A national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy

National Renewable Energy Laboratory

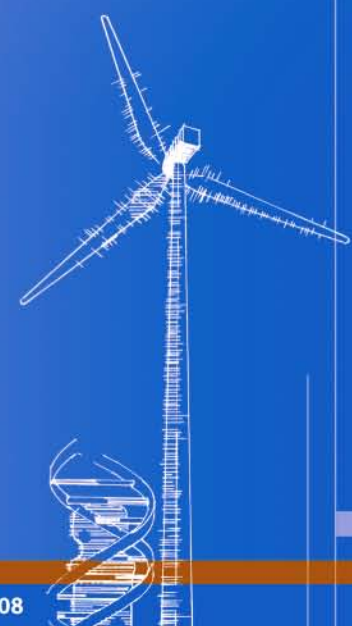
Innovation for Our Energy Future

Clean Energy Policy Analysis: Impact Analysis of Potential Clean Energy Policy Options for the Hawaii Clean Energy Initiative

Technical Report
NREL/TP-7A2-47891
April 2010

S. Busche and E. Doris
National Renewable Energy Laboratory

R. Braccio, D. Lippert, P. Finch, D. O'Toole, and J. Fetter
Booz Allen Hamilton



NREL is operated for DOE by the Alliance for Sustainable Energy, LLC Contract No. DE-AC36-08-GO28308

Clean Energy Policy Analysis: Impact Analysis of Potential Clean Energy Policy Options for the Hawaii Clean Energy Initiative

Technical Report
NREL/TP-7A2-47891
April 2010

S. Busche and E. Doris
National Renewable Energy Laboratory

R. Braccio, D. Lippert, P. Finch, D. O'Toole, and J. Fetter
Booz Allen Hamilton

Prepared under Task No. IDHW.9120

National Renewable Energy Laboratory
1617 Cole Boulevard, Golden, Colorado 80401-3393
303-275-3000 • www.nrel.gov

NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC

Contract No. DE-AC36-08-GO28308

NOTICE

This report was prepared as an account of work sponsored by an agency of the United States government. Neither the United States government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States government or any agency thereof.

Available electronically at http://www.osti.gov/bridge

Available for a processing fee to U.S. Department of Energy
and its contractors, in paper, from:
U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831-0062
phone: 865.576.8401
fax: 865.576.5728
email: mailto:reports@adonis.osti.gov

Available for sale to the public, in paper, from:
U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
phone: 800.553.6847
fax: 703.605.6900
email: orders@ntis.fedworld.gov
online ordering: http://www.ntis.gov/ordering.htm

Printed on paper containing at least 50% wastepaper, including 20% postconsumer waste

Acknowledgments

This report was produced with funding from, and in coordination with, the Department of Energy (DOE). The authors would like to acknowledge the significant contributions of the members of the Hawai‘i Clean Energy Initiative’s technical and integration working groups, as well as other stakeholders in Hawai‘i. The input provided by these members was integral to ensuring the validity of these analyses to the Hawaiian context. During the review process, the authors benefited from extensive comments from a variety of stakeholders, including:

Joyce McLaren, NREL

Easan Drury, NREL

Joel Bluestein, ICF International

John Sheehan, University of Minnesota

Peter Lilienthal, HOMER Energy, LLC

Alison Silverstein, contractor to DOE.

In addition to these reviewers, we appreciate the assistance of Karen Petersen in NREL’s Communications Office for her editing support. Of course, any remaining errors are the responsibility of the authors.

List of Acronyms

AFV	alternative fuel vehicle
AMI	advanced metering infrastructure
AMP	Alameda Municipal Power
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning
ASTM	American Society for Testing and Materials
BBL	barrel (of oil)
BHA	Boston Housing Authority
C&I	commercial and industrial
CAFE	corporate average fuel economy
CARB	California Air Resources Board
CLUE	Center for Land Use Education
CIS	customer information system
CO_2	carbon dioxide
CNG	compressed natural gas
DBEDT	Hawai‘i Department of Business, Economic Development and Tourism
DHHL	Department of Hawaiian Homelands
DLNR	Department of Land and Natural Resources (Hawai‘i)
DND	Department of Neighborhood Development (Boston)
DOD	Department of Defense
DOE	Department of Energy
EE	energy efficiency
EERE	Energy Efficiency and Renewable Energy (DOE)
EIA	Energy Information Administration (DOE)
EIS	environmental impact statement
EPA	Environmental Protection Agency
EPRI	Electric Power Research Institute
EV	electric vehicle
FFV	flex fuel vehicle
FY	fiscal year
GAHP	Green Affordable Housing Program (Boston)
GAO	Government Accountability Office
GHG	greenhouse gas
GM	General Motors
GVW	gross vehicle weight
GW	gigawatt
GWh	gigawatt hour
HB	house bill
HARC	Hawai‘i Agricultural Research Center
HCEI	Hawai‘i Clean Energy Initiative
HDOA	Hawai‘i Department of Agriculture

HECO	Hawaiian Electric Company
HELCO	Hawaii Electric Light Company
HERS	Home Energy Rating System
HHFDC	Hawai‘i Housing Finance and Development Corporation
HNEI	Hawaii Natural Energy Institute
HPHA	Hawai‘i Public Housing Authority
HUD	Department of Housing and Urban Development
ICE	internal combustion engine
IRP	integrated resource plan
KIUC	Kauai Island Utility Cooperative
kW	kilowatt
kWh	kilowatt hour
LADWP	Los Angeles Department of Water and Power Residential Electric Vehicle Services
LBE	lead by example
LCFS	low carbon fuel standard
LEED	Leadership in Energy and Environmental Design
LY	legislative year
MECO	Maui Electric Company
MGY	million gallons per year
MPG	miles per gallon
MW	megawatt
MWh	megawatt hour
NHTSA	National Highway Traffic Safety Administration
NRDC	Natural Resources Defense Council
NREL	National Renewable Energy Laboratory
O&M	operation and management
PBF	Public Benefit Fund
PBFA	Public Benefit Fund Administrator
PHEV	plug-in hybrid electric vehicle
PTC	production tax credit
PUC	Public Utilities Commission
PV	photovoltaic
QHTB	qualified high-tech business
RECO	Residential Energy Conservation Ordinance
REZ	Renewable Energy Zone
RFS	Renewable Fuel Standard
RPS	renewable portfolio standard
SAE	Society of Automotive Engineers
SB	senate bill
SHW	solar hot water
SMUD	Sacramento Municipal Utility District
TOU	time-of-use
UL	Underwriters Laboratory
USGBC	United States Green Building Council

Executive Summary

In partnership, the U.S. Department of Energy (DOE) and the State of Hawai‘i have established the Hawai‘i Clean Energy Initiative (HCEI) to facilitate the state's transition to 70% clean energy by 2030. As requested by the HCEI technical working groups, the authors provided analyses of 21 clean energy policy options being considered for recommendation to the 2010 Hawai‘i State Legislative Session. This report provides detailed analyses of the following policies to determine the impact they may have on ratepayers, businesses, and the state in terms of energy saved, clean energy generated, and the financial costs and benefits.

Table ES-1. Policy Options Analyzed for the HCEI Working Groups

Working Group	Policy Options Analyzed
Electricity	Amended Fossil Fuel Power Plant Restrictions
	Food and Energy Security Fund
	Extension of the Sunset of Act 221/215 for Clean Energy Projects
	Transmission Line Need and Prudence
	Rate Design
	Limiting the Biofuels Contribution to the RPS to 30%
End-Use Efficiency	Public Benefits Fund Increase
	Net-Zero Energy Capable Requirement for New Homes
	Photovoltaic -Ready Requirements
	Tax Incentives with Pass-Through Option for Nontaxable Entities for Green Buildings and Energy Efficiency Improvements
	Density Bonus
	Residential Energy Conservation Ordinance
	Lead by Example—Energy Efficient/Green Affordable Housing
	Lead by Example—30% More Energy Efficient New and Existing Public Buildings
Fuels	Expansion of the Biofuel Facility Tax Credit
	Lease of Public Lands for Renewable Energy
Transportation	Deployment of Electric Vehicle Infrastructure
	Electric Vehicle Charging Infrastructure Tax Credit
	Transitioning of Rental Cars to Plug-in Hybrid Electric Vehicles
	Income Tax Credits for Plug-in Hybrid Electric Vehicles and Electric Vehicles
	Subsidized Electricity for Electric Vehicles

The policy analyses were completed by the DOE Technical Assistance Team at the request of the HCEI working groups. The specific policies were chosen by the working groups to address barriers to clean energy development in Hawai‘i as identified by HCEI. Several of the policies were modified versions of policies that were recommended to but not adopted by the legislature in 2009. The analyses are intended to provide insight into the possible impacts, both qualitative and quantitative, that these policies may have in Hawai‘i based on the experience with these policies elsewhere to help inform the working groups' decision-making process when determining policy recommendations for the Hawai‘i 2010 legislative year (LY 2010). They were developed through an iterative process involving substantial input from the working group members, local stakeholders not officially involved in the HCEI process and local and national clean energy experts. As much as possible in this data-limited arena, Hawaiʻi-specific context has been incorporated into the analyses to better reflect the many unique aspects of energy use in the State of Hawaiʻi.

Each policy addresses a specific barrier to clean energy identified by the working group members. The costs and benefits of each policy are distributed differently among the various stakeholders affected by the potential policy. For some, such as the lead by example (LBE) policies considered by the End-Use Efficiency working group, the direct impacts and benefits fall on state agencies. Other policies, such as the Extension of the Sunset of Act 221/215, directly benefit the local high-tech industry. For many of these policies, the direct costs and benefits do not equally impact different stakeholders, and the costs may be predominantly up front while the benefits are reaped over multiple years. As such, it is critical for the working group members and policy makers to balance the state's clean energy goals with the costs and benefits of any policy that they choose to implement.

Note: The following are not DOE Technical Assistance Team policy recommendations, but analyses provided to inform the HCEI working groups of the possible impacts of the policies being considered by HCEI for recommendation to the 2010 Hawaiʻi State Legislative Session.

Table of Contents

List of Figures

List of Tables

Introduction

The Hawai‘i Clean Energy Initiative (HCEI), a unique partnership between the State of Hawai‘i and the U.S. Department of Energy (DOE), was launched in 2008 when the two parties signed a memorandum of understanding to establish a long-term partnership to drive a fundamental transformation of the state's energy use (SOH 2008). HCEI's goal is for 70% of Hawai‘i's energy needs to be met with clean energy[1] by 2030. HCEI is taking immediate steps to develop an environment that will facilitate the transition to achieve these progressive goals by addressing technical, policy, and market barriers. Over the past two years, HCEI efforts have included analyzing and recommending policies for adoption by the Hawai‘i State Legislature, conducting technical analyses, and convening stakeholders to grow support for a clean energy transition.

Four technical working groups were established to identify barriers to clean energy and methods to address these barriers. The four working groups, *Electricity*, *End-Use Efficiency*, *Fuels,* and *Transportation*, consist of local experts and stakeholders and are supplemented with national expertise provided by DOE, the National Renewable Energy Laboratory, Sandia National Laboratory, and representatives from leaders in the private sector. One of the tasks of the working groups is to promote the development of appropriate policies for implementation within the state to facilitate the transition to a clean energy economy for Hawai‘i by addressing the barriers to clean energy development and deployment. A fifth working group, *Integration*, reviews the work of the technical working groups and integrates their recommendations to create practical scenarios for moving Hawai‘i toward achieving 70% clean energy by 2030. Developing a favorable policy environment is a critical component in driving market transformation. As part of the support provided by DOE to HCEI, a variety of clean energy policies were analyzed to provide the working groups with insight into the possible impacts these policies would have in Hawai‘i. The analyses, presented in this report, informed the decision-making process of the working group members as they developed the list of HCEI policy recommendations to be presented to the state legislature. The analyses build on work from previous years as the working groups look toward developing policies to supplement the policies adopted during last year's legislative session.

Policy Analysis

While a multitude of policy options exist for any state interested in promoting clean energy, the policies analyzed herein were chosen by the HCEI working groups to address specific issues identified as critical barriers to renewable energy and energy efficiency in Hawai‘i by HCEI. The working groups recognize that some barriers are being addressed through venues outside of the legislative process, particularly through the Hawai‘i Public Utilities Commission (PUC), which currently has open dockets on feed-in-tariffs for renewable energy and decoupling. Therefore, the policies being considered do not constitute an exhaustive list of policy options to address all barriers to clean energy development in Hawai‘i. To continue to build a foundation for a clean energy transition, the working groups identified the policies listed in **Table ES-1** to achieve the following goals:

[1] "Clean energy" refers to renewable energy and reduced energy use from increased energy efficiency.

- Improve energy efficiency in the existing building stock and new construction
- Ready future residential construction for renewable energy installations and net-zero construction
- Build local capacity in the clean energy industry
- Encourage the adoption of renewable energy and energy efficiency through both financial and nonfinancial incentives
- Guide public entities to lead by example
- Facilitate private investment in clean energy in Hawaiʻi
- Revise existing incentives to focus more specifically on clean energy technologies.

There are a number of challenges in determining possible policy impacts, especially for Hawaiʻi. First, it is difficult, if not impossible, to attribute a specific amount of renewable energy development or savings due to energy efficiency improvements to the implementation of a particular policy because individual policies do not act in a vacuum. That is to say, state and local policy impacts are difficult to accurately assess. Secondly, as many of the policy options chosen for consideration by the working groups are innovative, there is little experience with them in other localities for use in analyzing impacts of the policy in action. Furthermore, due to the unique characteristics of an island economy, including the higher cost of living and much smaller size of the electricity grids, it is not always appropriate to apply mainland assumptions to the Hawaiʻi context. Lastly, as with all analyses, projecting long-term impacts involves many uncertainties because it is difficult to determine how the underlying assumptions will change over multiple years.

While recognizing these challenges and addressing them to the extent possible, the authors utilized information from existing literature and policy experience in other locations, as well as Hawaiʻi-specific data and information from various local stakeholders, to best determine the potential qualitative and, when possible, quantitative impacts for each of the policies being considered by the working groups for recommendation to the 2010 Hawaiʻi Legislature. The analyses were developed through an iterative process that involved multiple rounds of review by the working group members, who represent local stakeholders and local and national leaders in their respective fields. This process helped ensure that the analyses are as specific and relevant to the Hawaiʻi context as possible. The analyses are provided below, separated into sections based on the working group in which the policies were being considered.

Electricity

Electricity generation in Hawaiʻi is predominately through the use of fossil fuels. Of the electricity generated in the state, more than 90% of electric generation comes from fossil fuel sources (mainly petroleum and coal), with more than 75% generated using petroleum-fired power plants (EIA 2009c). The state's dependency on petroleum results in volatile and extremely high electricity prices when compared to the mainland average, as the price of electricity is highly dependent on the price of petroleum. The average residential electricity price in Hawaiʻi in June of 2009 was 22.20 cents per kilowatt hour (kWh), nearly double the average price in the country (EIA 2009c). Each county is served by a separate utility and, due to the costs associated with generation and distribution, the residential electricity rates vary greatly for each county, with current rates as high as 34 cents/kWh on Lanaʻi (**Table 1**).

Table 1. Utility Companies and Residential Rates in Hawaiʻi

County	Utility	Residential Rate as of October 2009 (cents/kWh)
Honolulu	Hawaiian Electric Company (HECO)	23.10
Hawaiʻi	Hawaii Electric Light Company (HELCO)	32.55
Maui[2]	Maui Electric Company (MECO)	Maui - 26.59 Molokaʻi – 31.60 Lanaʻi – 33.62
Kauaʻi	Kauai Island Utility Cooperative (KIUC)	32.07
Sources: HECO 2009, KIUC 2009		

The following policies were selected by the Electricity working group members in early 2009 as possible policy options for addressing barriers to clean energy development in Hawaiʻi to break the state's dependency on fossil fuel for electric generation. These policies were chosen to supplement existing clean energy policies, many of which have been adopted or considered based on the HCEI effort over the last two years, including a feed-in tariff and a 40% renewable portfolio standard (RPS) with a separate 30% energy efficiency goal for utilities, among others. The impact analyses below were completed over several months and provided to the working group members to aid them in determining which policies would best achieve the HCEI goals and therefore be included in their recommendations to the Hawaiʻi Legislature for adoption in LY 2010.

Policy Option: Amended Fossil Fuel Power Plant Restrictions

Summary

As Hawaiʻi looks to reduce its dependence on fossil fuels and move to 70% clean energy for its electricity sector, one option is to direct energy development away from fossil-fueled plants, thus promoting that all new generation be from renewable sources. Various options exist, ranging from allowing new fossil fuel plant construction only under certain circumstances, such as once the utility has met its RPS goals, to banning all new plants from being fossil fueled. The impacts to the ratepayers, state, and utility are undetermined, as there is currently no other jurisdiction that has implemented a similar policy.

Policy Definition/Options

There are multiple options for how to structure restrictions on new fossil fuel plants in Hawaiʻi. Any provision would likely be inserted into §269-92(e) (Hawaiʻi Revised Statutes 2008a) and apply to all plants, not just utility-owned plants. It is important to cover all plants to avoid a potential loophole that would allow independent power producers to capitalize on the ban on utilities by investing in cheaper fossil fuel plants instead of renewable energy technologies.

It is important to note that oil-fired power plants can generally burn biofuels such as biodiesel with minimal changes to the equipment, and vice versa. If a unit were constructed with the intent of burning only biofuel, it might be difficult to prohibit the use of fossil fuel in the unit in later years should compelling cost or supply chain considerations exist. Any new policy should have a

[2] MECO serves the islands of Maui, Molokaʻi and Lanaʻi. Each island has a different residential electricity rate.

threshold in terms of hours per year so that emergency backup generators are exempted, but they can't be substantial fuel consumers. The policy options below assume an RPS is in place.

Option 1: Prohibit new fossil fuel-only plants except for small distributed generation, defined as < 2 megawatts (MW).

- ***Pros:*** Provides a strong message that the movement to clean energy is irreversible. All energy stakeholders would be significantly motivated to develop solutions to foreseeable technical and economic challenges associated with clean energy development. Provides flexibility for generator needs for institutions or to provide assistance in case of a disaster.
- ***Cons:*** Approach is inflexible and limits the state's ability to secure power needed to address reliability and/or cost-related consequences of inadequate dispatchable power. May also create unintended consequences, such as a disincentive for utilities to retire inefficient, outmoded plants.

Option 2: Prohibition of all new fossil fuel plant construction. Facilities cofiring biofuel would have to have defined off-take agreements with biofuel providers for a certain level of capacity before the PUC would approve construction.

- ***Pros:*** Same as above, except with less flexibility.
- ***Cons:*** Same as above.

Option 3: Allow new fossil fuel plant construction, but only if the utility has exceeded the RPS and the proposed capacity addition would not place the utility into noncompliance.

- ***Pros:*** Provides flexibility, allowing for construction of fossil plants that support clearly defined public interest objectives.
- ***Cons:*** Provides limited incentive to exceed the RPS. Only provides benchmarks and guidance every five years, since the RPS is limited to every five years—and is currently written to last just through 2030. This policy would likely not trigger action until 2016 or 2017, since the state would need to wait to assess 2015 RPS compliance.

Option 4: Allow new fossil fuel plant construction only to replace older, inefficient units, so long as new units result in generation capacity requiring lower levels of fossil fuel input.

- ***Pros:*** Encourages retirement of older assets in favor of more efficient ones able to operate at higher capacities with lower fuel input. Creates an incentive to upgrade plants and use more efficient technology.
- ***Cons:*** May create an incentive to retrofit marginally inefficient units rather than providing increased levels of renewable generation. This problem can be addressed by requiring a minimum level of efficiency improvement.

What Other Locations Are Doing This?

While other countries are considering such policies, no jurisdictions have announced an outright ban on fossil fuel generation.

Costs and Benefits

See above for pros and cons. A cost/rate impact analysis has not yet been undertaken. It is also important to note that the availability of a stable, long-term supply of feedstock for biofuels could have grid stability or cost impacts as well, as noted in the cons section under Option 1.

How Does This Fit the HCEI Goals?

HCEI seeks to promote renewable energy generation by establishing the policy and regulatory framework to move the state away from fossil fuels. In the 2009 legislative session, a fossil fuel ban was proposed but did not make it through the legislature. The text of that bill (SB1671) is shown below for reference, as well as a summary of the KIUC testimony regarding the bill (Hawai‘i Senate 2009b).

> **§342B-Fossil Fuel Electricity Generating Facilities**
>
> (a) Effective July 1, 2009, no new covered source that is owned or operated by an electricity-generating public utility, as defined in section 269-1, with a rated capacity of more than two megawatts shall be permitted to generate electricity from fossil fuel sources; provided that electric utility cooperative associations shall be exempt from the requirements of this subsection until July 1, 2015.
>
> (b) Effective July 1, 2009, no covered source that is owned or operated by an electricity-generating public utility, as defined in section 269-1, with a rated capacity of more than two megawatts and existing on July 1, 2009, except for an electric utility cooperative association, shall be modified in any manner that allows it to use more fossil fuel as a source of electricity generation than is allowed under its permit as of July 1, 2009. No covered source that is owned or operated by an electric utility cooperative association with a rated capacity of more than two megawatts and existing on July 1, 2009 shall be modified in any manner that allows it to use more fossil fuel as a source of electricity generation than is allowed under its permit as of July 1, 2015.

Summary of the KIUC Testimony Regarding SB1671 (Yamani 2009)

KIUC supports the bill as it 1) prevents the construction of new electricity generation facilities that utilize ***SOLELY*** fossil fuels as their energy source and 2) enables PUC with the discretion to lift the prohibition under extraordinary circumstances. This flexibility allows utilities such as KIUC to work towards increasing use of renewable energy sources while still being able to ensure an adequate supply of electricity to its members/customers at an affordable rate. As it stands, this bill does not contain an absolute prohibition of construction of new fossil fuel generation facilities.

Key KIUC-requested changes to the bill include:

- Additional definitions for extraordinary circumstances
- Definition of new generation units as those without air permits as of 7/1/09
- Exemptions if
  - a fossil fueled facility has a renewable fuel procurement plan that allows transition to non-fossil fuel within the timeframe of the requirements in the bill
  - technical limitations require fossil fuels for start-up generation.

KIUC has taken steps to permit the use of biodiesel in each of its 13 generating units. A cost-effective sustainable source of biodiesel is required, and key is the ability to have a multi-fuel mix which enables KIUC to deal with fuel supply and economic changes over which they have no control.

Next Steps

There is currently little information on the effectiveness and impacts associated with this type of policy. If Hawai'i or any other state or country adopts a similar policy, data should be gathered from those regions to provide insight into the possible impacts and externalities that this policy may have.

Policy Option: Food and Energy Security Fund

Summary

HB1271, proposed during Hawai'i's 2009 legislative session, was designed to implement a tax on every barrel of petroleum sold by a distributor in Hawai'i. The bill was vetoed by Gov. Linda Lingle, partially due to the potential impacts it would have on the local airline industry as well as residents with lower incomes (Borreca 2009). The following evaluates a similar proposal to establish a tax to create a Food and Energy Security Fund, but limit the scope of the tax to only those barrels of petroleum used for electricity generation purposes. Maintaining the same tax level as was proposed in HB1271, $1.05 per barrel, but applying it only to petroleum used for electricity generation would generate more than $22 million for the Food and Energy Security Fund. Conversely, if the tax were set to maintain the same level of funding as proposed under HB1271, it would need to be set at $1.70 per barrel.

Policy Definition

The proposed policy would levy an environmental response, energy, and food security tax (per barrel of petroleum product sold by a distributor to a retail agent or end user, other than a refiner) on petroleum used for the production of electricity and for ground transportation. The tax would be levied on the distributor of the product, not the end user.[3] Hawai'i has a barrel tax of 5 cents per barrel at present. The policy option explored in this paper would be a revision to that policy.

Methodology and Assumptions

This section provides an analysis of a scenario in which a tax of $1.05 per barrel of oil is imposed for oil used for either electricity generation or ground transportation purposes, similar to the policy that would have resulted from HB1271, but excluding all fuel used for aviation purposes.

The assumptions necessary to calculate these figures are listed in **Table 2**.

Table 2. Food and Energy Security Fund Assumptions

Assumption	Value[4]	Source
Original level of tax as proposed in HB1271	$1.05	Hawai'i Senate 2009a
Overall level of oil demand (2010)	39.3 M barrels (21.1 M generation, 13.1 M barrels highway transportation, 5.1 M barrels nonhighway diesel usage)	HECO 2008; MECO 2007; HELCO 2007; Black & Veatch 2008; DBEDT 2007; DBEDT 2007 (liquid fuel demand figures)
Average heat rate per BBL oil in Hawai'i	11,000 BTU	Hawai'i heat rate per BBL oil (HECO 2008; DBEDT 2007)
Average household energy use per year	8,000 kWh	DBEDT 2007
Average commercial energy use per year	230,000 kWh	DBEDT 2007
Annual Hawai'i state population growth rate	1.02%	DBEDT 2007
Ratio of cars to people	0.9	DBEDT 2007

Costs and Benefits

Under the scenario outlined above, the total level of revenue raised from the tax is listed in **Table 3**.

[3] Structuring the policy so that distributors are taxed directly rather than end users is unlikely to make much difference in the end allocation of the tax, as fuel distributors are likely to pass through 100% of this cost to the end user. However, from an administrative standpoint, taxing the distributors is easier, as there are fewer distributors to monitor and collect from. As the original 5-cent barrel tax was designed this way, there is no obvious reason to propose a change to this feature.

[4] Values are in 2009 dollars (unadjusted).

Table 3. Food and Energy Security Fund Tax Scenarios

Scenario		Level of Tax	Total Revenue Raised
HB1271	Tax set to HB1271 level with all barrels taxed (excluding aviation fuel)	$1.05	$41.3 M

Further analysis of this scenario indicates that the tax would result in a rate premium of 0.2 cents per kWh. Correspondingly, the average increase in cost of electricity per household would be approximately $15.38 (an increase of 1%). For the commercial sector, the average increase in the annual cost of electricity per business would be $444 (an increase of 1%).

It is important to note that slightly more of this tax would be passed through to taxpayers via the electrical rate system, as opposed to at the filling station pump. This is because slightly more of the oil used currently goes to generation as opposed to fuel used for nonaviation transport (HECO 2008; MECO 2007; HELCO 2007; Black & Veatch 2008; DBEDT 2007).

Revenue Allocation

Part of the overall benefit of the tax would be that it could provide a steady source of revenue for state programs designed to lower the need for petroleum imports as well as mitigate the negative environmental effects that result from the burning of fossil fuels. If the revenues were allocated in the same way as proposed in HB1271, the revenue generated by the tax will be allocated as follows (Hawai‘i Senate 2009a):

- *5% to an Environmental Response Fund ($2.07 M)*: For oil spill planning, prevention and preparedness, education, research, training, removal, and remediation. For direct support of county used-oil recycling programs, and for support of environmental protection programs (including energy conservation, renewable energy development, maintenance of air and water quality, reduction of global warming emissions and hazardous solid waste, and a soil remediation facility for the state).
- *52% to an Energy Security Special Fund ($21.48 M)*: To be administered by the Department of Business, Economic Development and Tourism (DBEDT) in support of HCEI, the Renewable Energy Facilitator’s Office, the Greenhouse Gas Emissions Task Force, and the Climate Change Task Force, and to provide grants-in-aid to localities to help meet the goals of HCEI.
- *10% to an Energy Systems Development Special Fund ($4.13 M)*: Funds the Hawaii Natural Energy Institute (HNEI) at the University of Hawaii for the development of renewable energy and energy efficiency technologies.
- *33% to an Agriculture Development and Food Security Special Fund ($13.63 M)*: Funds activities intended to increase agricultural production or processing that may lead to reduced importation of food, fodder, or feed from outside the state.

These allocations were a result of lengthy negotiation in the state over HB1271 but could be subsequently changed if other issues were raised or additional needs were identified.

One other important note is that if the tax functions as proposed and clean energy generation increases, the amount of revenues that it will generate to fund state programs will fall off over time, possibly in an unpredictable manner. This would mean that budgeting would have to be done carefully to generate maximum impact in the short term without locking in long-term financial commitments that may rely on these funds as an important source of revenue.

Implementation

It is important to note that this tax would be a modification of the existing tax that is currently on the books. It would be passed through as the current 5-cent petroleum tax is: from fuel distributors to utilities and from utilities to ratepayers. While the 5-cent petroleum tax is not currently listed as a separate cost on the standard Hawaiʻi ratepayer's utility bill, it may be beneficial to identify this charge separately on the customer's bill as a "Food and Energy Security Fund" fee so that customers understand that the utility is administering the charge on behalf of the state rather than simply raising rates.

To prevent reallocation of this funding, the policy language should stipulate that this be set up as a special fund with long-term protection that ensures it would not be raided in future years for an alternative purpose. It may also be appropriate to include a provision stating that monies are additive and not substitutable, so that the funding is used to support additional programs not already funded by the state. Based on the state's goals, incorporating a sunset date of 2030 for the tax would provide funding stability for a clean energy transition while preventing it from being never-ending.

How Does This Fit the HCEI Goals?

This policy would increase the price of electricity from petroleum products, which would essentially make renewable resources more competitive compared to petroleum-based electricity. In addition, the state requires resources to design and implement programs; this policy would provide a source of revenue for renewable energy and energy efficiency programs, as well as technology development activities.

Next Steps

Further research is necessary to determine how the future flow of funding would be impacted by this policy. This is due to the fact that the policy, if successful, would reduce the barrels of oil being consumed in the state from the business-as-usual scenario, potentially resulting in less funding for the proposed programs in future years unless other sources of revenue are found to offset the decline of the tax inflows over time.

Policy Option: Extension of the Sunset of Act 221/215 (High-Tech Industry Tax Benefits) for Clean Energy Projects

Summary/Background

Act 221 created tax benefits for high-technology industries in Hawaiʻi for taxable years 2001 through 2005 (Hawaiʻi House 2004). This act makes three key provisions regarding tax credits for the development of high-technology industries in the state. These credits include the following:

1. Creation of a State Private Investment Fund

   Created with the mission to increase energy project and venture capital and to expand the growth of commerce in the state, the fund is versatile, with the ability to provide a variety of financial services, including loan guarantees, direct loans, and equity contributions to authorized technologies.

The fund also has been given authority to provide up to $36 million in tax credits to eligible companies. This authority extends until July 1, 2030.

NOTE: While the scope and duration of this fund are extensive, it is unclear whether funding was ever allocated to seed it. No limits on the types of technology that are eligible for funding/tax credits are put forth in the act itself, so this could be used as a possible vehicle to promote investment in clean energy technologies within the state, although it would not be specifically dedicated to clean energy technology unless its language is modified.

Specific Features of the State Private Investment Fund

- This fund would possess the ability to make equity investments, provide direct loans to, or provide loan guarantees to mobilize equity and near-equity capital for investment in such a manner that will result in a significant potential to diversify and stabilize the economy of the state.
- This fund would also be authorized up to $36 million worth of tax credits to allocate as it sees fit to eligible tax-paying companies.
- Tax credits transferred by the corporation shall not be exercisable before July 1, 2005, nor after July 1, 2030.
- The corporation shall limit the transfer of tax credits that may be claimed and used to reduce taxes owed for one fiscal year (including any tax credits that are carried over by a taxpayer from a prior fiscal year and used to reduce taxes otherwise imposed in the current fiscal year to not more than an aggregate total of $12 million per fiscal year.
- If the tax credits exceed the taxpayer's income tax liability for any taxable year, or for any other reason is not claimed by a taxpayer in whole or in part in any taxable year, the excess of the tax credit over liability, or the amount of the unclaimed tax credit, as the case may be, may be carried over and used as a credit against the taxpayer's income tax liability in any subsequent year until exhausted.
- This fund would be capitalized through the creation of a revolving fund for the corporation to be designated as the "capital formation revolving fund." The following shall be deposited into the capital formation revolving fund: all moneys (1) appropriated by the legislature, (2) received as repayment of loans, (3) earned on investments,(4) received pursuant to a venture agreement, (5) received as royalties, (6) received as premiums or fees charged by the corporation, or (7) otherwise received by the corporation.

2. Expansion of the High-Tech Business Tax Credit

This tax credit is designed to lower the overall cost of operating a high-tech business or research center in Hawai‘i by providing tax credits based on a sliding scale over a 5-year period postinvestment. The tax is capped at an upper bound of $700,000 in year one, declining to an upper bound of $200,000 in year five, provided all conditions for eligibility are met over the full time period.

Act 215 was enacted in 2004 and extended the benefits of Act 221 until December 31, 2010 (Hawaiʻi House 2004). The policy being considered by HCEI would extend the benefits of the tax credit out to December 31, 2015. This policy also intends to limit the future credits specifically to clean energy technologies, decreasing the scope from its more general previous one. The final year to register for the policy would be 2015, with 2019 being the final year one would be eligible to collect a credit.

Specific Features of the High-Tech Business Tax Credit

- §235-110.9, HRS, provided a 10% nonrefundable income tax credit to encourage investments in qualified high-technology businesses (QHTB) up to a maximum allowed credit of $500,000 per year per investor.
- Section 9 increases the total possible credit amount to $2 million graduated over five years (beginning at 35% of total tax liability and declining to 10% in year five) from the date of investment. The credit is capped at varying amounts ($700,000 in the year the investment is made to $200,000 in the last year). Thus, to claim the maximum possible credit, the investor would need a total tax liability per year of approximately $2 million.
- To qualify as a QHTB:
  1. More than 50% of total business activities are qualified research; and provided further that the business conducts more than 75% of its qualified research in the state; or
  2. More than 75% of its gross income is derived from qualified research; and provided further that this income is received from
     a. Products sold from, manufactured in, or produced in the state; or
     b. Services performed in the state.

3. Expansion of Research and Development Income Tax Credit

The state's R&D Income Tax Credit policy is designed to supplement an existing federal research and development tax credit (specifically Section 41 of the Internal Revenue Code); the combined tax credit would be more valuable to investors in the state.

It is a percentage-based credit, focused originally on providing a credit for incremental increases in research funding in state, now expanded to be a percentage of all research investment conducted in state.

Like the previous credit for high-technology investment, the policy being proposed here would extend this credit out from December 31, 2010, to December 31, 2015, and also limit it to clean energy technologies moving forward.

Specific Features of the R&D Income Tax Credit

- The caps from section 9 are maintained, specifically: $700,000; in the first year following the year in which the investment was made, $500,000; in the second year following the year in which the investment was made, $400,000; in the third year following the year in which the investment was made, $200,000; and in the fourth year following the year in which the investment was made, $200,000.
- Section 10 expands §235-110.91, HRS, which provides a 20% refundable state research and development tax credit, similar to the federal research and development tax credit. The state tax credit, under prior law, was based on increases in research expenses from the previous year.

Policy Definition

An option for modifying the existing policy so as to promote clean energy development in Hawaiʻi would be to make the tax benefits under Act 215 2004 in section §235-110.51 (Hawaiʻi House 2004) available only to clean energy technologies and extend the sunset to December 31, 2015.

Methodology and Assumptions

Because these tax benefits would apply to the types of companies that HCEI is looking to attract to or within Hawaiʻi, to limit the cost to the taxpayers, it is important for the policy to include an appropriate cap for program spending. Clearly stating the cap and providing updated information on remaining available funding will allow for interested businesses to incorporate the incentive into their financial planning model.

To estimate the potential bounds of associated costs, this analysis looks at two adoption scenarios, one in which credit demand is constant, and one in which credit demand increases based on historical trends. These scenarios reflect the actual impacts of the legacy High-Technology Business Tax Credit policy.

Costs and Benefits

Costs

According to the 2008 report on the credit by the Hawaiʻi Department of Taxation, the estimated credits claimed in 2006 total $105.4 million (Hawaiʻi Department of Taxation 2008). Of this total, 23% of the applications received were from "Non-Fossil Energy" companies. Thus, the estimated cost to the state for the year 2007, just from energy projects claiming this credit alone, is approximately $23 million. **Figure 1** below summarizes what the projected cost to the state would be from 2011 through 2015 should the credit be extended under two scenarios: one in which the demand for the credit remains constant from its 2007 levels, and one in which the demand for the credit continues to grow at the average rate that it did over the 2002–2006 period (estimated 49% growth per annum).

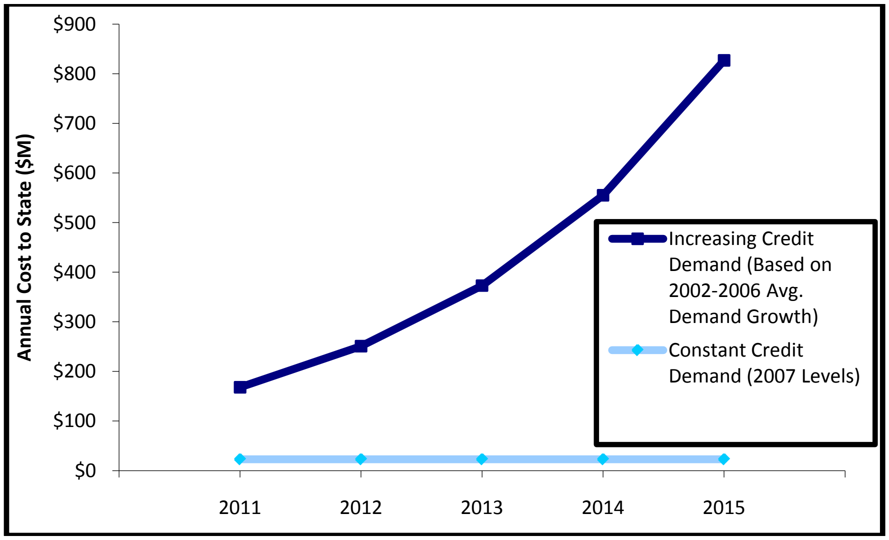


Figure 1. Potential cost to the state to extend the High-Tech Business Tax Credit through 2015 for energy projects

This suggests that, based on recent growth trends, it might be advisable to cap the annual available credits at a level within the state's budget requirements.

Benefits

While an upper bound is provided on the amount of credit that can be claimed per project, no limit is placed on the overall size of the project that may be eligible for the credit. This makes any projections for the overall benefit to be derived from such a policy difficult to justify, as the net benefit from a 50 MW solar project eligible for the upper limit on the tax credit would differ from the net benefit of a 500 MW project of the same type eligible for the upper bound of the credit.

However, due to the clause in the credit mandating either that 75% of all research conducted be kept within state borders or that 75% of all project income be from the production, manufacturing, or service provision within state borders, it is likely that jobs will be maintained or created in Hawai‘i and that revenues will be generated for the state through multiplier effects on income generated.

How Does This Fit the HCEI Goals?

All of these tax benefits would apply to the types of companies that are needed to fulfill Hawai‘i's RPS and Energy Efficiency Portfolio Standard. Encouraging clean energy businesses to invest in the state will help grow the local economy and aid Hawai‘i in achieving its clean energy goals. To ensure that the extension of the tax credit applies solely to clean energy businesses, the language in the act may need to be modified to define what clean energy technologies would be considered "high-tech," and thus eligible for the credit under this type of policy.

Next Steps

Determining a more clear definition of project eligibility under this policy would allow for a greater understanding of the benefits and costs that this policy would have for the state.

Another possible alternative to promoting investment in clean technology involves the utilization of the proposed venture capital fund. First, the language in the act provides for the distribution of tax credits longer term, as it does not sunset until July 1, 2030, thus matching the time frame of the HCEI goals. Second, the act specifies no limitations on the types of technology in which the fund could invest. Finally, the language in the act provides the state with several other financing options for the promotion of technology investments, including loan guarantees, direct loans, and equity investments, provided that funds could be obtained from the state to seed the fund. HCEI will seek working group feedback regarding whether this fund would serve the same industry need as Act 215 if it were used as a funding vehicle.

Policy Option: Transmission Line Need and Prudence

Note: This policy option was dropped from the working group's list of policy options for consideration early in the analysis process because the working group decided that the Renewable Energy Zone discussion was too immature in Hawai'i to consider this policy for this year. Therefore, this analysis is not fully formulated. The background and initial analysis are provided below with suggestions for next steps should more in-depth analysis be undertaken in the future.

Summary

Establishing Renewable Energy Zones (REZs) with a presumption of need facilitates the development of renewable energy in a REZ by removing the barrier associated with the PUC's process for determining whether a transmission line to the area is necessary. This policy leads to the construction of necessary infrastructure to the REZs so that the renewable energy generated can be delivered to the grid.

Policy Definition/Options

Statutory presumption of need: Act 155 of the 2009 session established a REZ process, but it stopped short of creating a presumption of need for transmission to designated zones (Hawai'i Senate 2009d). This policy could include a requirement that a certain percentage of the capacity of the line carry renewable energy on an annual basis. The prudence proceeding[5] for transmission has two parts:

1. *Is the line needed?* If the legislature created a statutory presumption of need for transmission that serves renewable energy in REZs, the PUC would be able to answer this in the affirmative.
2. *Was it built for the right cost?* Even if a statutory presumption of need were established, the PUC would still need to consider this question on a case-by-case basis. However, the legislative language could give some direction. The question is not whether the line was built to minimum cost, but whether the line was built to maximum effect. Therefore, it is a reasonable investment of ratepayer funds for these lines to do such engineering and routing, within reasonable cost boundaries, that address community siting concerns, land use concerns, etc. Metrics of success should be not only cost, but also community support, land use issues, expediency of building the line, and capacity of the infrastructure to accommodate future increases in clean energy.

---

[5] PUC process to determine whether a given investment or expenditure is justified

What Other Locations Are Doing This?

The Texas Legislature granted that facilities built to serve its Competitive Renewable Energy Zones should be considered used and useful, and are prudent and includable in the rate base, regardless of the extent of the utility's actual use of the facilities (Texas Utilities Code 2009). No other locations have currently established a statutory presumption of need, although it is being considered on the mainland, specifically in the West.

Costs and Benefits

One possible cost of this policy is the potential risk of building transmission that does not become immediately used and useful, therefore adding cost to the system. However, delays to the use and usefulness of new transmission capacity for a REZ are entirely appropriate. The lines will be sized to serve numerous developers over a long period, rather than a single plant built by the utility. This excess transmission will have impact and value for generations. Delay should not be viewed as imprudent, and there should be no delay-related penalties placed on the utility in return of or on the transmission investment.

The benefit of this policy would be removing a key roadblock for utility interconnection with renewable energy, therefore increasing developer interest in renewable energy. The policy creates certainty for developers, the utility, and the community on key questions, including where renewable development will happen, how big it will be, and when it will occur. It assures renewable project developers and financiers that transmission to this zone won't be an impediment to development.

How Does This Fit the HCEI Goals?

For Hawai'i to achieve its clean energy goals, success depends largely on an infrastructure build-out to support the interconnection of renewable energy. Statutory presumption of need could help streamline the approval and cost-recovery process for transmission.

The statutory presumption of need for transmission would likely be added to the current language on REZs that is, in effect, copied here from the Hawai‘i Revised Statutes HB1464, which became Act 155 (Hawai‘i Senate 2009d):

> (12) Formulate a systematic process, including the development of requirements, to identify geographic areas that contain renewable energy resource potential that may be developed in a cost-effective and environmentally benign manner and designate these areas as renewable energy zones;
>
> (13) Develop and recommend incentive plans and programs to encourage the development of renewable energy resource projects within the renewable energy zones;
>
> (14) Assist public and private agencies in identifying the utility transmission projects or infrastructure that are required to accommodate and facilitate the development of renewable energy resources;
>
> (15) Assist public and private agencies, in coordination with the department of budget and finance, in accessing use of special purpose revenue bonds to finance the engineering, design, and construction of transmission projects and infrastructure that are deemed critical to the development of renewable energy resources;
>
> (16) Develop the criteria or requirements for identifying and qualifying specific transmission projects or infrastructure that are critical to the development of renewable energy resources and for which the energy resources coordinator shall assist in accessing the use of special purpose revenue bonds to finance

Next Steps

Further analysis of the relevance of this policy in Hawai‘i based on barriers to developers and the direct cost impacts on developers that this type of policy would have in the state is necessary to better understand this policy’s applicability in driving clean energy development in Hawai‘i. HCEI is currently determining how this policy would facilitate and/or interfere with the HCEI strategy for REZ designation and renewable energy deployment.

Policy Option: Rate Design

This policy option was dropped from the working group’s list of policy options for consideration early in the analysis process for three reasons:

1. Any action must be coordinated with the Hawaiian Electric Company (HECO) schedule and plan—which is to delay the rate case until 2010 given delays in advanced metering infrastructure and smart grid, which are prerequisites to dynamic rates—as well as Kauai Island Utility Cooperative (KIUC).
2. The utilities do not currently have CIS (customer information system), which they need in order to institute automatic billing of dynamic rates. Right now, billing of the limited number of customers on time-of-use (TOU) rates is done manually.

3. The PUC has a number of other important, time-critical tasks at hand, and the group thinks it is more effective for the broad suite of HCEI goals for the PUC to focus solely on existing initiatives this year.

The background and initial analysis is provided below with suggestions for next steps should more in-depth analysis be undertaken in the future.

Summary
HCEI requested that the DOE technical assistance team provide an overview of rate design options that may increase development of clean energy. This section identifies and defines rate structures used in different jurisdictions.

1. *TOU and dynamic rates*[6]*:* These rates encourage residential and commercial customers to shift their electricity use to off-peak times. They are also enablers of pricing schemes for plug-in hybrid electric vehicles (PHEVs) and pure electric vehicles (EVs).
    a. TOU rates: Rates vary by time of day, day of week, and season; rates are higher during peak periods, and the rates and time periods are set in advance.
    b. Dynamic pricing (e.g., real-time pricing, critical-peak pricing): These have some degree of uncertainty and flexibility regarding the time certain prices are in effect and the price itself. Critical peak prices entail a much higher rate for a short period of time (e.g., one or two hours), and the times that these periods of high prices are in effect may not be known until the day before.

    Such rates require advanced meters; therefore, Hawai‘i's utilities must first install advanced meters as a prerequisite to TOU and dynamic rates. In the HECO energy agreement of 2008, the Hawaiian Electric Company utilities committed to file an application to install advanced meters by December 31, 2008, and to implement the meters as quickly as possible upon approval (HECO and State of Hawai‘i 2008). The Hawaiian Electric companies also committed to complete a program evaluation by December 31, 2009. Both actions, however, have been delayed.
2. Inclining block pricing:[7] Customers are charged one rate up to a certain threshold, and a higher rate for each unit of energy used above that threshold (e.g., 500 kWh/month for residential customers). This pricing strategy has been widely applied in the water sector (Hledik 2008).

[6] TOU and dynamic rates are most useful when there is a large variation in short run marginal costs of electricity generation and customers are assisted in installing automated systems to adjust demand based on the rate. Until substantial quantities of renewable power are online, Hawai‘i is unlikely to have large variations in the short run marginal costs of electric generation. As more renewable energy is brought online, further analysis of the impacts of these types of rate design options will help determine applicability and options for implementation.
[7] Inclining block pricing is a very effective tool for providing rate relief to people that use small quantities of power, while limiting the overall cost of the program and maintaining appropriate incentives for efficiency on the margin.

Time-of-use or dynamic pricing mechanisms can be instituted alongside block rates; these pricing schemes can be complementary tools to, respectively, shift demand from peak to off-peak times and encourage conservation.

Policies in this arena should be closely coordinated with the activities of the Hawaiian Electric companies and KIUC because utility analysis and buy-in are crucial for successful ratemaking and because the utilities' hardware and technical systems (e.g., meters, billing systems) must be able to handle dynamic electricity rates.

Policy Definition/Options

One policy consideration is to ask the PUC to explore the various rate options described above. One of the main questions around such a policy for Hawai‘i is whether or not statutory language is needed to prompt the PUC into investigating such options, or whether it is more appropriate to let the current utility/PUC process prevail.

What Other Locations Are Implementing Time-Based Rates?

Many utilities have piloted or fully implemented time-based pricing or inclining block rates, for example:

- *California:* Has TOU pricing in conjunction with inclining block pricing. The California PUC made dynamic pricing the default rate offering for all customer classes, except residential classes, in July 2008. The state has a host of dynamic, TOU, and block pricing programs, as well as numerous discounts and "smart rates" for demand response participants (CPUC 2008; PG&E 2009; SCE 2009).
- *Washington:* Had an unsuccessful pilot program for TOU pricing in 2002. Because the program had only a very small peak-to-off-peak price differential, even consumers who shifted their load significantly saw limited savings and chose to exit the program (EERE/DOE 2002).
- *British Columbia:* Revised its inclining block rate on April 1, 2009, to be 5.91 cents (Step 1) per kWh for the first 1,350 kWh used by each residential ratepayer over a two-month billing period. Above that level of electricity use, residential customers will pay 8.27 cents (Step 2) for each kWh of electricity (British Columbia Hydro 2009).
- *Massachusetts:* Is considering inclining block pricing. In July 2009, the Western Massachusetts Electric Company proposed residential inclining block rates at the level of 8 cents up to 300 kWh per month and 20 cents above 300 kWh per month (Massachusetts Department of Public Utilities 2009).

Costs and Benefits

To fully understand the costs and benefits in Hawai‘i, the utilities and the PUC would have to complete an assessment specific to Hawai‘i's load curve, rate structure, and customer demographic. Other jurisdictions have a wealth of data from their experiences. For example:

- Time-based pricing in other parts of the country have reduced residential peak load from 5% to 55%; the degree of reduction depends on program design (e.g., whether there is a significant price difference between on-peak and off-peak prices) and the type of technology deployed in conjunction with the pricing scheme (Faruqui and Sergici 2009).

- Another benefit may arise from the shifting of price risk from the utility to the consumer in the case of *real-time* pricing, which could potentially enable utilities to reduce rates by the amount of the risk premium. This value is estimated by the Federal Energy Regulatory Commission (FERC) to be about 6%. However, this could also result in much higher bills for consumers who do not manage their energy use in accordance with the real-time pricing. If real-time pricing were adopted, Hawai‘i may also want to consider adopting consumer protections (FERC 2009).
- Studies and pilots have shown a significant customer response to inclining block rates. Customers who use less than the monthly average would see bill savings of 50% to 60% from inclining block rates, while larger customers would see increases of 20% to 30% unless they curtailed their consumption (Faruqui and Sergici 2008).
- The bulk of the cost of implementing TOU rates and dynamic pricing comes from the metering requirement; meters cost $110 to $130, with additional costs for installation and utility data systems to handle the advanced meters (George and Wiebe 2007).

How Does This Fit the HCEI Goals?
TOU rates and dynamic pricing have been shown to drive demand response, and as wind and other nighttime renewables increase, pushing load from daytime to nighttime has the potential to reduce curtailment of these clean energy resources. They can also be important enablers for PHEVs. Inclining block rates can drive energy efficiency. All of these can play a role in reducing and shifting demand so as to help Hawai‘i achieve the HCEI goals.

Even without this policy in place, the Hawaiian Electric companies have agreed to take the first few steps down the road to allowing the implementation of truly dynamic pricing, per the 2008 Framework Agreement between the state, HECO, and the Consumer Advocate (HECO and State of Hawai‘i 2008).

§342B-Fossil Fuel Electricity Generating Facilities

(a) Effective July 1, 2009, no new covered source that is owned or operated by an electricity-generating public utility, as defined in section 269-1, with a rated capacity of more than two megawatts shall be permitted to generate electricity from fossil fuel sources; provided that electric utility cooperative associations shall be exempt from the requirements of this subsection until July 1, 2015.

(b) Effective July 1, 2009, no covered source that is owned or operated by an electricity-generating public utility, as defined in section 269-1, with a rated capacity of more than two megawatts and existing on July 1, 2009, except for an electric utility cooperative association, shall be modified in any manner that allows it to use more fossil fuel as a source of electricity generation than is allowed under its permit as of July 1, 2009. No covered source that is owned or operated by an electric utility cooperative association with a rated capacity of more than two megawatts and existing on July 1, 2009 shall be modified in any manner that allows it to use more fossil fuel as a source of electricity generation than is allowed under its permit as of July 1, 2015.

Next Steps
Monitoring the impacts of HECO's pilot advanced meters program will provide further insight into the opportunities and barriers to progressive rate design options in Hawai‘i, informing any future decisions on TOU, inclining block rates, and advanced metering deployment.

Policy Option: Limiting the Biofuels Contribution to the RPS to 30%

Summary
The October 2008 Framework Agreement states that "through 2015 no more than 30% of the Hawaiian Electric utilities' total RPS may come from imported biofuels consumed in utility-owned units" (HECO and State of Hawai‘i 2008). The working group, interested in ensuring that sufficient biofuel resources are available for both electricity generation and the transportation sector, asked for the following augmentations to the RPS to be analyzed:

1. Remove the 2015 sunset provision and continue the 30% cap through 2030 (the last RPS goal currently in statute).
2. Make the 30% limit apply to all biofuels, including biofuels produced in state.

A cap on the amount of biofuels would signal to producers of other types of clean energy that Hawai‘i is looking for a portfolio of energy technologies to be deployed by 2030. This would also have a major impact on the ability of the transportation sector to reduce its dependence on imported fuels and to meet the goals of HCEI, by making more biofuel available to that sector.

Thus, these two policies would send a market signal to guide the development of the biofuels industry in a direction that both encourages development of a diversified energy sector and recognizes the transportation sector's need to use biofuels to meet its 70% clean energy goal. The competition between electric generation and transportation should be reevaluated at every RPS review with regard to the state of the art in commercial biofuel production to determine whether subsequent changes to the RPS are needed.[8]

Policy Definition
The policy would be a suggested provision for §269-91 of Act 155 2009, stating that Hawai‘i's utilities would meet no more than 30% of the RPS requirement in each year of the RPS with biofuels (e.g., in 2030 a maximum of 30% of the 40% RPS may be met with biofuels); both locally produced and imported biofuels will count toward this cap.

This policy brings up a number of issues, which are identified in **Table 4**.

[8] According to current legislation (§269-95 of Act 155 2009), the RPS will be evaluated every five years starting in 2013.

Table 4. Issues Relating to Extending the RPS Cap for Biofuels

Issue	Explanation	Strategy
Electricity vs. transportation	The electricity sector has a number of possible solutions for clean energy; the transportation sector has limited options and needs liquid biofuels to reach 70% clean energy, even with aggressive EV assumptions.	Biofuels limit in the RPS
In-state production vs. imported biofuels	The original language of the RPS limited just *imported* biofuels to 30% of the RPS to avoid crowding out of in-state biofuels in the next six years (however, this did not *ensure* a market for in-state biofuels).	Financial incentives for biofuels facilities to produce fuel for either the transportation or electricity sector; renewable fuel standard (RFS) to create a market for biofuels in the transportation sector
Price volatility	An important goal of HCEI is to reduce price volatility associated with an economy that is dependent on oil. Volatility in the biofuels markets tends to closely mirror that of the oil markets (Aseambankers 2008).	Biofuels limit in the RPS

An important question to consider is whether there will be sufficient renewable energy resources in the state to meet the remainder of the RPS without biofuels. Based on the analysis below, Hawai‘i does have sufficient renewable resources to meet the RPS without relying on biofuels for electricity generation (**Figure 2**). Examining the specific projects proposed in the Framework Agreement, the projection is that by 2030 biofuels-related generation would represent 35% of the RPS (i.e., 35% of the 40% RPS, or 14% of total generation) (HECO and State of Hawai‘i 2008).

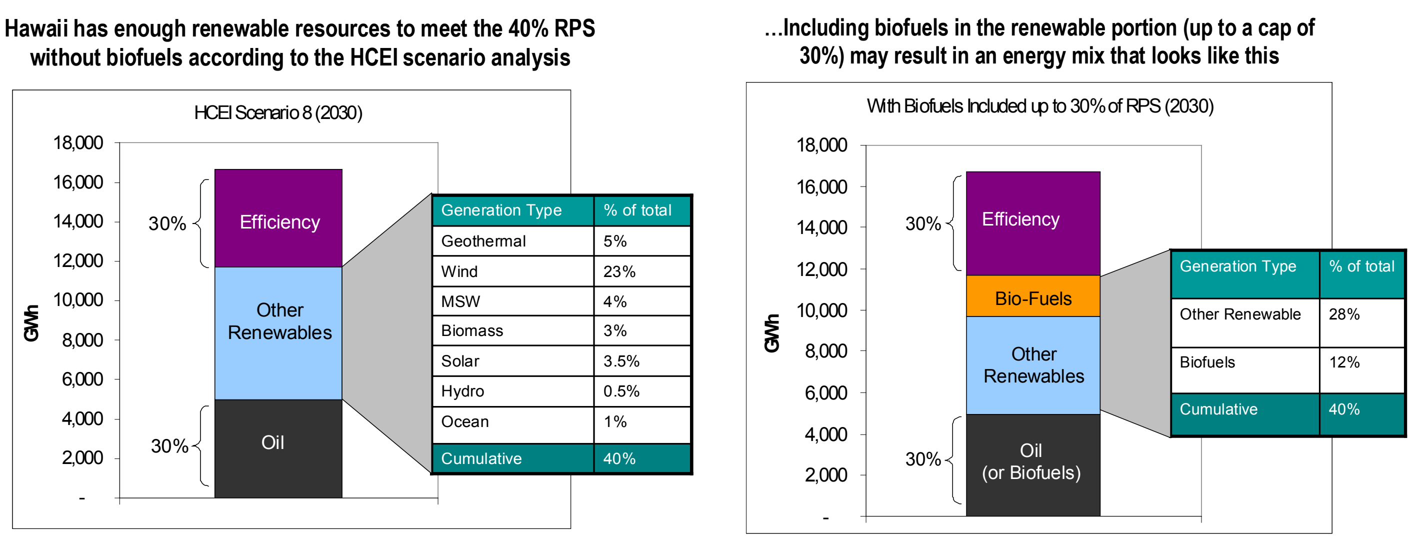


Figure 2. Resources available to meet the RPS

Methodology and Assumptions

Demand Scenario

The demand for biofuels from the electricity and transportation sectors was modeled out to 2030 using the most current publicly available data and historical trends and is presented in **Tables 5 and 6** below (BAH 2008).

Table 5. Electricity Consumption

RPS Year	2010	2015	2020	2030
RPS in statute	10%	15%	25%	40%
30% of the RPS cap (million gallons/year or MGY)	27.6	43.9	76.9	132.9

Table 6. Transportation Diesel Demand

Year	2010	2015	2020	2030
Total petro-diesel use with CAFE (MGY)	66.2	67.4	69.1	73.5

Production Scenario

In coordination with HCEI, a biofuels production scenario was developed using publicly available data (Poteet 2006; DBEDT 2008a). This analysis attempted to create an "aggressive yet realistic" scenario that balanced the future demands of the electricity generation and transportation sectors. As a result, the scenario included the production of ethanol, biodiesel, and electricity from biomass utilizing approximately 12% (206,000 acres) of Hawaiʻi's zoned agricultural land. Yields (gallons/acre) for both biodiesel and ethanol were based on tested yields of biofuels crops (sugarcane, jatropha, palm, etc.) (BAH 2008). Significantly higher yields from future biofuels crops, such as algae, were not included in the production scenario to maintain a conservative estimate (as these crops are not yet commercially proven). The results showed that approximately 73 MGY of biodiesel and 93 MGY of ethanol could be produced in state.

Comparison of the Production and Consumption Scenarios

Applying the biofuels production numbers to the demand scenario, there is enough land for biodiesel to meet 55% of the "30% cap of the total RPS" in 2030 (**Table 7**) (Keffer et al. 2006). If land currently slated for ethanol production was also converted to biodiesel, it would meet nearly all "30% cap of the total RPS."

Table 7. Local vs. Imported Biodiesel Projections

RPS Year	2010	2015	2020	2030
% of biofuels cap (30% of the RPS) that can be met with locally produced biodiesel	265%	167%	95%	55%
Number of additional gallons of biodiesel (beyond local production) per year required to meet the 30% cap (MGY)	-	-	3.6	59.6

Costs and Benefits

With future costs of biofuels unknown, both in Hawaiʻi and on the global market, and limited accuracy in long-term projections of crude oil prices, it is difficult to calculate the monetary costs and benefits associated with a cap on biofuels. Thus, we have qualitatively examined the costs and benefits.

Benefits
Limiting the amount of the RPS that can be met with biofuels will encourage the development of other forms of renewable energy. This will benefit both the people of Hawaiʻi, by encouraging diverse sources of energy, as well as the investors currently considering installing nonbiofuels renewable energy capacity in Hawaiʻi, by giving them confidence that there will be a market for the energy that they generate at least until 2030.

Costs
Because Hawaiʻi's electricity is currently produced predominantly by liquid fuels, namely diesel and heavy fuel, biofuels require little to no change in infrastructure. Thus, limiting the amount of biofuels used in the system may increase costs (as other renewable energy sources have higher capital cost, but no ongoing fuel costs). However, if Hawaiʻi switches a significant percentage of its generation from one fuel source to another without adding diversity, it will still be as vulnerable to price fluctuations as it is currently because biofuels and their feedstocks are a globally traded commodity, and their costs are partially linked to the cost of oil.

What Other Locations Are Doing This?
No other state is pursuing this exact policy, although some states are limiting technology-specific approaches to meeting their RPS/RFS.

- *California (Office of the Governor of California 2008a):*
    - RPS goal: 33% by the end of 2020 (no technology-specific targets)
    - State target for bioenergy: The following targets to increase the production and use of bioenergy, including ethanol and biodiesel fuels made from renewable resources, are established for California:
        - Regarding biofuels, the state must produce a minimum of 20% of its biofuels within California by 2010, 40% by 2020, and 7% by 2050
        - Regarding the use of biomass for electricity, the state must meet a 20% target within the established state goals for renewable generation for 2010 and 2020
    - Low Carbon Fuel Standard (LCFS): The LCFS will require fuel providers (defined as refiners, importers, and blenders of passenger vehicle fuels) to ensure that the mix of fuel they sell into the California market meets, on average, a declining standard for greenhouse gas (GHG) emissions (Office of the Governor of California 2008b).
- *Iowa:*
    - RPS goal (DSIRE 2009e): 105 MW between the two utilities based on each utility's percentage of their combined estimated Iowa retail peak demand in 1990: 55.2 MW (52.57% of demand) for MidAmerican and 49.8 MW (47.43% of demand) for IPL

- RFS (State of Iowa 2009): The goal of the Iowa Renewable Fuel Standard is to replace 25% of gasoline in the state with biofuels (ethanol or biodiesel) by January 1, 2020. One provision of the standard is to require retailers to sell a certain percentage of renewable fuels as part of their total gasoline sales. Both biodiesel and ethanol count toward meeting the RFS schedule.

- *Maryland:*
    - RPS goal (DSIRE 2009f): 4% by 2009 + 1% annual increase for Class 1; 3.6% by 2009 for Class 2
    - Renewable Fuels Mandate (DOE 2009): All diesel motor vehicle fuel and all other liquid fuel used to operate motor vehicle diesel engines must contain at least 2% renewable diesel fuel by July 1, 2010; 3% renewable diesel fuel by July 1, 2011; 4% renewable diesel fuel by July 1, 2012; and 5% renewable diesel fuel by July 1, 2013. For these purposes, eligible renewable diesel fuel includes diesel fuel that is derived predominantly from renewable biomass and yields at least a 50% reduction in life-cycle GHG emissions relative to the average life-cycle GHG emissions for petroleum-based diesel fuel sold in 2005. The Maryland Department of Energy Resources must also study the feasibility, benefits, and costs of applying the percentage mandates on a statewide average basis rather than for every gallon of diesel motor fuel sold.
- *Massachusetts (Massachusetts 2008):*
    - Biofuels Mandate: Only biofuels derived from waste feedstocks will initially be considered to qualify as an advanced biofuel to meet the Massachusetts Biofuels Mandate (established in the Clean Energy Biofuels Acts of 2008) for diesel and home heating oil. For consideration as a qualifying fuel, the waste-derived biofuel must yield a 50% GHG reduction threshold required in the Massachusetts law as determined by a preliminary analysis based on both California Air Resources Board (CARB) and EPA methodologies.
- *Pennsylvania:*
    - RPS (DSIRE 2009g): 18% during compliance year 2020–2021 (8% Tier I and 10% Tier II)
    - RPS targets (DSIRE 2009g): Solar PV set-aside of 0.5% for June 1, 2020, and thereafter
    - Renewable Fuel Mandate (DOE 2009): All diesel fuel sold in Pennsylvania must contain biodiesel according to the following schedule:
        - 2% biodiesel by volume one year after in-state production of biodiesel reaches 40 million gallons
        - 5% biodiesel by volume one year after in-state production reaches 100 million gallons
        - 10% biodiesel by volume one year after in-state production reaches 200 million gallons

    - 20% biodiesel by volume one year after in-state production reaches 400 million gallons
  - All gasoline sold in Pennsylvania must contain at least 10% cellulosic ethanol by volume one year after in-state production of cellulosic ethanol reaches 350 million gallons.
- *Texas (Texas 2009):*
  - RPS goal: 2,280 MW by January 1, 2007, increasing to 5,880 MW by January 1, 2015
  - RPS technology-specific target: At least 500 MW from renewables other than wind.
- *Washington:*
  - RPS (DSIRE 2009h): Utilities subject to the standard must use eligible renewable resources or acquire equivalent renewable energy credits, or a combination of both, to meet the following annual targets:
    - At least 3% of its load by January 1, 2012, and each year thereafter through 12/31/2015
    - At least 9% of its load by January 1, 2016, and each year thereafter through 12/31/2019
    - At least 15% of its load by January 1, 2020, and each year thereafter.
  - RFS (DOE 2009): At least 2% of all diesel fuel sold in Washington must be biodiesel, beginning November 30, 2008, or when a determination is made by the director of the Department of Ecology that feedstock grown in Washington State can satisfy a minimum 2% fuel blend requirement. The biodiesel requirement will increase to 5% once in-state feedstocks and oil-seed crushing capacity can meet a 3% requirement.

How Does This Fit the HCEI Goals?
HCEI is focused on creating a sustainable alternative-fuel strategy for Hawai‘i. These two modifications to the RPS are in line with the goals of HCEI because they will help steer Hawai‘i away from a scenario where biofuels are the predominant replacement for liquid hydrocarbon fuels and toward a scenario with significantly more energy diversity. In addition, capping the contribution of biofuels would be a first step toward ensuring that Hawai‘i has biofuels capacity remaining to meet its transportation goals.

Next Steps
Further research on how grid reliability in island grids like Hawai‘i's will be affected by high penetration of renewable energy will help strengthen the understanding of the role liquid fuels will play in meeting the RPS goals.

End-Use Efficiency

Improving energy efficiency is a critical component for any state interested in transitioning away from fossil fuel energy dependency, as initial gains from energy efficiency improvements are typically less costly than meeting the demand with renewable energy generation. Doing so requires incentivizing efficiency improvements in new *and* existing buildings and can be accomplished through such measures as offering financial and nonfinancial incentives as well as mandating improvements in building codes.

The following policies were selected by the End-Use Efficiency working group members in early 2009 as possible policy options to build upon the previous years' efforts for addressing barriers to energy efficiency improvements in Hawai'i. For example, based on HCEI efforts, the 2009 Clean Energy Omnibus Bill separated out energy efficiency goals from the existing RPS, requiring utilities to meet 40% of generation with renewable energy and achieve a 30% reduction in energy use through efficiency programs by 2030 (HB1464). The impact analyses below were completed over several months and provided to the working group members to aid them in determining which policies would best achieve the HCEI goals.

Policy Option: Public Benefits Fund Increase

Summary

The existing Public Benefit Fund (PBF) is designed so that 1% of the expected annual revenues for HECO, Hawaii Electric Light Company (HELCO) and Maui Electric Company (MECO) go to the PBF Administrator (PBFA) to be used to support energy efficiency (EE) programs throughout the state. Increasing the PBF surcharge will result in an increase of funds for EE programs as well as an increase to the ratepayers' monthly bills. The current PBF surcharge is expected to generate about $19.6 million in 2009[9] and result in a monthly increase to residential bills of about $1.30 on average—less than a 1% increase. Increasing the PBF surcharge to 2% of annual revenues will result in approximately $82.4 million[10] in funding for 2011 and a total of $400 million from 2011 through 2014. Under the current PBF surcharge, residential customers, on average, pay an additional $16 per year but will experience a net savings of $29 as a result of reduced energy use from efficiency measures implemented through PBFA programs if all of the savings are achieved. However, based on experience in other states, it is unlikely that the current level of PBF funding will be sufficient to achieve the expected savings.

Policy Definition

The PBF, for which funds are raised through a surcharge on the ratepayers' electricity bills, provides financial support for EE programs throughout the state. The amount of the surcharge is determined based on generating a percentage of projected utility revenues.

Policy Design and Implementation: What Are Other Locations Doing?

A variety of other states have implemented PBF surcharges to raise funds to support EE improvements. In a recent report analyzing state EE programs, a strong correlation was found between spending on EE (both in terms of the percent of utility revenues and on a per-capita basis) and actual energy savings in the 14 states considered to be EE leaders (Kushler et al. 2009). Based on rankings from industry experts, the top two factors in enabling states to achieve large EE savings from utility programs are:

[9] As the management of the PBF funds transferred from the utility to the PBFA mid-2009, the $19.6 million represents the amount expected to be raised while the program is administered by the PBFA. As such, $19.6 million represents approximately 60% of 1% of the total expected revenues for HECO, HELCO, and MECO.

[10] Raising the PBF fee from 1% to 2% will result in more than a doubling of PBF funding between 2009 and 2011 because the utilities' revenues are expected to increase substantially over these years and the funds raised are based as a percentage of utility revenue.

- The size of the EE program budget relative to total utility revenues
- A strong state legislative mandate for EE (Kushler et al. 2009).

By establishing the goal of achieving 30% EE improvements by 2030, the State of Hawai‘i has already demonstrated strong legislative support for EE. The newly implemented PBF establishes consistent funding for EE programs; however, it is uncertain whether the funding is sufficient to achieve the goal of reducing energy use by 30% through EE improvements. When compared to the leading states, Hawai‘i’s funding for EE from the PBF relative to utility revenues is equal to that of New Jersey and New York, ranking the state 11th overall (**Table 8**).

Table 8 presents the ranking of the states considered to be the leaders in energy efficiency (Kushler et al. 2009) in the country for 2007[11] in terms of:

- Total 2007 spending on EE as a percentage of total utility revenues
- Annual EE savings achieved in 2007
- Ratio of spending to annual energy savings achieved in 2007.

Table 8. EE Funding and Savings by the Leading States for EE

Top-Ranked States	Total EE Spending as % of Total Revenues for All Utilities	Top-Ranked States	EE Statewide Annual Savings as % of Total State kWh Sales	Top-Ranked States	Ratio of EE Spending (as % of Utility Revenue) to Statewide Annual EE Savings
Vermont	3.5%	Vermont	1.8%	Nevada	1.3
Washington	2.4%	Connecticut	1.3%	Massachusetts	1.6
Oregon	2.2%	Oregon	0.9%	Connecticut	1.6
Connecticut	2.1%	California	0.9%	New York*	1.7
Minnesota	1.9%	Massachusetts	0.9%	Vermont	1.9
California	1.9%	Rhode Island	0.8%	Texas	2.0
Iowa	1.8%	Washington	0.7%	California	2.0
Rhode Island	1.6%	Minnesota	0.7%	Rhode Island	2.0
Wisconsin	1.4%	Iowa	0.7%	Wisconsin	2.1
Massachusetts	1.4%	Wisconsin	0.7%	Oregon	2.4
New Jersey	1.0%	New York*	0.6%	Iowa	2.6
New York*	1.0%	Nevada	0.6%	Minnesota	2.7
Nevada	0.8%	New Jersey	0.3%	New Jersey	3.3
Texas	0.2%	Texas	0.1%	Washington	3.4
*Data from New York is for 2006.					
Author’s adaptation from Kushler et al. 2009					

[11] Except where otherwise noted

For Hawai‘i to achieve the efficiency goal of 4,300 gigawatt hours (GWh) annually by 2030, the state will have to achieve efficiency gains of approximately 1.7% per year.[12] For 2009, if the state achieves 1.7% gains in efficiency, the current level of funding from the PBF surcharge would result in a funding-to-savings ratio of approximately 0.6, lower than that of any of the leading states. If Hawai‘i is indeed able to achieve this level of efficiency gains with such a low spending-to-savings ratio, it would be outperforming the leading states in this metric. However, as only one state, Vermont, has achieved greater than 1.7% efficiency gains in 2007, it may be necessary to consider whether or not a greater level of funding will be needed for Hawai‘i to achieve such progressive EE savings.

The current energy savings goals from energy efficiency as determined by the PBFA are listed in **Table 9** (Chang 2009; DBEDT 2008a). As a percentage of the total utility electric sales for 2008, the savings goal for 2009 is 1.2%, and for 2010 it is 1.3%. These annual savings goals are substantially lower than the estimated 1.7% annual savings required to meet the 2030 Energy Efficiency Portfolio Standard goals.

Table 9. Current PBF Savings Goals

	2009 Goals (kWh)	2010 Goals (kWh)
Residential	68,722,000	71,245,000
Commercial	57,301,000	61,370,000
Total	126,023,000	132,615,000
Current PBF savings goals as a percentage of 2008 electric utility sales (excluding KIUC sales)	1.2%	1.3%

According to the Energy Agreement signed by the State of Hawai‘i, Division of Consumer Advocacy of the Department of Commerce and Consumer Affairs, and the Hawaiian Electric companies, when these parties requested that the PUC establish a PBF in 2008, they also requested that the PBF surcharge be increased according to the schedule in **Table 10** (DBEDT 2008b). However, as currently designed, an increase in the percentage of the PBF surcharge for future years has not been determined.

Table 10. The PBF Surcharge Increase as Suggested by the Energy Agreement

Years	Percentage of Hawaiian Electric Companies Total Revenues
1 & 2	1%
3 & 4	1.5%
Subsequent years	2%

Methodology and Assumptions

To determine the possible impacts on residential customers, the average residential customer is assumed to use 7,827 kWh of electricity per year, as this was the average residential energy use for 2007 (DBEDT 2007). It is also assumed that any percentage increase in the amount of

[12] Based on the estimated energy efficiency savings needed to meet the 4,300 GWh efficiency goal as defined in the Booz Allen Hamilton Scenario Analysis completed for HCEI (BAH 2008).

funding designated to the PBF would also result in a similar percentage increase in the PBF surcharge to residential customers. The electricity rates are based on the current residential electricity rates for HECO, HELCO, and MECO as of August 2009 (HECO 2009b).

To determine the statewide[13] impact of increasing the percentage of utility revenues designated to the PBF, the projected utility revenues are based on:

- The historical average annual growth rate in utility (HECO, HELCO, and MECO) revenues of 13% from 2002 through 2006 (DBEDT 2008a)
- Total utility revenues of $3.2 billion for 2009 based on a 13% increase in HECO, HELCO, and MECO revenues from 2008 (DBEDT 2008a).

Costs and Benefits

State Investment

The incremental investments are expected to be minimal, since the PBFA currently administers the EE programs supported by the existing PBF. Currently, 17% of the funds raised go to administration of the PBF, including education and outreach, and an increase in the size of the PBF surcharge would also provide for greater funding to cover increased administration costs as well as an increase in education and outreach programs (Sonoda 2009).

Resident Investment

Based on the existing PBF charge for 2009, the average residential customer incurs a $1.30 increase in the energy charge for consumption portion of the monthly electricity bill[14] (**Table 11**, highlighted in grey). The remaining, unshaded portions of **Table 11** show how additional incremental PBF surcharge increases would affect monthly bills, up to a doubling of the current PBF rate. Doubling the current rate would result in a total increase of $2.61 compared to a bill without any PBF surcharge—less than a 2% change in the average residential customer's bill.

Table 11. Impact on Residential Customers with Various Increases in the PBF Surcharge

Ratepayer Fee ($/kWh)	Customer Monthly Bill Change ($+)
No PBF	$0.00
$0.001986	$1.30
$0.0025	$1.63
$0.0030	$1.96
$0.0035	$2.28
$0.0040	$2.61

[13] Because KIUC customers do not pay the PBF surcharge, they are not eligible to participate in the programs funded by the PBF. However, the vast majority of the state's population is eligible, as only a small percentage of residents are KIUC customers.

[14] The per-kWh charge (energy charge) is based on the electricity rate and the customer's usage. The entire bill would include the fixed charge and other fees as well. The PBF itself is directly related to the customer's usage and does not alter the fixed charges.

Under the current PBF surcharge, residential customers pay an average of $16 more per year but experience a net savings of $29 from energy efficiency savings implemented with funds from the PBF (**Table 12**).[15] As it is unlikely that the current PBF surcharge provides sufficient funds to achieve this level of savings, based on experience in other states, raising the PBF surcharge may be necessary to achieve even the proposed level of savings of 71 GWh. Raising the PBF surcharge to 2% without increasing the expected energy savings would still result in, on average, a net positive financial gain for residential customers of about $13 per year.[16] Further, if the PBF surcharge is raised to 2% and the expected energy savings are doubled, residential customers will experience an annual net savings of $58 on their electricity bills. However, based on the experience to date in other states, expecting that increasing the PBF surcharge to 2% of revenues will result in a doubling of efficiency savings is likely inappropriate, and the level of funding necessary to achieve the current expected savings should be evaluated to determine whether it is sufficient.

Table 12. Net Residential Savings from the PBF

	Expected Statewide Annual Savings (kWh)	Annual Cost per Residential Customer	Annual Gross Savings per Resident	Annual Net Savings to Customers
Current savings, 1% PBF	71,245,000	$15.54	$44.53	$28.98
Current savings, 2% PBF	71,245,000	$31.09	$44.53	$13.44
Double savings, 2% PBF	142,490,000	$31.09	$89.06	$57.97

The current PBF surcharge for commercial and industrial customers is set at $.001015/kWh for 2009. It is challenging to determine the average effect that an increase will have on commercial and industrial customers, however, because there are many different classes of commercial and industrial customers, and developing an average energy use for commercial customers would not provide a good picture of the financial impact that a PBF rate increase would create.

Benefits

If the funding for the PBF as a percentage of utility revenues is increased, the PBFA will be able to support additional EE savings throughout the state. **Table 13** presents an estimate of the annual funding for the PBF based on a variety of incremental increases in the percentage of total utility revenues, with the first column (1.00%, highlighted in grey) demonstrating the expected funds if the percentage of revenues designated to the PBF is not increased.

[15] Customers who participate in the PBFA programs will experience greater direct financial savings than those who do not. However, all customers benefit from reduced energy demand, as fewer power plants and transmission lines need to be constructed to meet the demand as demand growth is reduced through increased energy efficiency.

[16] This may happen if it is believed that the current funding levels are insufficient to support the existing savings goals.

Table 13. Projected PBF Funds Generated

	1.00%	1.25%	1.50%	1.75%	2.00%
2011	$41,182,705	$51,478,381	$61,774,057	$72,069,733	$82,365,410
2012	$46,581,774	$58,227,217	$69,872,661	$81,518,104	$93,163,548
2013	$52,688,663	$65,860,829	$79,032,994	$92,205,160	$105,377,326
2014	$59,596,168	$74,495,210	$89,394,252	$104,293,293	$119,192,335
2011–2014	*$200,049,309*	*$250,061,637*	*$300,073,964*	*$350,086,291*	*$400,098,619*

If the funding for the PBF is increased by the above percentages and the expected annual savings remain at 1.7%, the following spending-to-savings ratio will be achieved (**Table 14**):

Table 14. Spending-to-Savings Ratio

Ratio of EE Spending (as a Percentage of Utility Revenue) to Statewide Annual EE Savings	Ratio
1.0%	0.6
1.25%	0.7
1.50%	0.9
1.75%	1.0
2.00%	1.2

Note that, even if the PBF funds total 2% of utility revenues, the spending-to-savings ratio for Hawai‘i would still be lower than the spending-to-savings ratio for any of the leading states (**Table 8**).

How Does This Fit the HCEI Goals?
To reach the goal of 30% energy efficiency gains by 2030, the state will have to aggressively improve energy efficiency in both the commercial and residential sectors. Increasing the PBF surcharge will provide greater funding for EE programs throughout the state.

Next Steps
While the level of funding necessary to drive energy efficiency gains will be unique to each state as experience with PBFs increases throughout the country, further analysis of the correlation between the level of funding and level of efficiency improvements achieved will provide insight into the amount of dedicated funding required to drive significant gains in energy efficiency.

Policy Option: Net-Zero Energy Capable Requirement for New Homes

Summary
A net-zero energy capable requirement policy sets a future date by which all new residential construction must be designed to be sufficiently energy efficient to the point where it becomes cheaper to generate on-site renewable energy than to increase the efficiency of the home. This policy sets the foundation for the incorporation of on-site residential renewable energy systems in the near-term future as system prices drop.

As a result of this policy, the state experiences a reduction in the projected energy demand and fewer GHG emissions with minimal additional costs to the state for developing the policy and ensuring compliance. Furthermore, this policy leads to the growth of local energy efficiency and renewable energy capacities in the development and construction industries.

The cost per home to build approximately 50% more efficient—the point at which it is estimated to become cheaper to install a solar photovoltaic (PV) system rather than implement further efficiency improvements—is about 8%–12% more than conventional residential construction costs in Hawaiʻi today (Builder 2009). The point at which it becomes cheaper to install PV than to implement further efficiency improvements will change over time as the cost of PV continues to fall. Residents benefit by experiencing about a 50% reduction in their electricity bills, resulting in annual savings of approximately 5.5 megawatt hours (MWh) and $1,317 per home and cumulative statewide savings over 20 years of more than 6,500 GWh and $2.3 billion.[17] If, from 2015 on, all homes are built net-zero capable, the annual energy efficiency savings in 2030 would meet about 11% of the 4,300 GWh reduction goal for the state.[18] Further energy savings will be experienced depending on the number of homeowners that install a renewable energy system.

Policy Definition

Net-zero energy capable homes requirements mandate that all new homes built after a certain year are designed to be efficient to the point where it becomes less costly to meet the remaining demand with renewable generation than to implement further efficiency improvements. Initial analysis finds that this balance point for homes in Hawaiʻi is currently between 45% and 55% more efficient.[19]

A variety of policy design options exist to move the residential market toward net-zero energy homes:

- Mandating a specific efficiency improvement level, often by instituting efficiency requirements that become increasingly more stringent at specific intervals (i.e., every two years)
- Setting a future date for all new residential buildings to be built net-zero energy capable
- Requiring homes to achieve a specific Home Energy Rating System (HERS) index rating, with increasingly stringent requirements in future years and/or for larger homes.

Policy Design and Implementation: What Are Other Locations Doing?

Although there is not yet much experience with net-zero energy homes policies in the United States, a handful of localities have adopted or are considering the adoption of related policies that

[17] The estimated annual consumption is higher for new homes than for the existing residential building stock, based on recent experience in Hawaiʻi. This is mainly because a significantly higher percentage of new homes install air-conditioning.

[18] The state Energy Efficiency Portfolio Standard is targeting 4,300 GWh of efficiency savings in the year 2030. This goal is based on an analysis by Booz Allen Hamilton that assumes that all new homes after 2015 will be net-zero (50% more efficient, with the remaining 50% of demand coming from on-site renewable generation). A system such as this would likely export a large amount of energy to the grid during the midday. Possible curtailment is uncertain.

[19] This balance point is dynamic and will change as the cost of PV and efficiency measures change.

attempt to move the residential market toward net-zero energy homes. Many of the policies focus on incentivizing or mandating progressive efficiency policies as a step toward zero energy. For example, the city of Austin, Texas, requires all new single-family homes to be built net-zero energy capable by 2015. The city defines "net-zero capable" as:

> … homes that are energy efficient enough to be net zero energy homes with the addition of on-site or its equivalent, energy generation. This level of energy efficiency is approximately 65% more efficient than homes built to the City of Austin Energy Code in effect in November, 2006. (Austin 2007)

A bill introduced by the California Assembly (AB212) in 2009 (currently in committee) requires that all new residential construction be net-zero energy by 2020 or by a date upon which the California Energy Commission determines that PV is cost effective (Karrer 2009).

Massachusetts created a Zero Net Energy Building Task Force to develop recommendations for moving toward zero net energy construction; their initial report was released in March 2009 (Massachusetts 2009). The broad recommendations call for the state to systematically raise the state's energy efficiency standards until they reach net zero, develop a system for energy performance data aggregation for both residential and commercial buildings in the commonwealth, provide incentives and reduce regulatory barriers for efficiency measures, and develop a workforce development initiative for efficiency-related industries.

The city and county of Boulder, Colorado, have developed minimum efficiency standards based on a HERS rating system that must be met by all new residential construction, with larger homes required to meet more stringent efficiency standards (Boulder County 2009; Boulder 2009). The State of New Mexico's sustainable building tax incentive program provides larger incentives to more efficient homes (New Mexico 2009).

Methodology and Assumptions

Determining the estimated savings of a net-zero energy capable homes requirement is relatively straightforward, although highly dependent on the expected average energy use of these new houses if the policy were not instituted. However, it is difficult to estimate the costs associated with building homes to a specific efficiency improvement because there are a variety of measures that can be implemented to improve efficiency, and the costs can be very project-specific. However, to frame the policy issues for decision makers, a rough estimate of the costs and benefits is provided in the following sections based on the following assumptions:

- Average residential electricity price of $0.2394/kWh in real dollars (the current weighted average based on the number of residential customers for HECO, HELCO, and MECO) (HECO 2009b; DBEDT 2007)
- A 3% annual increase in the price of electricity
- PV installation costs in Hawai‘i of $8/Rated Peak Watt[20] (Norton 2009)
- Annual electricity generation of 1,460 kWh/year/kW of installed PV (PVWatts 2009)

[20] This reflects 2009 PV costs on Hawai‘i, which are higher than costs on the mainland.

- 5,663 new homes built per year (based on average of number of new residential units built in Hawai‘i from 2002 through 2007 [DBEDT 2007])
- 11,000 kWh/year average electricity use for new homes[21]
- Average cost of conventional residential construction in Hawai‘i of $160/square foot, or approximately $320,000 for a 2,000-square-foot home (Builder 2009).

Costs and Benefits

State Investment

The state investment needed to support this policy would likely be focused on the following areas:

- Development and implementation of the policy
- Training for county inspectors and other government employees required to ensure compliance
- Education for the building community and general public about the net-zero energy capable requirements for new homes.

The investment required to develop and implement the policy, including training county officials, would be similar to the investment required to develop other building code related policies in Hawai‘i. The costs associated with educating the building community and general public about the new program would depend on the level of investment that the state would be willing to direct toward these types of programs.

Resident Investment

While it is extremely difficult to determine the actual cost to build 50% more efficient in Hawai‘i, based on the experience of an Energy Star New Homes partner in Hawai‘i that has built hundreds of Energy Star qualified homes that achieve energy savings of 50%–60% when compared to homes built exactly to code, it can be estimated that the costs to achieve this level of efficiency are 8%–12% higher than traditional residential construction (Builder 2009). This equates to an incremental cost of roughly $26,000–$38,000 per house (**Table 15**). Assuming that, in Hawai‘i, the marginal cost of efficiency improvements surpasses the marginal cost of installing a PV system at or around the point at which a house achieves 50% efficiency improvements, the cost to the resident to install a PV system to meet the remaining demand is about $30,000 per house, excluding federal, state, or local incentives, which would further decrease the costs to the homeowner. For residents choosing to install PV to meet their remaining energy demands, the total cost to build net zero is calculated to be about 20% greater than conventional residential construction.[22]

[21] Due to a lack of measured data for the average energy use of new homes in Hawai‘i, this is a very rough estimate based on about 60% of new homes installing air-conditioning and the remaining 40% of homes having approximately the same annual average energy use as the existing building stock in Hawai‘i (7,827 kWh/year [DBEDT 2007]), with the installation of an air-conditioner adding approximately 5,500 kWh/year. The estimated annual consumption is higher for new homes than for the existing residential building stock, based on recent experience in Hawai‘i. This is mainly because a significantly higher percentage of new homes install air-conditioning.

[22] This is on par with the experience of net-zero residential construction in Tucson, Arizona, where costs to build net zero were approximately 20% more than conventional construction in demonstration homes (Miller 2009).

Table 15. Estimated Costs to Residents of Net-Zero Energy Capable Requirements for New Homes

	Per House	Statewide at X Number of Years			
		1	5	10	20
50% more efficient	\$26K–\$38 K	\$145M–\$217 M	\$725 M–\$1.1 B	\$1.4 B–\$2.2 B	\$2.9 B–\$4.3 B
50% of demand met with PV	\$30 K	\$171 M	\$853 M	\$1.7 B	\$3.4 B

Benefits

This policy helps minimize the increase in future grid demand for energy from the residential sector, resulting in a reduced need for investments in future energy generation installations and a reduction in energy use and greenhouse gas emissions from the business-as-usual projections. The estimated annual savings per house for a house built to be net-zero energy capable (i.e., 50% more efficient) are 5.5 MWh, resulting in a dollar savings of about \$1,300 per house per year from avoided energy costs (**Table 16**). If, from 2015 on, all homes are built net-zero capable, the annual energy efficiency savings in 2030 would meet about 11% of the 4,300 GWh HCEI efficiency goal. This policy results in cumulative statewide savings of approximately 6,500 GWh 20 years after the requirements are instituted. Depending on the number of homeowners that then choose to install a PV system to meet their remaining demand, the statewide energy savings will be even greater.[23]

Table 16. Estimated Savings of a Net-Zero Capable Requirement for New Homes

50% More Efficient	*Per House/ Per Year*	Statewide Cumulative Savings at X Number of Years			
		1	5	10	20
Energy savings	5.5 MWh	31 GWh	467 GWh	1,713 GWh	6,541 GWh
Dollars	\$1,317	\$7 M	\$121 M	\$491 M	\$2.3 B

How Does This Fit the HCEI Goals?

This policy fits in with the overall HCEI goals in that it significantly reduces the demand for energy from the residential sector and promotes the development of the local energy efficiency market throughout the state. Within 20 years, this policy could result in annual statewide energy savings of approximately 6,500 GWh, a substantial decrease in the expected residential energy demand.

Next Steps

To better understand the impacts that a net-zero energy capable policy will have on renewable energy development in the state, it would be beneficial to conduct research on the expected costs of residential PV in Hawaiʻi and how the rising cost of electricity will affect individuals' decisions on when to install a PV system. Understanding this relationship will result in an improved capability to estimate how reducing the costs to install PV through this type of policy will impact residential uptake of PV and other distributed renewable technologies. Furthermore, it would be important for further research on how large amounts of distributed PV might affect the grid considering how the PV generation peak would intersect with residential demand.

[23] Estimating the savings from possible PV installations is difficult because it depends on 1) the number of residents choosing to install PV after building a net-zero capable home and 2) the year in which the PV system is installed, as this will vary per resident interested in installing PV and may not be the same year in which the house is built.

Policy Option: Photovoltaic-Ready Requirements

Summary

PV-ready initiatives require that new homes be designed to allow for and maximize the future adoption of PV technologies. While similar policies currently being implemented in other parts of the United States include both PV and solar water heating requirements, because Hawai‘i already mandates that all new homes be constructed with solar water heaters, this policy would focus solely on PV-ready requirements.

Based on limited experience in other localities, this policy requires a state investment of between $10 and $50 per new house, with cumulative costs at 10 years ranging from $.6 million to $3 million, and a resident investment of $100 to $500 per house, with cumulative residential investment at 10 years ranging from $6 million to $28 million. If 5% of all new homes built install a 4 kW PV system, the cumulative energy savings at 10 years is estimated to be 90 GWh, saving residents a total of $26 million over the same time period from reduced energy bills.

Policy Definition

PV-ready initiatives require that new homes be designed to allow for and maximize the future adoption of PV technologies. While a variety of design aspects can be considered, they often include such components as:

- Siting the building to maximize solar gain
- Designing the roof to have the structural strength necessary for PV technology installations
- Placing auxiliary components on the roof so as to minimize shading where potential PV installations may be installed
- Installing appropriately sized busbar in the electrical panel board to be able to handle future PV installation
- Installing the necessary conduit for future PV installations
- Designating space for PV equipment (e.g., arrays, inverters), including installing the mandatory solar water heating system in a location that does not inhibit future PV installation
- Ensuring that all relevant wiring is appropriately marked and diagramed to facilitate future installations.

The rationale behind this policy is twofold:

- As the economics for PV improve and fossil fuel costs continue to be volatile, PV technologies will become financially competitive.
- Since rearranging already-installed equipment to make room for PV equipment and optimize solar gain is likely impossible and, at best, costly, building PV-ready homes ensures that the financial market barriers to PV adoption will be reduced to ensure earlier adoption of PV technologies as payback times are shortened due to optimal generation.

Many design and equipment siting elements either cannot be altered or become cost-prohibitive to alter once the house is constructed. Therefore, a PV-ready policy incorporates the potential design elements necessary for future PV installation. For the elements that can be retrofitted once a homeowner decides to install a PV system, the costs can be quite high. For example, because the retrofitting needed to install the conduit requires opening up walls, the cost to retrofit can range between $750 and $1,500 per installation (Duda 2009). If done at the time of construction, the cost is about $100 to $200. Also, installing a PV system on an existing home requires that the electrical panel board be replaced because standard residential busbars cannot handle the current produced by a PV system. In this case, retrofitting requires installing an entirely new electrical board, which can cost from $1,500 to $3,000, whereas the costs are as low as $200 if installed at the time of construction.

Policy Design and Implementation: What Are Other Locations Doing?

While this is a relatively new policy option across the country, solar-ready (PV and solar hot water heating) policies are being implemented in a variety of states and municipalities:

- *New Mexico*: Solar-ready legislation mandates that new homes be built so that the roof orientation, roof strength, and location of obstructions to sunlight are designed to incorporate future solar technology installations. The bill also calls for the installation of conduit, wiring, and roof brackets as needed for future solar technology adoption (New Mexico 2007).
- *Colorado*: Legislation requires homebuilders to offer customers the option to have their house built solar ready and allows the costs of solar technology to be rolled into the homebuyer's initial mortgage. Additionally, the homebuilder must provide the homebuyer a list of local solar businesses offering residential services. This list can be drawn from a master list maintained by the governor's office (DSIRE 2009a).
- *Tucson, AZ*: An ordinance developed by a stakeholder group including realtors, technicians, environmental groups, the Southern Arizona Homebuilders Association, architects, solar energy company representatives, and city government officials mandates that all new residences be denied a building permit unless they are designed to be built solar ready for both solar hot water (SHW) and PV technologies. The SHW requirements went into effect in March 2009, and the PV rules are in the process of being developed. Builders can have the requirements waived if they can demonstrate that it is impractical to incorporate solar technologies onto a specific home (due to shading, building orientation, and other constraints) (DSIRE 200b).
- *Oro Valley, AZ*: Oro Valley, a neighbor to Tucson, adopted similar requirements in June 2009 (Oro Valley 2009).
- *California and New Jersey*: Both states have or are considering initiatives that require developers of large developments to provide information on incorporating solar technologies into new homes, including rebates and other available incentives, as well as the option to install such technologies (DSIRE 2009a; New Jersey 2008).

As these programs are all relatively new, there has not been any analysis of the effectiveness of this type of policy on promoting solar installations.

Methodology and Assumptions
To help frame the policy and issues, estimates of the costs and benefits of instituting a PV-ready policy in Hawaiʻi are provided in the next section, based on the following assumptions:

- A range of $100 to $500 for the incremental cost to build PV-ready homes (Duda 2009; Miller 2009; Wu 2008)
- PV installation costs in Hawaiʻi of $8/rated peak watt[24] (Norton 2009)
- Average size residential PV system installed of 4 kW
- Annual electricity generation of 1,460 kWh/year/kW of installed PV (PVWatts 2009)
- Average PV system degradation of 0.5% per year
- Average residential electricity price of $0.2394/kWh, weighted based on the number of residential customers for HECO, HELCO, and MECO (HECO 2009b; DBEDT 2007)
- A 3% annual increase in the price of electricity
- Public costs for program implementation at 10% of the total costs, both public and private, associated with the program (Granade et al. 2009)
- 5,663 new homes built per year [based on average of number of new residential units built in Hawaiʻi from 2002 through 2007 (DBEDT 2007)].

Costs and Benefits
State Investment
Quantifying the cost to the state to design and implement this program is difficult due to the relative newness of this policy across the United States and limited existing analysis, although they are likely to be similar to the cost of implementing other building code requirements. **Table 17** provides a range of estimated costs per house and cumulatively statewide at 1, 5, and 10 years after program implementation based on industry estimations of the incremental cost to build a new home PV ready, as well as the estimated costs to the state associated with program implementation.

The main costs to the state are associated with the following tasks:

- Defining and quantifying PV-ready requirements
- Designing PV-ready regulations for Hawaiʻi
- Developing inspector capacity through training or hiring new employees for solar requirement inspections and/or plan reviews.

The inspection and/or plan review related costs can be recovered through fees for services rendered. These fees, however, must then be included in the cost to residents when analyzing the costs and benefits of this policy. Based on estimates for other code-related energy efficiency requirements throughout the country, the public costs for this type of policy in Hawaiʻi can be estimated to range from $10 to $50 per home, or $57,000 to $283,000 statewide per year (**Table 17**).

[24] This reflects 2009 PV costs in Hawaiʻi, which are higher than costs on the mainland.

Table 17. Estimated Costs of a PV-Ready Policy

	Per House	Cumulative Statewide Impact at X Year		
		1	5	10
Incremental cost to residents to build PV ready	$100–$500	$0.6 M–$3 M	$3 M–$14 M	$6 M–$28 M
Public cost to implement program	$10–$50	$57 K–$283 K	$283 K–$1 M	$566 K–$3 M
Cost to install 4 kW PV system (on 5% of new homes)[25]	$27.5 K–29.7 K	$7.7M–$8.4 M	$39 M–$42 M	$78 M–$84 M

Resident Investments

The up-front costs to residents, which can be rolled into the mortgage, are the incremental costs to design and construct a home to be PV ready and are estimated to be between $100 and $500 per home. If all new homes built over the next 10 years are built PV ready, the combined residential investment is estimated to be between $6 million and $28 million (**Table 17**).

Homeowners who choose to install PV systems will incur further costs based on the size of the system.[26] If 5% of the new homes built over the next 10 years install a 4 kW PV system, at current PV system installation costs in Hawai‘i, the combined costs would range from $78 million to $84 million. This level of investment is highly dependent on the size of the PV system installed, the costs of PV systems (which are expected to continue falling), and the number of residents who choose to install a PV system. As electricity rates increase, PV systems quickly become more financially attractive as the payback period is shortened.

Benefits

As a building block, this policy develops the foundation for optimizing future gains from solar technology adoption. The main benefit of PV-ready requirements is they ensure that new residential construction is designed to reap the maximum benefits of future solar technology installations by reducing technical and economic barriers. Widespread adoption of solar technologies on residential buildings will result in reduced energy demand on the grid and reduced GHG emissions compared to a business-as-usual case. Individuals who incorporate solar technologies will benefit from a reduction in electricity costs, a savings that can be substantial depending on the volatility of fossil fuel prices. This policy also helps develop a market for solar technology construction and design experts as well as increasing the awareness of solar technologies in the construction industry and among residents in general, crucial factors in addressing solar informational barriers.

Financial benefits to consumers and reduced demand for electricity from the grid depend on the future adoption of solar technologies. Although the costs associated with retrofitting an existing home for PV installations are not much more than including these updates at time of

---

[25] Although the industry does expect them to do so, PV costs are not assumed to decrease over time in this analysis. As such, the costs to residents will fall based on the price of a PV system. This cost reflects the reduced cost to install a PV system on a PV-ready home (estimated at $2,250–$4,500).

[26] While this policy does NOT mandate the installation of PV systems, the benefits from minimizing financial and technical barriers to PV installation on existing homes in the future (those built PV ready) is likely to result in an increase in the number of homeowners who choose to install PV systems at some future point. However, the relative increase in the number of homeowners installing PV systems as a result of this policy is unknown.

construction, many of the auxiliary components on the roof cannot be rearranged to maximize solar gain if a resident decides to install a PV system after the house is complete. PV systems installed in less-than-ideal configurations (e.g., partially shaded or in nonoptimal orientations) will have longer payback periods than those installed on houses that have been designed for future PV installation.

PV-ready policies are implemented to spur the adoption of PV technologies by removing the market barriers associated with the added up-front installation costs. It is difficult to determine how this policy may affect the number of homeowners who decide to install PV systems on new homes. **Table 18** provides estimates of the savings if 5% of all new homes install a 4 kW PV system, with the savings starting in the year in which the PV system is installed (which may not necessarily be the year in which the house is built), and incorporates both system degradation and the rising cost of electricity based on a business-as-usual scenario (see methodology and assumptions in previous section). Savings per house are estimated at 5.8 MWh per year, resulting in nearly $1,400 annual savings and statewide cumulative savings over 10 years of $26 million.

Table 18. Estimated Savings if 5% of New Homes Install a 4 kW PV System

	Per House/ Per Year	Cumulative Statewide Impact at X Year		
		1	5	10
Electricity	5.8 MWh	1.7 GWh	24.6 GWh	89.6 GWh
Dollars	$1,398	$0.4 M	$6 M	$26 M

While **Table 18** presents the projected energy savings at 1, 5, and 10 years to demonstrate the potential statewide impact at those increments, comparing the costs and savings in dollars at these increments can be misleading because the costs of a PV system occur primarily upfront at the time of installation, and the savings are spread across the life of the PV system. For an individual resident, over the 30-year life of a PV system, the resident can expect a simple payback period of about 17 years based on current PV costs and average electricity rates. For those residents living in areas with higher rates, the payback period would be shorter.

How Does This Fit the HCEI Goals?

This policy is designed in conjunction with increased energy efficiency requirements to ensure that, as PV technologies become cost-competitive with traditional energy sources, the residential building stock is poised to adopt such technologies by being physically capable of supporting a PV installation. This policy sets the stage for substantial reductions in residential net-energy demand from the grid by developing a building stock that is designed for optimal solar gain. If this policy is designed to maximize the solar gain potential for PV, this would also guarantee that maximum benefits from installed SHW systems are achieved.

Next Steps

To better understand the impacts that a PV-ready policy will have on renewable energy development in the state, it would be beneficial to conduct research on the expected costs of residential PV in Hawaiʻi and how the rising cost of electricity will affect individuals' decisions on when to install a PV system. Understanding this relationship will result in an improved capability to estimate how reducing the costs to install PV through this type of policy will impact residential PV adoption. It would also be beneficial to study the impacts of high penetration of distributed PV on the grid because, if this policy is implemented and the economics of PV systems improve, there could be extensive interest in installing PV systems in the future on both new and existing buildings.

Policy Option: Tax Incentives with Pass-Through Option for Nontaxable Entities for Green Buildings and Energy Efficiency Improvements

Summary

Green building tax incentives are implemented in states that are interested in promoting green building by reducing the up-front cost of energy efficiency and renewable energy technologies in new buildings. The pass-through option refers to a provision that allows a nontaxable entity to obtain the benefits of the tax credit by transferring it to a taxable entity in exchange for an equivalent cash payment.

Established tax credit best practices and experiences of states that have this type of policy indicate that policy success (as measured by increased green building development) depends on clarity of the certification system used, as well as appropriate incentive size (to ensure usefulness to developers) and overall cap (to protect the state from excessive revenue loss).

Based on the impact of other green building programs targeting new commercial construction, a preliminary estimate of the impact on Hawai‘i is made from such a program, resulting in an estimated 10 buildings participating in a 10-year, $20 million program, with a cumulative program savings of nearly 8,000 MWh.

Policy Definition

Green building tax incentives are implemented in states that are interested in promoting green building by reducing the first cost of energy efficiency and renewable energy technologies. In practice, state policies focus on income tax credits for *new* buildings in the commercial and residential sectors. This type of policy can also be designed to support energy efficiency retrofits in existing commercial buildings.

The pass-through option within this policy refers to a provision that allows a nontaxable entity to obtain the benefits of the tax credit by transferring it to a taxable entity in exchange for an equivalent cash amount. This provision expands the pool of potential green builders to include government and nonprofit agencies.

Policy Design and Implementation: What Are Other Locations Doing?

Currently, five states provide tax credits for new building development (**Table 19**). To date, none of the programs have publicly released a detailed evaluation of the programs.

Table 19. State Green Building Tax Credit Policies

State	Effective Dates	Applicable Sector		Credit Pass-Through?
		Multi-Family Residential	***Commercial***	
New York	1999–		X	
Oregon	2001–*	X	X	X
Maryland	2002–	X	X	
New Mexico	2007–2013	X**		X
Georgia	2008–2012	X	X	X
*Oregon's Business Energy Tax Credit program dates to 1980, but the Sustainable Buildings portion began in 2001. **Includes single family residential Note: Montana offers a corporate tax deduction of $3,600 for whole building energy conservation measures for new and existing buildings. It is not included in this review due to small-scale and noncredit nature.				

No explicit best practices are published for the development of green building incentive programs. Generalized tax credit design best practices can be found in Brown and Busche (2008) and include:

- *Coordination with other policies:* To maximize effectiveness of tax incentives, it is imperative that the incentives coordinate with other policies to address market barriers.
- *Appropriate size:* The appropriate incentive size will depend on the context of the respective market, which will make it unique to each state. It is not sufficient to merely have a tax incentive; it must be large enough to increase investment without being so large as to overdraw the state's resources.
- *Adequate caps:* The financial incentive is adequately capped to reflect the fiscal realities in the state and reduce market risk to consumers of not receiving the incentive if the demand is greater than expected (Brown et al. 2004).
- *Appropriate time span:* Tax incentives should be designed with a time horizon long enough to provide consistency to the market without becoming a crutch for the industry.
- *Appropriate technology:* As a best practice, if a national certification standard exists for the technology, all eligible technologies must be required to meet certification standards, even if adjustments must be made for local needs.
- *Nontaxed sector eligibility:* Incentives are designed so that nontaxed sectors (i.e., schools, nonprofits, etc.) are eligible to participate (Clement et al. 2005).

Other state experiences also offer lessons learned for the design of appropriate policies. New York, which has the oldest program, established unique building certification rules at the outset. While these rules fit the needs of New York State at the time (e.g., climate-specific needs), they predated the U.S. Green Building Council (USGBC) Leadership in Energy and Environmental Design (LEED) certification overtaking most of the national market share for green building certification. All other policies use some level of LEED certification or equivalent as well as additional criteria (e.g., climate- or commissioning-specific) as a certification requirement to receive the incentive. This use of preestablished and known criteria reduces the administrative burden on the state of creating and revising regulations and allows builders to use a well-established system for credit qualification. The Oregon Business Energy Tax Credit also offers a tax credit to commercial entities that install qualifying conservation retrofit projects that are at least 10% more efficient than the existing installation (Oregon 2009).

Three of the states with this type of policy (Oregon, New Mexico, and Georgia) have a pass-through or transfer provision, allowing for nontaxable entities to apply for and resell the credit to an entity with a tax appetite. Of these, only Oregon has extensive experience with the pass-through mechanism. In Oregon, about 80% of the dollar volume of all Business Energy Tax Credit applications (of which the green buildings credit is a small portion) use the pass-through mechanism. Initially, the pass-through option was used primarily by entities without a tax appetite, but as time passes, more organizations with a tax appetite prefer to have the up-front lump sum and are applying for the pass-through (Dillard 2009). It is currently unclear what the implication of this change in usage will be for state policy costs.

The structure of the pass-through mechanism, and therefore state involvement in coordinating the pass-through option, varies by state. Oregon sets a price for the value of the pass-through and offers a free service to connect potential nontaxable entities with entities interested in purchasing the tax credits. The policy in New Mexico allows for the taxable pass-through option but does not set a conversion rate nor regulate in any way the structure of the pass-through deal. This reduces the implementation burden on the state, and the State of New Mexico reports that the pass-through option is being used under this methodology (Marbury 2009). Instead of using a pass-through mechanism, another option to expand eligibility of the program to nongovernmental and other organizations without a tax appetite is to provide a tax rebate. The policy could be designed similarly to Hawai‘i’s ACT 154, which allows for taxpayers claiming refunds for the purchase of SHW, PV, or wind renewable energy systems to receive tax rebates if they do not have sufficiently high tax liability.

Methodology and Assumptions

In order to frame the policy and related issues for decision makers in Hawai‘i, the results of the policy experience in other states are used to develop a rough estimate of probable impacts if Hawai‘i were to implement this policy. The following assumptions were used to develop the analysis:

- 10 buildings participating in a 10-year program (estimate based on the experience in New York, Oregon, and New Mexico)
- An average commercial building size of 50,000 square feet with a lifespan of 30 years
- 14.5 kWh/square foot average energy intensity for commercial buildings for climate zone 4 (CBECS 2003)
- Energy savings of 30% over current code for participating buildings
- State investment of $20 million (estimate based on other program experience).

The following analysis provides rough estimates of what the policy impacts may be in Hawai‘i in terms of the number of new green buildings participating in the program. However, it is impossible to predict the number of buildings that will participate, and costs and savings are highly sensitive to the number of buildings in the program. Furthermore, estimates are not provided for the possible impacts if this policy is designed to also provide tax incentives for energy efficiency improvements in existing buildings. To prevent depletion of state resources if many buildings take advantage of tax incentives for energy efficiency improvements, the state can set a cap on the amount of funding provided through this incentive.

Costs and Benefits

State Investment

The scope of these programs is limited based on the relatively large magnitude of investment necessary to encourage green building in the market. State investments and known number of buildings in program to date are listed in **Table 20.** The level of state investment necessary to stimulate green building would vary based on many factors, including the cost of electricity, the cost premium to build green, and the number of buildings that the state would like to be involved in the program. When designing such a program, the state can set a cap on the level of funding it will provide to prevent excessive revenue loss if a multitude of developers are interested in the tax incentives.

Table 20. Investment and Participation in Existing State Programs

State	Total Investment	Commercial Buildings	Residential Buildings
New York	$25 M (2001–2008)	7	NA
Oregon[27]	*Unknown*	*Unknown*	*Unknown*
Maryland	$30 M (2003–2011)	*Unknown*	*Unknown*
New Mexico	$10 M (50% residential, 50% commercial)	1 (2008)	> 50
Georgia	$10 M (2008–2012)	--	--

Benefits

In general, the impacts of the commercial programs in other states are between 1 and 20 commercial office buildings. Assuming a program comparable to other states and a state investment of $20 million over 10 years, and a relatively average impact of 10 buildings participating,[28] the program would save Hawai‘i more than 8,000 MWh of electricity over the life of the program (10 years), with additional savings continuing throughout the life of the buildings totaling about 65,000 MWh (See **Figure 3**).

[27] This Sustainable Building Tax Credit program is a part of the Business Energy Tax Credit program in Oregon, and separate program tracking has not been undertaken.
[28] This assumption comes from a combination of the slowing of commercial growth in Hawai‘i as a result of the economic downturn and the other state program impacts (Magin 2009).

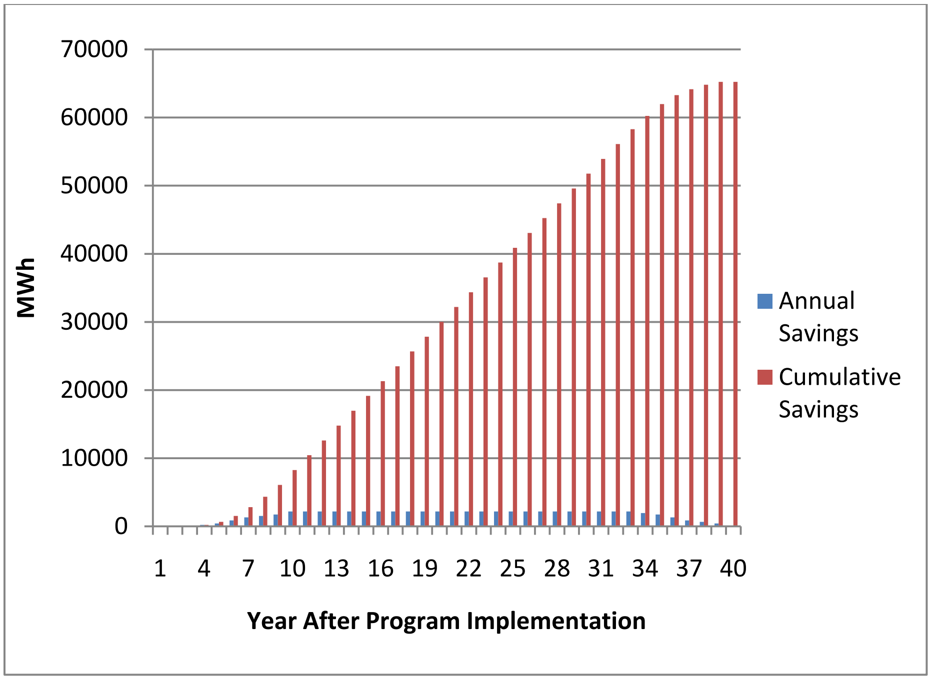


Figure 3. Potential annual and cumulative electricity savings

The high program investment required to facilitate green building commercial development results in a rather high cost-to-savings ratio of $9/kWh on average during the 10 years that the program is in place. However, over the life cycle of the buildings, the cost-to-savings ratio is $0.31/kWh.

How Does This Fit the HCEI Goals?

This policy ensures long-term energy efficiency and renewable energy by reducing the energy use baseline of new buildings in the State of Hawai‘i. It provides an incentive to green builders that reduces some of the risks of increased first costs of green building. In partnership with the required energy efficiency measures through building codes, it encourages further advancements by front-running builders and draws the green building industry to Hawai‘i. Finally, the tenants of the buildings will reap the benefits of lower energy costs, contributing directly to the goal of reducing the energy cost burden on consumers.

Next Steps

The dearth of information on the expected growth in commercial buildings in Hawai‘i makes it difficult to estimate the number of potential participants that would be interested in this type of incentive. As these data are released by DBEDT in the coming months, this information can be used to determine more Hawai‘i-specific impacts of this type of policy.

Policy Option: Density Bonus

Summary

A density bonus allows the state to offer developers the opportunity to increase the maximum allowable development on a property in exchange for meeting certain green building standards as defined by the state. Depending on the green building requirements, the participating buildings could achieve substantial energy savings. The possible statewide impact of this policy cannot yet be determined, as there is no data on the number of commercial buildings in Hawai‘i or the expected growth in the commercial building sector, although this data is expected to be released by the state in the coming months.

Policy Definition

This definition is adapted from the Center for Land Use Education (CLUE 2005): A density bonus is a nonfinancial incentive tool that permits developers to increase the maximum allowable development on a property in exchange for helping the community achieve public policy goals (such as energy efficiency or green design certification). Increasing development density may allow for increases in developed square footage or increases in the number of developed units. This tool works best in areas where growth pressures are strong and land availability limited, or when incentives for attaining the goals outweigh alternative development options.

In the case of Hawai‘i, there is precedence for allowing density exceptions for certain projects. For example, affordable housing projects in the City and County of Honolulu are allowed to apply for density exemptions under Section 201H-38 HRS, which also requires the review of the density exemption to be expedited. Similarly, one option for implementation of this type of policy would be similar to the implementation of expedited permitting, which requires counties that issue building permits to offer expedited permitting to private entities that incorporate energy and environmental design standards into their building (HRS 46 19.6). Policy success also depends on funding incorporated into the policy design to assist the counties in implementation of the program through funding or state-level training on density bonuses, how they are implemented, and their role in the overall building permit process.

Policy Design and Implementation: What Are Other Locations Doing?

Currently, at least seven localities across various geographic and climatic regions provide density bonuses for green buildings (**Table 21**). To date, Arlington is the only program to be evaluated.[29] The Arlington program is considered a success because the costs to the municipality have been minimal and the program has achieved high market penetration: 40% of buildings in progress since the beginning of the program are participating in the density bonus program. The program meets the needs of the municipality by incorporating green design elements in new commercial developments as well as those of the developer as the project generates additional revenue from the development of additional rental or residential space.

Table 21. Localities Implementing Density Bonuses

Locality	State	Year Implemented
Arlington	Virginia	2005
Ashland	Oregon	2005
Bar Harbor	Maine	2006
Nashville	Tennessee	2007
Portsmouth	New Hampshire	2007
Seattle	Washington	2006
Sunnyvale	California	2004

[29] The program in Arlington was evaluated by the team in Seattle that developed that city’s ordinance.

All localities, with the exception of Ashland, use the USGBC LEED certification system to ensure compliance with green building requirements, although compliance standards vary for different density bonus values, depending on local needs and interests. Ashland designed a unique system of points to determine density bonus qualifications that fit the water and energy conservation needs specific to the town. The benefit to using an established certification system is that the locality (or state) does not need to invest in the development of a unique system; however, tailoring can be done to meet the specific needs of the locality. The primary drawback to using a preestablished certification scheme is that it generally costs money for builders to become certified, thereby decreasing the overall value of the incentive.

No explicit best practices for design of density bonuses are published, although they have long been a successful tool for encouraging builders to achieve other public policy goals. For example, in 1989, California required localities to issue density bonuses to builders that committed resources to low-income housing development, resulting in increased low-income developments in the state (HCD 1989).

Methodology and Assumptions

Estimating the costs and benefits of this policy proves difficult, as only the program in Arlington has been formally evaluated. Also, there is currently no data on the number of commercial buildings in Hawai‘i, or the expected growth in the commercial buildings sector, although DBEDT is in the process of conducting a survey to determine the number of commercial buildings in the state and is expected to release this data in the fall of 2009 (Tian 2009).[30] Once this data is released, the programmatic uptake results from the Arlington program, with 40% of new buildings participating, can be applied to the estimated growth in the number of commercial buildings as a first step in determining the possible impact that this policy may have in Hawai‘i.

Costs and Benefits

As there is insufficient information to estimate the expected growth in the number of commercial buildings throughout the state, it is impossible to estimate the impacts this policy may have in Hawai‘i. The following section provides further qualitative insight into the costs and benefits of such a policy.

State Investment

To effectively implement this policy, state investment would likely be necessary to train the counties, provide appropriate technical assistance, and allocate funds for staffing. California, which implements the statewide requirement for local density bonuses for low-income housing, invested in the development of model ordinances for localities to use to minimize local investment in the program and ensure effective implementation. Other localities have invested in staff training. Arlington, the only formally evaluated program, did not initially fund additional staff members. However, within two years, the program had enough interest that the city identified the need for two more staff resources as funding became available. Hawai‘i may consider a budget allocation to assist with these needs in any proposed legislation.

[30] Arlington, VA

Benefits
If LEED certification is used, savings over Hawai‘i’s current code could range from 10% to 50% for participating buildings, depending on the level of LEED certification required to be met for a development to qualify for a density bonus. If the program uptake in Arlington, Virginia, is used as the possible programmatic uptake in Hawai‘i (40% of new buildings), the energy savings improvements could be substantial if there is considerable growth in the number of commercial buildings.

How Does This Fit the HCEI Goals?
This policy ensures long-term energy efficiency and renewable energy by promoting energy efficiency in new commercial buildings in the State of Hawai‘i. It provides an incentive to green builders with minimum cost to the state and localities. In partnership with the required energy efficiency measures through building codes, it encourages further advancements by front-running builders and draws the green building industry to Hawai‘i.

Next Steps
Further analysis of the demand for increased density allowances among developers in Hawai‘i would provide deeper insight into the effectiveness of this policy and the number of green building projects that this policy would promote.

Policy Option: Residential Energy Conservation Ordinance

Summary
In the fall of 2008, HCEI recommended that the legislature adopt a policy requiring that historical energy bills be provided by the owner at the time of sale and time of lease to a prospective buyer or renter. In 2009, the legislature passed HB1464, which requires, prior to the sale of a house, the seller to provide the buyer with electricity bills from the previous three months. The requirements for energy information exchange prior to a lease were not adopted.

Providing potential buyers and renters with information about the historical energy usage of a home allows them to incorporate the lifetime energy costs into their decision-making process. Strengthening the existing policy by incorporating rental units and requiring the transfer of a standard energy disclosure form from the seller/lessor to the buyer/renter or implementing a Residential Energy Conservation Ordinance (RECO) would allow buyers/renters to make better-informed decisions when deciding on a home, while also promoting energy efficiency improvements in the existing residential building stock. As it is challenging to determine the increased savings that would result from requiring a standard energy disclosure versus three months of utility bills as is currently required, this section focuses on the possible impacts of establishing a RECO.

Based on the estimated impacts of existing programs, energy savings in Hawai‘i could range from 70 to 300 GWh over 20 years, depending on the number of homes that are required to implement upgrades and the level of efficiency improvements they achieve. Maximum costs per home can be capped to minimize the financial burden on homeowners; the maximum implementation costs to residents in other locations with RECOs typically range from $800 to $1,100 per house.

Policy Definition
Hawai‘i passed legislation in 2009 that requires sellers to provide buyers with the electricity bills from the three previous months (HB1464). For LY 2009, the initial legislation recommendations from HCEI included mandates for similar requirements for leased properties; however, this was cut during the 2009 legislative process. Requiring the exchange of the level of energy efficiency of a home at the point of sale or lease provides buyers with the information necessary to incorporate future energy costs into the decision-making process.

There are two main directions that can be taken to strengthen this policy:

- **Requiring standard energy disclosure forms** to be provided by the seller/lessor to the buyer/lessee at the point of sale/lease. More stringent disclosure requirements mandate that the seller/lessor have an audit completed prior to sale/lease. After completing the audit, the auditor prepares a uniform document for the seller/lessor to provide to potential buyers/renters detailing the energy efficiency level of the home. A key to successful disclosure-only policies is educating the public on how to interpret the data on the disclosure document, including providing prospective home buyers/lessees with information on average residential energy use for comparison purposes, the costs and benefits of efficiency upgrades, and how to read to the disclosure document (Brown et al. 2009). In existing programs in the United States, audits are generally conducted by either a certified inspector or a government inspector who completes an initial audit and, if necessary, a second audit post-upgrades to ensure compliance. Berkeley, however, contracts with a nonprofit organization for these types of audits (Boulder 2007).
- **Developing and implementing a RECO**, which mandates that, prior to sale or lease, homes meet a minimum efficiency standard. The efficiency requirements are generally identified as a list of efficiency measures that must be met, and an audit is performed to determine whether or not the house, in its existing condition, is in compliance.[31] If a house already meets the minimum requirements, then no further action is necessary. If a house is not in compliance, then the owner must implement the efficiency measures as defined by the RECO. To prevent excessive costs to owners with highly inefficient homes, this policy is usually designed with a ceiling for the costs of required efficiency upgrades (either a set amount or a small percentage of the total sale price, typically 1% or less). The policy can also be designed to allow buyers/lessees to waive this right at the time of sale.

Both of these policies address the difficulties in improving the efficiency of the existing building stock by encouraging (standard energy disclosure forms) or mandating (RECO) energy efficiency improvements. In the United States, energy efficiency was considered to be an important factor for over 90% of potential homebuyers, and this policy helps standardize this metric for home buyers/lessees when considering multiple housing options and essentially places a higher value on more efficient homes (Brown et al. 2009).

[31] In existing programs in the United States, audits are generally conducted by either a certified inspector or a government inspector who completes an initial audit and, if necessary, a second audit after the upgrades have been completed to ensure compliance.

Developing a RECO for Hawaiʻi requires the development of a list of efficiency standards that are specific to the local climate. Local energy efficiency and building code experts are likely best equipped to develop a list of relevant measures for Hawaiʻi. Based on energy efficiency studies completed for the KIUC, cost-effective measures may include:

- Window upgrades
- Water heater upgrades
- Low-flow shower head and faucet aerator installations
- Insulation and other building envelope improvements (KEMA 2005).

Establishing a builder education program may also be helpful to ensure that builders and local trades people are kept abreast of energy efficient technologies and practices to implement when retrofitting homes.

Incorporating rental units into either of these types of policies is integral to addressing the market barrier that exists because the renter pays for the electricity use and the landlord does not have an incentive to fund efficiency improvements for which the renter reaps direct financial benefits. In Hawaiʻi, rental units represent about 50% of the total residential building stock (DBEDT 2008a). Therefore, any energy use disclosure or RECO policy that exempts residential rental units will be unable to address energy efficiency issues in half of the residential building stock.

Policy Design and Implementation: What Are Other Locations Doing?
A variety of disclosure policies exist throughout the country. Maine requires all lessors to provide renters with information about the energy efficiency of the unit before signing a rental agreement, and Kansas requires all realtors and homebuilders to provide a standard energy efficiency disclosure form to potential buyers. Austin's Energy Conservation Audit and Disclosure Ordinance, which went into effect on June 1, 2009, requires all single-family houses more than 10 years old to have an energy audit completed before a sale is finalized. Similar energy efficiency disclosure policies are currently being considered in other states, including Oregon and California.

RECO policies, which have been around since the early 1980s, currently exist in a variety of forms as well (**Table 22**). The RECOs in San Francisco and Berkeley are considered to be the most successful in the country, measured in terms of compliance and estimated energy savings (Suozzo et al. 1997).

Table 22. Implementation of State/Local RECOs

	Year	Property Type	Single-Family Cost Ceiling	Penalties for Non-Compliance
Ann Arbor, MI	1987	Rental	None	Y
Berkeley, CA	1981	Single-family, multi-family, ownership	0.75% of sale price	N
Boulder, CO	Under development	Rental	--	--
Burlington, VT	1997	Rental	None	Y
Roseville, CA[32]	1982	Single-family, multi-family, ownership	None	N
San Francisco, CA	1982	Single-family, multi-family, ownership	1% of sale price or assessed value, not to exceed $1,000	Y
Wisconsin	1985	Rental	None	Y
Author's adaptation from Suozzo et al. 1997, Table 9				

To prevent excessive costs to the owner, RECOs generally stipulate a cost ceiling for mandated efficiency upgrades as well as waiving the requirements if they are deemed inappropriate in a specific situation. Some programs set the ceiling at a specific dollar value, while others cap mandatory spending at a certain percentage of the sale price of a home (usually 1% or less).

Based on the most comprehensive case study analysis that exists in the literature, the following best practices emerge (Suozzo et al. 1997):

- Support stakeholder involvement, especially within the industries most affected (i.e., realtors, energy auditors, and homeowners).
- Establish methods for compliance tracking and penalties for noncompliance.
- Collect and publicize data on impacts (i.e., ease of compliance, dollar and energy savings, job creation, etc.).
- Perform periodic revision of minimum efficiency standards as best available technologies improve.

Methodology and Assumptions

As it is challenging to quantitatively determine the impact of requiring a standard energy disclosure form, the following analyzes the potential impacts of a RECO. The following assumptions are used to estimate the impacts that a RECO may have in Hawai'i:

[32] This program is no longer enforced, as the policy was designed to require that, at the time of sale, all homes built prior to 1979 have an energy audit completed. The onus for setting up the audit fell on the real estate agent. As the majority of the residential building stock is now too new to be required to have an audit, the program just stopped being used (Morrison 2009).

- 8,254 homes sold per year, based on the average number of homes sold per year from 2002 through 2007 (DBEDT 2007)
- Average energy use per home of 7,827 kWh/year (DBEDT 2007)
- Average residential electricity price of $0.2394/kWh, weighted based on the number of residential customers for HECO, HELCO, and MECO (HECO 2009b; DBEDT 2007)
- A 3% annual increase in the price of electricity
- Cost of $100 for the initial audit (Boulder 2007)
- Average cost for energy efficiency improvements ranging from $700 to $1,000 per house for those not in compliance with the RECO standards (Boulder 2007; Geller et al. 2005)
- Estimating that only 10% to 25% of the homes sold per year would be required to implement efficiency improvements to comply with the RECO, achieving efficiency gains from 5% to 10% [while there is little data on actual savings generated, the San Francisco RECO estimates efficiency savings of 15% (Geller et al. 2005)].

Costs and Benefits

State Investment

The state investment required in Hawai‘i will depend greatly on policy design. The main state investment associated with a RECO would be to develop, implement, and enforce this policy. The majority of existing RECO programs recover the public costs through minimal filing fees, generally ranging from $15 to $50 (Souzzo 1997; Boulder 2007). Incorporating the process into existing inspection processes that occur at the time of sale also helps minimize additional costs.

Monitoring and verification and consistent disclosure reporting are integral to successful implementation (Brown et al. 2009). Training for auditors and county officials, as well as an education campaign to explain the program to the general public and affected industries (e.g., realtors), is a valuable way to enable program success, although it requires further state investment (Geller et al. 2005).

Resident Investment

The cost to residents is highly dependent on policy design as well. For RECO policies, the main costs, beyond the cost of an audit, which is estimated to range between $100 and $500 per home, will be dependent on the types of efficiency measures that must be implemented (Brown et al. 2009). To minimize the costs, ceilings can be determined for mandated efficiency improvements so that a seller will pay no more than either a certain dollar amount or a set percentage of the total sale price.

For locations with high energy costs like Hawai‘i, this type of policy has the potential to incorporate future energy costs into the decision-making process of buyers/renters. If this becomes a market driver, potential sellers/lessors with inefficient homes may have the incentive to implement efficiency improvements to make their homes more marketable. The costs for these individuals would vary based on the energy inefficiency of their homes or rental units. Interestingly, a study of states with property condition disclosure laws (not specific to efficiency, however) found that this information does not financially harm the seller but actually results in a higher sale price because it increases the buyer’s confidence in the property (Nanda & Ross 2008).

The ranges in **Table 23** represent the range in costs with 10% to 25% of homes sold annually being required to implement efficiency improvements. The per-house cost range is chosen based on the average costs to meet RECOs in other localities. This range could be higher or lower depending on the compliance standards as defined in a Hawai‘i-specific RECO or the cap set for spending.

Table 23. Estimated Costs to Residents ($)

	Per House	Per Year	Cumulative		
			5 Years	10 Years	20 Years
Audit	100	83 K–206 K	413 K–1.0 M	825 K–2.1 M	1.7 M–4.1 M
Upgrade	700–1,000	578 K–2.1 M	2.9 M–10.3 M	5.8 M–20.7 M	11.6 M–41.3 M

Benefits

RECOs increase the transparency for buyers/renters when choosing between multiple units because they can incorporate the energy-related operation and maintenance (O&M) costs into the total cost of the unit, allowing the buyer/renter to make a more informed decision. In locales with high or volatile energy prices, this information can be particularly beneficial to buyers/renters when determining the financing necessary for purchasing or leasing a unit. One unique benefit of this policy is that it incentivizes efficiency improvements in the existing building stock, whereas code improvements and other similar policies are limited to addressing energy efficiency issues in new construction.

This policy has the potential to increase private investment in energy efficiency improvements of the existing building stock. The benefits of RECOs have been documented, and it is estimated that they result in a 10% to 15% improvement in home and rental unit efficiency (Boulder 2007). On the mainland, it can be expected that each home turns over about once every five years and that the majority of the existing residential building stock will be reached within about 20 years; however, the overall benefits in Hawai‘i depend on the local turnover rate (Brown et al. 2009).

In addition to reducing energy demand and GHG emissions, the benefits of this policy also include job creation and energy efficiency capacity building at the local level. Less tangible benefits are achieved as key information barriers are addressed by internalizing the value of energy performance into homes and rental units (Brown et al. 2009).

The ranges in **Table 24** represent the range in savings with 10% to 25% of the homes sold annually being required to implement efficiency improvements under a RECO. **Table 24a** demonstrates the expected range of savings if the 10% to 25% of homes that are required to implement efficiency improvements under the RECO experience, on average, a 5% increase in efficiency.[33] **Table 24b** demonstrates the expected range of savings if the 10% to 25% of homes that are required to implement efficiency improvements under the RECO experience, on average, a 10% increase in efficiency.

[33] While the mainland average energy savings is estimated to be between 10% and 15%, because of Hawai‘i's minimal heating and cooling load, especially in the existing building stock, a 5%–10% estimate for energy savings has been used to demonstrate probable ranges for gains in efficiency.

Table 24. Estimated Savings

	24a. 5% Efficiency Gains				24b. 10% Efficiency Gains			
	Per Year	Cumulative Statewide			Per Year	Cumulative Statewide		
		5 Years	10 Years	20 Years		5 Years	10 Years	20 Years
GWh	.3–.8	5–12	18–44	68–170	.6–1.6	10–24	36–89	136–339
Dollars	77 K–193 K	1.3 M–3.1 M	5.1 M–12.7 M	23.8 M–59.6 M	155 K–387 K	2.5 M–5.0 M	10.2 M–25.5 M	47.7 M–119.2 M

How Does This Fit the HCEI Goals?

More stringent disclosure requirements will provide buyers/renters with better information about the energy efficiency level of the home or rental unit they are considering, allowing buyers/renters to incorporate energy-related O&M costs into their purchasing decisions. By mandating efficiency improvements in inefficient homes, a RECO guarantees efficiency improvements are adopted in the existing residential building stock. Unlike most other efficiency policies, these types of policies address inefficiency problems in the existing building stock, helping Hawai‘i achieve its long-term efficiency goals since, at the time of the most recent census, over 80% of the homes in Hawai‘i were built prior to 1990 (Census 2000).

Next Steps

Data on the level of efficiency of the existing residential building stock would allow for further refinement of the costs and benefits of this type of policy in Hawai‘i and a better understanding of the specific efficiency measures that would likely be most beneficial if included in a RECO.

Policy Option: Lead by Example—Energy Efficient/Green Affordable Housing

Summary

A lead by example (LBE) energy efficient affordable housing policy promotes the energy efficiency improvements over code in new, state-funded affordable housing projects, a market that has traditionally focused on lowest capital cost projects without incorporating the long-term costs associated with doing so. Based on case studies of existing green affordable housing projects throughout the United States, the up-front cost to developers to build green affordable housing averages about 2.4% of the conventional costs (Bradshaw et al. 2005). Over the life cycle of the building, the costs of building a green affordable unit are lower than the costs of conventional construction because the savings from reduced O&M costs over the life of the building are greater than the increase in up-front capital costs. However, because the benefits are distributed unevenly, so that the developer pays for the increased investment and the owner and residents benefit from reduced O&M and utility costs, there is currently no incentive for developers to build more efficient projects.

While Hawai‘i has a significant demand for affordable housing, the state does not expect there to be an increase in construction of new state-funded affordable housing developments. However, if the state does fund enough projects to meet the demand through 2015 and requires that these projects be designed to be 15% more efficient than code, the estimated cumulative energy savings from 2010 through 2015 are 99 GWh.

Policy Description

An LBE energy efficient affordable housing policy requires developers of publicly funded affordable housing to build more energy efficient units to meet higher efficiency standards as defined by the state. Many green affordable housing projects incorporate sustainability measures beyond just energy efficiency related improvements. These requirements can be determined based on nationally recognized standards, such as LEED, or on specific standards developed by the state. The main benefits of this program include:

- Financial savings from reduced energy costs for residents of affordable housing in the form of reduced monthly combined mortgage and utility bill costs for homeowners and reduced combined monthly rent and utilities for renters
- Reduced energy demand statewide
- Increased knowledge of green building practices for local developers.

This policy addresses the following key barriers to energy efficient construction in affordable housing:

- Historically, developers of affordable housing projects focus solely on up-front capital costs and ignore energy-related O&M costs because the tenants are typically responsible for the utility bills, creating a disincentive for developers to invest in efficiency measures that may increase the up-front costs of construction.
- Contracts for affordable housing are generally awarded to the lowest bidder, creating an incentive for low-cost construction.
- In the instances where the developer of the project does not maintain management of the project, there is little incentive for the developer to incorporate O&M costs (such as equipment repair) into the design process, often leading to the use of lower-quality materials and equipment, which require more frequent replacement and are often less energy efficient.

Policy Design and Implementation: What Are Other Locations Doing?

A variety of states and cities have adopted requirements for green affordable housing, either incorporating existing green standards or developing their own, that must be incorporated into any affordable housing project applying for state funding. These requirements often extend beyond simply increasing energy efficiency and usually include water conservation, material conservation, and other sustainable measures as well. For example, Florida, Minnesota, New York, Ohio, and San Francisco, California, have partnered with Enterprise Community Partners Inc. and adopted the Green Communities Criteria for affordable housing, which incorporate integrated design, site, and locational considerations; water conservation; energy efficiency; environmentally preferable material use; and O&M considerations (Green Communities 2009). Eligible projects under the Green Communities program may qualify for additional funding support through the program.

The Green Communities energy efficiency related criteria include the following (Green Communities 2008):

- New construction meets Energy Star or American Society of Heating, Refrigerating and Air-Conditioning (ASHRAE) 90.1-2004 standards, depending on size of the structure.
- The energy efficiency in all remodels is improved by 15% compared to the prerenovation energy use.
- Installed appliances meet Energy Star standards.
- The Energy Star Advanced Lighting Package is installed in all interior units.
- Outdoor lighting is installed with daylight sensors and timers.
- Units are submetered for electricity.
- A variety of other optional measures are taken.

Maine developed its own Green Building Standards in 2005 (Maine 2007). The energy efficiency related standards address energy efficiency in three areas:

- Building envelope
- Systems and appliances
- Interior lighting.

While developing unique, state-specific standards ensures that the requirements best meet the local context, adopting existing, nationally recognized standards reduces the financial burden associated with developing new standards. Boston, for example, requires that all public affordable housing be LEED Silver certifiable (the certification is not required, but meeting the standards is) and meet Energy Star standards. Washington State and the city of Seattle require that all affordable housing projects that receive state or city funding, respectively, either meet or exceed the Energy Star Homes Northwest standards or be 15% better than the Washington State Energy Code for multifamily units (Washington 2008). Another option is to adopt an existing standard and amend it as appropriate. For example, Minnesota currently amends the Green Communities criteria with state-specific requirements.

Requiring better-than-code construction for affordable housing may necessitate education programs for local developers. Boston's Green Affordable Housing Program (GAHP), instituted in 2007, used initial grant funding not only to develop the program requirements, but also to provide green building training courses for the development community, mandatory for any developer applying for GAHP funding (Burke et al. 2007).[34] All affordable housing projects in Boston that receive city funding must meet the GAHP standards, even if only a portion of the units are considered affordable housing (Feuerbach 2009).[35] Any developer receiving GAHP

[34] Some of the funding also went directly toward installing distributed renewable energy technologies on existing affordable housing developments.

[35] The Department of Neighborhood Development (DND) funds projects in which all units are considered affordable housing and others in which only a portion are designated affordable and the others are sold or rented at market rate. In both cases, all units, both affordable and market rate, must meet the green affordable housing standards. For

funding is also required to leverage it with funding from other sources, including utilities and nongovernmental organizations.

Methodology and Assumptions
Affordable housing in Hawai'i encompasses a variety of programs, including residences for the homeless, public housing, and affordable rentals and homeownership for those earning up to 140% of the U.S. Department of Housing and Urban Development's (HUD's) median income for each county.

- Public housing, which is owned by the Hawai'i Public Housing Authority (HPHA), refers to subsidized housing available for those who make less than 50% of the median income.[36]
- The Hawaii Housing Finance and Development Corporation (HHFDC) focuses on affordable rentals and affordable units for first-time buyers.

As such, state funding for affordable housing comes from a variety of departments depending on the type of affordable housing. This allows for an LBE affordable housing policy to be designed to focus on a specific type of affordable housing if so desired. For example, in Boston, the funding for *public housing* is managed by the Boston Housing Authority (BHA), while the Department of Neighborhood Development (DND) manages the funding for *affordable housing* that is generally developed for households on the higher end of the HUD median income affordable housing requirements. Any projects receiving funding from and subject to the design review of the DND for affordable housing must meet the DND's green affordable housing requirements (LEED certifiable, among other conditions), as the requirements are incorporated into the design review process (Feuerbach 2009).[37] Therefore, this policy has been designed to target green buildings for affordable housing on the higher end of the HUD median income, but not public housing, because the latter is funded and managed by the BHA.

The expected growth in state-funded affordable housing units is a key component in determining the impacts of a policy such as this in Hawai'i. The number of public housing units owned and administered by the HPHA remained constant from 2003 through 2005 at 6,262 units and fell to 6,195 units in 2008 (DBEDT 2007; DBEDT 2008a). Staff at the HPHA confirmed that, although about 0.7% to 1.3% of the existing public housing units are expected to be retrofitted and brought up to code each year, there is not expected to be any growth in the number of public housing units, and affordable housing for those with incomes below 50% of the median income is expected to remain in short supply (HPHA 2009; SMS 2006).

The DBEDT Data Book does not track the number of *all* affordable housing units. However, according to an HHFDC study currently in progress, from 2010 through 2015, 17,400 affordable

---

example, if 15% of the units in a development receive state affordable housing funding, all units in the development must still meet the GAHP building standards.

[36] The HPHA also administers the Section 8 housing program, which provides federal subsidies for those earning up to 80% of the median income and renting from privately owned units. Under this program, tenants pay 30% of their income toward rent, and the remainder is provided to the landlord through federal subsidization up to the U.S. Department of Housing and Urban Development's fair market rent.

[37] Occasionally the DND provides funding to the BHA for public housing projects. In these cases, the project will likely not be subject to the DND's design review because it will fall under the purview of the BHA.

rental units and 6,800 affordable *for-sale* units are expected to be needed to meet the demand (SMS *in publication*). The demand for affordable rental units is determined by the expected growth in the number of households with incomes up to 80% of the median income and therefore includes households that would qualify for public housing offered by the HPHA. The demand for affordable for-sale units is determined by the expected growth in the number of households with incomes between 80% and 140% of the median income. Although this is the projected demand for affordable housing over the next six years, it does not mean that the growth in affordable housing development will match this demand.

Quantitatively estimating the costs and benefits of implementing an LBE affordable housing policy based on existing projects is challenging because many of the existing policies do not solely address energy efficiency improvements and instead focus more broadly on incorporating a variety of sustainable measures. To determine approximate energy savings, this analysis assumes that the entire affordable housing demand is met by 2015 and that the average energy use per residential unit is 7,827 kWh per year (DBEDT 2007).[38] As such, the estimated savings presented in this analysis likely provides a ceiling on the possible savings. Estimates are provided for the energy savings based on these units being built 15% and 30% more efficient.

Costs and Benefits

State Investment

The costs to the state to implement an LBE energy efficient affordable housing policy vary depending on the level of support that the state wishes to provide. Initial state funding would be necessary to develop the requirements and determine how to incorporate the new energy efficiency standards into the current system for allocating funding for affordable housing. It will require more time and investment if the state chooses to develop unique efficiency standards instead of adopting or amending a nationally recognized green community or green building standard. It may also be necessary for the state to provide training about the standards to state officials as well as to the development community in general. If the efficiency standards are incorporated into the design review, as they are in Boston, the incremental cost to the state to enforce compliance will be minimal. Providing a training course to developers will require further funding.

Resident Investment

Residents of affordable housing units will not experience an increase in costs because the incremental up-front costs will be borne by the project developer. Due to the increased efficiency of the units, the residents will experience a decrease in their monthly utility bills. Across the country, low-income families typically spend 14% of their income on energy while non-low-income families spend an average of only 3.5% (EERE/DOE 2001). As such, improving energy efficiency standards for affordable housing can help drastically reduce the costs that these families are spending on energy, allowing them to purchase other essentials.

[38] This is the annual average residential energy use for the state of Hawai‘i in 2007 and is highly dependent on whether or not any of the affordable housing units install air-conditioning. If air-conditioning units are installed, the estimates for average use will be much higher.

Developer Investment
The up-front cost of green affordable housing throughout the country is about 2.4% more than the costs to build conventional affordable housing (Bradshaw et al. 2005). The affordable projects analyzed to determine this average are green affordable housing projects and do not focus solely on energy efficiency improvements but rather on incorporating sustainable measures more broadly. This analysis is unable to estimate incremental costs for building affordable housing in Hawaiʻi to achieve a specific increase in efficiency.

The cost and benefits to developers also vary depending on whether or not the developer maintains ownership of the project. By maintaining ownership, the developer will reap the financial benefits of reduced O&M costs over the life cycle of the building.

Benefits
Overall, the net present value of green affordable housing is higher than the net present value of conventional affordable housing developments even though the up-front costs are estimated to be about 2.4% higher (Bradshaw et al. 2005). This means that, when comparing the up-front capital costs and the O&M costs, including utility costs, over the lifetime of the building, it is cheaper to build green affordable housing than conventional affordable housing. However, because the costs and benefits are not evenly distributed (the developer pays the up-front incremental costs, the owner benefits from reduced O&M costs, and the residents benefit from reduced utility bills), a disincentive remains for developers to build more sustainable affordable housing projects. An LBE energy efficient affordable housing policy addresses this disincentive. **Table 25** provides the cumulative energy savings estimates from 2010 through 2015 if the policy is designed so that all state-funded affordable housing projects are built either 15% or 30% more efficient than the current code.[39]

Table 25. Estimated Cumulative Efficiency Savings

15% More Efficient than Code	99 GWh
30% More Efficient than Code	199 GWh

How Does This Fit the HCEI Goals?
Adopting an LBE energy efficient affordable housing policy helps achieve the efficiency improvement goals of HCEI by incorporating efficiency improvements into all future affordable housing projects, a sector that currently has a strong incentive to favor developments with low up-front capital costs and discount the life-cycle O&M and utility costs.

Next Steps
Determining the costs and possible savings of this type of policy in Hawaiʻi requires a better understanding of the expected growth in state-funded affordable housing projects based on the number of projects that will be implemented to meet the growing demand.

[39] This assumes that the entire demand for affordable housing is met by 2015 with projects eligible for state funding and with an equal amount of units being built each year.

Policy Option: Lead by Example—30% More Energy Efficient New and Existing Public Buildings

Summary

In 2006, the state instituted an LBE initiative to increase energy efficiency for the state executive agencies' buildings and operations (established by Act 96, SLH 2006, Part III). The various efforts include:

- Providing energy efficiency education programs
- Requiring LEED Silver for new construction
- Reducing petroleum consumption by the state vehicle fleet through increased efficiency and fuel diversification
- Increasing procurement of environmentally preferable products.

A near-term goal of reducing energy consumption by 9% of the FY 2005 baseline was established for FY 2008 with an overall goal of a 26% reduction in energy consumption by FY 2015 (DBEDT 2009). These goals are expected to be met through education programs and through repair and maintenance and O&M of existing facilities. Energy use in FY 2008 was 3.6% higher than the baseline year, although energy consumption fell 1.2% between FY 2007 and FY 2008.

Policy Definition

Although an LBE initiative for new and existing state buildings exists, the state was unable to meet its near-term goal for reducing energy consumption by 9% of the FY 2005 baseline by FY 2008. The policy can be refined and strengthened to encourage implementation of more stringent energy efficiency measures so that the energy use from state facilities is reduced sufficiently to meet aggressive long-term targets.

To strengthen the existing LBE initiative, a variety of policy options exist, including:

- Setting a more stringent goal for overall energy efficiency improvements by a certain date
- Requiring more rigorous certification achievement (i.e., HERS, LEED Gold—could be certified or certifiable) for new construction.

Policy Design and Implementation: What Are Other Locations Doing?

More than 40 states either have implemented or are considering implementing some sort of LBE energy efficiency initiative for state facilities (EPA 2008). The long-term energy reduction goals for most of these states range from 10% to 35% of their established baseline energy use, usually based on the annual energy use from some year in the middle of this decade. Some notable aspects of these initiatives include the following:

- Alabama has required each agency to assign an Energy Officer to oversee the implementation of energy efficiency programs.

- Various states require new buildings to meet specific building standards, such as LEED Silver (some with amended energy efficiency requirements as well), HERS ratings, Energy Star ratings, etc.
- California mandates that state agencies that are leasing buildings seek leases in buildings that are Energy Star rated.
- Louisiana requires all state facilities over 15,000 gross square feet to be built 30% more efficient than code. The size of the buildings required to comply decreases annually so that by 2011 all buildings greater than 5,000 gross square feet must comply. Other states have similar policies.
- Montana requests that state employees reduce work-related travel when possible.
- Utah has implemented a one-year pilot program mandating that all employees work a four-day work week (Monday through Thursday, 10 hours a day) and are expecting to save $3 million in avoided utility costs.

The main funding options used for similar policies currently implemented in other states include the following (EPA 2006):

- Revolving loan funds
- Energy performance contracting (Hawai‘i is already doing this as part of the LBE initiative—10 State Capitol District buildings are planned to be retrofitted as a part of the performance contract with NORESCO)
- Public Benefit Fund
- General Fund
- Redirection of the energy efficiency savings from the O&M fund toward capital investments for further efficiency gains
- Modification of procurement rules to incorporate a life-cycle cost basis into the decision-making process.

Measurement and verification are integral to successfully achieving LBE goals. To do so effectively, a state should develop a baseline against which to measure savings and develop a database and procedures to ensure consistency in the measurement and verification process. Hawai‘i has done both, by setting FY 2005 as the baseline and acquiring the utility information for each department directly from the utility to ensure the consistency of annual measurements.

Costs and Benefits

State Investment

The investment required by the state is highly dependent on the expected growth in new buildings, the number of major renovations and the level of energy efficiency that must be achieved. While the costs will be incorporated into the up-front cost of the building, the financial benefits from reduced energy costs will be spread out over the life cycle of the building.

Benefits
The general benefits of an LBE energy efficiency program for state facilities include:

- Leveraging public purchasing power to drive the market and demonstrate feasibility of efficiency measures and technologies
- Reducing building operation costs, therefore freeing up financial resources for other expenditures
- Achieving cost savings through the aggregated purchase of more efficient technologies
- Developing the local market for clean energy products, manufacturers, and services (e.g., energy service companies, renewable energy equipment installers, and energy-efficient product retailers)
- Providing an example for the public (EPA 2006).

How Does This Fit the HCEI Goals?
Strengthening the existing LBE goals for energy efficiency in new and existing public buildings will allow the state to demonstrate that the HCEI goals are achievable. This type of policy also spurs local market development and knowledge of energy efficiency technologies and methods.

Next Steps
Further research in the following areas would be beneficial, as they would provide a better understanding of the impacts of this policy as well as the most effective strategies for implementation.

- Determine the rate of retrofit and expected growth of state facilities to better understand how these efficiency gains will impact the state, both in terms of costs and expected energy and dollar savings.
- Work with the state to determine the best mechanism to ensure the state meets its efficiency goals and has sufficient support to do so.

Fuels

Liquid fuels in Hawai'i are used not only for transportation, which requires about 60% of the energy demand in the state, but also to generate electricity, with 90% of the state's total energy consumption fueled with imported oil (EIA 2009). Hawai'i residents are consistently subject to one of if not the highest average fuel prices in the nation (Pacific 2009). For example, at the time of this writing, the average price at the pump for regular fuel in Hawai'i was $3. 25, about 25% higher than the national average, and prices were higher in only one state, Alaska (AAA 2009).[40] The high price of fuel in Hawai'i negatively impacts the economy by driving up the cost of other goods and services because transportation-related costs to bring these goods and services to the state can be very high.

The state's dependency on imported fuels leaves the state vulnerable to price fluctuations and supply constraints. To break the state of this dependency, the Fuels working group members selected the following policies as possible options for addressing barriers to the development of local renewable liquid fuel opportunities. Developing locally grown fuels is an important goal for the state, as it hopes to not only transition away from fossil fuel dependency, but also to produce much of its energy from in-state resources to strengthen the local economy and break the dependency on imported energy sources. Besides developing the appropriate policy environment to facilitate the growth of this industry, HCEI is also analyzing the state's biofuel resources to determine the feasibility of and barriers to local biofuel growth.[41] The impact analyses below were completed over several months and provided to the working group members to aid them in determining which policies would best achieve the HCEI goals and should be recommended to the state legislature for adoption in LY 2010.

Policy Option: Expansion of the Biofuel Facility Tax Credit

Summary

Hawai'i has an existing tax incentive for ethanol production facilities, the Ethanol Facility Tax Credit. Enacted in 2006, this policy is a refundable investment tax credit (Hawai'i Revised Statutes 2008b). Changes to the existing legislation, which were proposed in the 2009 legislative session but not passed, would expand the credit to larger facilities as well as facilities that produce any biofuel, not just ethanol (Hawai'i House 2009b).[42] For the purposes of this policy, "biofuel" means ethanol, biodiesel, diesel, jet fuel, or other liquid fuel meeting the relevant fuel specifications of ASTM International (formerly ASTM, the American Society for Testing and Materials), per the definition in HB1054. If the proposed changes to the legislation are enacted and do not result in an expanded biofuel industry in the state, additional legislative actions are presented in this document for future consideration.

Policy Definition

Hawai'i's facility tax credit currently states that any ethanol facility with a production capacity between 500,000 and 15 MGY is eligible for a tax credit equivalent to 30% of the dollar amount of its nameplate capacity (i.e., $0.30 per gallon of installed capacity) (Hawai'i Revised Statutes

---

[40] The state gasoline taxes in Hawai'i, which rank seventh in terms of cheapest state gasoline taxes, (including excise taxes, environmental taxes, special taxes, and inspection fees) are $0.05/gallon less than the national average at $0.17/gallon as of July 2009. The local option taxes in Hawai'i are as follows: Honolulu - $0.165/gallon, Maui - $0.16/gallon, Hawai'i - $0.088/gallon, and Kaua'i - $0.13/gallon (EIA 2009b).

[41] See the Bioenergy Master Plan for further details (HNEI 2009).

[42] See the end of this document for a discussion on the definition of biofuel.

2008b). This refundable tax credit is applicable on an annual basis during an eight-year credit period, and is capped at 100% of the total investment made by the taxpayer in the qualifying facility during the credit period. The policy has a number of other provisions, including a requirement that the facility produce at least 75% of its capacity each year to be eligible for the credit. The state's financial exposure is capped at $12 million annually over the maximum 16-year credit period, and the credit is only applicable to the first 40 MGY of ethanol production capacity built in the state.

This legislation provides impetus for first movers to develop biorefineries by providing a mechanism whereby the total investment cost of the facility can be recovered over the course of eight years. As the policy is currently structured, the tax credit would be financially favorable to plants with lower capital costs, since the state policy would provide a benefit up to $2.40 per gallon of installed capacity ($0.30 for eight years). However, plants with lower capital costs are likely to have less feedstock flexibility and therefore may experience higher operating costs or higher risk associated with feedstock supply availability. Focusing on smaller capacity, less flexible plants may be limiting the usefulness of the current incentive, especially in the context of the state's goal of 70% clean energy, which will require large-scale biofuels production.

Additionally, the current legislation only incentivizes the first 40 MGY of ethanol production capacity in the state. Analysis in the Bioenergy Master Plan and by Booz Allen Hamilton has suggested that the state has the potential to produce approximately 200 MGY of biofuel.[43] A policy that is broader and encourages the state to develop its full biofuel production capacity would have a greater impact on moving Hawai‘i toward its ultimate goal of energy security through locally produced biofuels. However, a broader incentive would be more costly to the state.[44]

HCEI's proposal to the 2009 legislature, which was introduced but not passed in the 2009 session, would make facilities that produce any kind of biofuel eligible for the tax credit and allow plants bigger than 15 MGY to claim the tax credit for the first 15 MGY of capacity.

- ***Pros:*** The policy encourages the development of biodiesel, biobutanol, and other biofuels as well as ethanol. As the tax credit is allowable for eight years, the current policy language allows biofuel plant owners to recover a significant portion of their capital investment (up to 48% for cellulosic plants and 100% for all other biorefineries evaluated). Allowing plants larger than 15 MGY to claim the tax credit would enable plants to benefit from greater economies of scale—as much as the feedstock supply allows.
- ***Cons:*** The policy still limits the total biofuel production volume covered by the tax credit to 40 MGY, and uncertainty remains about the level of support necessary to drive sufficient growth in biofuel facilities.

[43] The Bioenergy Master Plan states that Hawai‘i could produce at least 94 MGY of ethanol, 104 MGY of renewable diesel, and 79 MGY of renewable fuel oil (DBEDT 2009). An earlier Booz Allen Hamilton analysis estimated 115 MGY ethanol and 80 MGY biodiesel (BAH 2009).
[44] This policy is based on the existing facility tax credit. Other alternatives are considered below.

If, by 2011, existing policy does not result in construction of new biofuels facilities in the state, additional policy may need to be explored. Three policy alternatives are examined in Scenarios A, B, and C.

A. *Expansion of the existing legislation to cover the total biofuel production potential of Hawai'i* (i.e., beyond the 40 MGY limit): Allow all biofuel plants with a capacity more than 15 MGY to benefit from the existing tax credit
   i. ***Pros:*** Encourages the state to develop its full biofuel production capacity and covers up to 100% of the investment cost for each biofuel facility
   ii. ***Cons:*** Significantly increases the total cost burden on the state and does not encourage speed of investment (an alternative is to increase the size of the credit rather than increase total capacity eligible)

B. One-time investment tax credit for 30% of any size plant
   i. ***Pros:*** Encourages construction of most economical facilities by leveraging economies of scale (facilities can be sized for the feedstock resource base) and encourages the state to develop its full biofuel production capacity
   ii. ***Cons:*** Only covers a maximum of 30% of the total investment cost of each plant, thus reducing the incentive for biofuel plant construction on an individual basis

C. *Production tax credit (PTC):* This would have much the same effect as the current policy but would be based purely on fuel production. The PTC would not necessarily have to provide a tax credit for the first eight years of plant operation; it could instead be structured to be granted to a certain number of total gallons per year, or the first 200 million gallons of fuel produced in the state, or a number of other options.
   i. ***Pros:*** Encourages first movers, as the more biofuel they produce the larger their benefit from the credit, and also limits the state's liability
   ii. ***Cons:*** Depending on the tax credit structure, one producer could capture a significant portion of the credit; the policy faces potential issues and challenges related to interstate commerce clause protection

Methodology and Assumptions

Methodology

- This analysis only includes ethanol and biodiesel because, to date, most of the work has been done to understand these fuels in Hawai'i. Also, while other bioderived fuels and bioproducts will likely be important elements of Hawai'i's bioenergy future, they are not explored in this analysis.
- This analysis makes no presumption regarding fuel demand, i.e., whether fuel will be used for electricity or transportation, or on which island fuel will be consumed.

Key Assumptions

- The analysis uses biofuel production assumptions from the 2009 Booz Allen Hamilton bioenergy decision-level analysis that looks at a combined "aggressive but realistic" scenario for ethanol and biodiesel production—see **Figure 4** (BAH 2009). The scenario is based on Hawaii Natural Energy Institute (HNEI) and Hawaii Agricultural Research Center (HARC) reports on ethanol and biodiesel, respectively, and used filters to exclude land with food production already in place, irrigation needs, or land already divided into small parcels. In this scenario, ethanol production is based on potential production from sugarcane and cellulosic feedstock, while biodiesel production figures are derived from waste oil potential as well as feedstocks such as oil palm, kukui, castor bean, and jatropha.

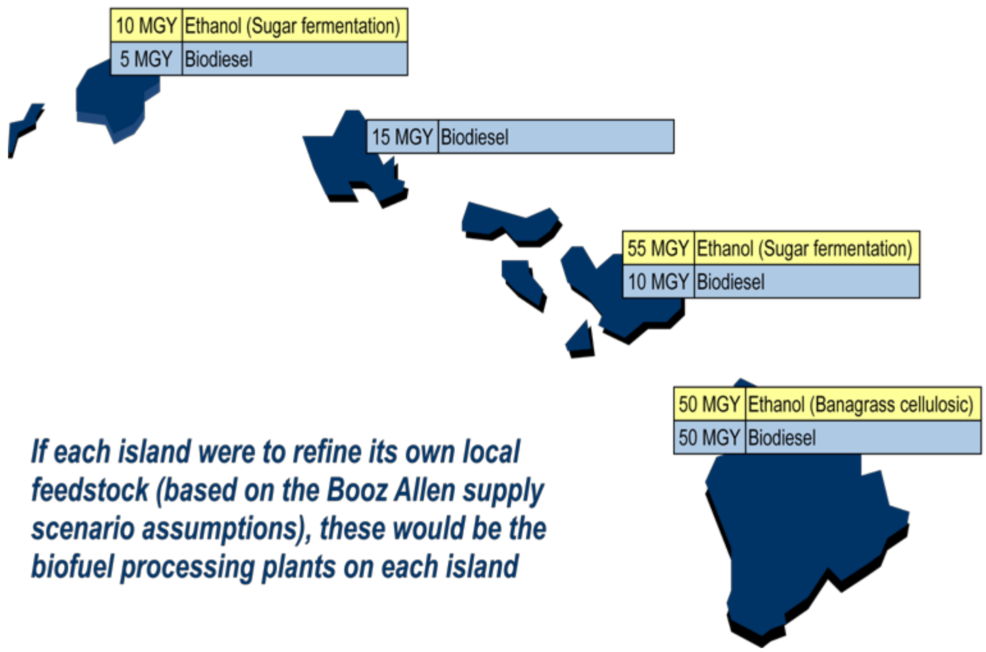


Figure 4. Hawai'i biofuel production by island

- This analysis employs capital costs from a variety of sources and does not make presumptions about production costs given the wide range of values in the 2009 Biofuels Assessment (BAH 2009) and other sources, as shown in **Table 26**.

Table 26. Capital Cost of Various Plants (Per Gallon Installed Capacity)

Sugarcane Ethanol		
40 MGY	*$1.66*	Shapouri and Salassi 2006
20 MGY	*$2.15*	Shapouri and Salassi 2006
Cellulosic Ethanol		
40 MGY	*$5.00*	Aden et al. 2002
Biodiesel		
0.5 MGY	*$1.90*	Schumaker et al. 2003
5 MGY	*$1.13*	Schumaker et al. 2003
>5 MGY	*$0.90*	Kalani 2008

Costs and Benefits

The different policy strategies listed above would have different costs and benefits. If *all* the capacity shown above were constructed, the state would be responsible for the following costs—

thus this represents maximum cost. Note that this implicitly assumes that all plants would be built before 2017, as required by the current law.

Current Proposal

If the policy is adopted with the following provisions, the cost to the state would be up to $96 million for the addition of 40 MGY of biofuel production capacity from 2010 to 2017 (the state could potentially be providing the tax credit on the first 40 MGY of biofuel production capacity through 2025, since plants are eligible to claim the credit for eight years of production). The total cost of building the plants would be about $96 million, meaning that over time the state could pay the entire investment cost of the plants. The benefit would be at least 40 MGY of ethanol production capacity in-state (**Figure 5**).

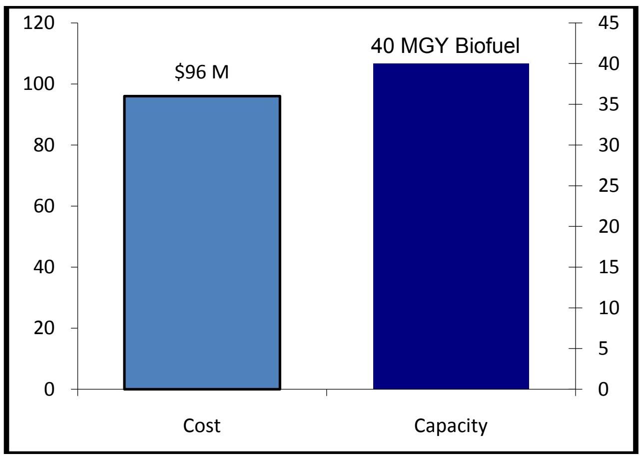


Figure 5. Cost to the state and biofuel production capacity under current legislation (upper bound cost)

Alternate Options for Future Consideration

A. *Expand the existing legislation to cover the total biofuel production potential of Hawai'i:* Assuming that the facility size is still limited to 15 MGY of nameplate production capacity, the resulting biofuel production facility footprint would be 13 (8 ethanol plants and 5 biodiesel plants). The cost to the state would be up to $333 million for the addition of 115 MGY of ethanol production capacity and 80 MGY of biodiesel production capacity (**Figure 6** – Scenario A).

B. *One-time investment tax credit for 30% of any sized plant:* The total cost to the state drops significantly compared to Scenario A but increases slightly from the cost of the existing policy, mainly because the tax credit for each facility can only be applied in one year (**Figure 6** – Scenario B). However, under this scenario, the amount of state financial outlay in any applicable tax year may exceed the $12 million cap in the current law. The cost to the state would be $131 million ($109 million for ethanol and $22 million for biodiesel). The total capital cost of the plants would be $436 million ($363 million for ethanol, $73 million for biodiesel), as this scenario assumes that facilities larger than 15 MGY would be built to take advantage of economies of scale. Scenario B assumes that Maui and Kaua'i use fermentation to make ethanol from sugarcane, and Hawai'i uses a cellulosic conversion process to produce ethanol from banagrass. The benefit would be a total biofuel production capacity of 115 MGY of ethanol and 80 MGY of biodiesel. However, individual plant owners would only recover 30% of their biofuel plant investment, as opposed to the potential for a full reimbursement in the existing law. Thus, because this policy provides a lower financial incentive for developers, it is not certain that the policy would result in the same high level of biofuel production.

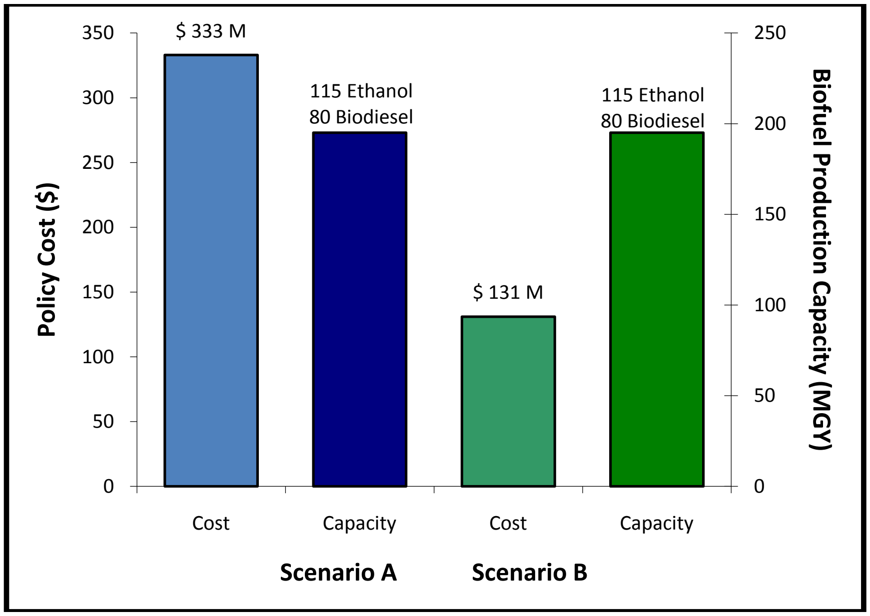


Figure 6. Cost to the state and biofuel production capacity under two tax credit scenarios (upper bound cost)

NOTE: Scenario B provides a lower incentive for each plant; thus it is not certain it would achieve this level of production.

C. *Production tax credit (PTC):* This analysis shows the impact if a PTC of $0.50, $0.75, and $1.00 per gallon were provided to make in-state ethanol and biofuels competitive with alternatives (**Figure 7**). The PTC would be an annual benefit that the state would provide based on the level of in-state production. The PTC could be structured in a number of different ways to limit the state's financial exposure while pursuing different public policy objectives, for example:

i. Reward first movers (e.g., PTC for the first 100 MGY produced in-state).

ii. Encourage multiple plants to be built (e.g., provide a PTC to the first 20 million gallons produced by each plant).

iii. Reward multiple movers (e.g., limit the PTC to the first 30 MGY produced each year).

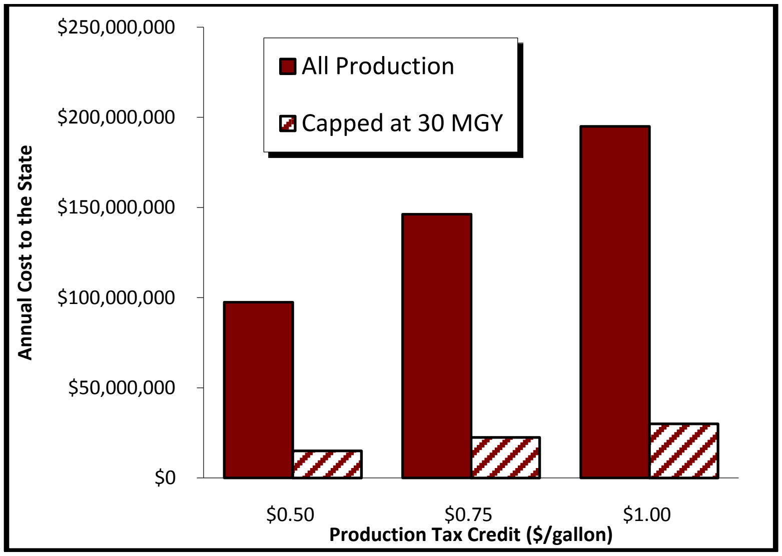


Figure 7. Range of costs to the state for a PTC for ethanol and biodiesel (based on a maximum production scenario where all production receives a tax credit or the credit is limited to 30 MGY)

Another cost to the state will be the avoided tax revenue associated with lower gasoline sales. The fuel produced under these scenarios could go to electricity or transportation. If we assume that all ethanol goes to transportation, the state would lose $13 million per year in gasoline tax revenue (115 MGY ethanol × 0.67 adjustment for ethanol energy content × 17¢ per gallon gasoline tax), which would be offset with nearly $3 million of revenue from ethanol tax (115 MGY ethanol × 2.4¢ per gallon ethanol tax).

What Other States are Providing Incentives for Biofuel Production?

Most states now have some incentive for biofuels—either research and development grant funding or tax credits based on investment (i.e., facility size or cost) or production (i.e., gallons produced). Most state tax credits apply to ethanol and biodiesel, and some also include butanol and other biobased fuels and coproducts. In addition to informing Hawai‘i’s policy development as precedents, these policies create competition among states for investment by biofuels firms. Following are a few examples of facility *investment* tax credits:

- *Arkansas:* The Arkansas Alternative Fuels Development Fund includes three types of grant incentives, including capital and operation incentives for alternative fuel producers and feedstock processors, production incentives for feedstock producers, and distribution incentives for alternative fuel distributors. Alternative fuel producers can receive $0.20 per gallon of alternative fuels produced, not to exceed $2 million. Feedstock processors can receive up to $3 million or 50% of the project cost, whichever is less, for the construction, modification, alteration, or retrofitting of feedstock processing facilities that are located and operated in Arkansas (House Bill 2002, 2009, and Arkansas Code 15-13-101, 15-13-102, 15-13-301 to 15-13-305, and 19-6-809) (U.S. DOE 2009).
- *Connecticut:* The Connecticut Qualified Biodiesel Producer Incentive Account provides grants to qualified biodiesel producers and distributors. A qualified biodiesel producer is eligible for up to 60 monthly grants from the account, up to a total grant per fiscal year equal to 1) $0.30 per gallon for the first 5 million gallons of biodiesel produced; 2) $0.20 per gallon for the second 5 million gallons of biodiesel produced; and 3) $0.10 per gallon

for the third 5 million gallons of biodiesel produced. Any portion of biodiesel produced by a qualified biodiesel producer in excess of 15 million gallons per fiscal year is not eligible for these grants. A one-time grant for the purchase of equipment or establishment or retrofit of production facilities is also available; grants may not exceed either $3 million or 25% of the equipment or construction cost. Additional grant funding up to $50,000 per distributor/site is available for the actual costs of creating storage and distribution capacity for biodiesel (Connecticut General Statutes 32-324a to 32-324f) (U.S. DOE 2009).

- *Florida:* A credit against the state sales and use tax is available for costs incurred between July 1, 2006, and June 30, 2010, for 75% of all capital operation and maintenance, and research and development costs incurred in connection with an investment in the production, storage, and distribution of biodiesel (B10-B100) and ethanol (E10-E100) in the state, up to a maximum of $6.5 million in each fiscal year for all taxpayers (DSIRE 2009c).

- *Georgia:* Tangible personal property used in or for the construction of an alternative fuel production facility dedicated to the production of ethanol, biodiesel, butanol, and their byproducts are exempt from the state sales and use tax. The exemption applies to tangible personal property purchased between July 1, 2007, and June 30, 2012 (Georgia Code 48-8-34.4) (U.S. DOE 2009).

- *Kansas:* Any newly constructed or expanded biomass-to-energy facility is exempt from state property taxes for a period of up to 10 taxable years (Kansas Statutes 74-8949b, 79-32,233, and 79-229) (U.S. DOE 2009). In addition, Kansas has production tax credits for ethanol and biodiesel (DSIRE 2009d).

- *Nebraska:* Investors in Nebraska biodiesel production facilities are eligible to receive a tax credit of up to 30% of the amount invested in the facility between January 1, 2008, and January 1, 2015, not to exceed $250,000. The credit is only available for facilities that produce B100, perform all processing in Nebraska, and are at least 51% owned by Nebraska individuals or entities. The tax credit may be reclaimed if the biodiesel production facility remains in operation for less than three years (Nebraska Statutes 77-27,263) (U.S. DOE 2009).

- *North Carolina:* A tax credit is available for the processing of biodiesel, 100% ethanol, or ethanol/gasoline blends consisting of at least 70% ethanol. The credit is equal to 25% of the cost of constructing and equipping the facility, and a facility must be placed in service before January 1, 2011. In lieu of the above credit, a taxpayer that constructs and places into service, in North Carolina, three or more commercial facilities for processing renewable fuel and invests a total amount of at least $400 million in the facilities is allowed a credit equal to 35% of the cost to the taxpayer of constructing and equipping the facilities (North Carolina General Statutes 105-129.16D) (U.S. DOE 2009).

- *South Dakota*: A tax refund is available for contractors' excise taxes and sales or use taxes paid for the construction of a new agricultural processing facility, which includes an expansion to an existing soybean processing facility if the expansion will be used for the production of biodiesel. The project cost must exceed $4.5 million in order to qualify for the refund (South Dakota Statutes 2009).

How Does This Fit the HCEI Goals?

To get to 70% clean energy in the transportation sector, biofuel will be needed to replace gasoline and diesel as a liquid transportation fuel. In addition, Hawai‘i’s utilities are interested in using biofuel grown in-state as a replacement for oil in their electric generating units. The state sees in-state biofuel production as part of an integrated agriculture solution for Hawai‘i. However, even with the existing ethanol facility tax credit, Hawai‘i has yet to see a project developer build an ethanol production facility. This may be an indication that additional legislative action is required to drive increased in-state biofuel production.

> **Developing an Improved Definition for Biofuels**[1]
>
> An updated biofuel definition stressing adherence to standard fuel specifications would ensure consistent fuel quality for end users. The HCEI analysis team is working with DOE to develop an improved definition.
>
> The ethanol definition in the existing legislation states that “qualifying ethanol production” means ethanol produced from renewable, organic feedstocks, or waste materials, including municipal solid waste. All qualifying production shall be fermented, distilled, gasified, or produced by physical chemical conversion methods such as reformation and catalytic conversion and dehydrated at the facility.
>
> The following biofuel definition was proposed last year: “Biofuel” means ethanol, biodiesel, diesel, jet fuel, or other liquid fuel meeting the relevant fuel specifications of ASTM International (formerly ASTM, the American Society for Testing and Materials).

Next Steps

Analyzing the size of incentives offered in other states and their impacts will provide insight into the likely impacts of different incentive sizes and what incentives will best meet HCEI goal. Furthermore, additional research is necessary to determine if production tax credits in other states have been challenged under the Interstate Commerce Clause and what the outcome has been in each case.

Additional Information

Biodiesel cost references: Imperium’s 100 MGY plant in Grays Harbor County, Washington, cost $78 million—or $0.78 per gallon of capacity (Gonzalez 2007). Imperium’s planned, but now cancelled, 100 MGY facility in Campbell Industrial Park was announced to cost $90 million (HECO 2007; Kalani 2008)—or $0.9 per gallon of capacity. The 105 MGY Green Hunter Biodiesel facility in Houston, Texas, was built for $70 million—or $0.67 per gallon of capacity (Krauss 2009).

Ethanol cost reference: A University of Hawaii report for DBEDT assumes a 6 MGY plant costs $15 million to construct ($2.50/gal NPPC)—this figure is based on a scaling exponent of 0.6 based on chemical plants (Surles et al. 2007).

§235-110.3 [Ethanol] Biofuel Facility Tax Credit

(The proposed bill from 2009, HB1054, is included below for reference; strikeouts are deletions and underlines are additions):

(a) Each year during the credit period, there shall be allowed to each taxpayer subject to the taxes imposed by this chapter, ~~an ethanol~~ a biofuel facility tax credit that shall be applied to the taxpayer's net income tax liability, if any, imposed by this chapter for the taxable year in which the credit is properly claimed.

For each qualified ~~ethanol~~ biofuel production facility, the annual dollar amount of the ~~ethanol~~ biofuel facility tax credit during the eight-year period shall be equal to thirty per cent of its nameplate capacity if the nameplate capacity is greater than five hundred thousand ~~but less than fifteen million~~ gallons. A taxpayer may claim this credit for the first fifteen million gallons of capacity of each qualifying ~~ethanol~~ biofuel facility; provided that:

(1) The claim for this credit by any taxpayer of a qualifying ~~ethanol~~ biofuel production facility shall not exceed one hundred per cent of the total of all investments made by the taxpayer in the qualifying ~~ethanol~~ biofuel production facility prior to and during the credit period;

(2) The qualifying ~~ethanol~~ biofuel production facility operated at a level of production of at least seventy-five per cent of its nameplate capacity on an annualized basis;

(3) The qualifying ~~ethanol~~ biofuel production facility is in production on or before January 1, 2017; and

(4) No taxpayer that claims the credit under this section shall claim any other tax credit under this chapter for the same taxable year.

(b) As used in this section: "Biofuel" means ethanol, biodiesel, diesel, jet fuel, or other liquid fuel meeting the relevant fuel specifications of ASTM International (formerly ASTM, the American Society for Testing and Materials).

Policy Option: Lease of Public Lands for Renewable Energy

Summary

Hawai'i's policy for the leasing of public land for renewable energy was formalized on July 15, 2009, by Act 19 of the Special Session of 2009 (Act 19). This act amends the Public Lands, Management, and Disposition section of the Conservation and Resources portion of the Hawai'i Revised Statutes. The legislation outlines a process of public involvement in the leasing process but specifically notes that a public auction is not required.

This legislation specifies the information required from the potential lessees of the land and the actions that the Department of Land and Natural Resources (DLNR) board must take to evaluate the proposals and determine who gets an award (see the section **Additional Information** below for full language from the act). Developing a process for incorporating an interagency panel in which the relevant state and county agencies (including but not limited to DBEDT, DHHL, and HDOA) provide advisory input to DLNR in order to better inform the agency of the competing interests and needs of the land.

Possible Policy Additions

1. Using the process specified in Act 19 (Hawaiʻi Senate 2009c), it could be recommended that DLNR reach out to DBEDT, DHHL, and HDOA and create a formal consultative relationship by which the three agencies advise DLNR during the decision-making process before any leases are offered. Also, the process of using this advisory panel in conjunction with the public comment process could be attempted for at least three leases before any adjustments are made to the legislation.
2. It could be recommended that DBEDT, HDOA, DLNR, and DHHL develop and prepare a single, clear, consistent policy on use and lease of state lands for agriculture, grazing, forestry, and bioenergy feedstock production, in consultation with relevant stakeholders and to promulgate policies of energy and food security. Such a plan could include components describing favorable lease terms for bioenergy demonstration projects to provide impetus for project developers to choose Hawaiʻi as the location to showcase their technologies.
3. Report of the policy and any processes and results shall be submitted to the legislature by December 2011.

Evaluation Discussion

For renewable energy projects, the DLNR's decisions will be better informed if the concerns of DBEDT, DHHL, and HDOA are well understood. For some types of renewable energy projects, input from DBEDT may be sufficient. However, for bioenergy projects or other renewable energy projects that require significant amounts of land, AG's input is important.

The policy option put forth in Part I assumes that active communication during the lease review process will be the most effective method of ensuring that the DLNR understands the exact concerns of DBEDT, DHHL, and HDOA. Because these concerns will be island-specific, and at times plot-specific, ongoing consultation between the departments will be necessary as the DLNR evaluates lease proposals.

Costs and Benefits

This policy for DLNR coordination with relevant state and county agencies isn't particularly specific; costs could vary depending on the level of interaction that DLNR actually pursues. Benefits of this type of interagency interaction include better coordination and communication resulting in more informed decision making by DLNR with respect to land leases for renewable energy projects.

What Other Locations Are Doing This?

Colorado is the only state that is currently implementing a similar interagency coordination policy. The Colorado State Land Board is a five-person citizen group representing education, agriculture, local government, and natural resources, plus one citizen-at-large commissioner (Colorado State Land Board 2007). The board is pursuing renewable energy development on trust lands; wind, solar, geothermal, and other alternative/renewable energy sources are all being studied for feasibility. The State Land Board acts under the legislative/statutory mandate contained in HB07-1145, which state that leasing arrangements for renewable energy resource development are to be administered by the State Board of Land Commissioners in an expedited manner that encourages the maximum economic recovery of renewable energy resources. Colorado provides standard forms for leasing lands for wind or solar on its Web site, though negotiation of prices and lease terms need to be negotiated on a case-by-case basis.

How Does This Fit the HCEI Goals?

To reach the goal of 70% clean energy, significant investment will be required for renewable energy generation and for biofuel production. This will require an effective use of land resources. Coordination and consultation among state agencies ensures the best information is available and used for long-term land-use decisions.

Next Steps

Further research in the following areas would provide a better understand of the impacts of this type of policy:

- Analyze how improved coordination among relevant state agencies in other states has affected the efficiency of land use and the development of renewable energy generation.
- Determine whether coordination between federal and state agencies in Hawai‘i and other states has impacted land use strategies and how coordination efforts can be best facilitated. For example, a large-scale coordination of agencies has led to a programmatic environmental impact statement (EIS) that has increased the value of auctioned land in the West for geothermal land (the PEIS came out 12/08, and all the 2009 auctions have been higher value) (DOE CIO 2009). This indicates that agency coordination can improve interest and value of renewable energy land. While this policy in Hawai‘i may not be focused specifically on geothermal development, lessons can be learned from other examples of coordination for maximizing land use strategies to promote renewable energy development.

Additional Information

Hawai‘i State Senate, Act 19 of the Special Session of 2009

RELATING TO RENEWABLE ENERGY PRODUCERS.

SECTION 1. Chapter 171, Hawai‘i Revised Statutes, is amended by adding a new section to be appropriately designated and to read as follows:

§171- Renewable energy producers; lease of public lands without public auction.

(a) The board may lease or renew a lease of public lands to renewable energy producers, as defined in section 171-95, without public auction only pursuant to a public process that includes public notice under section 1-28.5 providing other interested renewable energy producers opportunity to participate in the process; provided that nothing in this section shall be construed to prevent the board from conducting direct negotiations; provided further that the renewable energy producer shall be required to submit as part of the proposal for the board's evaluation, as assisted by the department of business, economic development, and tourism, the following:

(1) A timeline for completion of the project;

(2) A description of a financial plan for project financing;

(3) A description of the conceptual design of the project;

(4) A description of the business concept for the project; and

(5) A description of landscape and acreage requirements including public and private lands.

Upon completion of the board's evaluation and determination to award or not award a lease to a renewable energy producer, the board shall prepare a report outlining the reasons for the decision.

(b) A lease to a renewable energy producer under this section shall not result in the involuntary termination of a lease of public land held by an existing lessee who is currently in compliance with the terms of the lease.

(c) To inform the public prior to the lease of public land or the renewal of a lease of public land for a proposed renewable energy project under this section, the department of land and natural resources shall conduct not less than two public hearings on the island where the public land to be leased for the proposed renewable energy project is located; provided that the notice of the hearing shall be published as provided in section 1-28.5. The board shall prepare and distribute an outline of the proposals for the renewable energy project and receive testimony from interested parties and the general public at each public hearing.

(d) Any action taken by the board upon a proposal subject to this section shall take place on the island where the public land to be leased for the proposed renewable energy project is located.

(e) For any lease issued pursuant to this section, the renewable energy producer shall have the right of first refusal upon renewal of the lease.

Transportation

The energy used by the transportation sector accounts for about 60% of Hawai‘i's total energy use (EIA 2009). This is not surprising for an economy dominated by the tourism industry with nearly 7 million tourists visiting each year, most arriving by air (DBEDT 2008). Many of these tourists rely on rental vehicles to tour the islands, as limited options for alternative transportation exist, especially outside of Honolulu. In fact, approximately 60% of all transportation-related expenditures by tourists are on rental cars (DBEDT 2008). Unless alternative transportation options are developed in Hawai‘i, the tourists and local residents alike will continue to be susceptible to the rising and volatile costs of fuel.

To facilitate the development of alternative transportation options in Hawai‘i, the Transportation working group identified the following policies as possible options to address barriers to development, building on legislation passed in the previous year. The impact analyses below were completed over several months and provided to the working group members to aid them in determining which policies would best achieve the HCEI goals and should be recommended to the state legislature for adoption in LY 2010.

Policy Option: Deployment of Electric Vehicle Infrastructure

Summary

There are many barriers to electric vehicle deployment in Hawai‘i, including vehicle costs, public perception, and infrastructure constraints. Developing a policy environment to address these barriers at an early stage will position Hawai‘i as a leader for electrical vehicle deployment.

Policy Definition

By the time the Society of Automotive Engineers (SAE) certifies the J1772 standard for electrical connectors, Hawai‘i should already understand the barriers to electric vehicle deployment and have an action plan for how the state will encourage consumers to install the infrastructure required for EV or PHEV use. In addition, Hawai‘i should have a plan for installing charging infrastructure in state facilities. The plan should include a timeline and have identified resources for the following:

- *Education*: establish state education and outreach programs that promote the installation of EV infrastructure (within six months)
- *Permitting*: understand what is needed for permitting related to EV deployment, and begin permitting the installation of J1772 outlets in homes and businesses (within six months)
- *Guidelines*: understand the state role in establishing a common standard for EV infrastructure, and adopt the federal EV infrastructure standard for installation guidelines as soon as one is established (within 12 months)
- *State implementation*: identify and secure suitable standard (110 volt and 208–240 volt) electric outlets for low-voltage charging of EVs in every government building (within 12 months).

Methodology and Assumptions
SAE J1772 is a proposed North American standard for the electrical connector on PHEVs and EVs and is maintained by SAE. For the purposes of this analysis, EVs will refer to all electric drive vehicles. The SAE J1772 plug standard obtained certification by Underwriters Laboratory (UL) in June 2009 (Abuelsamid 2009a). SAE is still discussing the connector in committee but is expected to have a vote on the final connector specifications soon. Many car companies are participating in discussions or supporting the standard, including General Motors (GM), Chrysler, Ford, Toyota, Honda, Nissan, and Tesla. (Note: The Chevrolet Volt will be shipped with a J1772 connector and have charging capabilities at both 120 and 240 volts [GM 2009].)

Due to the strong backing of this standard by major car companies and the certification by UL, it is likely that this connector will become the standard for the EV charging interface.

Costs and Benefits
The main benefit for Hawai‘i is readiness to act when there is an infrastructure standard for EVs. Implementation of this plan will enable Hawai‘i to be recognized as a national EV infrastructure leader and should encourage the sale of electric vehicles to Hawai‘i by creating clarity in the market.

There will be significant costs to roll out EV charging infrastructure on a broad scale in Hawai‘i, but it has not yet been determined how these costs will be apportioned to various parties—i.e., homeowners, businesses, the U.S. Department of Defense (DOD), or the state. Establishing state education and outreach programs would also require dedicated resources, as would state administrative efforts to streamline permitting, set guidelines, and identify 110 volt and 208–240 volt outlets in public buildings. Installing the actual charging capability in state facilities will also involve costs for planning, labor, and hardware. These costs merit further analysis than is provided in this report.

What Other Locations Are Doing This?

- *San Francisco* (Office of the Mayor 2008): Efforts include expedited permitting, incentives to install infrastructure, harmonizing of local standards, and a host of other efforts, including:
    - Expedited permitting and installation of EV charging outlets at homes, business, parking lots, and other buildings throughout the Bay Area
    - Expedited permitting and approval for facilities that provide extended-range driving capability for EVs in the region through battery exchange locations or fast-charging
    - Incentives for employers to install EV charging systems in their workplace and provide similar incentives to parking facilities and other locations where EV charging stations can be installed
    - Harmonizing of local regulations and standards across the region that govern EV infrastructure to achieve regulatory consistency for EV companies as well as expanded range for EV consumers
    - Linking of EV programs and infrastructure to regional transit and air-quality programs

- Establishment of programs for aggressive pooled-purchase orders for EVs in municipal and state government and private sector fleets and future commitment of purchasing preference for EVs
    - Identification and procurement of suitable standard (110 volt and 208–240 volt) electric outlets for low-voltage charging of EVs in every government building in 2009
    - Identification of a roll-out plan for placement of EV charging equipment throughout each city, including city parking lots and curbside parking.
- *Los Angeles* (LADWP 2009): The Los Angeles Department of Water and Power Residential Electric Vehicle Services (LADWP) encourages the use of all alternative-fuel vehicles and has one of the largest utility EV fleets. The LADWP still offers a discounted electric rate of 2.5 cents per kWh for EV charging on nights and weekends and also provides information about TOU meters and hardware installation options.

How Does This Fit the HCEI Goals?
To reach the 70% clean energy goal, Hawai‘i must realize significant deployment of electric drive vehicles in combination with the use of local and imported biofuels. Charging infrastructure is a key catalyst to wide-scale deployment of EVs, and the state can take a leadership role in ensuring the coordinated and timely establishment of such infrastructure.

Next Steps
Once the standards for infrastructure have been established and the state has begun to deploy charging infrastructure at its own facilities, Hawai‘i will need to evaluate a number of other issues, including:

- Whether the government should pay for, or at least provide subsidies and rebates for, charging infrastructure at nonpublic facilities
- Whether the state should subsidize electricity rates for EV charging (note that this is addressed in a separate policy paper).

Policy Option: Electric Vehicle Charging Infrastructure Tax Credit

Summary
Charging station availability will be a key driver for EV use in Hawai‘i. Whereas individuals will have the opportunity to charge at home, tourists will require public charging stations to refuel their vehicles. Without widespread availability of EV charging infrastructure throughout the state, particularly at locations like hotels and businesses, where building occupants are likely to stay for extended periods of time and could recharge their vehicles without issue, it is highly unlikely that there will be widespread adoption and use of EVs in Hawai‘i.

Policy Definition
To facilitate early development of both public and private EV charging infrastructure in Hawai‘i, a tax credit could be implemented for the first five years of EV introduction in Hawai‘i to offset some of the charging infrastructure cost.

Methodology and Assumptions
Industry representatives estimate that charging stations will cost $2,000 to $6,000 for the next few years (Rocky Mountain Institute 2009). The proposed tax credit starts in 2012 and is valued at $1,000 to ensure that the state does not create price inflation for charging stations and that prices stay competitive. It is assumed that two charging stations would be required for each EV in the early stages of EV introduction in the state, and that the tax credit proposed would be available to individuals and businesses.

It is assumed that after 2016 the cost of an installed EV charging station will be significantly reduced, and the adoption of EVs in the state will have increased to the point where there will be sufficient impetus for EV charging station installation without the need for state aid. If policy makers determine that the market needs additional policy support after 2016, legislators can decide to extend the tax credit at a later date.

In order to spur competition and limit the state's risk exposure, it is important to limit the amount of tax credit that any one company or entity can claim. The proposed way to limit this is to prohibit any single organization from claiming more than $50,000 in income tax credits in any given year. Only individuals and companies with income tax liability would be eligible; the credit would *not* be refundable or transferable.

Costs and Benefits
Figure 8 shows the magnitude of the tax credit cost to the state over the five-year period. The tax credit analyzed here would cover a portion of the cost of 68,900 EV charging station installations at either $1,000 or $500 per station. A $1,000 tax credit would cost the state $69 million with a maximum annual exposure of $23 million in 2016, while a $500 tax credit would cost the state $34 million with a maximum exposure of $12 million in 2016. The state could also elect to include an annual cap (e.g., $10 million or $20 million) on the total credits that it would issue in a given year. Avoided gasoline consumption based on the 34,450 EVs deployed during this time period and covered by this tax credit amounts to 7.6 million gallons, approximately 760,000 barrels of oil. Assuming that all electricity used to power these EVs is renewable to create an upper bound for potential savings, the reduction in CO_2 emissions from the reduced gasoline consumption would amount to 74,343 tons.

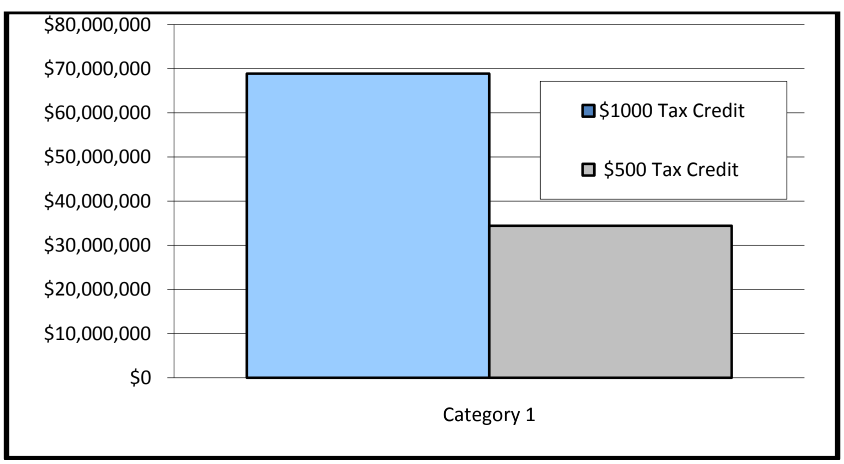


Figure 8. Five-year charging station credit

What Other Locations Are Doing This?
Many state-level projects applied for and received federal assistance for EV charging infrastructure installation under the 2009 Clean Cities Grants, as shown in **Figure 9** (Green Car Congress 2009).

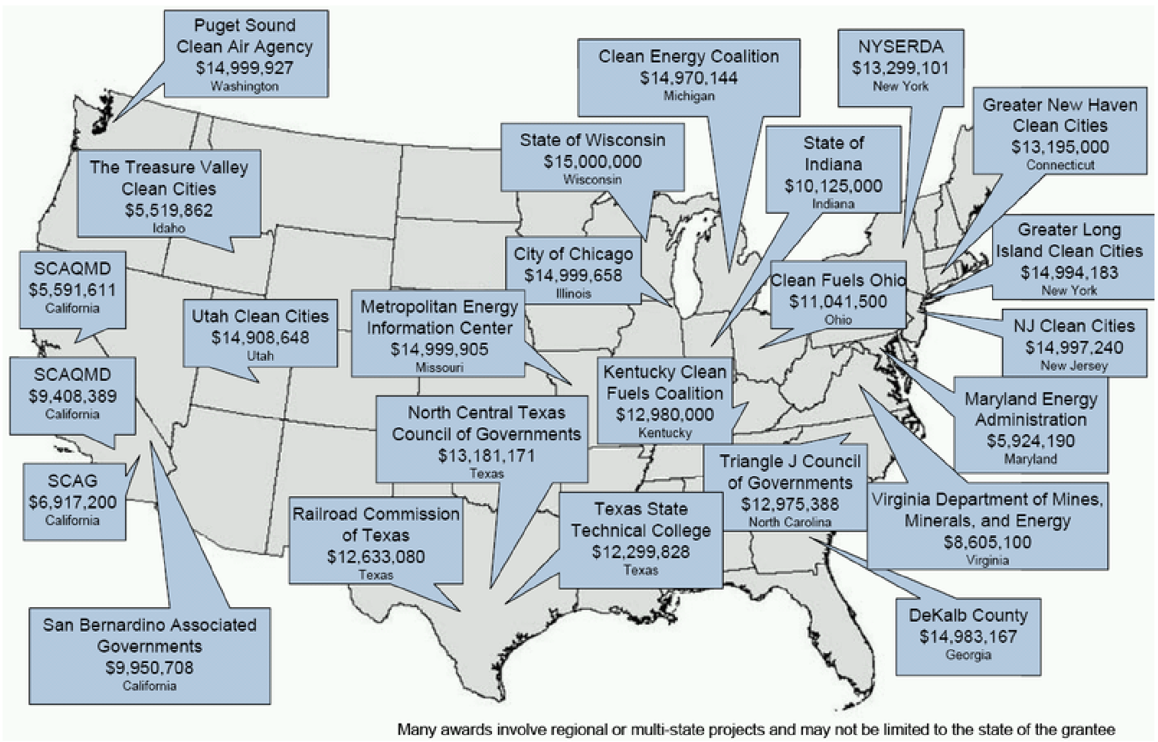


Figure 9. U.S. DOE 2009 Clean Cities grant awardees

Details of a few relevant projects are shown below. Note that all projects required a minimum of 50% cost share by the participants.

- *Federal government* (Doggett, S. 2009a): $99.8 million awarded to Phoenix-based Electric Transportation Engineering Corp (eTec), which, together with Nissan, has pledged the biggest deployment of electric vehicles—and creation of the largest charging infrastructure—ever undertaken. With the grant and matching funds provided by regional project participants, eTec has pledged to install about 2,500 charging stations in each of five selected markets: the states of Tennessee and Oregon, the cities of San Diego and Seattle, and the Phoenix/Tucson region. The project will collect and analyze data from vehicle use in diverse topographies and climate conditions, evaluate the effectiveness of the charging infrastructure, and conduct trials of various revenue systems for the infrastructure.
- *Government of California* (Doggett, S. 2009a): $8 million was contributed to the aforementioned federal project to aid in development of an EV charging infrastructure for San Diego.
- *City of Chicago, Department of Environment's Chicago Area Alternative Fuels Deployment Project* (Green Car Congress 2009): The project will deploy 554 alternative

fuel and hybrid electric vehicles and install 153 alternative fueling and EV charging stations throughout the Chicago region. The initiative also includes garbage trucks, also known as refuse collection vehicles. The project will result in expanded availability of alternative fuels, with 17 new CNG and E85 fueling stations and 63 EV charging stations. Total DOE award: $14,999,658.

- *Triangle J Council of Governments' Carolinas Blue Skies & Green Jobs Initiative* (Green Car Congress 2009): The project will include vehicles and fueling infrastructure for electric, hybrid-electric, compressed natural gas, propane, E85, and biodiesel fuels and technologies to be deployed throughout North Carolina and South Carolina. The project includes 45 E85 and B20 stations, eight propane stations, and 132 EV recharging sites. New vehicles to be deployed include 55 compressed natural gas (CNG) vehicles, 363 propane vehicles, 89 hybrid electric vehicles, and 56 neighborhood electric vehicles. Total DOE award: $12,975,388.

How Does This Fit the HCEI Goals?
To reach the 70% clean energy goal, Hawai‘i must realize significant deployment of electric drive vehicles in combination with the use of local and imported biofuels. Charging infrastructure is a key catalyst to wide-scale deployment of EVs. The state can help drive the timely and large-scale build out of such infrastructure by offering incentives for infrastructure installations in the early years when equipment costs will be the highest.

Next Steps
Depending on the actual cost of charging infrastructure and the rate of adoption, it may be necessary to increase the level of the incentive or extend the time period of the tax credit to achieve the desired effects. These issues should be revisited as more information becomes available regarding the cost of EV charging infrastructure and the rate of consumer EV adoption.

Policy Option: Transitioning of Rental Cars to Plug-in Hybrid Electric Vehicles

Summary
Rental vehicles make up a relatively small proportion (5%) of total vehicles in Hawai‘i, but they are a significant share (28%) of the new cars brought into the state each year. Because of this quick rate of turnover, rental car fleets have the potential to reach a higher saturation of PHEVs sooner than the general vehicle population. Also, because rental car purchase decisions are centralized, deployment requires fewer individual decision makers.

Rental car companies would bear the up-front costs of transitioning to PHEVs if a policy were implemented to require rental fleets to begin the transition. However, these costs could be offset with a combination of tax credits, increased resale value, and a price premium for PHEV rental vehicles. Rental car companies may also see positive public relations benefits. Renters could benefit from lower fuel costs compared to vehicles powered by conventional internal-combustion engines.

In addition to the benefits of saving oil, PHEV rentals offer potential educational and public relations benefits. If these rental vehicles are resold in Hawai‘i, this policy could accelerate the adoption of PHEVs in the state's general vehicle population.

Policy Definition
This policy is designed to facilitate the transition of a large portion of Hawai'i's rental car fleet to PHEVs. This policy could be a voluntary action by the rental car companies, and could achieve significant PHEV adoption provided there is sufficient participation by the rental car companies.

Methodology and Assumptions
For this preliminary analysis, it is assumed that all vehicles are PHEVs rather than purely electric vehicles, since renters may be concerned about being stranded when the battery runs out of electricity. Also, it is assumed that these PHEVs will operate on electricity 50% of the time, since visitors may not be able to charge these vehicles as regularly as residents. Once PHEVs are introduced in Hawai'i, a pilot study would be needed to shed light on consumer behavior.

This analysis applies the Electric Power Research Institute/Natural Resources Defense Council/Argonne curve to the rental car companies, following the assumption that the curve is actually a supply curve that represents the maximum level of deployment (EPRI and NRDC 2007). According to this curve, the first PHEVs will be introduced into the market in 2012 at the level of 4% of new vehicles, increasing to 60% of new vehicles by 2030. The curve yields a final PHEV market penetration of 66% of all vehicles (**Figure 10**).

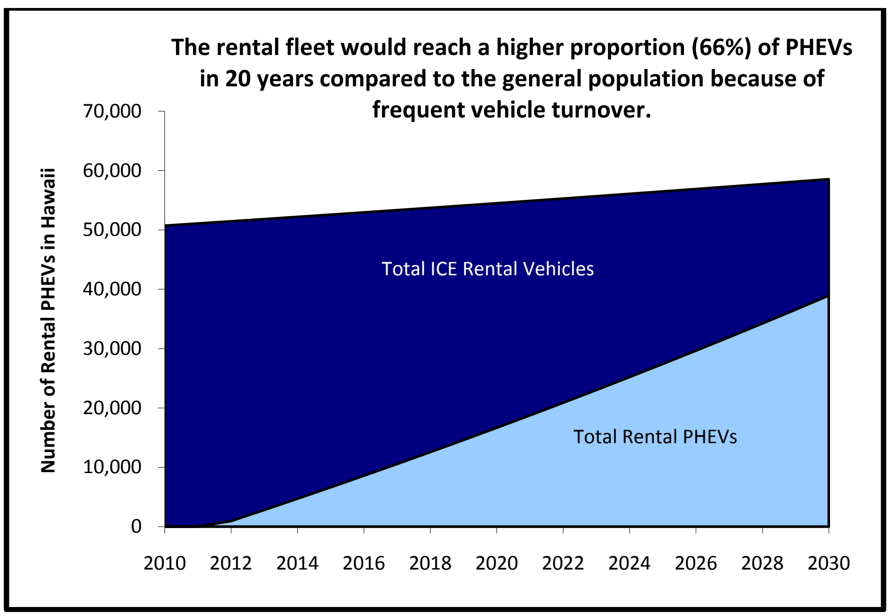


Figure 10. Rental fleet PHEV projected growth in Hawai'i

Unlike previous transportation analyses, life-cycle cost was not employed in this analysis, because any operational cost savings for rental vehicles would accrue to the renter, not to the rental car company that bears the initial capital cost.

Additionally, this analysis does not include infrastructure costs, which would be significant for a fleet of nearly 40,000 PHEVs. At this point it is not clear who would bear the cost of the infrastructure to support the vehicles, or how much infrastructure would be required—this should be a topic of further analysis.

The assumptions employed in this analysis are detailed below. Future analysis would benefit from refined assumptions from industry and other stakeholders in Hawaiʻi.

Table 27. Assumptions for Rental Car Transition to PHEVs

Assumption	Value[45]	Notes/Source
Average fuel economy of new conventional cars 2010–2014	27.3 mpg	NHTSA 2009
Fuel economy (corporate average fuel efficiency) 2015–2030	35.5 mpg	Federal Register 2009
All types of vehicles travel the same number of miles per year	9,206 miles/yr	DBEDT 2007
# of total rental vehicles in 2010 in Hawaiʻi	50,000	Enterprise 2009
# of years that each vehicle stays in the rental fleet	2 years	Enterprise 2009
Average miles driven per rental	300 miles	Enterprise 2009
Rental PHEVs use electricity 50% of the time	50% electricity	Based on 70% electricity use (ORNL Feedback 2008), adjusted as described above
Growth rate of rental cars	0.72%	Based on total statewide vehicle growth rate
Average # of days per rental	6 days	Enterprise 2009
Average cost of car rental	$678	DBEDT 2007
EV charging efficiency 2010–2030	0.32 kWh/mile	EPRI and NRDC 2007
Cost premium for a PHEV or EV in 2010	$20,000	GAO 2009
Cost premium for a PHEV in 2030	$4,300	Kromer and Heywood 2008
Cost premium for an EV in 2030	$10,200	Kromer and Heywood 2008
Average price of electricity in Hawaiʻi 2010–2030	$0.30	Based on historical trends (EIA 2008)
Average price of gasoline in Hawaiʻi 2010–2030	$3.34–$4.38	EIA 2009a, EIA 2009d
Federal tax credit for EV (maximum would be $7,500, but the amount of credit depends on the size of the battery)	$7,500	EERE 2009

Costs and Benefits

Costs and Benefits to the Rental Car Companies

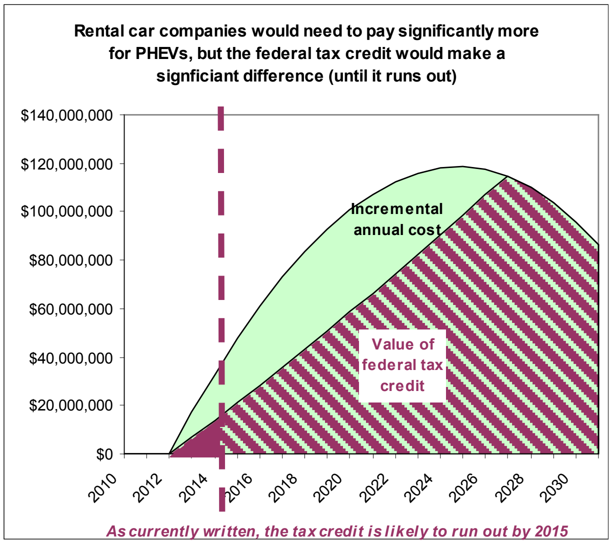
Rental car companies would need to bear the increased up-front cost of this policy but could likely recover any additional costs in higher prices for renters. If the high PHEV scenario were achieved, rental car companies would collectively need to pay a maximum of about $118 million

[45] Values are in 2009 dollars (unadjusted).

per year in incremental costs in 2024, decreasing to $86 million per year in 2030 as PHEV prices continue to fall.

This cost could be offset by multiple approaches—or, more likely, through a combination of solutions, including:

- *Federal tax credit:* This analysis shows the impact of the $7,500 federal tax credit but also points out that the tax credit is likely to run out by 2015. As written, the tax credit only applies to the first 200,000 qualifying vehicles sold by each manufacturer. Also, the value of the tax credit depends on the size of the battery; for example, the Chevrolet Volt with its 16 kW battery would be eligible for the full credit (**Figure 11**).
- *Resale value of PHEVs:* After two years, the rental company would be able to realize an increased resale value for each PHEV—shown below to be equal to half the original premium of the PHEV (**Figure 11**).
- *Renter premium for PHEVs:* The remainder of the cost difference (in light green below), after the federal tax credit and resale value are applied, could be covered by renters paying premiums on their PHEV rentals. The experience of Enterprise and other companies with Prius hybrids could very well inform the path for PHEVs and provide some important data (e.g., whether visitors will pay a premium for hybrids, resale value of rental hybrids).
- *Tax on non-PHEVs:* Another way to close the light green gap would be to levy a tax on all rental vehicles.



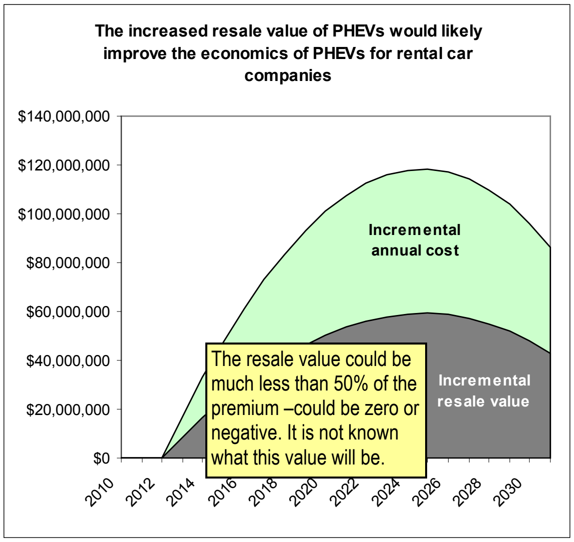


Figure 11. PHEV costs in the rental fleet

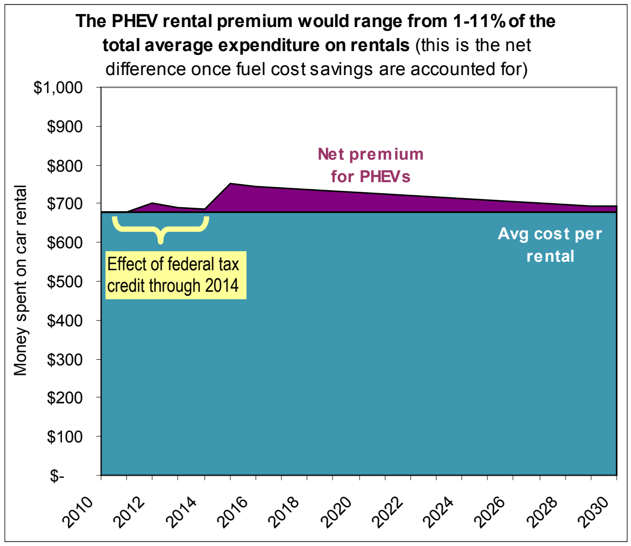


Figure 12. PHEV rental car resale premium

Costs and Benefits to Renters if PHEV RENTERS Paid the Premium

The chief benefit to renters would be the choice to pay a premium to drive a PHEV during their visit to Hawai‘i. If the federal tax credit ended in 2014 and the resale value were 50% of the incremental cost, this analysis shows that consumers could make up the rest of the incremental cost (i.e., the light green space in the charts in **Figure 11**) with a premium ranging from $25 in 2012 up to $73 in 2015 when the federal tax credit is presumed to run out and then down to $14 per rental in 2030 (**Figure 12**). This is the net cost—the total premium with the fuel cost savings netted out. An average rental driving distance of 300 miles per rental would see savings of $3 to $4, assuming that renters would pay retail electricity rates (30 cents per kWh) to charge the vehicle and operate on electricity for half their miles. Fueling the vehicle with electricity more than 50% of the time would result in larger savings for the PHEV renter.

Costs and Benefits to Renters if ALL RENTERS Paid a Tax

The tax on rental vehicles would be $1 per *rental* from 2012 to 2014 and increase to $14 and $17 per rental for the next 15 years. This would mean a maximum 2% increase in the cost of each rental. PHEV renters would recover $3 to $4 per rental in lower fuel costs. Note that each rental is assumed to be six days. (Calculated as follows: Tax to offset increased cost = incremental cost of PHEVs—incremental resale value of PHEVs—federal tax credit through 2014)

Possible Costs to Hotels or Others

In order to transition the rental vehicle fleet to PHEVs, there are options for visitors to pay for the electricity they use as a fuel.

1. In order to buy a precise amount of electricity at a hotel, for example, the utility could install its own charging stations in hotel parking lots and institute a charge-card system or similar mechanism for payment. Such a system does not yet exist, but could be instituted.
2. Alternatively, hotels could charge a block rate for EV parking that would enable them to not be counted as a “utility;” such a structure would likely need to be approved by the PUC.

3. Another option is for the hotel to absorb the cost of the electricity. If each vehicle charged the battery long enough to travel 40 miles each day, the cost to the hotel would likely be \$3 to \$4 per day.

Benefits to the State

This policy would result in reduced gasoline consumption of approximately 5 million gallons per year and about 50,000 tons of avoided CO_2 emissions annually in 2030 (not counting any additional emissions related to additional electrical generation needs).

Another set of broader national and international benefits, which is specific to the rental car sector, would come from the public perception of Hawaiʻi as a center of innovation, clean technology, and environmental stewardship. A rental car fleet of PHEVs would have the effect of educating the state's 8 million yearly visitors about the societal benefits of PHEVs.

Finally, as Enterprise's experience with hybrid technology has shown, bringing advanced technologies into rental car fleets provides an excellent platform to train local mechanics on the care and maintenance of such vehicles.

Costs to the State

The state would lose about \$900,000 per year in tax revenue from gasoline sales, a portion of which could be made up with taxes on electricity generation.

What Are Other Jurisdictions Doing with Respect to Rental Car Fleets?

Table 28. Rental Car Fleet Policies in Various Jurisdictions

	Vehicle Surcharge	Vehicle Registration Fee	State Sales Tax	Airport Access Fee	Tax for a 4-Day Midsize Rental
Honolulu	\$3.00 (per day)	\$0.30 (per day)	4.1666%	11.11%	\$41.77
Boston	-	3.80% (per day)	5.0%	11.11%	\$57.14
Chicago	\$2.75 (per rental)	6.0% (environmental protection tax)	6.0% (auto rental tax)	6.0% (transportation tax)	\$42.22
Miami	\$2.05 (per day)	\$0.35 (per day)	6.0% (plus 0.5% local tax)	9.0%	\$37.76
San Francisco	\$12.00 (per rental)	-	8.25%	-	\$30.39
Source: Authors' adaptation from Michigan State University 2002					

Cities and states have proposed using the proceeds from rental car taxes in different targeted ways, for example:

- *Milwaukee* (*JSOnline* 2009): A \$2 per day rental car tax increase was proposed to pay for the local bus systems.

- *Boston* (Potter 2005): A $10 "transaction fee" was debated to pay for a new police station.
- *Florida* (Hafenbrack 2009): A $2 per day fee for car rentals was proposed to pay for a commuter rail system serving southeast Florida.

Hawai'i could consider proposing a special fee to help fund the large-scale roll-out of PHEVs in its rental car fleet. According to this analysis, the fee would be $1–$17 per *rental*, or $0.17–$3 per *day*, between 2010 and 2030.

How Does This Fit the HCEI Goals?
To reach the 70% clean energy goal, Hawai'i must realize significant deployment of electric drive vehicles, as well as increase its use of biofuels. Bringing EVs into Hawai'i through the rental car fleets would help accomplish this goal.

Next Steps
Research in the following areas would help better determine the impacts of this policy:

- Collect data on hybrid rental car programs to assess consumer response, sensitivity to price premiums, vehicle performance, and other factors.
- Monitor technical and cost specifications of plug-in hybrids to determine suitability for rental car fleets.
- Track proposed rules in other jurisdictions to determine whether any rules are successfully passed and the impacts of those polices.
- Investigate the possible impacts on vehicle rental model, such as whether the longer turnaround time in the company parking lot (while the vehicle is recharged) would pose a barrier to adoption, and whether the PHEVs can be "turnbacks"—sold back to the manufacturer—or are necessarily "risk" vehicles that the rental car company must sell itself after retiring it as a rental car.

Policy Option: Income Tax Credits for Plug-in Hybrid Electric Vehicles and Electric Vehicles

Summary
There are a number of ways for the state to address the higher cost of PHEVs and pure EVs. One option is to provide income tax credits for the purchase of PHEVs and EVs. This policy explores the tax credits that would be needed in Hawai'i to bring PHEVs and EVs to long-term cost parity with comparable internal combustion engine (ICE) vehicles purchased in the same year.

Policy Definition
This policy would use income tax credits for PHEVs and EVs to bring them to long-term cost parity with ICE vehicles. This analysis assesses the impacts of an income tax credit if it were continued through 2030.

One of the challenges to widespread adoption of PHEVs and EVs is the up-front cost of the vehicles, which, according to the U.S. Government Accountability Office (GAO), are likely to have at least a $20,000 premium when they first become available (GAO 2009). One way to defray the up-front cost of the PHEV and EV is by providing an income tax credit that consumers can claim in the year they purchase the new vehicle.

The key determinants in the effectiveness of such a policy from an energy perspective are the amount of money the state is willing to put behind it and the kinds of vehicles that qualify. There are multiple ways to structure this kind of incentive, such as:

- Providing the incentive for only the difference in price between the electric drive vehicle and a similar model conventional vehicle
- Setting a minimum fuel economy threshold or battery size for PHEVs and EVs to qualify
- Creating a sliding-scale incentive that increases with a car's efficiency or battery size.

Table 29. Overall Policy (Income Tax Credits or Grants)

Pros (+)	Accelerates the deployment of alternative fuel vehicles, especially those that have a significant price premium that may otherwise discourage consumers—enabling the reduction of oil use in transportation
Cons (-)	Expensive for the state
	Risk of free-ridership can be lessened by program design such as sliding scales, sunset dates, etc. (A 2009 Canadian study estimated that 74% of people who bought hybrids would have done so even without tax rebates [Chandra, Gulati, and Kandlikar 2009].)

Another option would be to use grants instead of income tax credits; grants are discussed below.

Hawai'i has debated whether to offer grants or tax credits for EV and PHEV incentives. While the two policies appear very similar, in fact their impact is very different if the grants are capped. When grants are capped, the number of vehicles touched by the state incentive is much lower. Therefore, the average consumer would bear a much higher burden of the cost of switching to PHEVs and EVs under a capped grant program than under a tax credit—since only the early birds in each grant period would benefit from the state incentive.

The pros and cons of an income tax credit versus a grant policy are detailed in **Table 30**.

Table 30. Comparison of Credits and Grants

	Income Tax Credits	**Grants**
Pros (+)	Provide financial incentive for residents with income tax liability	Provide financial incentive for all consumers
	May be easier for consumers to understand and capture	Can easily cap the state's financial liability (e.g., $5 million of grants available each year)
Cons (-)	Difficult to establish a cap on the state's financial commitment	Possibly greater administrative cost and time to administer grants
		May require more outreach to consumers and be more difficult for consumers to figure out—and might be on a different schedule than tax credits

Methodology and Assumptions

Types of Vehicles

In this analysis, we look only at tax credits, and only for PHEVs and EVs. Flex fuel vehicles (FFVs) that run on high blends of ethanol (e.g., E85)—while also important for Hawai'i to reach 70% clean energy—only have a price premium of $100 to $200, which is not considered to be a barrier to consumer purchase; therefore, they are not included in the tax credit proposed policy. Rental vehicles also are not included in this analysis, which only looks at vehicle incentives for individual consumers. Other analyses specifically focus on rental cars.

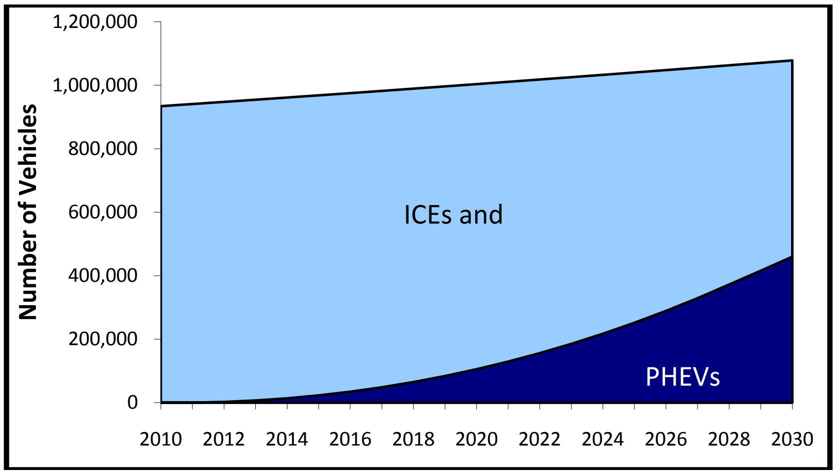


Figure 13. PHEVs and EVs in Hawai'i (excluding the rental fleet)

Baseline

This analysis uses the number of vehicles in Hawai'i and the vehicles sales from the DBEDT Data Book (DBEDT 2008).

PHEV and EV Adoption Curves

This analysis is based on the high deployment curve estimated by EPRI and NRDC (2007) as a maximum deployment scenario. The analysis assumes that EVs and PHEVs need to achieve economic parity with conventional ICE vehicles to reach this level of adoption. (HCEI does not yet have information that would be provided from a vehicle choice model, which would show what level of increased adoption would be driven by what level of income tax credit. This work is not expected until mid-2010 at the earliest.)

Fuel Cost of Conventional Vehicle

When calculating total vehicle costs, it is necessary to determine the fuel cost of a new vehicle. The fuel efficiency of a new ICE averages 27.5 miles per gallon (MPG) in the early years (NHTSA 2009) and 35.5 MPG when stricter Corporate Average Fuel Economy (CAFE) standards take effect in 2015 (Federal Register 2009). The analysis uses Energy Information Administration (EIA) projections for the gasoline price (EIA 2009a), to which $0.50 was added because Hawai'i tends to have more expensive gasoline than the mainland (EIA 2009d).[46]

[46] According to EIA, the average difference between the mainland and Hawai'i retail price of regular gasoline was $0.49 from June 2008 to June 2009.

Fuel Cost of Electric Drive Vehicle
The total fuel cost of an electric drive vehicle is highly dependent on the price of electricity, the proportion of time the vehicle runs on electricity, and the efficiency of the battery (assumed here to remain constant at 0.32 kWh/mile from 2010 to 2030, as reported by Kromer and Heywood 2008).

Analytical Approach
The analysis determines the income tax credit required to bring PHEVs and EVs, which are expected to have higher capital costs and lower operating costs, to cost parity with ICE vehicles. The model assumes that the tax credit could change every year to reflect changing technology costs.

Costs and Benefits
Costs to the State/Consumers
The annual cost of this policy would be approximately $50 million per year until 2025 if there is still a federal tax credit, or up to $320 million in 2030 with no federal tax credit. While the subsidy needed to reach cost parity with conventional vehicles lessens over time, the number of cars increases; therefore, the overall cost of the policy increases over the next 20 years.

If this amount were apportioned over all vehicles in the state, both advanced vehicles and conventional vehicles, it would mean a fee of $2–$15 through 2014, while the federal tax credit would also presumably still be in effect. This fee could rise to $200–$300 per vehicle in 2030. That would be a significant increase over existing base taxes and fees for car ownership, which are currently $100–$300 depending on vehicle weight, county of residence, and other factors (Honolulu 2009). (This analysis does not predict the base level of vehicle fee in 2030.)

Benefits to the State
The benefits of reaching this level of adoption of PHEVs and EVs would be 101 million gallons per year of avoided gasoline use by those vehicles in 2030—corresponding to approximately 800,000 tons of avoided CO_2 emissions. However, this gasoline would need to be replaced with electricity. If the electricity were produced by oil combustion in existing generating units, it would require about 83 million gallons of oil per year. Alternatively, Hawai‘i could supply that power from renewable sources.

Benefits to PHEV and EV Owners
The value of the state income tax credit that would be needed to bring PHEVs and EVs to cost parity with ICE vehicles is shown below—note that an income tax credit is just one way to bring PHEVs and EVs to price parity. The level of tax credit in the analysis is equivalent to the long-term price premium; EVs start out less expensive than PHEVs because of lower fuel costs, but projections show that the up-front costs of PHEVs will fall more quickly (**Figure 14**).

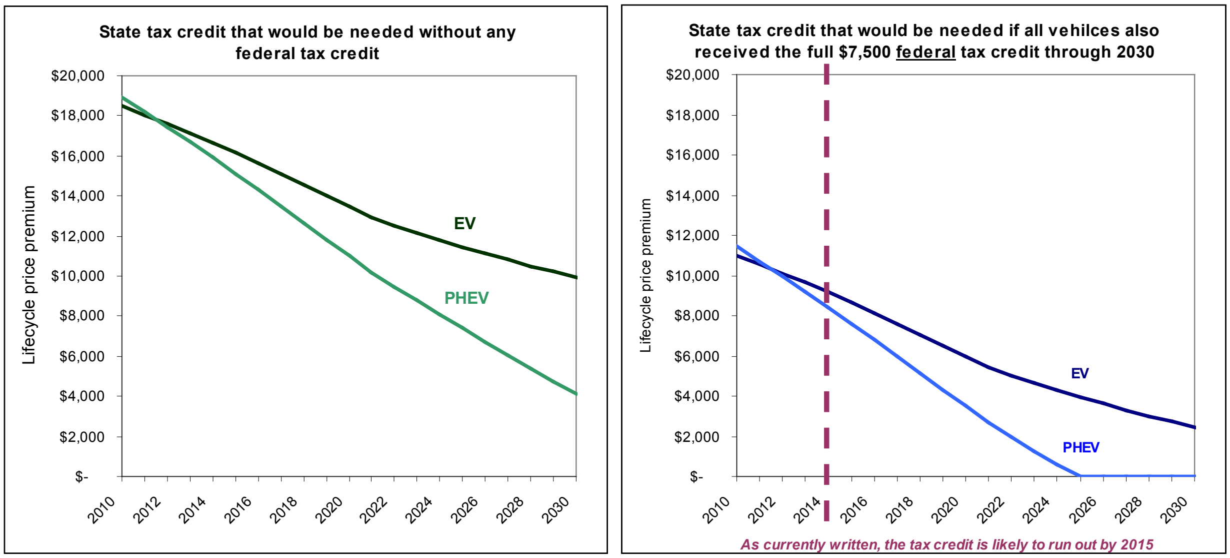


Figure 14. State tax credit needed to achieve cost parity with ICE vehicles

What Other Locations Are Doing This?

A number of states provide tax credits for PHEVs and EVs—or alternative fuel vehicles (AFVs) in general, a category that includes FFVs—for example (U.S. DOE 2009):

- *Maryland:* Hybrid electric vehicle and PHEV/EV tax credit of $250–$2,000, depending on how much of the car's energy can be provided by the battery
- *Oregon:* Tax credits for EVs (up to $1,500) and for charging equipment (35%), or $750 for conversion (Oregon Office of Innovative Partnerships and Alternative Funding 2009)
- *Arizona:* EV charging: a tax credit of up to $75 is available to individuals for the installation of EV recharging outlets in a house constructed by a taxpayer
- *Colorado:* Base tax credit of 20% for AFV infrastructure, and more if the unit is publicly accessible and more if the unit uses renewable sources for at least 70% of the energy dispensed
- *Georgia:* 20% up to $5,000 for an AFV, and 10% up to $2,500 for EV chargers
- *Illinois:* 80% of incremental cost of AFV or conversion—up to $4,000; Illinois also offers fuel rebates for alternative fuels
- *Louisiana:* Tax credit of 20% cost of conversion, incremental cost of AFV, cost of constructing an alternative fueling station
- *New Jersey:* AFV rebate up to $4,000 for light-duty vehicles ($2,000 for bi-fuel), and more for medium- and heavy-duty vehicles; zero-emission vehicles are exempt from state sales and use tax
- *New Mexico:* Hybrids that get at least 26.5 MPG get a tax exemption
- *New York:* 50% tax credit for alternative fueling infrastructure through 2010
- *Oklahoma:* Through 2010, 50% tax credit for cost of conversion or incremental cost of new AFV, or 10% tax credit for total vehicle cost, up to $1,500 for new *and* resold AFVs.

How Does This Fit the HCEI Goals?

To reach the 70% clean energy goal, Hawai‘i will need significant deployment of PHEVs and EVs in combination with biofuels. This policy would accelerate the rate of electric drive adoption in the state by eliminating the price premium associated with electric drive vehicles.

Next Steps

Applying information from a vehicle choice model would help better determine the impact of financial incentives on the vehicle adoption curve. Until this model exists, however, assessing the extent to which current state incentives for hybrids have led to clearly identifiable impacts on vehicle adoption rates can provide insight into the impact that this policy may have in Hawai‘i. Further analysis of the incentive design is needed (i.e., using a time-phased model where incentives are low in the early years—to decrease free-ridership of early adopters—and higher in the middle years) to determine the most appropriate method for driving mass market adoption.

Policy Option: Subsidized Electricity for Electric Vehicles

Summary

This policy explores the electricity rates that would be needed in Hawai‘i to bring PHEVs and pure EVs to long-term cost parity with comparable ICE vehicles purchased in the same year.

Policy Definition/Options

One of the challenges to widespread adoption of PHEVs and EVs is the up-front cost of the vehicles, which are likely to have at least a $20,000 premium when they first become available, according to GAO (GAO 2009). One way to reduce the price premium of electric drive vehicles is to subsidize electricity when it is used as transportation fuel. Any such policy would require assessment and approval from the PUC. This analysis assesses the impacts if the policy were continued all the way through 2030, but the state may elect to offer the policy for a more targeted time period.

The pros and cons of instituting a subsidy for electricity are listed below in **Table 31**.

Table 31. Pros and Cons of Subsidized Electricity for EVs and PHEVs

Pros	Cons
Increase the adoption rate of EVs by improving the financial picture for drivers	The subsidy would also benefit those who already have the financial resources to afford the up-front premium
Provide extra incentive for PHEVs to use electricity whenever possible—which yields a net oil savings for the same number of miles driven	The financial burden of this policy would be carried by all ratepayers, some of whom may be less able to afford the rate increases
Similar to a TOU rate, electricity rate subsidies at certain times of day could encourage off-peak charging and provide benefits to the grid	

Methodology and Assumptions
The methodology for this section was to use the high deployment curve estimated by the Electric Power Research Institute (EPRI) and NRDC (2007) as a maximum deployment scenario (EVs are 0% of new cars in 2010, increasing to 69% in 2030). This analysis assumed that EVs and PHEVs need to achieve economic parity with conventional ICE vehicles to reach this level of adoption.[47]

Fuel Cost of Conventional Vehicle
When calculating total vehicle costs, it is necessary to determine the fuel cost of a new vehicle. The fuel efficiency of a new ICE vehicle averages 27.5 MPG in the early years (NHTSA 2009) and 35.5 MPG when stricter CAFE standards take effect in 2015 (Federal Register 2009). The analysis uses 2008 EIA Energy Outlook projections for the gasoline price (EIA 2009a), to which \$0.50 was added because Hawai‘i tends to have more expensive gasoline than the mainland (EIA 2009d).[48]

Fuel Cost of Electric Drive Vehicle
The total fuel cost of an electric drive vehicle is highly dependent on the price of electricity, the proportion of time the vehicle runs on electricity, and the efficiency of the battery (assumed here to remain constant at 0.32 kWh/mile from 2010 to 2030, as reported by Kromer and Heywood 2008).

Analysis
The analysis determines the electricity rates required to bring PHEVs and EVs, which are expected to have higher capital costs and lower operating costs, to cost parity with ICE vehicles, which generally have lower capital costs and higher fuel costs. The model assumes that the electricity subsidy would adjust every 5 years to reflect changing technology and costs.

The analysis looked at a variety of scenarios for PHEVs and EVs and explored the impact of the \$7,500 federal tax credit for electric drive vehicles. The federal tax credit applies to the first 200,000 qualified vehicles from each vehicle manufacturer and is based on a sliding scale depending on the size of the battery—in this analysis it is assumed that all PHEVs and EVs purchased in Hawai‘i would qualify for the full \$7,500 credit.

[47] Information that would be provided from a vehicle choice model, which would show what level of increased adoption would be driven by what level of financial incentive, is not available at the present time. This work is not expected until mid-2010 at the earliest.
[48] According to EIA, the average difference between the mainland and Hawai‘i retail price of regular gasoline was \$0.49 from June 2009 to June 2009. For example, in January 2009 the price was \$1.35 on the mainland and \$1.85 in Hawai‘i.

Table 32. Assumptions for Analysis of Subsidized Electricity for EVs

Assumption	Value[49]	Notes/Source
Calculations exclude rental vehicles		Rental vehicles to be addressed in separate analyses
Average fuel efficiency of new conventional vehicles 2010–2014	27.3 MPG	NHTSA 2009
Fuel efficiency (CAFE) 2015–2030	35.5 MPG	Federal Register 2009
All types of vehicles travel the same number of miles per year	9,206 miles/yr	DBEDT 2007
PHEVs are assumed to be fueled by electricity 70% of the time	70% electricity	ORNL Feedback 2008
Electric vehicle charging efficiency 2010–2030	0.32 kWh/mile	EPRI and NRDC 2007
Cost premium for PHEVs and EVs in 2010	$20,000	GAO 2009
Cost premium for PHEVs in 2030	$4,300	Kromer and Heywood 2008
Cost premium for EVs in 2030	$10,200	Kromer and Heywood 2008
Average price of electricity in Hawaiʻi 2010–2030	$0.30	Based on historical trends (EIA 2009c)
Average price of gasoline in Hawaiʻi 2010–2030	$3.34–$4.38	EIA 2009a plus HI escalation factor of $0.50
Federal tax credit for EVs (max)	$7,500	EERE 2009 (for first 200,000 vehicles per manufacturer)
Discount rate	4.40%	Federal reserve—nominal 20 year treasury bond rate 8/3/09 (Federal Reserve 2009)

Costs and Benefits

Cost to the State

The cost of this policy to the state would depend on the level of subsidy. Because the up-front premium for EVs and PHEVs is quite significant, this analysis reveals that electricity would require a negative rate to enable these vehicles to reach economic parity with conventional ICE vehicles—requiring significant subsidies spread across all electricity ratepayers.

As shown in **Figure 15**, based on the aggressive adoption curve provided by an EPRI/NRDC study and the subsidies shown above, the annual cost of this policy would be approximately $50 million per year until 2025 (dark blue line in chart) if there is still a federal tax credit, or up to $320 million in 2030 with no federal tax credit (light blue area in chart). Note that while the subsidy needed to reach cost parity with conventional vehicles lessens over time, the number of cars increases; therefore, the overall cost of the policy increases over the next 20 years.

The lost tax revenue from gasoline sales would also have an impact for the state. It would amount to about $17 million annually in avoided revenue in 2030. Some of this could be made up by electricity tax; this requires further investigation by DBEDT.

[49] Values are in 2009 dollars (unadjusted).

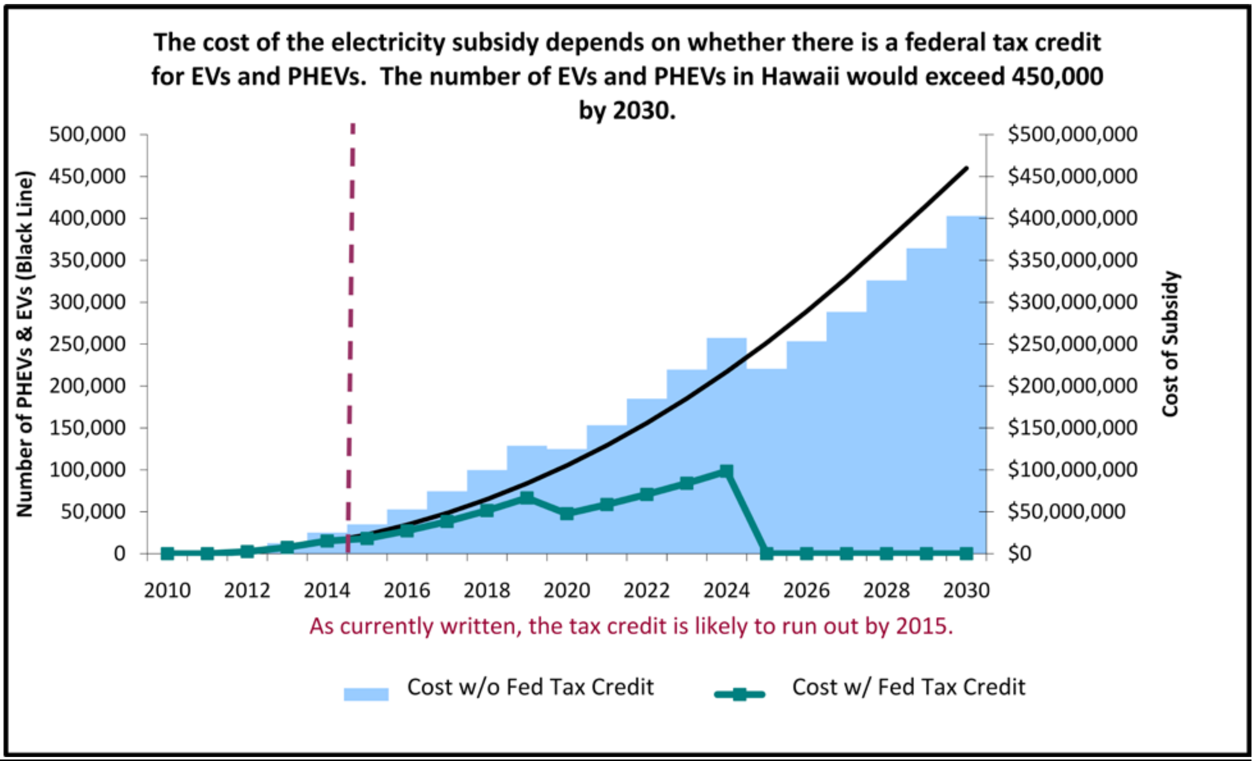


Figure 15. PHEV and EV cost subsidy

Another tax impact would be the extra excise tax on the more expensive PHEVs, which at the excise tax rate of 4.5% would amount to about $16 million per year in 2030.

Cost to Ratepayers

Subsidizing electricity for EVs will have an impact on the entire rate base, assuming that this subsidy is borne by all ratepayers. This analysis assesses the impact on ratepayers by calculating the total funding needed for the subsidy and apportioning it across future statewide electricity sales—as predicted in the utility Integrated Resource Plans (IRPs). In the case without a federal tax credit, ratepayers would experience an increase in their electricity rates equal to 0.01% of the per-kWh rate in 2011, increasing to a 7% increase in 2030. This would amount to each person paying an extra $250 per year in 2030. With the $7,500 federal tax credit, the rate increases are only 1% to 2%, and the maximum rate increase per person would be $48 a year in 2030. Note that, as currently written, the federal tax credit only applies to the first 200,000 eligible vehicles from each manufacturer; the credit would likely run out by 2015 (see dotted line in **Figure 15**). Also, the maximum value of the federal tax credit is $7,500, but the actual value depends on the size of the battery. For example, the Chevrolet Volt with its 16 kW battery would be eligible for the full credit.

Note that this electricity impact would be one of multiple rate impacts of an overall clean energy initiative: Capital-intensive renewable energy projects, new transmission, energy storage and grid upgrades, and advanced meters will likely be elements of the clean energy transformation—and these are elements that will necessarily be included in the rate base. Such costs must be considered as the state decides whether to subsidize electric drive vehicles primarily through ratepayers or through taxpayers.

The range of electricity prices needed to reach economic parity shows that whether or not there are federal tax credits, PHEVs and EVs both require negative electricity prices (i.e., subsidies) in their early days (**Figure 16**).

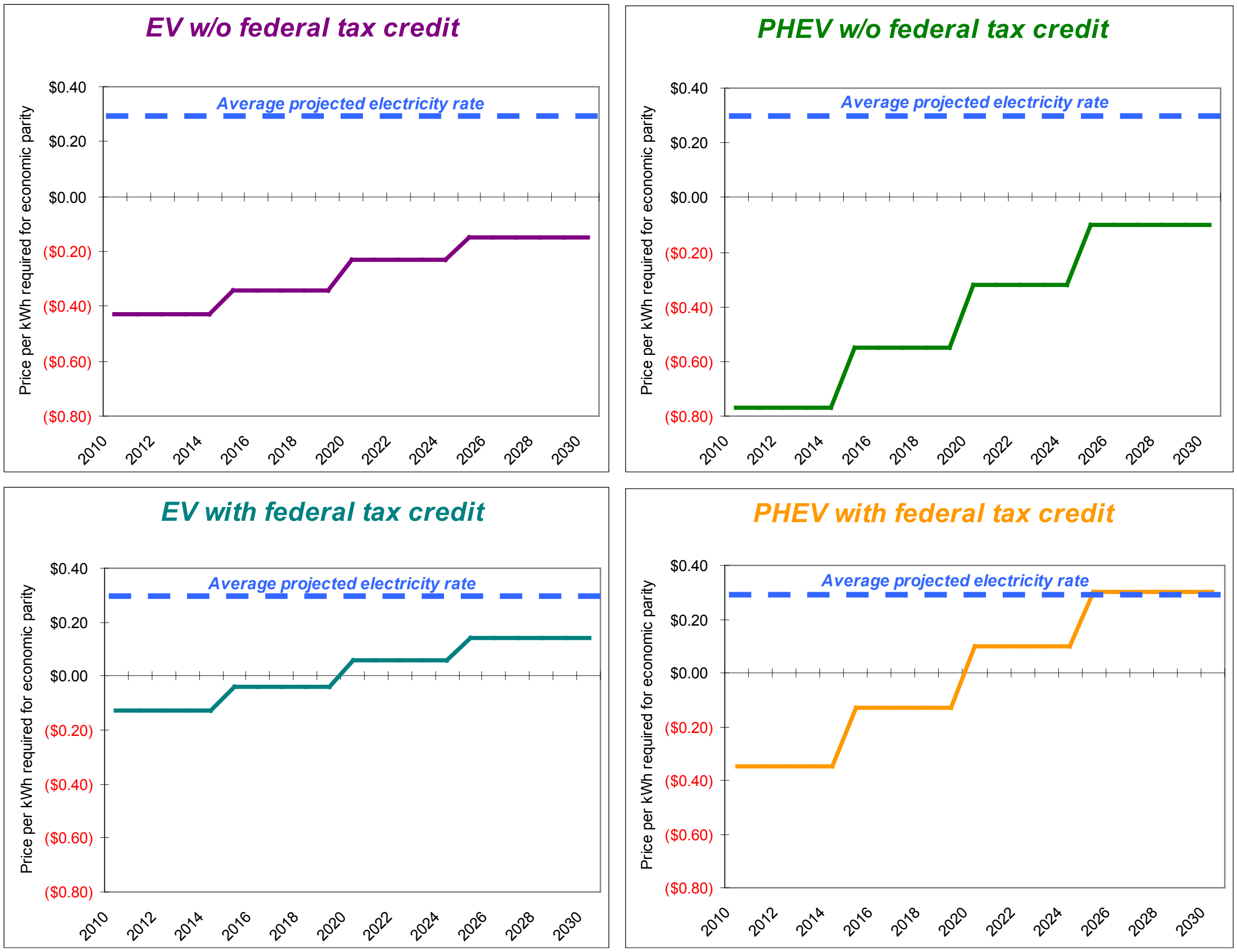


Figure 16. EVs and PHEVs with and without a federal tax credit

Benefits to a Vehicle Owner Purchasing a PHEV/EV in 2010

Assuming PHEVs/EVs purchased in 2010 will run for 10 years, the present value of the savings (at a discount rate of 4.4%) from the electricity subsidy would be $18,935 for a PHEV owner and slightly less for an EV owner, since EVs require smaller subsidies to reach cost parity with conventional ICE vehicles traveling the same number of miles. This is because EVs and PHEVs both start out with a price premium of $20,000, but EVs have lower fuel costs.

For PHEVs/EVs purchased in 2015 or 2020, it is a different story. According to estimates, the PHEV will end up costing $4,300 more than an ICE in 2030, whereas the EV will end up costing $10,200 more (Kromer and Heywood 2008). Therefore, the present value of the savings from a PHEV purchased in 2020 would be about $11,000, and the present value of an EV would be about $13,500. This reflects the fact that the EV will be more expensive than the PHEV in 2020—a difference that will not be fully compensated for by lower fuel costs—and will thus require a large electricity subsidy.

The above examples are for PHEVs and EVs without federal tax credits; for vehicles with federal tax credits, the present value would be reduced by $7,500 for as long as the credit lasts.

Benefits to the State

The benefits of reaching this level of adoption of electric vehicles would be 101 million gallons per year of avoided gasoline use by those vehicles in 2030—corresponding to approximately 1 million tons of avoided CO_2 emissions. However, this gasoline would need to be replaced with electricity. (If the electricity were produced by oil combustion in existing generating units, it would require about 83 million gallons of oil per year. Alternatively, Hawaiʻi could supply that power from renewable sources.)

What Other States and Jurisdictions are Implementing Electricity Subsidies?

No other states have rolled out electricity subsidies on a statewide basis, but a few utilities, facilities, and cities are providing free or subsidized electricity. The impacts/effectiveness of such policies are still to be determined, as PHEVs and EVs are not available at sufficient scale to assess economic and electric system impacts. Examples include the following:

- *The Sacramento Municipal Utility District (SMUD):* SMUD offers a subsidized electricity rate of approximately 50% of the regular residential rate for electricity to charge an EV. EV drivers must sign up for the appropriate residential TOU rate. SCE and PG&E also offer subsidies to EV chargers (Sacramento Municipal Utility District 2009).
- *Alameda Municipal Power (Alameda Municipal Power 2009):* Subsidies will be applied to the charges billed under any of Alameda Municipal Power's (AMP's) applicable residential, commercial, or municipal rate schedules. This experimental supplemental schedule is applicable to customers operating registered, street-legal EVs with a gross vehicle weight between 750 pounds and 8,000 pounds, to electric golf carts, and to electric fleet operations. The program is experimental and will remain in effect until such time that AMP implements a superseding TOU or other rate schedule for EV charging or until canceled by the Public Utilities Board. To be eligible for the discounts, customers must charge vehicles at off-peak hours on the weekdays (8 p.m. to 8 a.m.) and any time on weekends and holidays. Discounts per vehicle per month are shown in **Table 33**.

Table 33. Discount Rates by Vehicle Size

Very Light Duty (750 lbs.–1,999 GVW)	150 kWh/month x $0.06/kWh ($9/vehicle/month)
Light Duty (2,000 lbs.–4,999 GVW)	250 kWh/month x $0.06/kWh ($15/vehicle/month)
Medium Duty (5,000 lbs.–8,000 GVW)	350 kWh/month x $0.06/kWh ($21/vehicle/month)
Commercially Operated Golf Carts and Fleet Vehicles	50% of the metered kWh for the separately metered golf cart or fleet vehicle charging facility
GVW = gross vehicle weight	
*If a participating customer can demonstrate that vehicle charging consumption is significantly different than shown above, an adjustment to the discount may be made at AMP's sole discretion.	
Source: Authors' adaptation from *Alameda Municipal Power 2009*.	

- *Los Angeles International Airport (LAX 2009):* LAX offers free parking and recharging for EVs in some parking structures.
- *San Jose (Abuelsamid 2009b):* Using the company's ChargePoint Network, subscribers receive a smart card that allows them to fuel up at any station. Users can pay for 10 sessions a month for $15 or purchase unlimited monthly access for $50. Whether this results in electricity effectively provided at a lower rate will depend on the driving characteristics, battery, and charging parameters of each vehicle; the program is still mainly in the planning/conceptual stages.

How Does This Fit the HCEI Goals?
To reach the 70% clean energy goal, Hawai'i will need significant deployment of electric drive vehicles in combination with biofuels. This policy is one way to accelerate the rate of electric drive adoption in the state, and–importantly–encourage owners of PHEVs that are capable of operating on either electricity or gasoline to use electricity as much as possible.

Next Steps
There is currently limited data on how this policy might impact vehicle purchase decisions. The development of a vehicle choice model might be the most immediate way to approximate the impact of subsidized electricity policies, which would illuminate the effectiveness of this policy considering that many consumers make decisions based on first cost rather than total cost of ownership.

Fact Sheet Addendum: Electric Vehicle Tax Credit plus Electricity Discount
Policy Definition
In August 2009, the Transportation working group reviewed analyses on EV tax credits and electricity subsidies for EVs. Each of those analyses looked at the level of subsidy that would be needed to bring EVs and PHEVs to cost parity with conventional ICE vehicles.

Out of that discussion, the group was interested in a combined policy—a tax credit to lower the up-front cost of the vehicle and an electricity subsidy to lower the ongoing operating costs. This analysis explores the policies in multiple configurations:

- Bringing the vehicles to *full cost parity* vs. to *half cost parity* (meaning that the state subsidizes half of the "total" price premium of the EV/PHEVs; the "total" price premium takes into account both the initial price premium and the long-term fuel cost of the EV/PHEV compared to the ICE)—which assumes that even if consumers must pay half of the total price premium, Hawai'i will be able to reach the very aggressive EV and PHEV adoption curves assumed in the analysis. See below for more discussion on this point. See Figure 17 and the following text for more discussion of this point.
- Providing a discount of *25 cents per kWh electricity* versus *5 cents per kWh electricity* used to charge EVs and PHEVs. One way to deploy this discount would be through TOU rates rather than a straight subsidy—these calculations would hold *if* all vehicle charging were done at the off-peak rate and the difference between the peak and off-peak rate matched the assumptions in this analysis.

The level of tax credit needed for each vehicle is shown under four different scenarios.

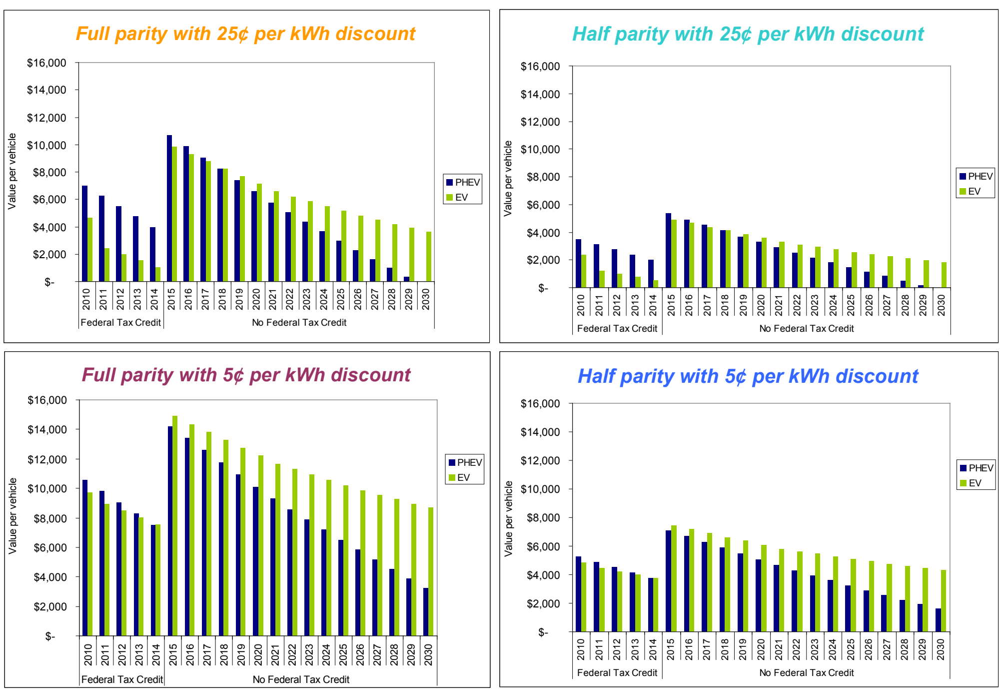


Figure 17. PHEV and EV incentive scenarios

Costs and Benefits

For this policy, the main question is whether bringing EVs and PHEVs to "half" cost parity with ICE vehicles would result in the same aggressive adoption curve as giving a higher subsidy that brings them to "full" cost parity. This is the working assumption, though it seems unlikely. However, without a vehicle choice model, we cannot predict the level of adoption that a particular incentive would be likely to achieve.

The costs of bringing vehicles to half cost parity would, of course, be lower. Under the combined scenario with electricity discounted 5 cents, the annual cost to the state would be about $200 million by 2030. By 2030, the tax credit makes up about 70% of this cost, and the electricity subsidy makes up about 30%.

Please see EV Tax Credit and Electricity Subsidy policy briefs for Methodology, Benefits, Assumptions, Precedents, Resources & References, and other information.

Next Steps

Conducting research on existing state incentives for hybrids would help determine what factors beyond the up-front cost and cost of ownership are considered by those purchasing hybrids. This would provide insight into the capacity of this policy to drive market adoption beyond those who would purchase EVs for other, noncost reasons.

Conclusion

The Hawai‘i Clean Energy Initiative has set progressive clean energy goals to transition the state away from its current dependency on imported fossil fuels. Achieving 70% clean energy by 2030 will require a significant, coordinated effort from myriad stakeholders throughout the state to address the technical, market, policy and other barriers to clean energy development and deployment. As a variety of policy options are available for policy makers to implement, it is critical that policy makers are able to weigh the costs and benefits of each option when determining which are appropriate for creating the policy environment desired.

To aid HCEI in determining which policies aligned with the clean energy goals, 21 policies were analyzed based on policy experience in other localities and states; technology deployment models; and personal communication with policy implementers, stakeholders, and industry leaders. As many clean energy policies have been implemented recently and substantial experience with these policies is limited, it can be challenging to determine potential quantitative policy impacts. Therefore, when it was not possible to estimate quantitative impacts, qualitative analysis and contextual factors were provided to reveal potential policy impacts.

Each policy chosen by the working groups for analysis addresses specific barriers to clean energy, and impacts on stakeholders vary. For some, such as LBE policies considered by the End-Use Efficiency working group, the direct impacts and benefits fall on state agencies. Others, such as the Extension of the Sunset of Act 221/215, directly benefit the local high-tech industry. For many of these policies, the direct costs and benefits do not equally impact different stakeholders, and the costs may predominantly be upfront while the benefits are reaped over multiple years. Each policy uniquely addresses a barrier in Hawai‘i to a clean energy transition as identified by the working members. The analyses herein allow for stakeholders and policy makers to weigh the costs and benefits when comparing multiple policy options.

Moving Beyond Hawai‘i

Hawai‘i’s efforts to transition to clean energy provide an example for other states and for island nations that hope to pursue similarly progressive renewable energy and energy efficiency targets. Based on the policies adopted in LY 2009 and those to be adopted in future years, others can benefit from the lessons learned from both the impacts of each policy as well as the effectiveness of the process for pursuing these goals. While policies must inherently be designed to fit specific local contexts, the lessons learned in the coming years in Hawai‘i will provide insight into policy effectiveness in addressing barriers to clean energy development and driving market transformation. As an increasing number of cities and states begin to adopt similar policies, the database of information on policy impacts will grow. This will allow for more in-depth analysis of the impacts of these types of policies, aiding all state and local policy makers as they determine which policies are appropriate to their local context and clean energy goals.

References

[AAA] American Automobile Association. (2009). "AAA's Daily Fuel Gauge Report for October 13, 2009." Accessed October 2009. http://www.fuelgaugereport.com/

Abuelsamid, S. (2009a). "Underwriters Laboratories approves SAE J1772 charging plug." *AutoBlogGreen.* Accessed November 2009. http://green.autoblog.com/2009/06/28/underwriters-laboratories-approves-sae-j1772-charging-plug/

Abuelsamid, S. (2009b). "First Coulomb ChargePoint stations now available in San Jose, CA." *AutoBlogGreen.* Accessed November 2009. http://green.autoblog.com/2009/01/08/first-coulomb-chargepoint-stations-now-available-in-san-jose-ca/

Aden, A.; Ruth, M.; Isben, K.; Jechura, J.; Neeves, K.; Sheehan, J.; Wallace, B.; Montague, L.; Slayton, A.; Lukas, J. (June 2002). "Lignocellulosic Biomass to Ethanol Process Design and Economics Utilizing Co-Current Dilute Acid Prehydrolysis and Enzymatic Hydrolysis for Corn Stover." NREL/TP-510-32438. Golden, CO: National Renewable Energy Laboratory.

Alameda Municipal Power. (2009). "Electric Rate Schedules." Accessed November 2007. http://www.alamedamp.com/electricity/rates/evx.html

Aseambankers. (21 March 2008). "Equity Focus – Plantation." Malaysia Equity Research. Kuala Lumpur: 21 March 2008.

[Austin] Austin Zero Energy Capable Homes Task Force. (2007). "Memorandum." Accessed June 2009. http://www.ci.austin.tx.us/council_meetings/wams_item_attach.cfm?recordID=7329

[BAH] Booz Allen Hamilton. (2008). *HCEI Electricity and Transportation Wedge Analysis*. Washington DC: Booz Allen Hamilton.

[BAH] Booz Allen Hamilton. (January 2009). "HCEI Bioenergy Supply, Demand, Cost and Risk Analysis." Washington DC: Booz Allen Hamilton.

Borreca, R. (2009). "Override on Energy Tax Fails." *Honolulu Star-Bulletin*. 16 July. Accessed October 2009. http://www.starbulletin.com/news/20090716_override_on_energy_tax_fails.html

Boulder County. (2009). "Chapter 11 Energy Efficiency." Accessed June 2009. http://www.bouldercounty.org/lu/building_division/building_code/pdf/Chapter11BuildSmart.pdf

Boulder. (2007). "Draft: Consideration of a Residential Energy Conservation Ordinance (RECO) for Boulder, CO." City of Boulder. Accessed July 2009. http://www.bouldercolorado.gov/files/Environmental%20Affairs/CAPAG/reco_report_boulder.pdf

Boulder. (2009). "Green Building and Green Points Guideline Booklet." City of Boulder. Accessed June 2009. http://www.bouldercolorado.gov/files/PDS/green_points/902.pdf

Bradshaw, W.; Connelly, E. F.; Cook, M. F.; Goldstein, J.; Pauly, J. (2005). "The Benefits and Costs of Green Affordable Housing." *New Ecology Inc.* Accessed July 2009. http://www.dnr.state.md.us/ed/finalcbreport.pdf

British Columbia Hydro. (2009). "Conservation Rate." Accessed November 2009. https://www.bchydro.com/youraccount/content/residential_inclining_block.jsp

Brown, E.; Busche, S. (2008). "State of the States: Renewable Energy Development and the Role of Policy." NREL-TP-670-43021. Golden, CO: National Renewable Energy Laboratory.

Brown, E.; Quinlan, P.; Sachs, H.; Williams, D. (2004). "Tax Credits for Energy Efficiency and Green Buildings: Opportunities for State Action." Report: ACEEE-E021. Washington DC: American Council for an Energy-Efficient Economy.

Brown, M.; Chandler, J.; Lapsa, M. V.; Ally, M. (2009). "Making Homes Part of the Climate Solution: Policy Options to Promote Energy Efficiency." ORNL/TM-2009-104. Oak Ridge, TN: Oak Ridge National Laboratory.

Builder. (9 September 2009). Energy Star New Homes Partner Builder in Hawaiʻi. Personal communication to Sarah Busche.

Burke, P. M.; Nelson G.; Rickerson W. (2007). "Boston's Green Affordable Housing Program: Challenges and Opportunities." *Journal of Legislation and Policy* (11:1); pp. 1-32.

[CBECS] Commercial Buildings Energy Consumption Survey. (2003). Energy Information Agency of the Department of Energy. Accessed August 2009. http://www.eia.doe.gov/emeu/cbecs

Census. (2000). "Profile of Selected Housing Characteristics – Hawaiʻi." U.S. Census. Accessed August 2009. http://factfinder.census.gov/servlet/QTTable?_bm=n&_lang=en&qr_name=DEC_2000_SF3_U_DP4&ds_name=DEC_2000_SF3_U&geo_id=04000US15

Chandra, A.; Gulati, S.; Kandlikar, M. (2009). "Green Drivers or Free Riders? An Analysis of Tax Rebates for Hybrid Vehicles." University of British Columbia. Accessed November 2009. http://www.publicaffairs.ubc.ca/download/HybridVehicles_2009.pdf

Chang, M. (28 September 2009). Hawaiʻi Energy Efficiency Program. Personal communication to Sarah Busche.

City and County of San Francisco (2009). "Mayors Aim to Make San Francisco Bay Area the Electric Vehicle Capital of the U.S." Accessed November 2009. http://www.sfgov.org/site/mayor_index.asp?id=93399

Clement, D.; Lehman, M.; Hamrin, J.; Wiser, R. (2005). "Draft report: international tax incentives for renewable energy: lessons for public policy." Center for Resource Solutions. Prepared for Energy Foundation China Sustainable Energy Program. Accessed July 2009. http://www.resource-solutions.org/lib/librarypdfs/IntPolicy-Renewable_Tax_Incentives.pdf

Colorado House. (2007). "HB07-1145 Concerning Renewable Energy Resources Development on State Lands Managed by the State Board of Land Commissioners." Colorado Legislative Council Staff Fiscal Note. Accessed November 2009. http://www.statebillinfo.com/bills/fiscal/07/HB1145_r2.pdf

Colorado State Land Board. "Renewable Energy Projects." Accessed November 4, 2009. http://trustlands.state.co.us/Projects/Pages/RenewableEnergy.aspx

[CPUC] California Public Utilities Commission. (2008). "Decision adopting dynamic pricing timetable and rate design guidance for Pacific Gas & Electric Company, D. 08-07-045." http://docs.cpuc.ca.gov/PUBLISHED/FINAL_DECISION/85984.htm

[CLUE] Center for Land Use Education. (2005). "Planning Implementation Tools: Density Bonus." University of Wisconsin – Steven's Point. Accessed July 2009. http://www.uwsp.edu/CNR/landcenter/pdffiles/implementation/densitybonus.pdf

Daly, B. (2009). "State Properties Could Host Vast Amounts of Renewable Power." *The Boston Globe.* Accessed November 2009. http://www.boston.com/lifestyle/green/greenblog/2009/02/state_properties_could_host_va_1.html

[DBEDT] Department of Business, Economic Development and Tourism. (2006). "DBEDT Data Book 2006." Hawai'i Department of Business, Economic Development and Tourism. Accessed November 2009. http://hawaii.gov/dbedt/info/economic/databook/db2006/

[DBEDT] Department of Business, Economic Development and Tourism. (2007). "DBEDT Data Book 2007." Hawai'i Department of Business, Economic Development and Tourism. Accessed June 2009. http://hawaii.gov/dbedt/info/economic/databook/db2007/

[DBEDT] Department of Business, Economic Development and Tourism. (2008a). "DBEDT Data Book 2008." Hawai'i Department of Business, Economic Development and Tourism. Accessed October 2009. http://hawaii.gov/dbedt/info/economic/databook/db2008/

[DBEDT] Department of Business, Economic Development and Tourism. (2008b). "Energy Agreement Among the State of Hawai'i, Division Advocacy of the Department of Commerce and Consumer Affairs, and the Hawaiian Electric Companies." Hawai'i Department of Business, Economic Development and Tourism. Accessed August 2009. http://hawaii.gov/dbedt/info/energy/agreement/signed2008oct20.pdf

[DBEDT] Department of Business, Economic Development and Tourism. (2008c). "Annual Visitor Research Report." Hawai'i Department of Business, Economic Development and Tourism. Accessed September 2009. http://hawaii.gov/dbedt/info/visitor-stats/visitor-research/

[DBEDT] Department of Business, Economic Development and Tourism. (2009). "Report to the 2009 Hawai'i State Legislature: Lead by Example – State of Hawai'i Agencies' Energy Initiatives FY 2007-2008." Hawai'i Department of Business, Economic Development and Tourism. Accessed August 2009. http://hawaii.gov/dbedt/info/energy/efficiency/state/lbe/LBE-08.pdf

Dillard, S. (6 July 2009). State of Oregon. Personal communication to Elizabeth Doris.

Doggett, S. (2009a). "eTec signs $99.8 Million contract, provides scope of work, launches website." *Green Car Advisor.* Accessed November 2009. http://blogs.edmunds.com/greencaradvisor/2009/10/etec-signs-998-million-doe-contract-provides-scope-of-work-launches-website.html

Doggett, S. (2009b). "Calif. Gives eTec $8 Million for Electric Vehicle Charging Infrastructure for San Deigo." *Green Car Advisor.* Accessed November 2009. http://blogs.edmunds.com/greencaradvisor/2009/08/calif-gives-etec-8-million-for-electric-vehicle-charging-infrastructure-for-san-diego.html

[DSIRE] Database for State Incentives for Renewable Energy. (2009a). "Colorado Building Energy Code with Mandatory Solar Option." North Carolina Solar Center. Accessed July 2009. http://dsireusa.org/incentives/incentive.cfm?Incentive_Code=CO36R&re=1&ee=1

[DSIRE] Database for State Incentives for Renewable Energy. (2009b). "Tucson – Solar Design Requirement for Homes." North Carolina Solar Center. Accessed July 2009. http://dsireusa.org/incentives/incentive.cfm?Incentive_Code=AZ26R&re=1&ee=1

[DSIRE] Database for State Incentives for Renewable Energy. (2009c). "Renewable Energy Technologies Investment Tax Credit." North Carolina Solar Center. Accessed November 2009. http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=FL35F&re=1&ee=1

[DSIRE] Database for State Incentives for Renewable Energy. (2009d). "Kansas Incentives/Policies for Renewables & Efficiency." North Carolina Solar Center. Accessed November 2009. http://www.dsireusa.org/incentives/index.cfm?re=1&ee=1&spv=0&st=0&srp=1&state=KS

[DSIRE] Database for State Incentives for Renewable Energy. (2009e). "Iowa Alternative Energy Law." North Carolina Solar Center. Accessed November 2009. http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=IA01R&re=1&ee=1

[DSIRE] Database for State Incentives for Renewable Energy. (2009f). "Maryland Energy Renewable Portfolio Standard." North Carolina Solar Center. Accessed November 2009. http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=MD05R&re=1&ee=1

[DSIRE] Database for State Incentives for Renewable Energy. (2009g). "Pennsylvania Alternative Energy Portfolio Standard." North Carolina Solar Center. Accessed November 2009. http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=PA06R&state=PA&CurrentPageID=

[DSIRE] Database for State Incentives for Renewable Energy. (2009h). "Washington Renewable Energy Standard." North Carolina Solar Center. Accessed November 2009. http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=WA15R&re=1&ee=1

Duda, M. (26 October 2009). Distributed Energy Partners. Personal communication to Sarah Busche.

[EERE/DOE] Office of Energy Efficiency and Renewable Energy. (2001). "Making Paradise More Affordable with Weatherization." U.S. Department of Energy. Accessed July 2009. http://apps1.eere.energy.gov/weatherization/pdfs/states/30650.pdf

[EERE/DOE] Office of Energy Efficiency and Renewable Energy. (13 November 2002). "Puget Sound Energy to Restructure Time-of-Use Pilot." *EERE Network News.* U.S. Department of Energy Accessed November 2009.
http://apps1.eere.energy.gov/news/news_detail.cfm/news_id=6156

[EIA] Energy Information Administration. (2009a). "Annual Energy Outlook 2009." U.S. Department of Energy's Energy Information Administration. Accessed November 2009. http://www.eia.doe.gov/oiaf/aeo/index.html

[EIA] Energy Information Administration. (2009b). "Federal and State Motor Fuel Taxes." U.S. Department of Energy's Energy Information Administration. Accessed November 2009. http://www.eia.doe.gov/pub/oil_gas/petroleum/data_publications/petroleum_marketing_monthly/current/pdf/enote.pdf

[EIA] Energy Information Administration. (2009c). "Hawai'i State Energy Profile." U.S. Department of Energy's Energy Information Administration. Accessed August 2009. http://tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=HI

[EIA] Energy Information Administration. (2009d). "Petroleum Navigator." U.S. Department of Energy's Energy Information Administration. Accessed November 2009. http://tonto.eia.doe.gov/dnav/pet/pet_sum_mkt_a_epm0_ptc_cpgal_m.htm

Enterprise representative. (2009). Personal communication to Ralph Braccio and Dawn Lippert.

[EPA] U.S. Environmental Protection Agency. (2006). "Clean Energy-Environment Guide to Action: Policies, Best Practices and Action Steps for States." Accessed July 2009. http://www.epa.gov/cleanenergy/documents/gta/guide_action_full.pdf

[EPA] U.S. Environmental Protection Agency. (2008). "State Planning and Incentive Structures." Accessed July 2009. http://www.epa.gov/cleanenergy/energy-programs/state-and-local/state_planning.html#eepf

[EPRI and NRDC] Electric Power Research Institute and Natural Resource Defense Council. (2007). "Environmental Assessment of Plug-In Hybrid Electric Vehicles Volume 1: Nationwide Greenhouse Gas Emissions." Accessed November 2007. mydocs.epri.com/docs/public/000000000001015325.pdf

Faruqui, A. (2008). "Inclining Toward Efficiency." *Commission Watch.* Accessed November 2009. http://www.soprisfoundation.org/PDFs/PUF_IncliningTowardEfficiency.pdf

Faruqui, A.; Sergici, S. (2009). "Household Response to Dynamic Pricing of Electricity – A Survey of the Experimental Evidence." The Brattle Group. Accessed November 2009. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1134132

Federal Register. (2009). "Proposed Rulemaking to Establish Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards; Proposed Rule." Environmental Protection Agency, Department of Transportation, National Highway Traffic Safety Administration. Accessed November 2009. http://www.nhtsa.dot.gov/portal/fueleconomy.jsp

Federal Reserve. (2009). "Statistics & Historical Data." Board of Governors of the Federal Reserve System. Accessed August 3, 2009. http://www.federalreserve.gov/econresdata/releases/statisticsdata.htm

[FERC] Federal Energy Regulatory Commission. (2009). "Staff Report: A National Assessment of Demand Response Potential." http://www.ferc.gov/legal/staffreports/demand-response.pdf

Feuerbach, J. (26 August 2009). City of Boston Department of Neighborhood and Development. Personal communication to Sarah Busche.

Galbraith, Kate. (2009). "New Measures to Aid Solar on Public Lands." Green Inc., *The New York Times.* Accessed November 2009. http://greeninc.blogs.nytimes.com/2009/06/29/new-measures-to-aid-solar-on-public-lands/

Geller, H.; Mitchell, C.; Schlegel, J. (2005). "Nevada Energy Efficiency Strategy." Southwest Energy Efficiency Project. Accessed July 2009. http://www.swenergy.org/pubs/Nevada_Energy_Efficiency_Strategy.pdf

George, S. S.; Wiebe, M. (2007). "Benefit-Cost Analysis for Advanced Metering and Time-Based Pricing." Vermont Department of Public Service Workshop. Accessed November 2009. http://publicservice.vermont.gov/planning/vermontdpsworkshopcompressed.pdf

Gibson, Lisa. (October 2008). "Innovation and Technology in Hawai'i: An Economic and Workforce Profile." Hawaii Science and Technology Council. Accessed October 2008. http://www.hec08.com/followup.html

[GM] General Motors. (2009). "Plug Standard Needed For Electric Car-Charging Cord Interface: SAE J1772." GM-Volt. Accessed November 2009. http://gm-volt.com/2009/04/16/plug-standard-needed-for-electric-car-charging-cord-interface-sae-j1772/

Gonzalez, A. (2007). "Biodiesel Plant Stirs Hopes in Grays Harbor." *The Seattle Times.* Accessed November 2009. http://seattletimes.nwsource.com/html/businesstechnology/2003838495_imperium16.html

[GAO] Government Accountability Office. (2009). "Federal Energy and Fleet Management: Plug-In Hybrids Offer Potential Benefits, but High Costs and Limited Information Could Hinder Integration into the Federal Fleet: Report to Congressional Requesters." Accessed November 2009. http:/www.gao.gov/products/GAO-09-493

Granade, H. C.; Creyts, J.; Derkack, A.; Farese, P.; Nyquist, S.; Ostrowski, K. (2009). "Unlocking Energy Efficiency in the U.S. Economy." McKinsey. Accessed August 2009. http://www.mckinsey.com/clientservice/electricpowernaturalgas/downloads/US_energy_efficiency_full_report.pdf

Green Car Congress. (2009). "US DOE Awards $300 Million in Clean Cities Grants to Support Alternative Fuels, Vehicles, and Infrastructure Development." *Green Car Congress.* Accessed November 2009. http://www.greencarcongress.com/2009/08/clean-cities-300m-20090826.html

Green Communities. (2009). "Local Programs." *Green Communities.* Accessed August 2009. http://www.greencommunitiesonline.org/local/

Green Communities. (2008). "Green Communities Criteria." *Green Communities.* Accessed August 2009. http://www.practitionerresources.org/cache/documents/666/66641.pdf

Hafenbrack, J. (2009). "Special session could help rail." *Sun Sentinel.* Accessed November 2009. http://www.sun-sentinel.com/news/florida/fl-tri-rail-special-20091106,0,6651439.story

Hawai'i Department of Taxation. (2008). "The Impact of the High Technology Business Investment Tax Credit on Hawai'i's Economy for Calendar Year 2007." Hawai'i Department of Taxation. December 2008. Accessed November 2009. http://www.state.hi.us/tax/a5_1annual.htm

Hawai'i House. (2004). "Act 215." Hawai'i House of Representatives. Accessed November 2009. http://www.capitol.hawaii.gov/session2004/bills/HB2396_cd1_.htm

Hawai'i House. (2009a). "House Bill of 1464 of the 2009 Legislative Session." Hawai'i State House of Representatives. Accessed November 2009. http://www.capitol.hawaii.gov/session2009/Bills/HB1464_SD2_.HTM

Hawai'i House. (2009b). "House Bill 1054 of the 2009 Legislative Session." Hawai'i State House of Representatives. Accessed November 2009. http://www.capitol.hawaii.gov/session2009/Bills/HB1054.htm

Hawai'i Revised Statutes. (2008a). "Hawai'i Revised Statutes §269-92, Renewable portfolio standards." Hawai'i State Legislature. Accessed November 2009. http://www.capitol.hawaii.gov/hrscurrent/Vol05_Ch0261-0319/HRS0269/HRS_0269-0092.htm

Hawai'i Revised Statutes (2008b). "Hawai'i Revised Statutes §235-110.3, Ethanol facility tax credit." Hawai'i State Legislature. Accessed November 2009. http://www.capitol.hawaii.gov/hrscurrent/vol04_Ch0201-0257/HRS0235/HRS_0235-0110_0003.htm

Hawai'i Senate. (2009a). "Senate Bill 1271 of the 2009 Legislative Session." Hawai'i State Senate. Accessed August 2009. http://www.capitol.hawaii.gov/session2009/Bills/HB1271_SD1_.HTM

Hawai‘i Senate. (2009b). “Senate Bill 1671 of the 2009 Legislative Session.” Hawai‘i State Senate. Accessed August 2009. http://www.capitol.hawaii.gov/session2009/Bills/SB1671_SD1_.HTM

Hawai‘i Senate. (2009c). “Act 19, Senate Bill 50 of the 2009 Special Session.” Hawai‘i State Senate. Accessed November 2009. http://capitol.hawaii.gov/splsession2009/

Hawai‘i Senate. (2009e). “Senate Bill 1464 of the 2009 Legislative Session.” Hawai‘i State Senate. Accessed November 2009. http://www.capitol.hawaii.gov/session2009/bills/HB1464_CD1_.pdf

[HECO] Hawaiian Electric Company. (2007a). “Hawaiian Electric Contracts with Imperium to Provide Biodiesel for Planned Campbell Industrial Park Generation Station.” Accessed November 2009. http://www.heco.com/portal/site/heco/menuitem.508576f78baa14340b4c0610c510b1ca/?vgnextoid=72c14a82c8ee5110VgnVCM1000005c011bacRCRD&vgnextfmt=default&cpsextcurrchannel=1

[HECO] Hawaiian Electric Company. (2007b). Integrated Resource Plan - 3. Hawaii Electric Light Company. Accessed August 2009. http://www.heco.com/portal/site/helco/menuitem.b136fe8120a5c28884276c10c510b1ca/?vgnextoid=b41d9a796a4e2110VgnVCM1000005c011bacRCRD&vgnextfmt=default&cpsextcurrchannel=1

[HECO] Hawaiian Electric Company. (2008). Integrated Resource Plan - 4. Accessed November 2009. http://www.heco.com/vcmcontent/IntegratedResource/IRP/PDF/HECO_IRP4_Plan2009_2028_Final_Report.pdf

[HECO] Hawaiian Electric Company . (2009). “Effective Rates Summary for HECO, MECO and HELCO.” Accessed October 2009. http://www.heco.com/vcmcontent/StaticFiles/FileScan/PDF/EnergyServices/Tarrifs/HECO/EFFRATESOCT09.pdf

HECO and State of Hawai‘i. (2008). “Energy Agreement Among the State of Hawai‘i, Division of Consumer Advocacy of the Department of Commerce & Consumer Affairs, and Hawaiian Electric Companies: Summary of Key Agreements.” Accessed November 2009. http://www.heco.com/vcmcontent/StaticFiles/pdf/HCEI_Summary-Final.pdf

Hledik, R. (2008). “Integrating Dynamic Pricing With Inclining Block Rates.” Hewlett Foundation Stanford Energy & Feedback Workshop. Accessed November 2009. piee.stanford.edu/.../05-04_Integrating_Dynamic_Pricing_with_Inclining_Block_Rates.pdf

Honolulu. (2009). “Hawai‘i’s Tax Climate.” City and County of Honolulu. Accessed November 2009. http://www.honolulu.gov/menu/ecodev/tools/taxes.htm

[HPHA] Hawai‘i Public Housing Authority. (24 August 2009). Personal communication to Sarah Busche.

Hurlbut, D. (2009). "Competitive Renewable Energy Zones in Texas." National Renewable Energy Laboratory. Presentation to the Colorado Public Utilities Commission. June 22, 2009.

Kalani, N. (2007). "Imperium Closes Hawai'i Office." *Puget Sound Business Journal.* Accessed November 2009. http://seattle.bizjournals.com/seattle/stories/2008/08/11/daily16.html

Karrer, P. (2009). "California Introduces Bill for Net Zero Energy Buildings." Building Codes Assistance Project. Accessed June 2009. http://bcap-energy.org/node/400

Kawafuchi, K. (2008). "The Impact of the High Technology Business Investment Tax Credit on Hawai'i's Economy for Calendar Year 2007." State of Hawai'i Department of Taxation. Accessed November 2009. http://www6.hawaii.gov/tax/a5_1annual.htm

Keffer et al. (2006). "Potential for Ethanol Production in Hawai'i." University of Hawai'i.

KEMA. (2005). "Energy Efficiency Potential Study." Prepared for KIUC. KEMA, Inc. Accessed August 2009. http://www.kiuc.coop/pdf/Kauai%20EE%20Report%20Final.pdf

Black & Veatch. (2008). "Integrated Resource Plan - 3." Kauai Island Utility Cooperative. Accessed November 2009.
http://www.kiuc.coop/IRP/Tariff/IRP2008_2008%20KIUC%20IRP.pdf

[KIUC] Kauai Island Utility Cooperative. (2009). "Rate Data Sheet." Accessed August 2009.
http://www.kiuc.coop/pdf/ratedata_2009.pdf

Krauss, Clifford. (June 2009). "Houston Biodiesel Plant For Sale." *Green, Inc., The New York Times.* Accessed November 2009. http://greeninc.blogs.nytimes.com/2009/06/23/houston-biodiesel-plant-for-sale/

Kromer, M.; J. Heywood. (2008). "A Comparative Assessment of Electric Propulsion Systems in the 2030 U.S. Light-Duty Vehicle Fleet." Society of Automotive Engineers International and Massachusetts Institute of Technology. Accessed November 2009.
http://www.sae.org/technical/papers/2008-01-0459

Kushler, M.; York, D.; Witte, P. (2009). "Meeting Aggressive New State Goals for Utility-Sector Energy Efficiency: Examining Key Factors Associated with High Savings." Washington DC: American Council for an Energy-Efficient Economy.

[LADWP] Los Angeles Department of Water & Power. (2009). "Residential Electric Vehicle Services." Accessed November 2009. http://www.ladwp.com/ladwp/cms/ladwp002056.jsp

Lantz, Eric. (2009 – Draft Copy). State Clean Energy Practices; State Policy and the Pursuit of Renewable Energy Manufacturing. Golden, CO: National Renewable Energy Laboratory

[LAX] Los Angeles World Airports. (2009). "LAX Parking." Accessed November 2009.
http://www.lawa.org/welcome_lax.aspx?id=58

Magin, J. L. (2009). "New Project Activity Stalls, Hawai'i Permits Tumble." *Pacific Business News.* Accessed July 2009. http://pacific.bizjournals.com/pacific/stories/2009/05/11/story1.html

Maine. (2007). "MaineHousing Green Building Standards." MaineHousing. Accessed July 2009. http://www.mainehousing.org/Documents/HousingDevelopments/2007GreenBuildingStandards.pdf

Marbury, S. (6 July 2009). State of New Mexico. Personal communication to Elizabeth Doris.

Massachusetts Department of Public Utilities. (2009). "Petition by Western Massachusetts Electric Company for approval of a smart grid pilot program." Accessed November 2009. http://www.mass.gov/Eoeea/docs/dpu/electric/09-34/72109dpuord.pdf

Massachusetts. (2008). "Clean Energy Biofuels Act." Massachusetts Executive Office of Energy and Environmental Affairs. Accessed November 2009. http://www.mass.gov/?pageID=eoeeaterminal&L=4&L0=Home&L1=Energy%2C+Utilities+%26+Clean+Technologies&L2=Alternative+Fuels&L3=Clean+Energy+Biofuels+in+Massachusetts&sid=Eoeea&b=terminalcontent&f=eea_biofuels_biofuels_act&csid=Eoeea

[Massachusetts] Massachusetts Zero Net Energy Task Force. (2009). "Getting to Zero." The Commonwealth of Massachusetts. Accessed June 2009. http://www.mass.gov/Eoeea/docs/eea/press/publications/zneb_taskforce_report.pdf.

[MECO] Maui Electric Company. 2007. "Integrate Resource Plan - 3." Accessed November 2009. http://heco.com/portal/site/meco/menuitem.ed4aed221358a44973b5c410c510b1ca/?vgnextoid=eb282e1f9d380110VgnVCM1000005c011bacRCRD&vgnextfmt=default&cpsextcurrchannel=1

Michigan State University. (2002). "World Travel & Tourism Tax Barometer." Accessed November 2009. http://www.traveltax.msu.edu/barometer/index.htm

Miller, J. W. (17 July 2009). John Wesley Miller Companies. Personal communication to Sarah Busche.

Milwaukee Wisconsin Journal Sentinel Online. (June 13, 2009). "Budget proposals for sales tax, rental car fee draw mixed reviews." *JSOnline.* Accessed November 2009. http://www.jsonline.com/news/wisconsin/47968796.html

Morrison, P. (19 August 2009). Roseville Electric Department. Personal communication to Sarah Busche.

[Namasté] Namasté Solar. (7 July 2009). Personal communication to Sarah Busche.

Nanda, A.; Ross, S. L. (2008). "The Impact of Property Condition Disclosure Laws on Housing Prices: Evidence form an Event Study using Propensity Scores." University of Connecticut. Department of Economics Working Paper Series. Accessed July 2009. http://www.econ.uconn.edu/working/2008-39.pdf

New Jersey. (2008). "Chapter 33: An Act Concerning Solar Energy Systems and Supplementing Titles 48 and 52 of the Revised Status." State of New Jersey. Accessed July 2009. http://www.njleg.state.nj.us/2008/Bills/PL09/33_.pdf

New Mexico. (2007). "An Act Relating to Solar Development (HB0610)." State of New Mexico. Accessed July 2009. http://www.nmlegis.gov/Sessions/07 Regular/final/HB0610.pdf

New Mexico. (2009). "Clean Energy Tax Incentives: Sustainable Building Tax Credit." New Mexico Energy, Minerals and Natural Resources Department. Accessed June 2009. http://www.emnrd.state.nm.us/ECMD/CleanEnergyTaxIncentives/sustainablebuildingtaxcredit.htm

[NHTSA] National Highway Traffic Safety Administration. (2009). "Average Fuel Economy Standards, Passenger Cars and Light Trucks, Model Year 2011." Department of Transportation, National Highway Traffic Safety Administration. Accessed November 2009. http://www.nhtsa.dot.gov/portal/fueleconomy.jsp

Norton, P. (August 2009). National Renewable Energy Laboratory. Personal communication to Sarah Busche.

Office of the Governor of California. (2008a). "Executive Order S-14-08." Accessed November 2009. http://gov.ca.gov/executive-order/11072/

Office of the Governor of California. (2008b). "The Role of a Low Carbon Fuel Standard in Reducing Greenhouse Gas Emissions and Protecting Our Economy." Accessed November 2009. http://gov.ca.gov/index.php?/fact-sheet/5155/

Office of the Mayor. (2008). "Mayors Aim to Make San Francisco Bay Area the Electric Vehicle Capital of the U.S." City and County of San Francisco. Accessed November 2009. http://www.sfgov.org/site/mayor_index.asp?id=93399

Oregon. (2009). "Business Energy Tax Credit." Accessed September 2009. http://www.oregon.gov/ENERGY/CONS/BUS/BETC.shtml

Oregon Department of Energy (2009). "Application for Preliminary Certification for Alternative Fuel Infrastructure Project." Oregon Business Energy Tax Credit Program. Accessed November 2009. http://www.oregon.gov/ENERGY/CONS/BUS/docs/Alt_fuel_Infrastructure.pdf

Oregon Office of Innovative Partnerships and Alternative Funding. (2009). "Innovative Partnerships Program." State of Oregon. Accessed November 2009. http://www.oregon.gov/ODOT/HWY/OIPP/inn_ev-charging.shtml

ORNL Feedback. (2008). Personal communication to Ralph Braccio and Dawn Lippert.

Oro Valley. (2009). "Council Communication." Town of Oro Valley. Accessed July 2009. http://www.orovalleyaz.gov/Assets/_assets/newsroom/pdf/Ordiance_09-11_residential_solar.pdf

[Pacific] Pacific Business News. (2009). "Hawai'i Gas Prices Highest in U.S.; Above $3 on Maui." *Pacific Business News.* May 29, 2009. Accessed October 2009. http://pacific.bizjournals.com/pacific/stories/2009/05/25/daily48.html

[PG&E] Pacific Gas & Electric Company. (2009). "Pacific Gas & Electric Tariff Schedule Tariff Book." Pacific Gas & Electric Company. Accessed August 2009. http://www.pge.com/tariffs

Phillips, S.; Aden, A.; Jechura, J.; Dayton, D.; Eggeman, T. (April 2007). "Thermochemical Ethanol via Indirect Gasification and Mixed Alcohol Synthesis of Lignocellulosic Biomass." NREL/TP-510-41168. Golden, CO: National Renewable Energy Laboratory.

Poteet, M. (2006). "Biodiesel Crop Implementation in Hawai'i." Hawaii Agricultural Research Center. Accessed November 2009. https://www.eere-pmc.energy.gov/.../Hawaii.../biodiesel_report-revised.pdf

Potter, N. (2005). "Towns Tax Rental Cars for Extra Revenue." ABC News. Accessed November 2009. http://abcnews.go.com/Technology/Business/story?id=1415142

Public Utility Commission of Texas. (2005). Order Adopting New §25.1999 and Amendment to §25.231 as Approved at the February 10, 2005 open meeting. Accessed November 2009. http://74.125.95.132/search?q=cache:GrtWyXO591kJ:www.puc.state.tx.us/rules/subrules/electric/25.199/28884adt.doc+PURA+36.054&cd=2&hl=en&ct=clnk&gl=us&client=firefox-a

Public Utility Commission of Texas. 2007. Public Utility Regulatory Act. Accessed November 2009. http://www.puc.state.tx.us/rules/statutes/Pura07.pdf

PVWatts. (2009). "PVWatts performance calculator for grid-connected PV systems." National Renewable Energy Laboratory. http://rredc.nrel.gov/solar/codes_algs/PVWATTS/version1/

Rocky Mountain Institute. (2009). "Project Get Ready Menu." Accessed November 2009. http://projectgetready.com/resources/project-get-ready-menu-draft

Sacramento Municipal Utility District. (2009). "Electric Vehicles." Accessed November 2009. http://www.smud.org/en/community-environment/evs/pages/index.aspx

SCE (2009). "Regulatory Information – SCE Tariff Books." Southern California Edison. Accessed August 2009. http://www.sce.com/AboutSCE/Regulatory/tariffbooks/ratespricing/residentialrates.htm

Shapouri,H.; Salassi, M. (2006). "The Economic Feasibility of Ethanol Production from Sugar in the United States." United States Department of Agriculture (USDA), Office of Energy Policy and New Uses (OEPNU), Office of the Chief Economist (OCE), Louisiana State University (LSU). Accessed November 2009. www.usda.gov/oce/reports/.../EthanolSugarFeasibilityReport3.pdf

Shumaker, G.; McKissick, J.; Ferland, C.; Doherty, B. (2003). "A Study on the Feasibility of Biodiesel Production in Georgia." University of Georgia, Center for Agribusiness and Economic Development. Accessed November 2009. http://www.agecon.uga.edu/~caed/biodieselrpt.pdf

SMS. (2006). “Hawai‘i Housing Policy Study.” Hawai‘i Department of Business, Economic Development & Tourism. Accessed August 2009. http://hawaii.gov/dbedt/hhfdc/files-pdf/StateMASTER--Final.pdf

[SOH] State of Hawai‘i. (2008). “Memorandum of Understanding Between the State of Hawai‘i and the U.S. Department of Energy.” Hawai‘i Department of Business, Economic Development & Tourism. Accessed September 2009. http://hawaii.gov/dbedt/info/energy/hcei/hawaii_mou.pdf

Sonoda, D. (2 September 2009). Hawai‘i Energy Efficiency Program. Personal communication to Sarah Busche.

South Datoka Statute. (2009). “Tax Refunds for Construction of Agricultural Processing and New Business Facilities.” South Dakota Legislature. Accessed November 2009. http://legis.state.sd.us/statutes/DisplayStatute.aspx?Statute=10-45b&Type=Statute

Southern California Edison. (2009). Regulatory Information – SCE Tariff Books. SC. Accessed November 2009. http://www.sce.com/AboutSCE/Regulatory/tariffbooks/ratespricing/residentialrates.htm

State of Iowa. (2009). “Iowa Renewable Fuels Standard.” Iowa Office of Energy Independence. Accessed November 2009. http://www.energy.iowa.gov/renewable_fuels/IA_renewfuels_standard.html

Suozzo, M.; Wang, K; Thorne, J. (1997). “Policy Options for Improving Existing Housing Efficiency.” Washington DC: American Council for an Energy-Efficient Economy. Accessed July 2009. http://www.iamu.org/default%20page%20links/Attachment%20B%20Residential%20Energy%20Conservation%20Ordinances%20ACEEE.pdf.

Surles, T.; Foley, M.; Turn, S.; Staackmann, M. (2007). “A Scenario for Accelerated Use of Renewable Resources for Transportation Fuels in Hawai‘i.” University of Hawaii, Hawaii Natural Energy Institute, School of Ocean and Earth Science and Technology. Accessed November 2009. https://www.eere-pmc.energy.gov/Hawaii.aspx

Tax Foundation. (2009). “Rental Car Tax an Unfair Way to Fund Tri-Rail.” Accessed November 2009. http://www.taxfoundation.org/blog/show/24231.html

Texas. (2009). “Texas Renewable Portfolio Standard.” Texas State Energy Conservation Office. Accessed November 2009. http://www.seco.cpa.state.tx.us/re_rps-portfolio.htm

Texas Utilities Code. (2009). “Texas Utilities Code Section 35.053(d).” Accessed November 2009. http://www.statutes.legis.state.tx.us/Docs/UT/htm/UT.36.htm#36.053

Tian, Eugene. (4 September 2009). Hawai‘i Department of Business, Economic Development & Tourism. Personal communication to Sarah Busche.

[TSECO] Texas State Energy Conservation Office. (2009). “State Lands for Wind Power Development.” Accessed November 2009. http://www.seco.cpa.state.tx.us/re_wind.htm

[U.S. DOE] U.S. Department of Energy. (2009). “State & Federal Incentives & Laws.” U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Alternative Fuels & Advanced Vehicles Data Center. Accessed November 2009. http://www.afdc.energy.gov/afdc/incentives_laws.html

[DOE-CIO] U.S. Department of Energy, Office of the Chief Information Officer. (2009). “Renewable Energy Zones to be Identified on U.S. Public Lands.” Accessed November 2009. http://www.ens-newswire.com/ens/mar2009/2009-03-12-095.asp

U.S National Fuel Economy Policy (2009). “President Obama Announces National Fuel Efficiency Policy.” Council on Environmental Quality. Accessed November 2009. http://www.whitehouse.gov/the_press_office/President-Obama-Announces-National-Fuel-Efficiency-Policy/

[Washington] Washington State. (2008). “Evergreen Sustainable Development Standard Criteria.” Accessed July 2009. http://www.cted.wa.gov/DesktopModules/CTEDPublications/CTEDPublicationsView.aspx?tabID=0&ItemID=1545&MId=870&wversion=Staging

Williams, S.; Bourland, D. L. (2008). “Greener Homes, Greener Cities: Expanding Affordable Housing and Strengthening Cities Through Sustainable Residential Development.” In *Growing Greener Cities,* eds. E. L. Birch and S. M. Wachter. p. 106-123. Philadelphia: University of Pennsylvania Press.

Wu, N. (2008). “An Insider’s View of the Solar Mandate.” *Honolulu Star-Bulletin.* Vol. 13 (97). Accessed July 2009. http://archives.starbulletin.com/2008/04/06/business/story02.html

Yamani, M. V. (2009). “Senate Bill 1671 HD2 Testimony Fin 04-06-09 Testimony.” Presented at House hearing on Senate Bill No. 1671, S.D. 1, H.0. 2 - Relating to Renewable Energy. Accessed November 2009. http://www.capitol.hawaii.gov/session2009/getstatus.asp?query=sb+1671&currpage=1&showstatus=on&showtestimony=on

REPORT DOCUMENTATION PAGE	*Form Approved* *OMB No. 0704-0188*

The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to Department of Defense, Executive Services and Communications Directorate (0704-0188). Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ORGANIZATION.

1. REPORT DATE *(DD-MM-YYYY)*
April 2010

2. REPORT TYPE
Technical Report

3. DATES COVERED *(From - To)*

4. TITLE AND SUBTITLE
Clean Energy Policy Analysis: Impact Analysis of Potential Clean Energy Policy Options for the Hawaii Clean Energy Initiative

5a. CONTRACT NUMBER
DE-AC36-08-GO28308

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
S. Busche and E. Doris (NREL)
R. Braccio, D. Lippert, P. Finch, D. O'Toole, and J. Fetter
(Booz Allen Hamilton)

5d. PROJECT NUMBER
NREL/TP-7A2-47891

5e. TASK NUMBER
IDHW9120

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
National Renewable Energy Laboratory
1617 Cole Blvd.
Golden, CO 80401-3393

8. PERFORMING ORGANIZATION REPORT NUMBER
NREL/TP-7A2-47891

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)
NREL

11. SPONSORING/MONITORING AGENCY REPORT NUMBER

12. DISTRIBUTION AVAILABILITY STATEMENT
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

13. SUPPLEMENTARY NOTES

14. ABSTRACT *(Maximum 200 Words)*
This report provides detailed analyses of 21 clean energy policy options considered by the Hawaii Clean Energy Initiative working groups for recommendation to the 2010 Hawaii State Legislature. The report considers the impact each policy may have on ratepayers, businesses, and the state in terms of energy saved, clean energy generated, and the financial costs and benefits. The analyses provide insight into the possible impacts, both qualitative and quantitative, that these policies may have in Hawaii based on the experience with these policies elsewhere. As much as possible, the analyses incorporate Hawaii-specific context to reflect the many unique aspects of energy use in the State of Hawaii.

15. SUBJECT TERMS
Hawaii; Clean Energy Policy; Hawai'i; Hawaii Clean Energy Initiative; HCEI; Impact Analysis; Energy Bills; Hawaii Legislature

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
Unclassified	Unclassified	Unclassified	UL		19b. TELEPHONE NUMBER (*Include area code*)