.						
Establish Maui MPO in accordance with federal law.						
Goals						
Legislative target to reduce statewide VMT.						
Island-specific goals for bicycling, walking, and transit mode share.						
Establish performance metrics for planning agencies to measure and report progress.						

E. Data Needs for Refined Analysis of Transportation Petroleum Reduction Tactics

Under the *Transportation Energy Analysis* contract, the State Energy Office requested that the ICCT develop a list of data that could be used to refine analyses of transportation petroleum reduction tactics in Hawaii. While many of the following items are available in some form, much of this information would benefit from additional interagency coordination to improve data coverage and completeness, keep it up-to-date, ensure high data quality and consistency across agencies, and make it readily available for use in future analyses. The following list is intended to capture the most salient data needs identified in the ICCT's analysis.

Ground transportation

- Data on vehicle procurement and use by public agencies
  - Including federal, state, and county agencies, and public utilities
  - Emphasis on standardized data format and coverage across all agencies
  - Capital, operating, and maintenance costs
  - Track actual fueling costs and prices (by volume or energy content) to public agencies by fuel type (e.g. B20, B100, E10, electricity)
  - Annual vehicle mileage, fuel consumption, rated fuel economy, actual fuel economy
  - Vehicle age, environmental performance, model, technology and fuel type
  - Compliance with vehicle procurement rules for EVs, FCEVs, alternative fuel vehicles, and fuel economy leaders
  - Include cost per trip, average trip distance, and revenues for public bus and rail agencies
- Data on vehicles rented and leased by public agencies
  - Number of vehicles, and rental days, mileage, fuel use, rated fuel economy, actual fuel economy for each vehicle
  - Share of vehicle rentals and leases by technology and fuel type
  - Cost per rental day, cost per mile driven
  - Compliance with vehicle procurement rules for EVs, FCEVs, alternative fuel vehicles, and fuel economy leaders
- Data on transportation energy use by fuel type
  - Gasoline, diesel (hwy), diesel (off hwy), biodiesel, bioethanol, hydrogen, CNG, LPG, LNG, electricity, aviation gasoline, jet fuel [DBEDT currently tracks at a more aggregate level]
  - Add detail for alternative fuels: biodiesel, bioethanol, hydrogen, CNG, LPG, LNG
  - Differentiate between imported and domestically produced fuels
  - Improve definition of fuel categories and coverage (e.g. characterization of "small boats", exclusion of international bunker fuels)
  - Disaggregation to end use categories as available (e.g. using bottom-up inventories of public agency fuel use to determine private sector fuel use)
- Vehicle sales, total registrations, annual per-vehicle mileage, and total vehicle-miles traveled by vehicle class, age, technology type, and entity category
  - Digitized and integrated registration data from DMV and HDOT
  - Share of vehicle sales by technology and fuel type (especially EVs and FCEVs)
  - Share of vehicle registrations by technology and fuel type (especially EVs and FCEVs)

    - Disaggregate estimates to cars, light trucks/SUVs, medium- and heavy-duty trucks, buses, two- and three-wheelers
    - Differentiate between public agencies and private/commercial sector using public agency inventories
    - Preserve disaggregation to counties and estimate statewide averages and totals
- Derived vehicle stock turnover-related curves from registration and mileage databases for public and private/commercial vehicles
    - Percent of vehicles surviving by vehicle age (years)
    - Average retirement age by vehicle and technology type
    - Share of vehicle stock/mileage by vehicle age
    - Average degradation in vehicle-miles traveled with vehicle age
- Cost of alternative fuels and related infrastructure
    - Capital, operating, financing, and maintenance costs of hydrogen production facilities
    - Capital, operating, financing, and maintenance costs of biofuel production facilities
    - Capital, operating, financing, and maintenance costs of electricity generation and charging facilities
    - Volume of hydrogen availability in Hawaii and price per unit
    - Actual electricity rates paid by EV owners and operators
    - Average cost of electricity generation, transmission, and delivery by time of day, and load curves by utility
- Data on transportation mode shares
    - The only current source of mode share data is the American Community Survey. However, this data comes from a very limited number of surveys and doesn't measure non-work commute trips or allow for multiple transportation modes for individuals.
    - Acquiring this type of data would require the State to work with the counties to develop a detailed transportation survey program that would regularly and systematically collect data.
    - The State and Counties should seek to collect mode share data for:
        - Single occupant vehicles, carpooling, vanpool, transit, walking, bicycling, multi-modal, etc.
        - For commute and non-commute trips
        - For county and sub-county district areas, and
        - For peak/non-peak travel times

Other data may not be directly available to State and County agencies, but efforts to collect, validate, and standardize this information could be especially helpful to refining targeted analyses:

- Data on vehicle fleets operated by rental car and car-sharing companies
    - Number of vehicles, rental days, mileage, fuel use, rated fuel economy, actual fuel economy
    - Capital, operating, and maintenance costs (including actual fuel costs)
    - Share of vehicle rentals and leases by technology and fuel type
    - Cost per rental day, cost per mile driven (these can be indicative or averages if proprietary information cannot be published)
- Data on taxi companies
    - Number of vehicles, mileage, fuel use, rated fuel economy, actual fuel economy
    - Capital, operating, and maintenance costs (including actual fuel costs)

- Share of vehicles by technology, fuel type, and vehicle age

- Data on ground support equipment at airports and harbors
    - Number of vehicles, mileage, fuel use, rated fuel economy (if applicable), actual fuel economy
    - Capital, operating, and maintenance costs (including actual fuel costs)
    - Share of vehicles by technology, fuel type, and vehicle age
- Data from freight carriers on trucking and shipping fleets
    - Number of vehicles, mileage, fuel use, rated fuel economy (if applicable), actual fuel economy
    - Freight activity (tonne-miles traveled)
    - Capital, operating, and maintenance costs (including actual fuel costs)
    - Share of vehicles by technology, fuel type, and vehicle age
    - Level of market uptake of efficient technologies (e.g. for trucks, aerodynamic technologies, low-rolling resistance tires, auxiliary power units)
    - Voluntary SmartWay Transport Partnership defines a data reporting format and collects information from participating carriers, but few carriers in Hawaii participate
- Vehicle ownership and use by income group [some information currently compiled by the Center For Neighborhood Technology's H&T Affordability index]

Marine

Data needs

- Energy consumption by Ocean-going vessels (OGVs) that visit Ports in Hawaii each year
- Energy consumption by OGVs by modes (cruising, maneuvering, and hoteling) in Hawaii each year
- What's the tax rate, if any, for bunker fuels sold to ships, except for the throughput tax charged at the refinery level?
- How many shops are there in Hawaii that provide propeller polishing and hull cleaning services? How many vessels do they provide service to?

Data clarifications

- The Research and Economic Analysis division at DBEDT shows the gasoline and diesel sold to smaller boats totaled about 2.7 million gallon in 2013. This is a sharp drop from 5.4 million gallon in 2008. What are the factors, besides the recession, that contribute to the slump?
- Does the data provided by the division cover all smaller boats?
- What's the definition of smaller boats? Does it include inter-island ferries, cruise ships, barges and tugs?
- Does DBEDT have the data on bunker fuel prices in the past few years?

Aviation

Data needs

- Fuel cost to the airlines flying out of Hawaii
- The current penetration rate of aircraft winglet technology (in terms of the number of aircraft and activity hours or RPMs) for flights departing from Hawaii airports

- The cost to retrofit aircraft with winglet technology
- Average resale price (residual value) of aircraft by age and the cost of newer, efficient aircraft to replace them
- Estimate of a potential barrel tax rate in Hawaii
- The total APU usage and associated fuel burn at Hawaii airports
- The number of gates at Hawaii airports without electrification
- The cost of implementing gate electrification and connecting pre-conditioned air units
- Fuel efficiency of aircraft flying out of Hawaii airports

Data clarifications

- Does the reported jet fuel consumption in Hawaii (~228 million gallons in 2013) correspond to the amount of fuel *loaded* onto the aircraft departing from Hawaii airports?

F. Covered Fleets

Hawaii's vehicle procurement guidelines only apply to vehicles that are not subject to federal requirements for "covered fleets" (§490.2). Federal requirements apply to State fleets with 50 or more non-excluded light-duty vehicles weighing less than 8,500 pounds, at least 20 of which are capable of being centrally fueled, and which operate primarily within a Metropolitan Statistical Area. In Hawaii, there were seven covered fleets in 2013, all of which are operated on the island of Oahu.

For federally covered fleets, there is a potential loophole[406] in that agencies can receive credit for acquiring alternative fuel vehicles even if such alternative fuels are not available locally; for example, while flex fuel vehicles are capable of using E85 (85% ethanol and 15% gasoline), as of 2012 the only facilities with E85 were operated by the US Navy[407]. While a change to the State's vehicle procurement guidelines would not in itself affect the purchases for the seven covered fleets, the State could encourage these agencies to apply for Alternative Compliance under the federal requirements, which allows agencies to employ measures consistent with petroleum reduction plans in lieu of purchasing alternative fuel vehicles. Such measures include VMT reduction, electric-drive vehicles, fuel-efficient conventional vehicle technologies, biodiesel blends, idle reduction, and truck stop electrification[408].

Table 17. Hawaii fleets covered by federal alternative fuels requirements[409]

Fleet	Address	Contact
HECO Light Duty Fleet	P.O. Box 2750 Honolulu, HI 96840	Clayton Yoshida
Hawaii - Airports	400 Rodgers Blvd., Suite 700 Honolulu, HI 96819	Paul Nishimura
Hawaii Department of Agriculture	1428 South King Street Honolulu, HI 96814	Keith Aragaki
Hawaii Department of Trans-Highways	869 Punchbowl Street Honolulu, HI 96813	Lew Honda
Hawaii Public Housing Authority	1002 N. School Street, Bldg C Honolulu, HI 96817	Becky L. Choi
Hawaii State Motor Pool	DAGS Automotive Management Division P.O. Box 119 Honolulu, HI 96810	Brian Saito
University of Hawaii, Manoa Aux. Svcs.	Manager 1951 East-West Road, Honolulu, HI 96822	Raymond Shito

406 §490.306 of the Code of Federal Regulations states, "The alternative fueled vehicles acquired pursuant to section 490.302 of this part shall be operated solely on alternative fuels, except when these vehicles are operating in an area where the appropriate alternative fuel is unavailable."

407 Schroeder, J. (2012). Navy Opens E85 Station in Hawaii. Retrieved from http://domesticfuel.com/2012/04/03/navy-opens-e85-station-in-hawaii/

408 US DOE (2014). State and Alternative Fuel Provider Fleet Compliance Methods. Retrieved from http://www1.eere.energy.gov/vehiclesandfuels/epact/pdfs/fleet_compliance.pdf

409 US DOE (2013). State and Alternative Fuel Provider Covered Fleets. Last updated 9 Sep 2013. Retrieved from http://www1.eere.energy.gov/vehiclesandfuels/epact/covered_fleets.html

G. Glossary

This section contains a complete listing of keywords and acronyms found in the report.

Alternative transportation modes - Includes public transit as well as active modes (bicycling and walking)

B5 - Diesel fuel with 5 percent biodiesel blended in

BEV - Battery electric vehicle

CNG - Compressed natural gas

CMAQ - Congestion Mitigation and Air Quality Improvement

DERA - Diesel Emission Reduction Act

DOE - Department of Energy (U.S.)

DBEDT - Department of Business, Economic Development, & Tourism

Electric-drive vehicle - Includes hydrogen fuel cell and electric vehicles

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

FCEV - Fuel cell electric vehicle

FHWA - Federal Highway Administration

FTA - Federal transit administration (U.S.)

FY - Fiscal year

HART - Honolulu Authority for Rapid Transportation

HCEI - Hawaii Clean Energy Initiative

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

HSEO - Hawaii State Energy Office

HRTP - Honolulu Rail Transit Project

ICCT - International Council on Clean Transportation

LDV - Light-duty vehicle, including cars and light trucks class 1-2

LNG - Liquefied natural gas

LT - Light truck

MGY - Million gallons per year

MPG - Miles per gallon

NCDC - National Clean Diesel Campaign

NHTSA - National Highway Traffic Safety Administration

OGV - Ocean-going vessel

OMPO - Oahu Metropolitan Planning Organization

PHEV - Plug-in hybrid electric vehicle

PUC - Public utilities commission

PV - Photovoltaic

TDM - Travel demand management

VMT - Vehicle-miles traveled

US DOE - United States Department of Energy

US DOT - Department of Transportation

US EPA - United States Environmental Protection Agency

US HUD - United States Department of Housing and Urban Development