DBEDT Hawaii State Energy Office

HAWAII GREENHOUSE GAS PROGRAM UPDATE

Reporting Pursuant to Act 234, SLH 2007

This is to provide a five year update of Hawaii Greenhouse Gas Emission Reductions, pursuant to Act 234, Session Laws of Hawaii, 2007.

Act 234 and the Greenhouse Gas Emissions Reduction Task Force

In 2007, Hawaii became the second state in the Nation to set a binding cap on greenhouse gas (GHG) emissions through Act 234, which declared a policy to reduce GHG emissions statewide to 1990 levels by the year 2020. Act 234 served as the foundation for the Hawaii Greenhouse Gas Program, which was established by the Hawaii Department of Health (DOH) to combat the threat of climate change and sea level rise. This Program utilizes the Air Pollution Control Permit process of DOH's Clean Air Branch to regulate GHG emissions statewide, in conjunction with other Federal and Hawaii State programs to mitigate GHGs. Parts of Act 234 are codified in Hawaii Revised Statutes, Chapter 342B (Air Pollution Control).

Act 234 also established the Greenhouse Gas Emissions Reduction Task Force within the Department of Business, Economic Development, and Tourism (DBEDT), and directed the Task Force to prepare a Work Plan and regulatory scheme for implementing the maximum practically and technically feasible and cost-effective reductions in greenhouse gas emissions from sources or categories of sources of greenhouse gases to achieve the statewide greenhouse gas emissions limits by 2020. Act 234 was notable not only for its binding cap on GHG emissions statewide, but its direction to the State to adopt rules focused on the "maximum practically and technically feasible and cost-effective reductions in greenhouse gas emissions" (Act 234, Page 12, Line 12).

The Task Force and its committees held open, monthly meetings and posted materials, and, in November 2009, held public workshops on the proposed Work Plan in Lihue, Kahului, Hilo, Kona, and Honolulu. As prescribed by Act 234, members of the Task Force at that time were:

1. Mr. Laurence Lau (Department of Health),
2. Mr. Theodore Liu (Department of Business, Economic Development, and Tourism),
3. Mr. Mark Fox (The Nature Conservancy),
4. Dr. Makena Coffman (UH Manoa, Department of Urban and Regional Planning),
5. Professor Maxine Burkett (UH Manoa, Richardson School of Law),
6. Mr. Robbie Alm (The Hawaiian Electric Company, Inc.),
7. Mr. Jeff Mikulina (Blue Planet Foundation),
8. Mr. Frank Clouse (Refinery Industry Representative),
9. Mr. Gary North (Maritime Industry Representative), and
10. Mr. Gareth Sakakida (Transportation Industry Representative).

The Task Force was dissolved following its Legislative Report in 2010 (*Report to the Twenty-Fifth Legislature, State of Hawaii, Work Plan for Greenhouse Gas Emissions Reductions*). This Report included a Work Plan and proposed regulatory scheme for implementing the maximum practically and technically feasible and cost-effective reductions in GHG emissions from sources or categories of sources of GHGs (see Attachment 1: *Proposed GHG Reduction Work Plans for Hawaii,* ICF International).

Hawaii Administrative Rules

Act 234 also directed DOH to adopt rules, based on the recommendations and findings of the Work Plan, specifying how the State could effectively achieve the required “real, permanent, quantifiable, verifiable, and enforceable” reduction in GHG pollution (Act 234, Page 13, Line 17).

On June 30, 2014, Hawaii Administrative Rules, Chapter 11-60.1 was amended to adopt these new rules. Five years in the making, the revised rules require large existing stationary sources (“affected sources”) with potential carbon dioxide equivalent

(CO2e) emissions at or above 100,000 tons per year to reduce their emissions by 16 percent instead of the previous 25 percent target, measured relative to 2010 emissions. This change was based on an updated assessment of system-wide greenhouse gas emissions, and what it would take to meet the 1990 level required by law. In addition, each affected source must submit a GHG emission reduction plan for establishing measures that will be used to meet the emission cap. The approved GHG emission cap and associated monitoring, recordkeeping, and reporting provisions to be part of the facility's covered source permit.

The revised rules allow for affected facilities to "partner" with other facilities so as to ensure that the entire system of large polluters collectively achieves the required target. This system-wide approach enables the most cost-effective reductions to be taken first. Beginning in 2015, GHG emissions must be included in the calculations to determine annual fees for all facilities holding a covered source permit. Emissions of greenhouse gas from biogenic, transportation, and smaller sources are not included in the proposed rules.

The main requirements of the Hawaii GHG Program are set forth in Subchapter 11, Greenhouse Gas Emissions (see Attachment 2: *GHG Rules_SUBCHAPTER 11).*

Hawaii Clean Energy Initiative and GHG Emissions Reduction

As detailed in the attached Hawaii State Energy Office *Issue Brief* (see Attachment 3), the successful deployment of the Hawaii Clean Energy Initiative (HCEI) and other energy conservation efforts has resulted in unprecedented reductions in GHGs, expressed as CO2e. Assuming that HCEI meets its interim renewable portfolio and energy efficiency portfolio standard targets by 2020, the resulting amount of aggregate CO2e reductions is estimated to bring Hawaii into compliance with the amount of CO2e DOH deems sufficient to comply with Act 234 under its draft rules.

Figure 1 shows DBEDT's forecast of CO2e emissions, and demonstrates that 2020 emissions levels will be lower than 1990 levels (by approximately 4% based on conservative assumptions) as required by Act 234 if HCEI's mandated RPS and EEPS levels are met, noting that Hawaii is well ahead of its 2015 RPS target.

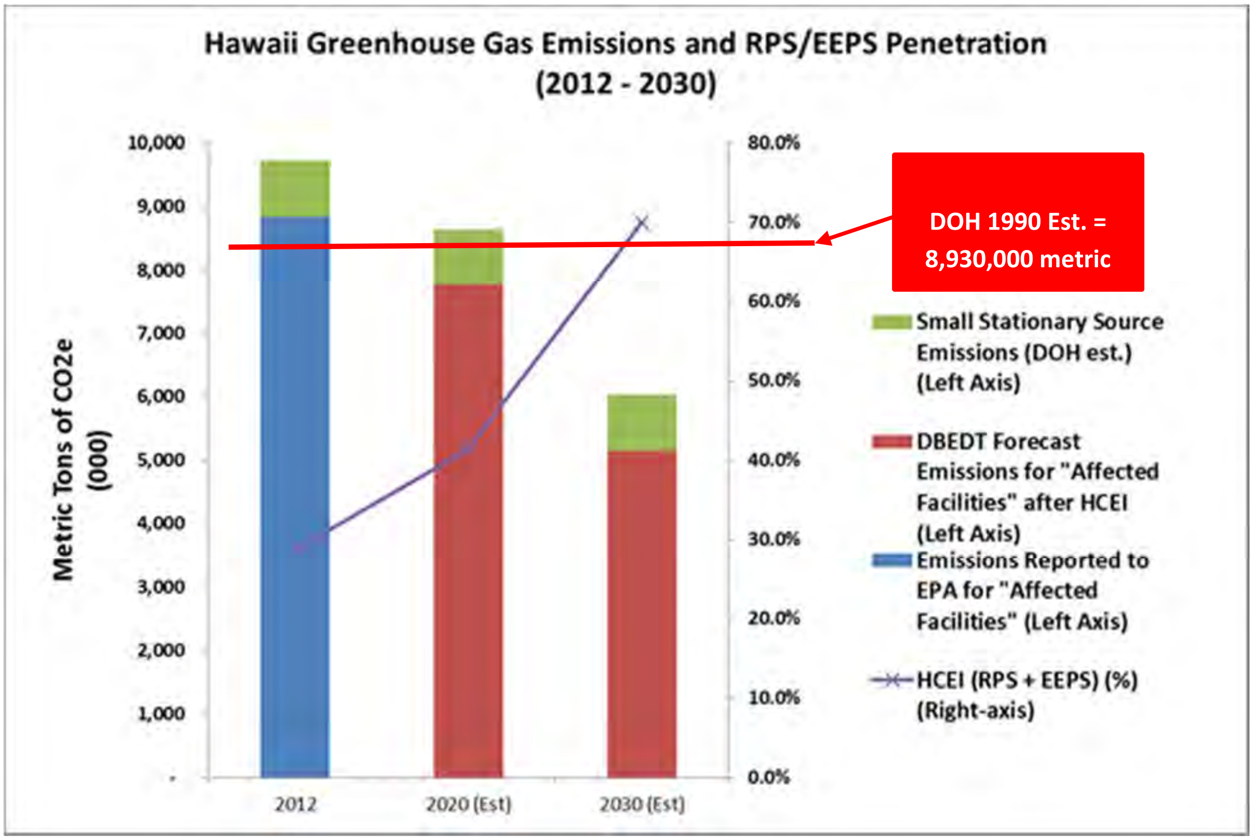

Figure 1

Conclusion

Hawaii's first GHG regulatory scheme and the Hawaii Greenhouse Gas Program resulted from a collaborative effort between diverse stakeholders vested in protecting Hawaii from the negative impacts of climate change and sea-level rise. Numerous parties came together to advise DOH in the Act 234 rulemaking process, and DOH now serves as the primary agency with regulatory oversight of Hawaii's GHG emissions. To this effect, DOH is the appropriate agency to provide greater detail regarding compliance with Act 234.

Attachments

1. *Proposed GHG Reduction Work Plans for Hawaii* (ICF report)
2. *GHG Rules_SUBCHAPTER 11*
3. *HSEO Issue Brief_ HCEI compliance in addressing the required greenhouse gas reductions of Act 234*

REPORT TO THE
TWENTY-FIFTH LEGISLATURE
STATE OF HAWAII

WORK PLAN FOR GREENHOUSE GAS EMISSIONS REDUCTIONS

UNDER SECTION 7, ACT 234, 2007 SESSION LAWS,
REQUIRING
THE GREENHOUSE GAS
EMISSIONS REDUCTION TASK FORCE
TO SUBMIT A WORK PLAN
AND PROPOSED REGULATORY SCHEME,
ALONG WITH ANY PROPOSED LEGISLATION

PREPARED BY:
THE GREENHOUSE GAS
EMISSIONS REDUCTION TASK FORCE
STATE OF HAWAII

December 30, 2009

1. Introduction

The Legislature has determined that Hawaii must do its share in reducing global greenhouse gas emissions. Although Hawaii's total emissions are a small part of the world's output, its per capita emissions are similar to other U.S. states. Section 7 of Act 234, 2007 Session Laws of Hawaii ("Act 234" or the "Act"), requires the Greenhouse Gas Emission Reduction Task Force (Task Force) to submit to the Legislature 20 days before the 2010 legislative session, a work plan and regulatory scheme, and any proposed legislation (collectively here, Work Plan), for achieving the maximum practically and technically feasible and cost-effective reductions in greenhouse gas (GHG) emissions from sources or categories of sources of greenhouse gases to at or below 1990 levels of emissions by the year 2020. The Work Plan includes this document (specifying the Task Force Recommendation), the attached consultant's report, response to public comments, and other exhibits.

To develop the Work Plan, the Task Force worked with the consulting group ICF International (ICF), administered through the Department of Business, Economic Development and Tourism (DBEDT), to produce various reports. In 2008, ICF produced an updated inventory of 1990 GHG emissions as required by section 3 of Act 234 to set the target for reductions. To determine the magnitude of the needed emissions reduction, ICF also compiled an inventory of 2007 emissions, the latest year feasible. In 2009, ICF produced an assumptions report (to inform a reference case projection of "business as usual") and the attached "Proposed GHG Reduction Work Plans for Hawaii" (ICF Work Plans Report, November 10), , which provides details on four alternative scenarios for greenhouse gas reduction within the State (titled Work Plan #1, #2, and #3). Work Plan #1 assesses the impact to the State of implementing the Hawaii Clean Energy Initiative (HCEI) plus additional policies, Work Plan #2 a state-level carbon tax, and Work Plan #3 the proposed federal cap-and-trade program (in its current legislative form). The ICF Report also provided estimates of the Hawaii greenhouse gas emissions under a 'business as usual' scenario ("Reference case"). DBEDT administered the contract with ICF and spent $500,000 of the $1,000,000 appropriated for Act 234 work, mostly for ICF's emissions inventory update, assumptions book, and ICF Work Plan(s) Report.

The Task Force and its committees held open, monthly meetings, posted materials on http://hawaii.gov/dbedt/info/energy/greenhouse, and, in November 2009, held public workshops on the proposed Work Plan in Lihue, Kahului, Hilo, Kona, and Honolulu.

Act 234 commits the State to achieve 1990 levels or beyond of greenhouse gas emissions by the year 2020. Act 234 specifies that emissions from aviation and international fuels be excluded. Using national and international standards for greenhouse gas emissions accounting, emissions in the year 1990 are estimated to be 13.660 megatonnes[1] [million metric tons] of carbon dioxide equivalents

[1] 1 megatonne = 1,000 kilotonnes. 13.660 MMCO2e=13,660 ktCO2e. The ICF Report uses "MM" on some tables synonymously with "Mt."

(MMCO2e). In 2007, Hawaii emitted about 15.487 MMCO2e[2]. These numbers include long-term carbon storage features, such as managed forests (sinks). To meet Act 234 requirements, Hawaii must reduce covered emissions by about 12% (or 1.827 MMCO2e) below 2007 levels by the year 2020.

2. Summary of Task Force Recommendation

The Task Force unanimously recommends that the Legislature strongly support Work Plan #1, the Hawaii Clean Energy Initiative (HCEI)[3] with additional specified policies (hereby called HCEI+). HCEI+ meets and surpasses the GHG emissions reduction target by an estimated 39% providing that its elements are met on time (see Table 2).

The majority of the Task Force (seven of ten)[4] recommends that the Legislature enact laws to implement and assure that HCEI+ meets its schedule in a timely manner. Some major areas of law-making will include electricity, transportation, support for the Public Utilities Commission, rule-making within the Department of Health, mitigation of impacts to disproportionately impacted households, and monitoring and compliance over time (see sections 3a to 3e below).

The majority of Task Force members (seven of ten)[5] strongly recommend there be additional assurances, incentives, and policy mechanisms for HCEI+ to become a reality on time. This set of the Task Force recommends that the cost of HCEI+ be more explicitly identified (see section 4 of this report, *Additional Questions and Research Needs*) and that the Legislature arrange for the funding of HCEI+ both in terms of staff/coordinating efforts and large infrastructure projects. Funding may include a variety of mechanisms such as private investment, user/consumer fees, and state and federal taxes. Funding should take into account any federal laws and funding mechanisms.

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[2] 15.487 MMCO2e with aviation & international fuel excluded. 20.326 MMCO2e with them included.

[3] HCEI seeks to achieve 70% clean energy use in Hawaii by 2030, up from less than 10% in 2007. Sub-targets include 40% use of renewable energy for electricity generation and 30% use of efficiency measures.

[4] This subset of Task Force members includes Mr. Laurence Lau (Department of Health), Mr. Theodore Liu (Department of Business, Economic Development, and Tourism), Mr. Mark Fox (The Nature Conservancy), Dr. Makena Coffman (University of Hawaii at Manoa, Department of Urban and Regional Planning), Professor Maxine Burkett (University of Hawaii at Manoa, Richardson School of Law), Mr. Robbie Alm (The Hawaiian Electric Company, Inc.), and Mr. Jeff Mikulina (Blue Planet Foundation).

[5] This subset of Task Force members includes Mr. Laurence Lau (Department of Health), Mr. Theodore Liu (Department of Business, Economic Development, and Tourism), Mr. Mark Fox (The Nature Conservancy), Dr. Makena Coffman (University of Hawaii at Manoa, Department of Urban and Regional Planning), Professor Maxine Burkett (University of Hawaii at Manoa, Richardson School of Law), Mr. Robbie Alm (The Hawaiian Electric Company, Inc.), and Mr. Jeff Mikulina (Blue Planet Foundation).

The majority of Task Force members (seven of ten)[6] suggest that a variety of assurance mechanisms be explored in order to act as a "backstop" (i.e. ensuring HCEI+ becomes a reality). For example, enforceable penalties could be added to the ACT 155 (2009) energy efficiency portfolio standard and renewable energy portfolio standard; greenhouse gas emissions limits that achieve the Act 234 target could be imposed via rules developed by the Department of Health on sources and categories of sources.

> Four Task Force members[7] suggest that a carbon tax could act as a "backstop" mechanism, i.e. it would take effect if HCEI+ does not meet identified conditions (triggers). For example, if a condition were not met, the law would impose a price floor on carbon or a carbon tax. Similarly, a "barrel tax" could also provide a funding mechanism for projects and implementation.
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> Four Task Force members[8] strongly recommend that there be a carbon tax in order to: 1) Provide incentives and a funding source to achieve HCEI+ goals; and 2) Help mitigate impacts to disproportionately burdened households. The level and scope of tax should be determined by further study. This set of Task Force members recommends that a state-level carbon tax be implemented promptly (not to wait for federal policies). This is seen as beneficial because there 1) is an urgent need to support HCEI+ objectives, 2) is uncertainty about the future (particularly in timing) of federal greenhouse gas emissions policy and 3) establishing a statewide accounting system will help with future compliance.
>
> Some Task Force members recommend there be flexibility in the treatment of the carbon tax depending on the form of future federal greenhouse gas emissions legislation. For example, depending on the federal program's impact to Hawaii, it may be possible that the scope of the carbon tax be redefined so as to avoid "double-taxation."
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> One member[9] strongly believes that achieving HCEI goals will be difficult if Hawaii needs to pay for HCEI as well as "pay into" a national cap-and-trade

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[6] This subset of Task Force members includes Mr. Laurence Lau (Department of Health), Mr. Theodore Liu (Department of Business, Economic Development, and Tourism), Mr. Mark Fox (The Nature Conservancy), Dr. Makena Coffman (University of Hawaii at Manoa, Department of Urban and Regional Planning), Professor Maxine Burkett (University of Hawaii at Manoa, Richardson School of Law), Mr. Robbie Alm (The Hawaiian Electric Company, Inc.), and Mr. Jeff Mikulina (Blue Planet Foundation).

[7] This subset of Task Force members includes Mr. Mark Fox (The Nature Conservancy), Dr. Makena Coffman (University of Hawaii at Manoa, Department of Urban and Regional Planning), Professor Maxine Burkett (University of Hawaii at Manoa, Richardson School of Law), and Mr. Jeff Mikulina (Blue Planet Foundation).

[8] This subset of Task Force members includes Dr. Makena Coffman (University of Hawaii at Manoa, Department of Urban and Regional Planning), Professor Maxine Burkett (University of Hawaii at Manoa, Richardson School of Law), Mr. Robbie Alm (The Hawaiian Electric Company, Inc.), and Mr. Jeff Mikulina (Blue Planet Foundation).

[9] Mr. Robbie Alm (The Hawaiian Electric Company, Inc.)

system. This member strongly urges avoiding “double-taxation” (as discussed above) and, more specifically, that a state-level carbon tax, in *place of* rather than *in addition to* a federal cap-and-trade program, is the fairest way to spread costs and address specific groups such as low-income households and perhaps agricultural activities.

Three Task Force members[10] support HCEI+ if it proceeds without additional intervention or implementation of “assurance measures,” as discussed above, and strongly object to a carbon tax or price floor on carbon. These members note that the goals of Act 234 would be achieved under the reference case and that Act 155 (2009) standards have already updated the reference case.

One member of this set[11] would be willing to explore the possibility of a state-level carbon tax after the resolution of federal greenhouse gas emissions policy, depending on its future form and impacts to Hawaii.

One member of this set[12] additionally objects to a “barrel tax.”

Other recommendations include:

- Expand the mandate of the Public Benefits Administrator beyond electricity.
- For mobile sources, begin by relying on proposed federal standards (35.5 miles per gallon by 2016), and then adopt California’s Pavley II standards (42 miles per gallon by 2020).
- Provide a monitoring system that makes sure that reductions and offsets are verifiable.
- Support and promote early and continual upgrading and compliance with of building and land use codes to promote a better built-environment for individual buildings, communities, towns and cities.
    - Buildings may easily last from 30 to 50 years and thus energy efficient codes should be adopted quickly; land use laws including zoning for mixed-use, compact development, and the reduction of sprawl, affect transportation particularly and are critical for long-term GHG reductions.
- Include life-cycle analyses of GHG emissions as a standard feature for the planning and design of significant projects and policies.
- Foster public engagement, awareness and education of Hawaii’s energy and greenhouse gas issues and impacts.
- Consideration of opportunities for carbon sequestration, offsets and other co-benefits from reforestation and certain agricultural management practices.

[10] This subset of Task Force members includes Mr. Frank Clouse (Refinery Industry Representative), Mr. Gary North (Maritime Industry Representative), and Mr. Gareth Sakakida (Transportation Industry Representative).
[11] Mr. Frank Clouse (Refinery Industry Representative).
[12] Mr. Gareth Sakakida (Transportation Industry Representative).

- The impacts to Hawaii from any potential federal greenhouse gas law should be further analyzed as policies unfold, including the potential of Hawaii to meet future greenhouse gas emissions targets in a cost-effective manner.

3. Discussion of Recommendation based on Identified Work Plans

The Task Force considered four scenarios, developed by ICF, that meet the Act 234 target, provided that the specified laws, policies, and programs are met on time. This timeliness requirement is a critical condition for success. The 'reference case' scenario projects emissions based on a business as usual trajectory, which incorporates existing laws and policies. The three alternative Work Plans are developed in comparison to the reference case and each other. Work Plan #1 is HCEI+, recommended above. Work Plan #2 is based on Work Plan #1 and adds a state carbon tax that would apply to "residual" carbon in covered fuel sources. Work Plan #3 is also based on Work Plan #1 and models the effects of a federal cap-and-trade bill, currently known as ACES or Waxman Markey passed by the U.S. House of Representatives in 2009. The details of the work plans are provided in the attached ICF Work Plan Report.

The work plans (and recommendation) address many of the factors specified in section 6 of Act 234 as specified in this Table 1.

Table 1. Legislative Requirements and Work Plan Status

Act 234, Section 6, Requirement	Status
(1) consultation with agencies	Covered in attached ICF work plants report
(2) identification and recommendation of measures and mechanisms for reduction, compliance, and incentives	In ICF report
(3) consideration of programs in other locations	In ICF report
(4) Find and develop analytical tools and models.	In ICF report
(5) contributions of sources, adverse effects on small businesses, minimum thresholds	In ICF report (except minimum thresholds)
(6) voluntary reduction opportunities	In ICF report
(7) market based mechanisms, cumulative impacts, effects on other pollutants	In ICF report
(8) Suggested rules for market mechanisms and reporting	Discussed in this report; specific rules are not proposed. Meeting the GHG target depends on meeting reference case or Hawaii Clean Energy Initiative (HCEI) and other policies in a timely manner
(9) Suggested mobile source regulations	Discussed in this report; suggested regulations are not proposed. Federal and California proposals are discussed in ICF report
(10) Minimize "leakage"	Discussed in ICF report; noted in this report as an important component of future energy laws (section 3)
(11) Suggest fees	Discussed in this report; fees are not proposed

	either generally or specifically. A state carbon tax and possible costs of a federal cap and trade proposal (Waxman-Markey) are discussed in ICF report. More research is needed.
(12) Public workshops	Done in November 2009. Summaries of workshops are attached as Exhibit A

The Task Force believes that the strong, broad support for the HCEI will continue because it is strongly in the state's interest and thus included HCEI in each work plan. Because it believes that HCEI will continue, the Task Force did not ask ICF to model a state carbon tax by itself. Because Hawaii is a small economy, the Task Force deemed it inappropriate to pursue a state-level cap-and-trade program and thus Work Plan #3 models the impact of the proposed federal program to Hawaii. Details of the elements in the three work plans are set out in Appendix B: Policy Modeling Assumptions, of the ICF Work Plan Report. Some major elements of the three work plans are set out in Table 2.

Table 2. Work Plans' Selected Elements

Policy	Description	CO2e Reduction in 2020
HCEI, Part of Work Plans #1, 2, 3		
Additional Renewable Power Generation & Biodiesel for Power Plants (paid by ratepayers)	HCEI, 2008 Energy Agreement elements 839 MW by 2020 5,820 GWh by 2030	<u>Total approx. 4,607 kt:</u> New generation: 3469 kt Biodiesel: 1135 kt
Wind Farm, Lana'i	200 MW by 2013	
Wind Farm, Moloka'i	200 MW by 2013	
Undersea Cable	Lana'i, Moloka'i, Oahu by 2013 (maybe Maui later)	
Other renewable generation projects, HECO owned	308 MW by 2015 (biofuels)	
Other renewable generation projects, not HECO owned	168 MW by 2020	
Sea Water Cooling	2 projects – Honolulu by 2015 Waikiki (date unknown)	126 kt
Plug in Hybrid Electric Vehicles (PHEV's)	2010 start – reaching 2% of new vehicles by 2020	56 kt
Additional Policies ("+"), Part of Work Plans #1, 2, 3 but became law & would be part of <u>future</u> reference case[13]		
Renewable Portfolio Standard (RPS) Act 155/2009	25% of electricity sales by 2020 (5% above reference case)	244 kt
Energy Efficiency Portfolio Standard (EEPS) Act 155/2009	20% electricity reduction by 2020 4,300 GWh of savings by 2030 Interim GWh targets to be set by the PUC	1,580 kt
Additional Policies ("+"), Part of Work Plans #1, 2, 3 and are NOT law yet		
Increased Vehicle Efficiency (average new vehicle)	35.5 mpg in 2016 to 42.4 mpg by 2020	27 kt
Building Codes	2010 - 30% over current, 2014 - 50% over current, then 5% every 3 years	715 kt
State Carbon Tax, Part of Work Plan #2		
	$10/tonne in 2010 to $40/tonne by 2020 Covers "residual" carbon content of all fossil fuels. Excludes non-energy emissions & feed stocks	<50 kt

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[13] The reference case and work plan #1 elements are somewhat out of date. Due to the timing of the completion of the ICF report relative to the end of the 2009 Legislative Session, it was decided not to consider as part of the reference case certain legislation that was later enacted but instead included such legislation in Work Plan 1 (HCEI+). These 2009 legislative acts are on the Renewable Portfolio Standard, Energy Efficiency Portfolio Standard, and Alternative Fuel Standard; (Table ES-3 of the ICF report), will result in further reductions in greenhouse gas emissions beyond what is attributed to the reference case whether or not any of the three work plans are adopted (i.e., they should now be considered as part of "business as usual").

Federal Cap & Trade, Part of Work Plan #3		
ACES/ Waxman-Markey 2009	\$20/tonne in 2012 to \$35/tonne in 2020	20 kt

The Task Force strongly recommends support for Work Plan #1, HCEI+. Although the reference case (by a relatively small margin) meets the requirements of Act 234, the majority of the Task Force recommends HCEI+ because greater emission reductions are not only found to be economically beneficial to the State, but are also likely to be necessary or required in later years by federal law. As such, there are clear advantages to early and aggressive greenhouse gas emissions reductions. HCEI+ provides for greater energy security, to Hawaii's larger economic and social benefit. HCEI+ has a greater cost but even greater benefits than the business as usual reference case.

Work Plan #1 makes key assumptions about implementing HCEI+ goals and the failure to meet the HCEI+ laws, polices, and projects on time poses a major risk to meeting the GHG target. This is true for all work plans (including #2 and #3). Implementing HCEI+ will require flexibility and agility, however, as federal laws regarding greenhouse gases and clean energy are simultaneously developing. For example, the U.S Environmental Protection Agency recently announced proposals to regulate greenhouse gases under the federal Clean Air Act. In addition, the U.S. House of Representatives has passed a bill to regulate greenhouse gases (the framework for Work Plan #3).

The Task Force notes that in the public workshops, agriculture representatives repeatedly sought support for water so that they could grow biofuels in Hawaii to support HCEI+.

The majority of the Task Force members believe it is important that the Legislature Arrange Financial Support for HCEI+. To meet the goals of HCEI+, laws and resources are needed to support its projects over time. In particular, HCEI+ requires large capital investments, and the costs and means of funding projects pose major unresolved issues. While the ICF work plans attempt to quantify the costs of currently prescribed goals of HCEI, the goals are still broad and thus relatively intangible as we move into the future. Although the ICF modeling effort assumes that electric utility ratepayers fund major HCEI projects, some Task Force members recommend that a carbon tax provide a funding base for clean energy projects not provided by private markets. The proper allocation between users/ratepayers, investors, and taxpayers remains to be determined and needs careful further consideration.

In considering how to distribute the cost burdens of energy security and climate change policies, it is important to consider how possible results are achieved. For example, raising electrical rates may encourage large customers to leave the electrical system and push the economic burden on the remaining ratepayers, who are often residential, small business and low-income customers who have the most limited options and resources. In the financing of key infrastructure where benefits cannot be easily apportioned, it may be preferable to raise finance from the tax base.

While HCEI+ will require major funding, Hawaii now pays about $5 billion to $7 billion per year to import fossil fuels, mostly oil. The more energy efficiency and use of local renewable energy Hawaii can implement, the more money we can keep and invest in the state. There are many ways to support HCEI+, including laws and policies. For legal support, the majority of the Task Force recommends that the Legislature enact laws to implement and assure that HCEI+ meets its schedule on time. Some major laws to enact are identified below. We look to the HCEI working groups for further information and recommendations.

3a. Adopt or Amend Energy Laws. Section 8 of Act 234 requires the Department of Health (DOH) to adopt rules to implement the work plan and regulatory scheme, but many parts of HCEI+ depend on appropriate state laws on energy efficiency and local renewable energy. The Legislature has already passed important laws in these areas including a more stringent Renewable Portfolio Standard and Energy Efficiency Standard. In addition, information is simultaneously being developed through efforts like the Bioenergy Master Plan. While the Task Force has no specific recommendation for bills but expects the HCEI working groups to make appropriate recommendations, the Task Force strongly insists the life-cycle impact of energy sources be considered in any adopted energy laws. Act 234 requires the Task Force to minimize "leakage" of greenhouse gas emissions. This means that, even though an energy technology may be relatively clean-burning within the boundaries of Hawaii, the process in which it is made elsewhere is also of importance.

3b. Adopt or Amend DOH and/or DoTax Laws. Pursuant to HRS chapter 342B, DOH has the authority to regulate air pollutants and greenhouse gases if designated as an air pollutant, require permits and permit fees, and monitor and enforce its rules. The regulation of greenhouse gases and the assessment of greenhouse gas fees require the adoption of rules. However, any DOH rules need to coordinate carefully with EPA statutes and rules. While EPA proposed in September 2009 to regulate greenhouse gases under the Clean Air Act, it has not yet done so, and Congress may enact a greenhouse gas law. DOH does not have authority to impose a carbon tax independently of air pollution permits. In any event, tax laws are under the jurisdiction and purview of the Department of Taxation (DoTAX), and any carbon tax would require new statutes for DoTAX.

3c. Adopt or Amend Laws To Help Low Income People. Climate change policies, if not carefully crafted, can disproportionately burden low-income households. This possible regressive impact needs to be directly addressed in the basic design of the system. The effect of work plans and the reference case on different ethnic and racial groups was also not modeled by ICF.

3d. Adopt or Amend Laws For Monitoring GHG. Hawaii needs to assure that emissions are in fact being reduced. EPA's new GHG mandatory reporting rule, adopted in September 2009, covers about 10,000 large facilities that account for about 85% of emissions nationally, but the EPA rule only covers about 30-40 facilities in Hawaii. If Hawaii seeks to cover more facilities than EPA, for regulation, taxation, or reporting, and particularly if Hawaii seeks a high performance alternative in any new federal GHG law, then we need to assure that Hawaii has a high quality monitoring system.

3e. Provide a "Backstop" for HCEI+. Because only certain components of HCEI are codified, including stringent renewable portfolio and energy efficiency standards for the electric sector under and Act 155 (2009), the majority of the Task Force recommends that there be a "backstop" or assurance mechanisms to ensure that HCEI+ policies are implemented on time. There should be continuing review if HCEI+ does not meet identified conditions (triggers) or if Congress enacts no federal GHG law, and if further study supports them.

ICF projects that all three work plans will have positive Economic Effects to Hawaii's economy. This is because oil prices are expected to continue rising (based on the U.S. Department of Energy, Energy Information Administration projections) and the large share of oil-dependence within Hawaii's economy. The move toward clean energy sources will provide long-term economic benefits in the form of price security (relative to fluctuating fossil fuel costs), reducing the fossil imports and keeping more dollars in the local economy, as well as greenhouse gas emissions reductions. Under all three work plans, residential consumer electric bills are projected to decrease even though electricity prices increase (due to increased efficiency).[14] It is important to note that within all three work plans, ICF assumes that HCEI components are financed through electricity ratepayers. In addition, within Work Plan #2, the impact to the economy of a carbon tax is based on the assumption that 90% of tax revenues collected would be returned to the tax payer in the form of a lump-sum rebate. From a modeling perspective, this is a similar scenario to having a carbon tax (level to be determined) where a portion of it is spent on HCEI projects and a portion is returned to residents (with the capacity to mitigate impacts on low-income households). The combination of HCEI+ and a state-level carbon tax in Work Plan #2 provides insight into the expected economic costs of HCEI from an economy-wide perspective as well as further benefits of a carbon tax.

However, there are also risks to the economy. The effect of work plans on businesses depends on energy's share of operating costs, business profitability, and its ability to pass costs to consumers. Some small businesses may have a harder time taking advantage of energy efficiency and will need help during a period of adjustment.

[14] This conclusion may need further study, particularly when efficiency is discretionary from a ratepayer perspective.

The issue of a possible carbon tax drew the most comments in public workshops. Transportation and agriculture representatives strongly opposed any carbon tax, and some citizens strongly favored it.

The Legislature should Support HCEI+ In Any Federal GHG Law. Although there is considerable uncertainty about the form of future federal greenhouse gas emissions policy, the Task Force recommends, based on Work Plan #3, that HCEI+ goals be pursued as a compliance mechanism to meet federal goals and policies. Work Plan #3 models both the impact of HCEI+ and a federal cap-and-trade program (based on the current bill form of the American Clean Energy and Security Act, ACES). Given that HCEI+ was shown to be beneficial to Hawaii's economy in Work Plan #1, and ICF identified a number of mechanisms by which Hawaii will receive additional federal funds as a result of the permit revenue, Work Plan #3 shows a positive benefit to Hawaii's economy. Thus it is in Hawaii's best interest to continue to pursue HCEI+ in the face of uncertainty regarding federal legislation. As specified in the current form of ACES, states can pursue clean energy goals beyond that of federal statute with the exception of state and regional-level cap-and-trade programs (which is not here being proposed). The impacts to Hawaii from any potential federal greenhouse gas law should be further analyzed as policies unfold, including the potential of Hawaii to meet future greenhouse gas emissions targets in a cost-effective manner.

4. Additional Questions and Research Needs

4a. Carbon Tax. The majority of the Task Force recommends further research on the implementation of a carbon tax, the optimal price of the tax, and use of tax revenue. A carbon tax is seen by some members of the Task Force as sending an important price signal to discourage the use of fossil fuels, encourage efficient use of fossil fuels, and encourage the use of substitute fuels such as local renewable energy (including HCEI+ projects). It can also be used to mitigate the effects of energy costs on disproportionately burdened households.

Although ICF modeled the effects of a carbon tax to Hawaii's economy within Work Plan #2, it was done in conjunction with HCEI+ (assumed to be funded by ratepayers). Combined with HCEI+, a state-level carbon tax reduces emissions very slightly (20 kt) below HCEI+ levels (4,800 kt). The differences in projected emissions reductions under each of the three work plans remain very small because of the dominance of HCEI+ in each plan.

Consistent with other jurisdictions, ICF assumes a carbon tax rate starting at \$10/tonne CO2e and moving to \$40/tonne CO2e over time. This tax equates to roughly \$4/barrel of oil and \$17/barrel of oil but is more broad-based than a "barrel tax" because it would also cover sources such as coal.

The use of Tax Revenue is an important issue that merits further inquiry. In Work Plan #2, ICF recommends returning 90% of the tax revenue to residents through the tax system. This could be done in a lump-sum payment or through adjusting other taxes such that the net effect of a carbon tax is revenue neutral. “Refunds” could be weighted to help low-income people or other groups disproportionately affected by a tax. Compensatory policies involving cash payments, tax credits, subsidies for energy services like bus fares or electricity charges, and special financing programs for energy efficiency measures are a few of the options that might also play a role. Such a program might be funded directly from GHG revenues or through cross subsidies. This is the primary benefit of using the tax system to ensure clean energy for Hawaii rather than solely ratepayers. In addition, a sole emphasis on ratepayers focuses solely on electricity whereas much of Hawaii’s fossil fuel usage is in transportation. For example, ground transportation was found to be the fastest growing emitter in Hawaii’s economy within the ICF inventory report.

A carbon tax could serve as a “backstop” mechanism to ensure the viability of HCEI+ by using it to set a floor on the price of oil. The intent is to provide some financial certainty for renewable energy suppliers similar to the effect of a feed-in tariff for suppliers of renewable power to the electric companies. For this backstop type, the tax would be triggered when price of oil goes down to a set level, to be determined. A carbon tax could also be used as a backstop to achieve GHG emissions reductions that HCEI+ did not. More research would be needed, however, to determine the level of carbon tax necessary to itself meet either HCEI+ targets or Act 234’s GHG target.

There is considerable uncertainty in terms of how a state-level carbon tax may in the future interact with federal greenhouse gas policy, particularly a federal-level cap-and-trade system. One identified concern is that a federal cap and trade system may require spending considerable sums to buy GHG emission allowances. Work Plan #3 estimates that the ACES/Waxman-Markey bill would require payments of about $212 million in 2012, declining to about $154 million in 2020 as emissions decline. Many Task Force members recommend that any future federal GHG law allow Hawaii an option to be flexible in how to reduce emissions if it will exceed national emission targets. The impact of this was not modeled, however, and thus the interaction between a federal-level cap-and-trade and a state-level greenhouse gas policy (possible carbon tax) should be further researched.

4b. Carbon Sequestration. Through a sub-committee of the Task Force, a study was conducted on the opportunity for carbon sequestration through Reforestation and Improved Agricultural Management Practices. It was determined that changes in land-use patterns play an important role in greenhouse gas emissions outcomes. In addition, it was determined that there are substantial co-benefits from reforestation projects, including watershed management and native species restoration. The Task Force strongly recommends there be further analysis and consideration of opportunities for the state to sequester carbon and achieve emission offsets through reforestation and certain agricultural management practices. In particular, whether

reforestation initiatives may be an appropriate use of state funds (or carbon tax revenues). These activities have the potential to produce co-benefits for the state's natural resources, watershed and diversified agriculture goals, while contributing to meeting state and federal emission targets. The study report on reforestation options can be found at:
http://hawaii.gov/dbedt/info/energy/greenhouse/ForestCarbonRpt.pdf.

4c. Minimize Leakage. Act 234 specifically asserts that the state minimize leakage of greenhouse gas emissions. Currently, the success of HCEI relies heavily upon the state's ability to Obtain or Produce Biofuels for transportation as well as for power production. The Task Force strongly recommends that all inputs into energy sources, i.e. a life-cycle perspective, be considered. This is particularly important for biofuels, as several sources of biofuels have been identified by national and international researchers to not have a positive energy content from a life-cycle perspective. Thus it is important to pursue study on the greenhouse gas impacts of different biofuel sources, both local and imported, and to develop biofuel policy on a life-cycle basis.

Similarly, the impact to the agricultural sector of any energy-related policy (including biofuels or taxation) should be further studied. The vast majority of Hawaii's food and fuel is imported into the State and thus any policy developed should seek to not disadvantage local agricultural producers toward imported sources. As such, the life-cycle impacts of the transportation of agricultural goods should also be further researched.

Additional Concerns

To some members of the Task Force, a carbon tax is viewed as unnecessary, harmful to the economy, and premature. Transportation representatives to the Task Force see an across-the-board tax as particularly harmful to aviation, ground transportation, and local fuel suppliers, especially given a rise in many other ground transportation taxes. They also predict a rise in the prices of the many products transported by their industries. There is concern that a state carbon tax would result in double taxation if a federal cap and trade system is enacted because Hawaii fuel prices are tied to mainland prices by contract and thus not properly harmonized. The carbon tax, as modeled by ICF, is seen as too vague to properly evaluate its application, and therefore needs considerably more study.

There is a need for a better estimate and explicitly detail the costs and benefits of HCEI+, particularly as projects unfold. There is need to refine the analysis of how different sectors of the economy and disproportionately affected people. This is especially true for transportation, which is a major source of GHG emissions.

In regards to air transportation, it was omitted from the scope of Act 234 for a variety of reasons and, in particular, because it covers many jurisdictions. While this seems currently prudent, as air transportation has become more efficient and greenhouse gas emissions have been reduced since 1990, it remains important to monitor emissions from the air transportation sector and possibly take future action.

5. Conclusions

Based on available information, the Task Force strongly recommends support measures be provided to HCEI+ as a means of achieving energy security and reducing greenhouse gas emissions.

There is much that can be done to reduce GHG emissions with existing legal authority, including efforts in which government leads by example. The Task Force encourages the Legislature and the Executive to augment existing emissions reducing measures and to implement initiatives to reduce its own carbon footprint. In addition, there is need for continuing public outreach and education on this topic.

The Task Force also recommends a reexamination of the emissions target established by Act 234 to determine whether it is an adequate response to the environmental threat and likely federal regulation (which is looking beyond the year 2020). Mounting science indicates that the effects of increased greenhouse gas emissions are impacting our global climate more rapidly and more severely than previously forecast. As an island state, our exposure to climate change makes us uniquely vulnerable to rising sea levels, impacts to fresh water availability, and severe storms, among other things.[15] In addition to needed emissions reductions, the state must adapt to likely climate change impacts. Elements of HCEI+ will enhance our resilience in the face of climate variability and change making it an even more important vehicle in the short term. An examination of current scientific recommendations for emissions reduction may suggest, however, that additional action will ultimately be required.

[15] Although the 2009 legislative session called to establish a Climate Change Task Force to address and plan for impacts of climate change, the Task Force has yet to convene. That Task Force is important to help prepare Hawaii for climate change impacts.

Report to the Legislature

EXHIBIT A

November 2009 Public Workshops
Summaries
and Public Comments Received

Hawaii Greenhouse Gas Emissions
Reduction Task Force

State of Hawai`i - Department of Business, Economic Development, and Tourism
Greenhouse Gas Emissions Reduction Task Force's
Investigative Committee Meeting
&
Kauai County Public Workshop

Minutes
Tuesday, November 3, 2009
5:30 – 7:00 p.m.
Lihu'e Civic Center, Moikeha Meeting Room 2A/2B, 4444 Rice Street, Lihu'e 96766

Attendance:

Task Force (TF) present:
1. Laurence Lau (DOH), Co-chair
2. Mark Fox (The Nature Conservancy)
3. Gary North (Matson Navigation Company)
4. Robert Alm (HECO)
5. Ted Peck, representing Ted Liu (DBEDT)

Members of the Public (who signed in):
1. Jerry Ornellas (Kauai County Farm Bureau)
2. George Matsuda (Kauai Commercial Co., Inc.)
3. David Ward
4. Randy Hee (KIUC)
5. Wayne Katayama (Kauai Coffee Co.)
6. Marcia Harter
7. John Harter
8. Brad Parsons

Staff present: Ted Peck, Estrella Seese, Gregg Kinkley, Chris Baron

The meeting opened with a 25 minute powerpoint slide presentation by Mr. Lau, co-chair of the GHGERTF. The presentation is available for view on the website:
http://hawaii.gov/dbedt/info/energy/greenhouse/GHG_Public%20Workshop%20Slides.pdf

Public Comments:

A citizen asked if renewable energy were separated from biofuels, how the two would compare. She also asked how the assumptions regarding biodiesel generation were made.

Mr. Peck responded that TF has requested but has not yet received the breakdown from ICF. Regarding the assumptions, Mr. Peck responded that they came from the voluntary agreement which the State signed with HECO utilities, as well as the statutory requirements that were already in place, and the IRP3 (Integrated Resource Planning Process 3) from HECO.

Jerry Ornellas from the Kauai County Farm Bureau reported that the farm bureau supports the policy of biofuels. Up until 1980, 60% of Kauai's electricity came from renewable energy; however the situation with irrigation water has really changed. The legislature needs to be able to assure that farmers have enough water to grow both biofuels and food. Biofuels need to be locally grown, so Hawaii needs to have the infrastructure to produce them before any laws are passed. Furthermore, regarding work plan 2, farmers will not be able to bear a carbon tax.

Mr. Peck pointed out that there is a bioenergy master planning process underway, which should address some specifics on these issues, especially concerns about water. Mr. Lau noted that the state constitution might require certain preferences in water distribution, and a constitutional amendment might be needed.

Mr. George Matsuda, Operations Manager for Kauai Commercial Company (trucking and storage), expressed concern about a carbon tax, which would harm the state's economy, the trucking industry, and consumers. Mr. Matsuda noted that a carbon tax is viewed more as a revenue source, since the ICF report shows that it would not significantly reduce GHG emissions. The Kauai Commercial Company believes that revenue for emissions reduction efforts would be best raised through the private sector, not through tax increases.

A citizen recommended that TF promote more conservation, and look into how to mitigate the negative effects on transportation.

Mr. Peck noted that KIUC runs rebate program that is meant to enable people to take efficiency measures in their homes. Federal ARRA economic stimulus money will be allocated to Kauai to help drive residential and commercial efficiency. Act 155 set goal of 30% reduction by 2020 through energy efficiency. Regarding mitigation, Mr. Lau reported that ICF recommends 90% of tax revenue be returned to the public as refunds. Other possibilities include 100% tax neutrality, or a focus on poorer populations.

Mr. Wade Takayama from Kauai Coffee expressed concern about a carbon tax. 100% of Kauai Coffee's electrical needs are met by two hydroelectric plants; a carbon tax would translate to higher operating costs, and Kauai Coffee does not have the ability to pass those higher costs on to the consumer.

A citizen asked if the sources of GHGs are being considered, and if locally any calculations on varriatns between imported or local biofuels were done. Mr. Peck responded that ICF assumed that biofuels were locally grown. Mr. Lau added that Act 234 required coverage of leakage.

Mr. David Ward suggested TF advocate biochar, which results from incineration and gasification of biomass. He said that biochar can sequester carbon dioxide in soil and can benefit soil by increasing agricultural yields and improving water and chemical fertilizer retention. He suggested a mandate that any new biomass facilities have a byproduct of biochar.

Mr. Ben Sullivan asked if TF considered an amendment to the Renewable Portfolio Standards (RPS) to distinguish between various renewable energy projects, giving them value based on their emissions. Mr. Peck responded that for the most part renewable energy projects are carbon neutral in production of power.

A citizen noted that while a carbon tax may have negative impacts, it also has the positive impact of changing behavior.

A citizen suggested that there should be a fleet vehicle miles per gallon standard for rental cars.

Mr. Peck pointed out that Hawaii is on the cusp of a large number of electric vehicles hitting the market, and that the state needs to work with communities to prepare, both in infrastructure such as charging stations, as well as changing peoples' way of thinking. He noted that we are at somewhat at the mercy of what cars get sent here; thus, it is important to create an environment where manufacturers of fuel efficient cars believe they can sell their vehicles here. Mr. Lau noted that aggressive national fuel efficiency standards will be coming soon.

A citizen asked where the biggest opportunities for reducing GHG emissions are, and what the opportunities are for rooftop solar panels. He suggested that rooftop solar combined with electric cars offer an opportunity to generate and transport renewable energy.

Mr. Lau responded that the areas with the biggest opportunities for reduction are electrical generation and energy efficiency. Mr. Randy Hee of KIUC commented regarding rooftop solar, KIUC gave to the PUC a proposal for set prices and allows self-generation of various sizes, and is studying how much penetration of rooftop solar is possible before hitting problems and needing mitigation with energy storage, etc.

Mr. Lau asked the public if the film industry's opposition to the construction of wind facilities is still an issue in Kauai.

Mr. Hee responded that the wind regimes and opportunities on Kauai are not as good as on other islands. Furthermore, an overarching issue is that Kauai has a large population of endangered seabirds, which would be threatened by wind facilities, and that Kauai county is making an isle-wide conservation plan that should address this issue. Another citizen responded that photovoltaic systems, due to fewer moving parts, have much less of a downside in this regard.

Mr. Ward pointed out that TF needs to consider the impending peak oil crisis and the current economy being on the verge of financial collapse; he was concerned about the danger of currency being reduced in value and then oil becoming unaffordable, as well as a resultant effect of the tourism industry collapsing.

Regarding peak oil, Mr. Peck noted that the State recognizes that there is a limited resource that the economy is based on, and that is why the basis for the Hawaii Clean Energy Initiative is a recognition of a need to address energy security primarily, as well as emissions reductions.

State of Hawai`i - Department of Business, Economic Development, and Tourism
Greenhouse Gas Emissions Reduction Task Force's
Maui County Public Workshop

Minutes
Wednesday, November 4, 2009
5:00 – 6:30p.m.
UH-Maui CC campus, Pilina Building, Multi-purpose room

Attendance:

Task Force (TF) present:
1. Laurence Lau (DOH), Co-chair
2. Robert Alm (HECO)

Members of the Public (who signed in):
1. Warren Watanabe (Maui County Farm Bureau)
2. Rebecca Minsky (Maui Community College)
3. Mark Rooney (Maui Community College)
4. Melissa Prince
5. Jeff Stark
6. Warren Bohalt (Kahuhui Trucking)
7. Jean Young (Green Building LLC)
8. Lou Young (Seabury Hall High School)
9. S. J. Mola (First Wind)
10. Michael Ribao (Maui Electric Co., Ltd.)
11. Derek Heafey (Hawaiian Commercial and Sugar Co.)
12. Phyllis Robinson (Creative Conflict Solutions)
13. Janet Ashman (HFBF)
14. Sean O'Keefe (AOB, Inc.)
15. Sarah Ruppenthal (Maui Weekly)
16. Nadine Newlight
17. Marc Drehsen
18. Bonnie Silveus
19. Torben Hjoring (Energy/Pro)
20. Byron W. Baker
21. Alex de Roode (Sustainable Living Institute of Maui, MCC)

Staff present: Ted Peck, Estrella Seese, Gregg Kinkley, Colleen Miller, Maile Sakamoto, Chris Baron

The meeting opened with a 25 minute powerpoint slide presentation by Mr. Lau, co-chair of the GHGERTF.
The presentation is available for view on the website:
http://hawaii.gov/dbedt/info/energy/greenhouse/GHG_Public%20Workshop%20Slides.pdf

Public Comments:

Bonnie Silveus, a student from Maui Community College (MCC) advocated for a law that would allow passengers to ride on mopeds, since this would encourage more transportation via mopeds, which would decrease fuel usage.

Jeff Stark commented that he is a member of the Maui mayor's clean energy initiative, and noted that the work group he is part of has worked on Maui's geothermal potential and has used the figure of 140 MW, whereas the Task Force (TF) presentation had the potential at 80 MW. He asked how the 80 MW was derived.

Mr. Peck responded that the 80 MW came from a compilation of studies, and that geology can make estimates about the geothermal potential, but specifics will not be known until you start drilling.

Lou Young proposed that, through mandatory requirements or incentives, all new construction include photovoltaic panels.

Mr. Lau responded that there is a State statue requiring all new construction to have solar water heaters. Mr. Peck noted that the State has passed a feed-in tariff. TF has also looked into requirement that new homes be solar-ready, which would cut future costs of fitting homes with solar panels.

Phyllis Robinson, a professor at MCC, pointed out that literature (specifically, Thomas Friedman's Hot, Flat, and Crowded) supports a carbon tax.

Mr. Lau noted that members of TF representing transportation and business are strongly opposed to a carbon tax, but others favor it. TF has not yet decided whether or not they will move forward with a carbon tax.

Warren Bohalt of Kahuhui Trucking and Storage strongly discouraged the TF from including a carbon tax in its recommendation to the legislature. He noted that a carbon tax would result in Hawaii residents seeing higher prices of goods and services delivered by the transportation sector. Furthermore, the tax would not significantly reduce GHG emissions, and is viewed as a source of funding for other emissions reduction efforts. He proposed that funding for reduction initiatives should be raised through private investment.

Warren Watanabe of the Maui County Farm Bureau reported that biofuels should be grown locally, but local farmers need assurances that they will have adequate and reliable sources of water. Furthermore, he noted that the Farm Bureau does not support a carbon tax, and that farmers cannot pass on to consumers the higher costs of production that would result from a carbon tax, and are worried about competition from mainland farmers.

Alex de Roode, director of the Sustainable Living Institute at MCC, urged the TF to link its recommendation to the number "350 ppm' (parts per million). 350 ppm (of carbon dioxide in the atmosphere) has been identified by scientists as the safe upper limit for carbon dioxide in the atmosphere. He noted that we are currently at 387 ppm. He mentioned the Blue Line Project, which seeks to raise awareness of the effect of a one-meter rise in sea levels. Furthermore, he suggested that carbon sequestration and carbon sinks can play a role in reducing emissions. He asked if the TF has considered a way of quantifying carbon sinks in soil and agriculture as a way of rewarding farmers who practice sustainable stewardship of the land.

Mr. Lau responded that the TF had not linked the report to 350ppm. The TF could possibly ask the legislature to reevaluate the target of Act 234, but given the resources available to the TF, it is uncertain that the TF will be recommending such an approach. Regarding carbon sequestration, Mr. Lau noted that the TF has considered sequestration potential of organic matter.

Bonnie Silveus asked if the TF considered setting a floor price on petroleum.

Mr. Lau responded that the TF has considered a floor price; however the TF has not come to a consensus regarding a carbon tax.

Alex de Roode asked if offsets could be purchased to pay for excess emissions if a carbon tax is passed, and if such offsets could be purchased locally.

Mr. Lau noted that more work needs to be done to determine the details of a carbon tax and to ensure that double taxation does not occur; also, he commented that there is a general consensus that Hawaii is too small to have a cap and trade system of its own. Mr. Lau explained that there are questions about how many offsets are available for purchase, given physical constraints of projects like reforestation.

A citizen pointed out that renewable energy projects are a form of offsets that have no physical constraints.

Mark Rooney, a student at MCC, recommended that TF look into methane gas recovery at small, unregulated landfills, as capturing methane can be a source of renewable energy.

Mr. Lau noted that landfill gas has impurities that must be treated, which would add some costs. Mr. Peck added that some counties are already looking into capturing gases from landfills for energy.

Nadine Newlight pointed out that in Nassau County, New York, energy is produced through sewage treatment. She suggested that methane capture abilities be added to Maui's water treatment plant.

Mr. Lau noted that the Department of Health loans money to counties at below market interest rates to build and rebuild wastewater and drinking water infrastructure, and that the loan program looks favorably at green projects.

A citizen suggested that people who travel should be given the option of offsetting their travel emissions, i.e. by donating $30 to reforestation efforts when they buy plane tickets.

State of Hawai`i - Department of Business, Economic Development, and Tourism
Greenhouse Gas Emissions Reduction Task Force's
Hawaii County, Hilo Public Workshop
Minutes
Monday, November 16, 2009
5:30 – 7:00p.m.
Office of Aging Conference Room, 1055 Kino'ole Street Suite 101, Hilo, 96720

Attendance:

Task Force (TF) present:
1. Mark Fox

Members of the Public (who signed in):
1. Kihei Nahalea (Hawaii Community College)
2. Dwayne Yoshina
3. Jay Ignacio (HELCO)
4. Yen Chin (HCEOC)
5. Richard Ha (Farm Bureau)
6. Linda Peters (County of Hawaii)
7. Clyde Haynoh (Hawaii LECET)
8. Peter Lu (Hawaii LECET)
9. Cory Harden
10. Diana Miller
11. Jon Olson (Mokuloa Group)
12. Don Theuron (University of Hawaii)
13. Mary Finley (HCEOC)

Staff present: Chris Baron, Gregg Kinkley, Maile Sakamoto, Estrella Seese

The meeting opened with a 25 minute PowerPoint slide presentation by Mr. Fox, member of the GHGERTF.
The presentation is available for view on the website:
http://hawaii.gov/dbedt/info/energy/greenhouse/PublicWkspSlides11-24-09.pdf

Public Comments:

A citizen reported that 8,000-10,000 tons/day of carbon dioxide is emitted by Kilauea volcano; the amount of sulfur dioxide emitted by the volcano is half of that amount.

Jay Ignacio asked if the analysis tried to model a carbon tax and a cap and trade scheme in isolation from HCEI.

Mr. Fox responded that due to budget restraints, the TF could only request modeling for a limited number of scenarios. The TF assumed that HCEI had a fair amount of momentum; thus the TF chose to model HCEI on its own and HCEI with the carbon tax and with a cap and trade scheme.

Cory Harden commented that Hawaii could import fewer essentials (i.e. food), and could focus on reducing population by depending less on tourism (which generates travel emissions and encourages migration to Hawaii) and promote family planning. He noted that teen pregnancy rates in Ka'u are around 50%.

Richard Ha of the Farm Bureau reported that farmers are concerned that encouraging biofuels will put pressure on food growers' water supplies. Farmers are also concerned that work plans 2 and 3 will have unintended consequences, i.e. if money is set to be returned to farmers at the end of the year under a carbon tax, some farmers might not make it till the end of the year.

Mr. North reassured that the TF is sensitive to farmers' concerns about water. He noted that there are multiple views on the TF, and that the TF is trying to communicate all views, as well as the public's views, in its report to the legislature.

A citizen commented that the legislature needs to pass new legislation concerning agricultural lands and the highest and best use qualifier. Currently, the highest and best use of lands favors hotels. Now, preserving agricultural lands and forests lands should be prioritized—this requires a fundamental change in the way the State does business. He further noted that the work plan is very Oahu-centric and relates to Big Island needs minimally. Much future development will come in East Hawaii because of the availability of cheap land, and many lots will remain isolated and rural. This will present transmission problems. It is likely that independent generation, i.e. photovoltaic panels, will be needed.

Richard Ha noted that biofuel is an important component of all three work plans. If oil is $200/barrel, the most a farmer can make on biofuel crops is $0.18/lb. Oil would have to reach $300/barrel before growing crops for biofuel would make economic sense for farmers. He noted that if biofuels are an important part of the solution, then farmers need to be subsidized. He pointed out that geothermal is a better solution given its energy return on investment (EROI is the ratio of energy retrieved to energy needed to retrieve; thus, net energy produced). Studies have estimated that if EROI falls below 3:1, society will fall apart. EROI for geothermal is 10:1. Furthermore, Hawaii has a lot of geothermal potential.

Yen Chen reported that he is working with the Hawaii County Economic Opportunity Council on a weatherization grant. HCEOC assumed that they would receive the State rebate incentive; however Hawaii Energy has denied that incentive. He noted that substantial subsidies are available to those who can afford to pay $6-7,000, but people in their HCEOC program who cannot afford those costs do not receive rebates. The net result of this decision is that there will be 13 fewer solar hot water systems on the Big Island, and at least 50 fewer statewide. He said that this is a serious environmental justice issue that needs to be resolved if the State is really committed to energy efficiency and to protecting vulnerable populations. Furthermore, he reported that he is uncomfortable with projections that are not backed with clear plans of how those projections will be reached.

A citizen commented that solar hot water is low hanging fruit; however, helping low income people via income tax credits is not a smart plan if people's energy bills are significantly more than their income taxes.

A citizen suggested that instead of relying on EIA figures, maybe we should rely on a range, since he claimed that EIA has been wrong 8 out of 9 years.

Don Thomas suggested that someone needs to test the biofuel projections against land available to estimate the burden that will be placed on arable land to see if the biofuel projections are practical. He noted that producing165 million gallons of liquid fuel requires 0.5 million acres of land; and the Big Island does not even have 1,000 acres of land to spare.

A citizen pointed out that the MIT (university)website has a Department of Energy, and the chairman of the department has written an analysis of different energy resources, and breaks down why each would succeed or fail. The chairman advocates solar energy.

Richard Ha noted that biofuels has an EROI of less than 2:1, which is less than what it takes to have a sustainable society. Hydropower is 100:1.

Dwayne Yoshina commented that the State had opportunities to become energy independent in the 1970s, but instead followed conventional wisdom and threw those opportunities away. He noted that what is needed now is a paradigm change. Hawaii must get off of oil and biofuels.

A citizen reported that Indonesia is the only stable source of palm oil. He noted that he cannot see how biodiesel will work in Hawaii: it is unlikely that the amounts of biodiesel needed will be able to be grown locally, meaning biodiesel would have to be imported, which would result in a huge carbon footprint and would still leave Hawaii energy insecure. He advocated for geothermal because it is a proven technology that is stable. He stressed that a responsible decision would pursue proven technologies.

Richard Ha noted that there is already a socioeconomic gap, and the people on the lower end of the gap are Hawaiians, Pacific Islanders, and Filipinos. As the gap gets bigger, the Aloha spirit goes with it. Geothermal could help mend the gap because the State would own the resource, meaning OHA would receive some of the royalties, which would benefit the Hawaiian community.

Kihei Nahale'a pointed out that history has shown that the government does not respect Native Hawaiian rights, and that money promised to the Hawaiian community does not filter down to the people who need it. He noted that the Mauna Kea observatory is an example. Hawaiians need to be respected, and they need to actually receive the revenue they are supposed to be getting. He noted that geothermal will tread heavily on Hawaiians' religious rights—they view geothermal not as a resource but as the *kinolau* [physical form] of Pele.

Richard Ha agreed with the previous speaker and noted that change needs to come from the ground up, not the top down.

Yen Chen pointed out that this is a top-down document, because there was no real consultation with people on the ground. He noted that he has been involved in public processes that were not really legitimate because they were treated as just a rubber stamp for what was already decided by people at the top. He asked how the TF will legitimately involve the people on the ground.

> Mr. North pointed out that the TF is made up of citizens—they are not the State. He is committed to communicating everyone's views to the legislature. People may send an electric copy of their opinions on the report to DBEDT so that it will circulate amongst the TF.
>
> Mr. Fox added that people should also send in recommendations for other ways of including the public in the discussion, and that the TF will consider those suggestions so long as the resources are available.

Yen Chen suggested to involve people, the State should do concrete projects that people actually want.

Diane Miller pointed out that geothermal has not been successful in the past. She prefers options that are less intrusive, such as wind, solar, and hydro-projects.

Jon Olson brought up the problem of getting the broader population to understand how they are invested in this issue. He noted that the government will be doing things that are going to be painful to many people, and the government needs to be upfront about that. He pointed out that California went after low-hanging fruit such as solar water heating and CFLs a decade ago. In contrast, Hawaii's solar hot water rebate system assumes you have a taxable income (not true for all people), and additionally requires people pay $5,000 upfront. Regarding geothermal, he noted that the concept is good, but the past attempt at geothermal was done in a high-thermal risk area.

Mary Finley asked if the solar saver program could come back, where the utilities provided the financing and the money saved on electricity paid for the solar hot water system.

A citizen pointed out that low-income people need solar water heating and energy efficient refrigerators. With a starting fund, a program to provide these systems to low-income people could be set up, and a portion of the energy savings would make the program self-sustaining.

State of Hawai`i - Department of Business, Economic Development, and Tourism
Greenhouse Gas Emissions Reduction Task Force's
Hawaii County, Kona Public Workshop
Minutes
Monday, November 16, 2009
5:30 – 7:00p.m.
Department of Liquor Control - Hearings Room, 75-5722 Hanama Place, Suite 1107, Kailua Kona, 96740

Attendance:

Task Force (TF) present:
1. Mark Fox
2. Gary North

Members of the Public (who signed in):
1. Trish Malone (James Kent Assoc.)
2. Tracy Salomon (Kona Brewing Company)
3. Ulrich Bonne
4. Rob Shallenheyer (The Nature Conservancy)
5. David Tarnas (SunFuels Hawaii)
6. Rod Hinman (Aurora Research, LLC)
7. Guy Toyama (H2 Technologies)
8. Robert Flatt
9. Joel Ranua (Sunetric)
10. David Coy
11. Doug Pierrine
12. Bill Brooks (Energy Specialists HI)
13. Alex Frost

Staff present: Chris Baron, Gregg Kinkley, Maile Sakamoto, Estrella Seese

The meeting opened with a 38 minute powerpoint slide presentation by Mr. Fox, member of the GHGERTF.
The presentation is available for view on the website:
http://hawaii.gov/dbedt/info/energy/greenhouse/PublicWkspSlides11-24-09.pdf

Public Comments:

Doug Pierrine stated his support for a carbon tax or fossil fuel tax. He noted that the State's goals cannot only be achieved through government action alone: citizens must also change their behavior, and a carbon tax would be a persuasive rather than coercive means of changing behavior. Furthermore, the revenue collected by a carbon tax would allow the State to achieve its energy goals.

Alex Frost asked how initiatives such as the undersea cable will be paid for, and if there is a cost analysis for these projects.

> Mr. Fox responded that there is a cost analysis in the ICF report; however, the question of funding these initiatives has been a topic of debate amongst members of the TF.
>
> Mr. North noted that an example of business taking the lead is the seawater air conditioning project on Oahu because business decided there is a return on investment. The cable is expensive, but we must first determine whether there is a return on investment.

Tracy Salomon, the sustainability coordinator at Kona Brewing Company, commented that the work plans are steps in the right direction. She is concerned about work plan # 1's reliance on HELCO. She commented that either the President or Vice President (of the U.S.) said that any renewable energy investment will come with rate increases for small businesses and residents. Biodiesel relies entirely on private industry, which would require a lot of incentives to ensure that biodiesel meets its targets. Thus HELCO is the biggest player in work plan 1, and HELCO has not shown a lot of support.

> Mr. Fox acknowledged Ms. Salomon's concerns, and noted that the TF asked ICF to model other scenarios and considered options for backstops considering the uncertainties of HCEI.
>
> Mr. North commented that he would be more concerned with the State government than with HELCO, particularly if they receive $800 million/year in carbon tax revenue. The State has not shown that it can solve the problem better than electric companies can. He noted that there needs to be partnership between the government and private industry.
>
> Ms. Seese noted that utilities entered agreement with State. The State has promised to help with certain things, and both sides are following those commitments. ICF estimates the undersea cable will cost $1 billion. Like all HCEI initiatives, the State is actively trying to determine how to fund it.

Ms. Salomon expressed her concern about the lack of a 'cap' on possible rates.

> Ms. Seese responded that a study has shown that without HCEI, rates would be much higher for consumers. The crossover point (where rates will be cheaper under HCEI than it would have been under business as usual) is 2022.

A citizen asked about the status of the feed in tariff (FiT).

> Ms. Seese replied that actual rates for the FiT will be set by June.

Joel Ranua asked whether phase two will include an escalation of the tariff rate.

Ms. Seese responded that the PUC order is to have a levelized rate, and an escalation is being considered. One of the ways to accomplish a levelized rate is to escalate the rate at first.

Robert Flatt asked whether work plan 3 is reliant on federal legislation.

Mr. Fox responded that it is, and that there has been communication with Hawaii's Congressional delegation about the impact of federal legislation on Hawaii, and whether federal legislation might have the detrimental effect of making it cheaper for Hawaii emitters to continue to import fossil fuel while purchasing offsets overseas.

Mr. Flatt commented that he would be against the carbon tax if the State has other ways to raise revenue.

David Tarnas of SunFuels Hawaii asked how UHERO (UH Economic Research Organization) work is being incorporated into the TF's analysis.

Mr. Fox responded that it has not yet been incorporated into the TF's anlysis.

Mr. Tarnas noted that one of the conclusions from the University's analysis is that increases in ground transportation are primarily responsible for the increases in GHG emissions from 1990 until today. He asked if TF has considered other fuels for vehicles other than biodiesel, i.e. low-carbon diesel, synthetic diesel.

Mr. Fox responded that all of the aforementioned alternative fuels were included in the ICF analysis.

Mr. North commented that you cannot just change the fuel—you need to also change the engines. Hawaii has a lot of trucks and buses for tourists, so incentives need to be made for private industry to buy new systems. He pointed out that this was not really the TF's agenda.

Mr. Fox noted that funding limited what ICF could be asked to model.

Ms. Seese commented that HCEI is looking at possible incentives for more efficient transportation, and noted the difficulties of both mandates and incentives: the transportation industry does not like mandates, but the State does not have the money to provide incentives.

Bill Brooks of Energy Specialists of Hawaii asked for clarification regarding reductions in aviation emissions discussed during the presentation.

Mr. Fox clarified that the legislature excluded aviation because it did not feel it had authority to regulate it; however, due to improved technology, aviation emissions decreased between 1990 and 2007.

Mr. Brooks suggested that the State get rid of the $380 cap on multi-family alternative energy tax credits—this cap covers apartments and condominiums, and virtually precludes those buildings from making serious investments in renewable energy. Furthermore, the Big Island has caps on what can be done with renewable energy within the HELCO grid. Because of this regulation, interested persons must first fund studies to prove that renewable energy will work before they are allowed to invest in the technology. HELCO needs smart-grid facilities for renewable energy. He also advocated the removal of the State cap of $5,000 on photovoltaic systems, since it restrains people from taking advantage of existing technology. He noted that revenue from a carbon tax could be directed towards these initiatives, as well as to financing incentives for small businesses, including farmers. Lastly, he requested clarification about when FiT guidelines will be established.

> Ms. Seese noted that developing FiT rates will start tomorrow. The PUC will issue its decision and order after May 15.

A citizen noted that coal-fired biomass can decrease carbon emissions from coal plants, and asked whether the TF considered that in their report.

> Ms. Seese responded that there is only one coal-fired unit in Hawaii, and it is a PPA. She noted that she does not think ICF made the assumption of coal-fired biomass on that unit.

A citizen asked whether the TF considered carbon capture and storage. He noted that there is areal push now for carbon sequestration technologies.

> Mr. Fox responded that the TF has looked into forest sequestration through reforestation, but it was not incorporated into any of the scenarios.

Ulrich Bonne summarized a written presentation that considered the impact of massively distributing photovoltaic (PV). The study looked at roof area on the Big Island to see if the area could generate a significant amount of kilowatts per hour through PV. The study concluded that photovoltaic could generate twice as much energy on the Big Island than what could be presently generated with fossil fuel. He noted that the excess energy generated can be used power all vehicles, if all vehicles were converted to electric vehicles.

Rod Hinman asked whether any of the work plans model the effect of rail on Oahu.

> Ms. Seese replied that the effect of rail was considered, but not modeled.

Mr. Hinman noted that the analysis of the carbon tax concluded that a carbon tax does not effect much change. He asked why a carbon tax was not modeled at a level that would effect a more significant change in emissions.

> Mr. Fox responded that the carbon tax was modeled to be comparable with the projected cost/ton of cap and trade.
> Mr. North commented that $10/ton is high; a proposal to raise the barrel tax on oil in the legislature by even $1 couldn't even pass during this last session.

Mr. Ranua commented that rates for the FiT need to provide an incentive for people to invest in solar.

Mr. Hinman, who shared that he is an electrical engineer, noted that the intention of the FiT is more to give incentives to mid-sized systems. He pointed out that Spain and Germany set the standard for the world, and the U.S. has fallen behind.

Mr. Brooks commented that it will take a lot of effort to change Hawaii's energy future, noting that people by nature are resistant to change. He requested that people be kept informed about how to keep the momentum going.

State of Hawai`i - Department of Business, Economic Development, and Tourism
Greenhouse Gas Emissions Reduction Task Force
Meeting Minutes
Tuesday, November 24, 2009
6:00 p.m. – 7:30 p.m.
Kawananakoa Middle School Cafeteria, 49 Funchal Street, Honolulu, 96813

Attendance
Task Force (TF) present:

1. Mr. Laurence Lau (DOH), Co-chair
2. Mr. Theodore E. Liu (DBEDT), Co-chair
3. Mr. Mark Fox (The Nature Conservancy)
4. Mr. Gary North (Matson Navigation Company)
5. Prof. Maxine Burkett (Center for Island Climate Adaptation and Policy, UH)
6. Mr. Jeff Mikulina (Blue Planet)
7. Dr. Makena Coffman (UH Manoa)
8. Mr. Gareth Sakakida (Hawaii Transportation Association)
9. Mr. Robbie Alm (HECO)

Members of the Public (who signed in):

1. Clarence Nishihara (State Senator)
2. Josh Stanbro (Hawaii Community Foudnation)
3. Tim Mistysyn (BEI Hawaii)
4. Jay Ogden (Non Toxic Solutions)
5. Peter Rosel
6. Jennifer Milholen
7. Jim Maskrey (Chamber of Commerce)
8. Melissa Pavlicek (WSPA)
9. Lorrie Johnson-Asher (UH Law School)
10. Rodney Chong (HECO)
11. Iman Nasseri (UHERO)
12. Dana Cusman (Watanabe Ing)
13. My Karlsson (UH student)
14. Robert McCann (AES Hawaii, Inc.)
15. Michael Rossio (Kalaeloa Partners, LP)
16. Hama Rusa (UH studdent)
17. Kelly M. Kohlhofer (UH student)
18. Chris Delamay (UH student)
19. Marcelo NaBregs (UH student)
20. Ka'iulani de Silva (HECO)
21. Clement Y. Mulalsp (UH student)
22. Lance Tanaka (Tesoro)
23. Andrew Tellio (UH student)
24. Mary Treanor (UH student)
25. Calvin Say (State Representative)

26. Anne Horiuchi (Goodsill Anderson, et al)
27. Craig Coleman (UH)
28. Janet Ashman (HFBF)
29. Sean O'Keefe (Alexander and Baldwin, Inc)
30. Edmund Lee
31. Mari Feiteira (KAHEA: the Hwn-Env. Alliance)
32. Annette Kaohelaulii
33. Stephen Ward (HECO)
34. Paul Oshiro (AnB)
35. Kat Brady (Life of the Land)
36. Henry Curtis (Life of the Land)
37. Laurens Laudowicz (100% Green)
38. Ryan Matsumoto (IDL)
39. Clint Cowen (Enlightened Energy)
40. Robbie Adams (Blue Planet Foundation)
41. Jay Schaat
42. Richard Ha (Big Island Farm Bureau)
43. Dwight Streamfellow (21st Century Technologies)
44. Gary Gill
45. Jim Wood

Staff present: Chris Baron, Colleen Miller, Ted Peck, Estrella Seese, Mari Takemoto-Chock

1) The meeting was called to order by Co-chair Lau at 6:02 p.m.

2) The meeting opened with a 25 minute PowerPoint slide presentation by Mr. Lau. The presentation is available for view on the website: http://hawaii.gov/dbedt/info/energy/greenhouse/PublicWkspSlides11-24-09.pdf

3) Public Comments

   Shannon Wood of Ahupuaa Hawaii strongly encouraged the TF to consider the city's projection of population growth, which is expected to reach 1.4 million people by 2025.

   Josh Stanbro commented that he was disappointed that all of the work plans include HCEI (Hawaii Clean Energy Initiative). He urged the TF to consider setting a floor on the price of oil, i.e. $100/barrel, because such a floor would encourage capital investment in renewable energy. He urged the TF to listen to science, not politics, because reality tracks science, and science demands a stronger response than what the current work plans present.

Henry Curtis of Life of the Land, commented that for HCEI to work, the PUC must accept it, and the PUC's contractor NRRI (National Regulatory Research Institute) has said nothing should be assumed, and is not accepting HCEI wholesale. He noted that ICF assumed that HCEI will be adopted in full force; however HCEI is already not working and out of date; thus the ICF report is already out of date. He claimed that ICF was merely regurgitating DBEDT's thoughts, and that this cost $500,000. He pointed out three unexplained assumptions in the report: (1) *clean energy means low climate impact energy*, which is not always true (i.e. palm-oil biodiesel grown where the Amazon rainforest is razed would be considered 'clean energy' under the Waxman-Markey bill); (2) *there is a perfect correlation between money saved and energy saved*, which is not always true (i.e. more efficient coal plants might increase the total use of coal; similarly, money saved through energy efficiency might be used on energy-intensive activities). He pointed out that in Hawaii, the definition of "renewable energy" includes energy from coal burned on-site, and all biodiesel regardless of whether only a fraction of the biodiesel's composition is renewable. He concluded by stressing the need for an 80% reduction in emissions.

> Mr. Lau clarified that the TF spent $200,000 on the inventory update and $300,000 on modeling the work plans.

Sean O'Keefe discouraged the TF from recommending a carbon tax. He emphasized that a carbon tax is not necessary for the State to meet its goals and pointed out that not all sources of GHG are included in the reference case projections. He noted that aviation emissions will decrease without legislative action; thus, the reference case would really result in around a 10% reduction below 1990 levels. Furthermore, the reference case does not represent the business as usual scenario, because it does not include legislation passed in the 2009 session. He pointed out that when aviation emissions and 2009 legislation are included in the business as usual scenario, the actual emissions reductions will be four times greater than what is currently attributed to the reference case. Lastly, he questioned how a carbon tax could have a net benefit to the economy. He warned the TF to keep in mind what the impact of a carbon tax will be in real, not abstract costs.

Roger Dunn cited Thomas Friedman's book Hot, Flat, and Crowded, which points out that whether or not Hawaii goes green, the rest of the world will. He expressed his support for a carbon tax, either as an oil surcharge fee or as a price floor on oil. He questioned how HCEI would be funded, and noted that energy legislation in Hawaii has not been successful in the past. He warned that Hawaii is falling behind the rest of the country and the world.

A man announced that he wants to personally 'insult' everyone for not doing more, and criticized the work plans for setting standards too low.

Jim Mastician from the Western State Petroleum Associates Group asked the TF to consider the economic aspects of the work plans. He suggested that the TF explain better how the work plans produce economic benefits. He expressed his desire that the State continue to thrive economically.

Craig Coleman commented that the TF recommendation will not likely have much of an impact, but urged the TF to include in its recommendation a plan for transitioning smoothly to the next task force on climate change, established by the legislature (2009), so that collected knowledge is not lost in the transition.

> Mr. Lau clarified that the new task force referenced will be looking at the effects of climate change on Hawaii.
>
> Ms. Wood pointed out that the Governor has not released the funds for the climate change Task Force.

Janet Ashman, representing the Hawaii Farm Bureau, expressed two concerns. (1) Farmers need assurances that enough water will be available to produce biofuels locally. She noted that legislation addressing this issue is currently in the works, and urged the TF to support this. (2) A carbon tax is not needed, and would result in double taxation when combined with cap and trade fees. She further noted that a carbon tax would downsize Hawaii's agriculture, and that a carbon tax is not cost-effective in the current economic climate.

Richard Ha, a farmer from the Big Island, urged the necessity of a 'system approach'. He cautioned against too radical a degree of innovation, since such leadership comes with a large risk of failure. He suggested the TF consider energy return on investment (RIO), which analyzes how many barrels of oil it takes to produce another barrel. Studies have shown that for a sustainable society, the ratio needs to be at least 1:3. He expressed his support for geothermal energy, which has a 1:10 ratio of energy RIO. He warned that peak oil will come before climate change, which intensifies the urgency to get off of oil. He pointed out that to switch to geothermal, an interisland cable is needed. Recognizing the cultural concerns surrounding geothermal, he stressed that decisions need to come from the ground up, and that discussions about geothermal expansion are currently in process.

Dwight Streamfellow offered four suggestions. (1) The TF should think about the relationship between energy and water, since water conservation often correlates to energy conservation. He noted that every gallon of oil needs three gallons of water to produce it, and that every gallon of biofuel needs 100 gallons of water. He urged the TF to consider the total energy used in the water system. (2) The TF should emphasize food sustainability. He noted that money spent importing food will increase with a carbon tax. Furthermore, the best way to get people to change is to increase the price of fuel; thus, mandates and taxes are useful. (3) He noted that food production is a huge energy consumer. A typical person consumes 19 kwh/day on food; in comparison, a typical house will consume 20 kwh/day. (4) He noted that increasing energy costs will encourage innovation.

Bill Haynes suggested that the TF consider natural gas. Natural gas is cleaner, though he was not sure if natural gas would be a cost-effective solution. He suggested that the TF consider the Pickens Plan.

Edmund Lee urged that the TF recommend an objective tax whose revenue will only be applied to clean energy initiatives and cannot be raided by the legislature. He expressed his concern about mechanisms to measure, verify, and enforce reductions. He urged that everyone should be subject to the law.

Marcelo NaBregs asked the TF to consider ethanol, since sugarcane can be easily grown in Hawaii, and ethanol made from sugarcane is viable whereas ethanol made from corn is energy-intensive. He added that fuel-efficient cars that can run on multiple renewable fuels and more efficient public transportation should be brought to Hawaii. Lastly, he suggested that natural gas can be a short-term solution that can rapidly lower emissions, although it is not a long-term solution.

4) The meeting was adjourned at 7:35 p.m.

CC Repair & Maintenance Service Inc.
PO Box 1750, Aiea Hawaii 96701
Phone: 808 478-9856 Fax: 808 486-8880
email: eric.ccrepair@clearwire.net

November 2, 2009

RE: DBEDT Task Force Commission recommendations concerning greenhouse gas emission to the 2010 legislature.

Dear Commission,

I would like to express my opinion as a concerned Hawaii resident, small business owner who has worked in the petroleum industry for 17 years, and also a associate member of the Western State Petroleum Association. There have been changes in our industry since the recent passing of the Hawaii Clean Energy Initiative, which I happen to support as a concern resident of Hawaii. A change I have noticed within the industry is a sincere desire to be a part of the solution. Renewable energy divisions within the industry such as (1)Chevron Energy Solution, (2) formation of a renewable energy manager for Tesoro as well as (3) Shell Oil's wind energy farms on Maui illustrate our industries' commitment to helping Hawaii achieve its emission and clean energy goals.

We are free to embrace and explore alternative and renewables only because there is a reliable energy source that has faithfully served us for many years and will continue to be our base load anchor when the sun, wind, and waves decide to take a rest. Our industry face many a challenges everyday in being that anchor for Hawaii and to propose stricter emission levels than what's been already accepted would make doing our jobs even more difficult and may very well raise the cost of living in Hawaii.

It is my hope that DBEDT would work together with our industry and develop responsible policies, culminating with incentives that DBEDT has traditionally supported to build Hawaii's economy and attracting capital investments from the petroleum industry as well as others. Hawaii will move toward being more energy independent, while maintaining a viable petroleum industry to continue serving the needs of Hawaii (energy portfolio anchor) which many seem to take for granted.

Thank you for your consideration on this matter.

Sincerely,

Eric Ching
CC Repair & Maintenance Service Inc.

KAUAI COFFEE®

November 3, 2009

Hawaii Greenhouse Gas Emission Reduction Task Force
c/o Mr. Chris Baron
Hawaii State Energy Office
Department of Business, Economic Development, and Tourism
Via email: cbaron@dbedt.hawaii.gov

Subject: Public Comment on Work Plans for Reducing Greenhouse Gas Emissions

Kauai Coffee Company farms 3,100 acres of coffee and also generates renewable energy at its two hydroelectric plants, producing all of the electricity it consumes as well as providing about five percent of the electric power for the island of Kauai.

Kauai Coffee Company is very concerned about the proposed carbon tax that is being considered by the Task Force under Work Plan #2. We strongly urge that the Task Force not include in its report to the State Legislature any recommendation for a carbon tax. We believe that such a tax will be harmful to the state's economy and especially to agriculture.

The range of carbon taxes suggested in the Work Plan would result in a new tax on petroleum fuels of four to seventeen dollars per barrel, and would impose an additional tax burden of $200 million to $870 million annually on Hawaii's citizens and businesses. A "carbon tax" of this size could more than triple the existing state tax on motor fuels, adding to the already high federal, state, and county fuel taxes paid in Hawaii.

Higher fuel prices are especially harmful to Hawaii agriculture because they drive up the cost of farming, the cost of processing, and the cost to ship products to markets. Higher fuel prices also result in higher costs for farm inputs, such as fertilizers and irrigation supplies, due to increased transportation costs to get these inputs to the farmer. Hawaii's farmers already face significant challenges from mainland and foreign agricultural producers, and are therefore very limited in their ability to pass on any increase in production costs. An increase in fuel costs in Hawaii while no similar increase is faced by farmers elsewhere will exacerbate our existing competitive disadvantage.

The Task Force has determined that a "carbon tax", if implemented, will not significantly reduce greenhouse gas emission in the state. Rather, it is viewed as a source of funding for other emission reduction efforts. If the state wishes to raise revenues for other emission reduction initiatives, we believe these efforts should best be funded through private investment or other means, not through tax increases.

KAUAI COFFEE COMPANY, INC.
Post Office Box 530 • Kalaheo, Kauai, Hawaii
Tel: (808) 335-5497 • *Toll Free:* (800) 545-8605 • *Fax:* (808) 335-6160
www.kauaicoffee.com

KAUAI COFFEE®

Thank you for the opportunity to provide comments on the work plans being considered by the Hawaii Greenhouse Gas Emissions Reduction Task Force.

Sincerely,

Wayne K. Katayama
President and General Manager
Kauai Coffee Company, Inc.

KAUAI COMMERCIAL COMPANY, INC.
1811 Leleiona Street • Lihue, Kauai, Hawaii 96766
PHONE: (808) 245-1985 • FAX: (808) 245-2079

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November 3, 2009

Hawaii Greenhouse Gas Emission Reduction Task Force
c/o Mr. Chris Baron
Hawaii State Energy Office
Department of Business, Economic Development, and Tourism
Via email: cbaron@dbedt.hawaii.gov

Subject: Public Comment on Work Plans for Reducing Greenhouse Gas Emissions

Kauai Commercial Company, Inc. (KCC) has been providing trucking/transportation services on Kauai for over 100 years. We are pleased to offer the following comments on the proposed work plans for reducing greenhouse gas emissions in the State of Hawaii.

KCC, like fellow members of the Hawaii Transportation Association, is very concerned about the proposed carbon tax that is being considered under Work Plan #2, outlined in the ICF International report *Proposed GHG Reduction Work Plans for Hawaii*. We strongly urge that the Task Force not include in its report to the State Legislature any recommendation for a carbon tax. We believe that such a tax will be harmful to the state's economy, to the trucking industry, to our customers, and to Hawaii residents.

The range of carbon taxes suggested in the Work Plan would result in a new tax on petroleum fuels of four to seventeen dollars per barrel, and would impose an additional tax burden of $200 million to $870 million annually on Hawaii's citizens and businesses.

A "carbon tax" of this size would more than triple the existing state tax on motor fuels, adding to the already high federal, state, and county fuel taxes paid in Hawaii. In addition to higher fuel prices paid directly at the pump, Hawaii residents will likely see higher prices for a variety of goods and services delivered by the transportation sector as its operating costs increase.

The Task Force has determined that a "carbon tax", if implemented, will not significantly reduce greenhouse gas emission in the state. Rather, it is viewed as a source of funding for other emission reduction efforts. If the state wishes to raise revenues for other emission reduction initiatives, we believe these efforts should best be funded through private investment or other means, not through tax increases.

Thank you for the opportunity to provide comments on the work plans being considered by the Hawaii Greenhouse Gas Emissions Reduction Task Force.

Sincerely,

George Matsuda
Operations Manager
Kauai Commercial Company, Inc.

KAHULUI TRUCKING & STORAGE, INC.

A Subsidiary of Alexander & Baldwin Inc.
140 HOBRON AVENUE
KAHULUI, MAUI, HAWAII 96732
PHONE 808-877-5001 FAX 808-877-0572

November 3, 2009

Hawaii Greenhouse Gas Emission Reduction Task Force
c/o Mr. Chris Baron
Hawaii State Energy Office
Department of Business, Economic Development, and Tourism
Via email: cbaron@dbedt.hawaii.gov

Subject: Public Comment on Work Plans for Reducing Greenhouse Gas Emissions

Kahului Trucking and Storage, Inc. (KT&S) has been providing trucking/transportation services on Maui for 100 years. We are pleased to offer the following comments on the proposed work plans for reducing greenhouse gas emissions in the State of Hawaii.

KT&S, like fellow members of the Hawaii Transportation Association, is very concerned about the proposed carbon tax that is being considered under Work Plan #2, outlined in the ICF International report *Proposed GHG Reduction Work Plans for Hawaii.* We strongly urge that the Task Force not include in its report to the State Legislature any recommendation for a carbon tax. We believe that such a tax will be harmful to the state's economy, to the trucking industry, to our customers, and to Hawaii residents.

The range of carbon taxes suggested in the Work Plan would result in a new tax on petroleum fuels of four to seventeen dollars per barrel, and would impose an additional tax burden of $200 million to $870 million annually on Hawaii's citizens and businesses.

A "carbon tax" of this size would more than triple the existing state tax on motor fuels, adding to the already high federal, state, and county fuel taxes paid in Hawaii. In addition to higher fuel prices paid directly at the pump, Hawaii residents will likely see higher prices for a variety of goods and services delivered by the transportation sector as its operating costs increase.

The Task Force has determined that a "carbon tax", if implemented, will not significantly reduce greenhouse gas emission in the state. Rather, it is viewed as a source of funding for other emission reduction efforts. If the state wishes to raise revenues for other emission reduction initiatives, we believe these efforts should best be funded through private investment or other means, not through tax increases.

Thank you for the opportunity to provide comments on the work plans being considered by the Hawaii Greenhouse Gas Emissions Reduction Task Force.

Sincerely,

Glenn M. Wilbourn
Executive Vice-President and General Manager
Kahului Trucking and Storage, Inc

Brad Parsons <mauibrad@hotmail.com>

11/03/2009 03:33 PM

To <cbaron@dbedt.hawaii.gov>

cc <gregg.j.kinkley@hawaii.gov>, <colleen.m.miller@dbedt.hawaii.gov>, <eseese@dbedt.hawaii.gov>, <tpeck@dbedt.hawaii.gov>, Laura Thielen <laura.thielen@hawaii.gov>

Subject RE: State GHG Task Force investigatory committee, Kauai meeting

Aloha all,

I hope you all know there is also a BLNR/DLNR hearing tonight in Lihue about Kokee and Haena Parks and the "*Recreational Renaissance Plan B*" regarding proposed fees and rules changes and that the community will likely view that as a more pressing issue tonight. I'm going to try to make some of both meetings, but don't be surprised if you have a small crowd because a lot of promo has gone into getting a big crowd to show up at the other meeting. It doesn't mean that the community is not interested in the GHG issues.

In case I can't stick around for the public comments, the following questions were posed to me by an interested individual on the work of the GHG Task Force:

It will be interesting to see how the GHGERTF examined the relationship between carbon sequestration and burning, both historically (in the 1990s with cane production) and presently, when cane and albezia biomass may be combusted to generate electricity. Burning biomass is not necessarily carbon neutral.

I believe there are a couple other noteworthy points to investigate:
How are air travel emissions calculated?
Is there any mechanism to calculate and count GHG emissions created elsewhere by importing fuels, e.g. ethanol from corn or cane, biodiesel from palm oil?

It should be noted that fossil fuel electrical production is by far the biggest GHG producer in the state. Transportation is also big, with marine diesel not to be overlooked.

Aloha, Brad

"Gilman, Gail" <ggilman@hawaiigas.com>

11/05/2009 01:11 PM

To "Chris Baron" <CBaron@dbedt.hawaii.gov>

cc

Subject Comments of The Gas Company on 9/30/09 ICF Report and Recommendations of the GHGERTF

Attached is the requested electronic copy of the comments of The Gas Company. Also, I would appreciate it if you would convey to the Task Force what The Gas Company means by its support of "HCEI plus." The Gas Company used this term in its comments to refer to the additional recommendations on page 9 of the ICF report (such as a second sea water air conditioning project for Waikiki, enhanced building codes, freight options, and urban form/smart growth). TGC has been participating the in the HCEI working groups, and has also supported most of the initiatives recommended for further legislative action in those groups. The sole initiative which TGC opposed, as far as I am aware, is the Residential Energy Conservation Ordinance, which we felt was insufficiently fleshed out and premature for proposal to the 2010 legislature. We would hate to see these more meritorious HCEI legislative initiatives get lost in a grand debate on the merits of a carbon tax. Thanks, Chris.

Gail S. Gilman
Division Manager, Regulatory Affairs
The Gas Company
P.O. Box 3000
Honolulu, HI 96802-3000
808-535-5914 (direct dial)
808-535-5944 (fax)

THE GAS COMPANY

MEMORANDUM

P.O. Box 3000
Honolulu, Hawaii 96802-3000

To: Hawaii Act 234 Greenhouse Gas Task Force

From: Gail Gilman, Division Manager, Regulatory Affairs

Date: November 13, 2009

Subject: Comments of The Gas Company on ICF International's 9/30/09 "Proposed GHG Reduction Work Plans for Hawaii," for Consideration by the Task Force in Preparing its Act 234 Recommendations to the State Legislature

---

The Gas Company (TGC) thanks the GHG Task Force for this opportunity to share its comments and concerns. We were not deemed to be an "affected business sector" in Act 234 with a seat on the Task Force itself, but we and our customers will, in fact, potentially be greatly affected by the recommendations of the Task Force.

TGC supports Work Plan 1, adoption of HCEI with the modifications recommended by ICF. With respect to Work Plan 2, HCEI + carbon tax, TGC has concerns about (1) the impact of any carbon tax on its customers, and (2) the way the tax might be implemented. TGC would like to see these concerns addressed in the event that either the majority or the minority recommends a carbon tax to the legislature.

<u>Opposition to A Carbon Tax</u>

First, TGC notes that combining a carbon tax with HCEI results in an additional reduction in CO2e of only .3% (52 kt), beyond HCEI alone. The additional savings is small, and is especially negligible in light of the largely unexplored cost to impose and collect the tax, as well as rebate 90% of the funds so collected. A carbon tax would be especially inappropriate given the state of the economy. TGC recently put into effect an interim utility rate increase, its first in eight years. This increase, combined with escalating fuel costs, has already caused high bill complaints to both our Customer Service Department and to the PUC from many small business customers. Adding a carbon tax would increase this burden on our customers.

One purpose of the carbon tax was to raise funds to "jump start HCEI." Yet HCEI itself says that it needs additional funding of only about $5.2 million per year, far less than the $200 million to $840 million that ICF predicts would be raised by the tax. Accordingly, recommending a carbon tax at this juncture would seem to be both imprudent and a waste of political capital that would distract from HCEI's working groups' own legislative proposals.

Next, TGC questions whether it is appropriate for the Task Force to recommend a state carbon tax in light of the fact that that <u>EPA has recently announced that it will be affirmatively regulating emissions of GHG under the Clean Air Act</u>. The October 27, 2009 Federal Register (74 Fed. Reg. 55292) contained EPA's NOPR on regulating the quantity of GHG emissions from stationary sources that would trigger the Prevention of Significant Deterioration and CAA Title V permit requirements. EPA proposed to set the threshold at 25K tpy of CO2e for stationary sources, and to set the level for changes in operations that will entail PSD review and potential application of BACT at between 10K tpy and 25K tpy. These regulations are slated to be finalized and go into effect before the March 2010 date of effectiveness of the Light Duty Vehicle Rule, in which EPA first announced that it was regulating GHGs under the Clean Air Act.

The new EPA regulations will have potentially profound impacts on TGC and its utility customers. Throughout its operation, TGC's SNG Plant has always been categorized as a non-major source because it has emitted only minor amounts of criteria pollutants, even though it is a "fuel conversion plant." Until this NOPR, the SNG Plant has operated under a non-covered source permit. When the rule becomes final, however, TGC will become a major source (in part because the rule does not exclude CO2e attributable to renewable biofuels or CO2 that is captured and sold, as discussed more fully below). As a result, TGC will have to seek a covered source permit under the CAA for the first time. Although EPA is proposing to allow the states some latitude in the fees they collect for Part 71 permits, the minimum fee computed by EPA for 2009 was $45.25 per ton. If a fee of this magnitude is adopted with respect to covered source permits attributable to GHGs, TGC anticipates that it will be paying somewhere in the vicinity of $2.25 million per year in newly applicable permit fees. TGC will not be able to pass through the increase in permit fees to its utility customers until its next rate case.

EPA indicates in the NOPR that the new rule and permit requirements are potentially applicable to hotels, universities, and other businesses, in proportion to their GHG emissions. The ICF study did not take into account EPA's recent decision to regulate GHGs under the CAA and its impact on the state's economy. TGC urges the Task Force to consider these potential impacts before making any recommendation with respect to a state carbon tax. At a minimum, TGC believes, the Task Force should evaluate the combined economic impact of these proposed state and federal curbs on GHG emissions before it recommends imposition of any carbon tax.

<u>Carbon Tax Implementation Issues</u>

If the majority of the Task Force, or any "minority reports," are, nevertheless, going to recommend a carbon tax, TGC would like to see certain issues explored.

As TGC understands it, the carbon tax would be imposed on fossil fuels only, and would be levied per tonne (that is, by mass/weight, rather than by energy content or volume), based on an emissions factor for each fuel. Feedstocks and non-energy emissions would be exempt from the tax. (See pp. 94 &135 of the ICF Report).

TGC uses a refinery byproduct as a <u>feedstock</u> for manufacturing its SNG. TGC assumes that any state carbon tax would have already been collected on its SNG feedstock at the refinery level. The tax-enhanced price of the SNG feedstock paid by TGC would be directly passed through to hit the bottom line of our residential and commercial customers through our fuel adjustment clause, albeit lagged by one month.

TGC has announced a plan to manufacture <u>biogas</u> from local sources, to blend with its SNG, with the goal of converting its utility gas sales to 50% biogas within five years. Both the manufacture of the biogas and its combustion yield CO2, but TGC understands that this biogenic CO2, which will be produced from renewable sources, would not be subject to the proposed carbon tax (at least as modeled by ICF). Accordingly, if either the majority report or any of the minority reports recommends a carbon tax, TGC asks that such recommendation expressly limit any carbon tax to emissions of CO2 from <u>fossil</u> fuels. Such a limitation would give TGC the opportunity to mitigate the impact of the carbon tax on its utility customers through increasing the amount of biogas in its blended product. Further, if the Task Force recommendations follow the ICF proposal that 90% of the proceeds from the carbon tax should be returned to taxpayers, some in the form of incentives toward reducing the use of fossil fuels, TGC would like to see the draft legislation state that at least some of those proceeds would be available for use to foster production of renewable biogas, via other tax incentives, state grants, or otherwise.

TGC's gas manufacturing process also produces CO_2, 30% of which is captured, purified, and sold for productive, but non-energy uses (e.g., to make dry ice or in carbonating beverages). TGC asks that any carbon tax recommendations take into account TGC's efforts to manage its CO_2 emissions for productive use in a non-energy capacity, possibly via a credit or offset of any carbon tax. That is, the tax should not be drafted in such a way that it assumes that all CO_2 from fossil fuels consumed or sold from the SNG Plant has been emitted through combustion in the production of energy. The ICF model assumes that non-energy emissions would not be addressed by a carbon tax. (See p. 94.)

TGC is also a distributor of LPG, some of which is produced by the local refineries, and some of which TGC imports. We sell the LPG to both utility and non-utility customers. TGC understands that any carbon tax on locally produced LPG would be imposed at the refinery level and included by the refineries in their pricing of LPG sold to us (and to our competing LPG suppliers). Importantly, TGC asks that any carbon tax that may be imposed at the level of the crude coming in to the refineries include a requirement that the tax effects must be distributed among the refinery products ratably in proportion to the carbon content of the various products they produce. That is, any carbon tax legislation should not leave it to the refineries whether to collect an amount equivalent to 100% of the tax so imposed from their sales of LPG and gasoline, for example, while allowing jet fuel and residual oil to escape paying any portion of the tax. Likewise, the tax should be imposed ratably and proportionally in accordance with the carbon content of the differing grades of LPG sold locally.

The equitable distribution of any carbon tax imposed at the refinery level is important to TGC, not only because we generally tend to buy the less carbon-intensive products of the refineries (as compared to the electric utilities), but also because we import LPG to supplement local refinery production. As we understand it, the carbon tax for our LPG imports would be levied directly on TGC and would apply to the CO_2e of the particular grade of imported LPG, as determined by the EPA GWP factor. Because the local refineries also sell LPG (and other fuels) to TGC's multiple competitors, to impose the tax on TGC's imports differently from how the tax is imposed on locally produced products could have significant unfair and deleterious competitive consequences on TGC and its customers. Any carbon tax proposal should thoroughly scrutinize and avoid any such potential competitive impacts.

Thank you for the opportunity for TGC to air its views.

John L. Jones
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GHG INVENTORY Public Comments
DBEDT Strategic Industries Division
P.O. Box 2359
Honolulu, HI 96804

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Subject: The Hawai'1 Greenhouse Gas Task Force

What I have read about the Task Force bodes the question as to how we can increase "Greenhouse Gases"? It is taken as a given, if we do nothing they will increase.
The socalled environmental groups have arrived at what they consider as being the socially acceptable answer: Solar Cells, Wind Farms, and green waste-algae-garbage inceneration.
To pay for this they propose the Cap and trade taxing of carbon that everyone can participate in for a clean energy future.
The problem with the existing condition is that Kauai depends upon Oil as a major energy source that appears to be most objectionable. The supply source is not a captive market supply and it is subject to fluctuations in the world market at the present exhorbitant prices. The combustion efficiency pegged at 35% is the source of Carbon dioxide and Nox and Sox gases that are objectionable. The carbon and hydrogen- oxygen are brought together during the combustion to produce the heat energy converted to steam that drives the turbines and the power as electricity.
The effort is to find a sustainable and clean source that does not produce the objectionable gases described above.

1. The socially acceptable solar cells do deliver clean souce energy. The problem is that at present 70% of the existing cells are only 10% efficient, even though new production will be 17% efficient and developers claim a 40% efficient cell is on the way. In addition, the cells need a supplemental supply for periods when they are not producing energy.
2. Wind farms have found acceptability with their socially acceptable clients. The problem: The continuing necessity for maintenance, unsightly appearance for residential areas with citizens who object, and the menace and damage in the natural flyways. Additionally where is the accountability when endangered species are affected-either death or maiming?
3. The socially acceptable "Green Waste" route for a sustainable energy source does not answer the question of clean source energy. Like all fossil fuels it too makes the same polluting carbon dioxide and Nox and Sox gases.

I clearly recall when in the midst of the depression our monetary system went off the Gold Standard (price at $35 per ounce). Silver Certificates and Gold were replaced with treasury notes in dollar denominations. What followed the great depression were the TVA, Boulder Dam and Grand Coulee Dam projects.
The vast expansion of "Clean" and cheap hydro-electric power was from a source that was sustainaable and continues that way.
The Carter administration using the GDP as a measure inflated the money supply by 13% with the consequence that the Fed raised interest rates to as much as 20% to get the economy in balance.

The Obama administration has inflated the money supply by 120% to affect the economy for their avowed purposes of stability. Anyone can look at the situation and conclude that the situatiion is not sustainable. Well, they have come up with the answer: Carbon Tax for everyone. The new monetary standard will be the "Carbon Dollar"! This is something we do not need and is not in the public interest.
Kauai has not tapped the potential for hydro-electric power generation of its streams and tidal wave sources. This clean source may not be socially acceptable but it is economically feasible and sustainable.

Considerably more sustainable and less environmentally offensive to the socially incorrect advocates is natural and synthetic (SYNGAS) gas. There is found to be a substantial and captive supply for some years to come. The combustion gas contains less of the offensive greenhouse mix.

Coal has been targeted as the culprit, "Dirty fossil Fuel". I can remember the days when coal dust from houses and furnaces of factories in and about Pittsburgh and the RR switching yards covered the new fallen snow. That was when the winters were cold and drifting snow and polar ice existed. Now in the pristine nature of our atmosphere the sun penetrates and regardless of the solar cycle our climate is warming.

Coal is a strategic raw material for our national security that is under attack by Cap and Trade. The Europeans see it as essential and Powerfuel's colliery at Hatfield in Stanforth, South Yorkshire, England announced on Feb. 19, 2009 the technology to remove and capture contaminants from SYNGAS made from coal. The process for their clean power station at Stanford will deliver as goal an energy solution with near zero emissions. The unit will remove 97% of the Carbon dioxide contained in the SYNGAS.

Carbon dioxide has been tested and found to be a boon to the oil industry. Compressed and injected as a liquid into the oil shale strata it displaces the oil and in the process substantially increases the reserve. The benefit is that the Liquid carbon dioxide remains and fills the void where the oil has been displaced. What a break through-more oil and less Carbon dioxide in the atmosphere!

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November 6, 2009

Theodore E. Liu, Director
Department of Business, Economic Development & Tourism
P.O. Box 2359
Honolulu, Hawaii 96804

Re: ICF International: Proposed Greenhouse Gas Reduction Work Plans

Aloha Director Liu,

My name is Henry Curtis and I am the Executive Director of Life of the Land, Hawai`i's own energy, environmental and community action group advocating for the people and `aina for almost four decades. Our mission is to preserve and protect the life of the land through sound energy and land use policies and to promote open government through research, education, advocacy and, when necessary, litigation.

"Proposed GHG Reduction Work Plans for Hawaii"[1] (September 30, 2009) was written by ICF International for DBEDT. The report could have been written by DBEDT, since it is a mirror image of DBEDT's values and beliefs.

When other state agencies have different ways of looking at issues, ICF mirrors DBEDT's position. For example, the Hawaii Public Utilities Commission (PUC) has opened a regulatory proceeding to analysis whether the utility planning framework needs to be updated. The PUC's consultant, the National Regulatory Research Institute ("NRRI") filed written comments in the docket on November 3, 2009: "The ...process should ask questions broad enough to avoid focusing on a single outcome (e.g. should HECO build an interisland transmission cable?), but focused enough to empower decisionmakers to solve the problems they face. A better question is 'What actions must Hawaii take to be prepared

[1] http://hawaii.gov/dbedt/info/energy/greenhouse/

under a variety of potential futures, to supply its energy service needs cleanly, reliably, and at reasonable cost?'"

However, ICF Report adopts the DBEDT position: "A new transmission link, using an undersea cable, is assumed to be built ...For modeling purposes it is assumed that the addition of this facility will cost about $1 billion to build; assuming $700-900 million for the undersea cable plus the cost of land based infrastructure on each end. ...All of these figures are estimated based on discussions with DBEDT as engineering studies have not been completed to-date or are not yet public." (pg 128)

One contentious issue is biofuels. Achim Steiner, Executive Director, United Nations Environment Programme (October 2009) noted: "Biofuels are a subject that has triggered sharply polarized views among policy-makers and the public. They are characterized by some as a panacea representing a central technology in the fight against climate change. Others criticise them as a diversion from the tough climate mitigation actions needed ...Above all the [United Nations] report spotlights the complexity of the subject and indicates that simplistic approaches are unlikely to deliver a sustainable biofuels industry"[2]

ICF Report assumes that biofuels are the answer: "The future supply and the source of biodiesel and ethanol are obviously critical to meeting the HCEI goals." (pg 86)

In areas where there are sharp disagreements between technology proponents and peer review scientific literature, ICF adopts the industry spin. Because plants are green, biofuel proponents argue that they are "Net Zero" or "Net Carbon Balance". The industry spin is based on no analysis, they simply mean "didn't look, don't care." Fossil fuels are used every step of the way in making biofuels: pesticides and fertilizers are made from fossil fuel; tractors and other farm equipment use diesel; fossil fuels are used to convert plant material into biofuel. Fertilizer use releases nitrogen compounds into the atmosphere which are far more potent greenhouse gas than carbon emissions. The changes in soil content (humus) is also a major greenhouse gas contributor. Finally, land use changes account for 1/5 of worldwide greenhouse gas emissions.

ICF Report states: "When manufactured from plant oils, biodiesel is also considered to be in net carbon balance, since it only emits as much carbon dioxide as was initially sequestered, or stored, within the plant used for fuel production." (pg 54)

A look at the footnotes in the ICF report shows that most sources are by the author (ICF), the state and federal government, HECO and MECO, and/or were written under contract to the foregoing. There are no countering papers cited. There is one and only one path forward: the path mapped out by DBEDT.

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[2] **Preface for "Towards sustainable production and use of resources: Assessing Biofuels" (October 2009),** *www.unep.fr/scp/rpanel/Biofuels.htm*

A major accounting error has been found in international greenhouse gas schemes including the Kyoto Protocol, the European cap and trade system, and the Waxman-Markey climate bill. Europe and the U.S. get credit for switching to biofuels but less developed countries are not penalized or capped for land use changes including destroying rainforests to grow biofuels. This was noted in a recent Wall Street Journal Editorial (Review and Outlook) published on October 29, 2009 titled "Sins of Emissions":

> "The latest embarrassment arrives via the peer-reviewed journal Science, not known for its right-wing inclinations. A new paper calls attention to what the authors (led by Princeton's Tim Searchinger) call "a critical accounting error" in the way carbon emissions from biofuels are measured in climate-change programs world-wide. Bernie Madoff had a few critical accounting errors too. ...
>
> Cap-and-trade programs exacerbate the problem because ...biofuels are generally grown in developing countries (where emissions aren't capped). So if Malaysians burn down a rain forest to grow palm oil that ends up in German biodiesel, Malaysia doesn't count the land-use emissions and Germany doesn't count the tail-pipe emissions."

The ICF Report states that imported biofuels are not counted: "GHG [greenhouse gas] emissions from the combustion of biofuels are treated as biogenic in the model. This means that the actual use of biofuels does not contribute to global Warming". (pg 87)

Blue Earth Biofuels has filed a federal lawsuit for breach of contract with HECO, MECO, Karl Stahlkopf and Aloha Petroleum. Current utility plans have no role for Blue Earth Biofuels. However ICF believes that the plant will clear all lawsuits and regulatory review, including environmental analysis, to come on line within 2 years: "For Biodiesel it is assumed that one of the plants currently being considered proceeds and comes into service in Maui in 2011 ...These assumptions are based on current plans for Blue Earth Biofuels ...which is assumed to be delayed due to the economic slowdown." (pg 133)

The Hawai`i Department of Health has not approved any air permits for a biodiesel fired generator. HECO and MECO hope to import palm oil; then to test generators at Kahe and Maalaea; and to give the data to DOH. The DOH will evaluate the data before issuing any biofuel air permit. ICF is unconcerned. "The use of biodiesel as compared with diesel or fuel oil will reduce other air emissions" (pg 53)

Numerous entities have pointed out that palm oil biodiesel has enormous negative consequences. These sources include the Wall Street Journal, and numerous Hawaii-based churches, environmental, cultural, justice and community groups. ICF Report: "the utilities are also testing the use of palm oil as a fuel. This could offer a lower cost alternative" (pg 51)

Hawai`i sugar companies are folding because they can not survive. However, ICF is undeterred: "It is assumed that ethanol plants will be developed within the State ...with the capacity of producing 40 million gallons per year of ethanol." (pg 87) "For Ethanol it is assumed that three plants will be built within the State: (1) In Oahu, a 15 million gallon/year (mmgy) plant ...to come on-line in 2012; (2) In Maui a 15 mmgy plant is assumed to come on-line in 2011; (3) In Kauai a 10 mmgy plant is assumed to come on-line in 2014." (pg 133)

A proposed 30 MW windfarm in Kahuku, Oahu is currently undergoing regulatory review by the PUC. Another 25 MW windfarm is planned by developers, but HECO has broken off talks. ICF states that 80MW of Kahuku wind will be on line in 2009 (pg 126-27)

First Wind has built a windfarm (KWP I) at Kaheawa Pastures mauka of Maalaea, Maui. They want a second windfarm (KWP II). Negotiations with MECO have stalled and any action is not likely soon because demand for electricity on Maui has fallen 10% in the past year.

MECO prefers diversification of wind sites, with the next windfarm being at Ulupalakua near Kula. This was originally a Shell proposal, but now Shell has been replaced by other investors.

However, ICF states that the new First Wind windfarm (KWP II) will be operational this year (2009) and that Shell is still here and will build a windfarm at Ulupalakua in 2015. (pg 126-27)

There have been as many as 8 proposals to build Ocean Thermal Energy Conversion (OTEC) facilities in Hawaii. The three strongest are by Lockheed Martin, Makai Ocean Engineering, and OCEES, all of which have been involved in local OTEC research and demonstration projects for decades, including the on-shore and off-shore demonstration projects at NELHA. One incredible weak outside OTEC proposal has been made by Sea Solar. ICF correctly points out that HECO has accepted a Lockheed Martin OTEC demonstration project scheduled for 2015. ICF also states that Sea Solar will build one in 2013. (pg 126-27) This will never happen.

Hamakua Biomass was to be fast-tracked through the regulatory process, ahead of the new PUC mandated Competitive Bidding process. But negotiations bogged down and the PUC noted that the fast track appeared to be no faster than the slow track, and so the PUC terminated the fast track process for Hamakua Biomass. The company must now go through the Competitive Bidding process. In Competitive Bidding they are going up against two other biomass companies. HELCO has the capacity to have at most one biomass contract. The three companies are bogged down in land acquisition, financing, and community opposition. They are a long way from completing their regulatory hurdles. ICF states that Hamakua Biomass will be the entity chosen and that a 25MW facility will come on line next year. (pg 126-27)

The Big Island is at 39% renewable. Several countries and some states exceed that. Oahu is at a mere 4% renewable, all of it comes from H-POWER. One third (1/3) of the energy H-POWER produces is burning plastics and other fossil fuels, but it all counts as green energy under state law. Oahu could add 400-

600MW of intermittent renewables onto its system to match the renewable penetration level on the Big Island. ICF Report: "Hawaii now derives a relatively high percentage of its electricity from renewable sources." (pg 44)

The Hawaii Clean Energy Initiative (HCEI) states that 70% of Hawai`i's energy will come from clean energy sources by 2030. That is, 70% of the non-marine, non-aviation energy demand, that is 70% of 67%, or 49% of the total. Of this, 21% is to come from energy efficiency, at a rate of acquisition that has never ever be achieved anywhere in the world. The remaining 28% will be clean energy, with "clean" being undefined. If it is assumed that clean means "renewable energy" or "alternative fuel", then it should be noted that these two terms, under existing state law, both include some fossil fuels. ICF Report: "Hawaii's most recent initiative—the Hawaii Clean Energy Initiative (HCEI)—sets an ambitious target of transforming the State's energy use to obtain 70% of Hawaii's energy from clean sources by 2030." (pg 6)

ICF then states there are three options or work plans, but weighs the options very differently. The report spends 52 pages on DBEDT's HCEI proposal; 12 pages on combining DBEDT's HCEI proposal with a federal cap and trade scheme; and a mere 8 pages on a carbon tax. All of these options focus on buzzwords and not on solutions.

ICF Report: "A carbon tax is a tax on the carbon content of fossil fuels including coal, oil and gas" (91) but not products made from coal, oil and gas. Importing energy to make goods in Hawai`i will be taxed. Importing finished goods made from the very same energy sources will not be taxed. Thus a carbon tax favors imports over local production and may increase our trade imbalance re imports and exports and thus make us less self-reliant. In addition, rainforest biofuel would not be taxed because it is "green."

It is assumed that to increase the amount of renewables on the system, the utilities need more command and control mechanisms. HCEI concentrates greater power in utilities and into the concept of centralization: interlocking island grids through inter-island cables, smart grids, the abilities of utilities to control energy devices inside residential and commercial buildings. All of this will cost $1-2 billion and theoretically enable the utilities to then let more renewables onto the grid.

This is the fourth major attempt by the utilities to expand the use of renewable energy. HECO established the HEI holding company (1981-83) because unregulated companies owned by HEI (HECO sister companies) could do what HECO couldn't. Then circa 2000 HECO decided that it wasn't parent companies but subsidiaries that would enable greater renewable penetration. Renewable Hawaii Inc was created as a HECO subsidiary. Neither HEI nor RHI succeeded. So in the 2002-07 the third method was used: change the definition of renewables to include some types of fossil fuel, such as heat recovered from burning coal, and biofuels made from fossil fuel. The use of "renewables" suddenly shot up. Now the fourth approach: strengthen HECO, build centralized power systems and renewables will follow.

One alternative is to spend the same $1-2 billion on rooftop solar water heaters, photovoltaic panels, and micro-wind systems. A second alternative is to use the money to supply 50% of the cost for homeowners and businesses to do it, on top of the tax breaks currently given.

Interconnected centralized systems using command and control systems or decentralized smart systems.

One could create two boxes and put certain types of coal, oil, gas, biofuel, solar, wind, wave and thermal in each box such that anything in Box A is better for the environment than anything in Box B. That is, there are certain ways of making solar would be worse than certain ways of making coal. One could use precious metals from the Congo civil war- the deadliest war since WW2. One could ship goods around the world using highly polluting vessels. Just because some bureaucrat assumes that renewables, or clean energy, lowers greenhouse gas levels, doesn't make it so. ICF: "Hawaii's energy-related GHG and CAC emissions will be reduced in proportion to the level of renewable energy used to substitute for fossil-fired" (pg 45).

Conclusion

In summary, the ICF analysis seems more of a paper designed to get another contract, rather than as a serious policy paper.

It is clear that we are in an energy crisis. Climate change is real. We must honestly appraise where we are, where we want to go, and how to get there. We must think outside of the box, beyond the thinking that got us to where we are today.

We must systematically analyze all of the options that are available and move forward.

Henry Curtis
Executive Director

A&B, INC.
HONOLULU

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HAWAIIAN COMMERCIAL & SUGAR COMPANY
P.O. BOX 266, PUUNENE, MAUI, HAWAII 96784

November 7, 2009

Hawaii Greenhouse Gas Emission Reduction Task Force, c/o Mr. Chris Baron
Hawaii State Energy Office
Department of Business, Economic Development, and Tourism
Via email: cbaron@dbedt.hawaii.gov

Subject: Public Comment on Work Plans for Reducing Greenhouse Gas Emissions

HC&S is Hawaii's last remaining sugar plantation and farms about 37,000 acres in central Maui. The sugar industry has been a pioneer in efficient cogeneration and renewable power production in Hawaii. Each year HC&S produces approximately 500,000 tons of sugarcane bagasse, which it burns in its Puunene Mill boilers to cogenerate steam and electricity. Each ton of this renewable biomass fuel can replace one barrel of imported oil while generating negligible greenhouse gas emissions. HC&S also generates renewable power at two hydroelectric facilities installed in its irrigation systems, also with no GHG emissions. In addition to meeting all of its own internal power needs, HC&S produces about seven percent of the electric power for the island of Maui, primarily from renewable biomass and hydroelectric resources.

Like any farm HC&S also relies upon fossil fuels to power its farm equipment and is therefore very concerned about the proposed carbon tax that is being considered by the Task Force under Work Plan #2. We strongly urge that the Task Force not include in its report to the State Legislature any recommendation for a carbon tax, as we believe that such a tax will be harmful to the state's economy and especially to agriculture.

The range of carbon taxes suggested in the Work Plan would result in a new tax on petroleum fuels of four to seventeen dollars per barrel, and would impose an additional tax burden of $200 million to $870 million annually on Hawaii's citizens and businesses. A "carbon tax" of this size could more than triple the existing state tax on motor fuels, adding to the already high federal, state, and county fuel taxes paid in Hawaii.

Higher fuel prices are especially harmful to Hawaii agriculture because they drive up the cost of farming, the cost of processing, and the cost to ship products to markets. Higher fuel prices also result in higher costs for farm inputs, such as fertilizers and irrigation supplies, due to increased transportation costs to get these inputs to the farmer. Sugar producers have virtually no control over the price of sugar so are not able to pass on these increased costs and, like most farms, already operate on very thin margins.

The Task Force has determined that a "carbon tax", if implemented, will not significantly reduce greenhouse gas emissions in the state. Rather, it is viewed as a source of funding for other emission reduction efforts. Ironically, such a tax increase has the potential to jeopardize the continued viability of HC&S' existing renewable energy production. If the state wishes to raise revenues for other emission reduction initiatives, we believe these efforts should best be funded through private investment or other means, not through tax increases.

Thank you for the opportunity to provide comments on the work plans being considered by the Hawaii Greenhouse Gas Emissions Reduction Task Force.

Sincerely,

Rick Volner
Senior Vice-President
Hawaiian Commercial and Sugar Company

PUBLIC INPUT SOUGHT FOR REDUCING GREENHOUSE GAS EMISSIONS
Tuesday, November 17 - 5:30pm to 7:00pm - Dept. Liquor Control – Kona Hearings Room
75-5722 Hanama Place, Suite 1107, Kailua-Kona, HI

INPUT by Ulrich Bonne, resident of Kailua-Kona, ulrichbonne@msn.com, 808-824-0108

Subject: SOLAR PHOTOVOLTAICS (PV) FOR ALL HAWAII COUNTY ROOFTOPS. POTENTIAL ELIMINATION OF ALL POWER-PLANT AND GROUND TRANSPORTATION COMBUSTION EMISSIONS

To avoid using extra real-estate for solar-PVs, I wondered whether there is enough idle and available roof space, with which we can potentially generate all the fossil-based electricity we now consume - about 70% of 1260 GWh/y (Gigawatt-hours per year), or ~880 GWh/y.

The finding is: "YES, WE CAN"

With help from the County Taxation Department's data on residential and commercial ground-floor area, and after allowance for shading, overhang and orientation, we could generate 1700 GWh/year. That leaves an excess of 820 GWh/y, which is more than enough to energize all 160,000 registered Hawaii County vehicles after conversion to EVs (Electric Vehicles). Such a fleet of EVs would need less than 700 GWh to drive the same miles as it does today, eliminate all emissions and make us sustainably energy independent.

Concerns about such PV implementation:
-- Are we replacing oil imports with PV imports?
    No. PVs would involve close to 40% more local labor
-- Wouldn't the needed energy storage costs make such massive PVs uneconomical?
    No. Storage would just add 1 to 10 cents/kWh (per cycle) to electricity cost
-- Wouldn't the high PV costs make such massive PVs uneconomical?
    No. The life-cycle cost of PV + storage electricity is lower than oil-based el.
-- Are we not going to be short on PV electricity as population increases?
    No, because 1) As population increases, roof area also increases and
    2) We could add PVs over other spaces such as parking lots
-- Would such massively distributed generation need new, costly, high-power lines?
    No. The average electric energy transmission and loss would be reduced, as it is generated closer to its consumption point than now, on average.

The full story, with underlying data and assumptions is available at http://minnefuels.pbworks.com/Self-Sufficiency-via-PVs

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Preserving Hawai'i 's precious natural heritage

November 20, 2009

TO: Dept. of Business, Economic Development & Tourism

RE: ACT 234 Relating to Greenhouse Gas Emissions

Aloha mai kakou –

Malama O Puna is a Hawai'i nonprofit environmental organization based in the Puna District of the Big Island. We offer the following comments on this long-overdue act, which we support.

We were not surprised to see that the largest sources of greenhouse gases are transportation and electric power generation – that is virtually a 'no-brainer'. We were dismayed, however, to note that there was not even the beginning of a 'solutions' section in all your material that we were able to download. Therefore, as talking points, let's start by suggesting economic incentives to create consumer behavior (some of it voluntary) that will lower emissions:

For Transportation:

1. Registration of new vehicles that are not gas guzzlers can receive a discount on the registration fee for the first 5 years. Conversely, SUVs can be charged higher rates.
2. A tax on the importation of gas guzzlers that is imposed on the automotive dealers and which will be inevitably passed on to the purchaser.
3. Requirements that diesel trucks install exhaust filters.
4. Supporting improved public transportation on the neighbor islands, park and ride areas, roofed bus shelters, car-pool lanes and other incentives for the public to drive personal vehicles less often – especially for long distances.
5. Bringing State and County services into rural areas (one stop consolidated offices) to obviate the need for long distance driving to county centers.

For Electrical Power Generation:

1. Tax incentives for new installations and retrofits of residential electric and hot water systems that run on alternate energy (solar, wind, etc.).
2. For seniors on limited incomes who don't need tax incentives but need financial help to retrofit their homes, offer a State-backed credit that can be applied to materials and/or labor. Give companies that accept these credits a special tax exemption to sweeten the pot.
3. The largest home user of electricity is the electric hot water heater, followed by the stove. If at all legally possible, ban the importation of these into the state. Offer a cash-for-clunkers type of program so that people can turn in

their old stoves and hot water heaters if they purchase energy efficient gas/propane/solar replacements.

4. HEI and HELCO currently offer incentives to new homeowners to install electric hot water heaters (and stoves?). Outlaw this practice.
5. Create a logo/sticker that appliance dealers can display to indicate that they are part of a program that only sells energy efficient appliances.
6. Government MUST act as a role model and set an example. Retrofit all (federal, state, county) government buildings with solar panels and mandate a gross reduction of on-grid usage – with the grid only being used as a back-up system. It will be more expensive up front, but will be cost effective in the long run and, of course, it will reduce emissions. New government buildings that are in the planning stages should have requirements written right into the RFP that the structure be energy efficient – this would include lots of windows, skylights and atria to maximize natural light, orientation on the site that would promote natural ventilation, etc.

Trees are the best investment that we can make for cooling the urban hardscape:

Parking lots should be designed so that the orientation of tree plantings runs on a N/S axis, which would provide shade as the sun moves from east to west. Grated tree wells would allow trees to grow larger with a more spreading (and therefore effectively cooling canopy) while not reducing the number of parking spaces. Large parking areas can be built underground with planted parklands on street level. This is do-able and there are wonderful examples in Indianapolis, so we don't have to reinvent the wheel. The Hawai'i County landscaping ordinance (Rule 17) should specify orientation of tree plantings as well as providing a list of tree species most suitable for planting in commercial developments – with a focus on those that will provide more shade. The County grubbing and grading ordinance should be modified to prevent residential pin-to-pin bulldozing, with a requirement that each parcel maintain a minimum 10-foot planted buffer along the property lines – said buffer to include at least 1 tree per 15 linear feet.

Trees are nature's own way of soaking up and storing carbon dioxide. Once planted, they will continue to do this job for many human generations, so they are an extremely cost-effective method. By emitting oxygen, they also purify the air. And they provide a multitude of other benefits as well. They must be an integral part of any plan that you formulate. I am sure that there are a lot of other things that can be done to reduce global warming and greenhouse gas emissions. It only remains to see if our government will put more emphasis on short-term economic opposition to some of these ideas or dig in its heels to support the long-term goals as an overriding priority.

Thank you for your patience in reading this long letter. I hope that some of my thoughts will inspire you with more of your own. We must think outside the box and we must do it without delay. There is no single solution, but with many mini-solutions working in concert, Hawai'i can become a leader in keeping our planet's air clean and pure.

Aloha no,

René Siracusa

René Siracusa
President

"Richard Ha" <richard@hamakuasprings.com>

11/21/2009 12:05 PM

To <cbaron@dbedt.hawaii.gov>, <colleen.m.miller@dbedt.hawaii.gov>

cc

Subject Green House Gas Emmissions task force

Aloha Chris and Colleen:

My name is Richard Ha. I am commenting on behalf of the Hawaii Farm Bureau Federation which is a state wide organization of farmers.

1. **We want water**

Farmers don't have the necessary guarantee of water they need now---how will they grow the biomass that is called for in the Hawaii Clean Energy Initiative that these plans support?

2. **We don't want a carbon tax**

We are opposed to a carbon tax or any additional tax that would drive up the cost of fuel will also drive up costs of everything else and hit local farmers hard, especially because, unlike the utilities, they cannot pass the costs on to the consumer without losing their market to competition.

Beyond that, we suggest that an Energy Return on Investment evaluation be conducted on all energy alternatives. Each island brings a different set of resources to the table. We need to look at the issue from each individual islands perspective.

Richard Ha

WSPA
ASSOCIATES

841 Bishop Street, Suite 2100
Honolulu, Hawaii 96183

November 24, 2009

We are members of the Hawaii business community and engage in business with energy companies across the state. We support the legislature's expressed intent to reduce emissions in our state to 1990 levels by 2020 and are encouraged by the ICF report stating that these levels are already expected to be achieved without further legislative action.

We are writing to question the Task Force's recommendations beyond the original legislative mission to generate proposals to reduce greenhouse gas emissions to 1990 levels by 2020 without a much more thorough and public discussion of the economic impacts to Hawaii businesses, consumers, taxpayers and utility ratepayers. We understand, for example, that California's climate change regulations have been estimated by the California Small Business Roundtable to increase the costs for small businesses by as much as $49,000 per year.

We support reducing greenhouse gas emissions using programs that continue to assure an adequate supply of reliable and affordable energy to consumers in Hawaii. We support policies that are based on sound science, are cost-effective, use technologically feasible means, provide regulatory certainty and minimize compliance costs. We believe that market-based mechanisms provide the greatest hope of meeting climate change objectives with the least disruption to the economy, jobs and our lifestyles.

ALEXANDER & BALDWIN, INC.

November 30, 2009

Hawaii Greenhouse Gas Emission Reduction Task Force
c/o Mr. Chris Baron
Hawaii State Energy Office
Department of Business, Economic Development, and Tourism
Via email: cbaron@dbedt.hawaii.gov

Subject: Public Comment on Work Plans for Reducing Greenhouse Gas Emissions

Alexander & Baldwin, Inc. is pleased to provide comments on the *Proposed GHG Reduction Work Plans for Hawaii*, prepared by the State Greenhouse Gas Emissions Reduction Task Force. A&B has closely followed the activities of the Task Force since its inception, and appreciates the effort that has gone into meeting its many mandates under Hawaii's Global Warming Solutions Act (Act 234). However, A&B is very concerned about the proposed carbon tax that is being considered by the Task Force under Work Plan #2, and we strongly urge that the Task Force not include in its report to the State Legislature any recommendation for a carbon tax, for the reasons outlined below.

We would first like to highlight two key points which we believe should help to inform future decision making, both by the Task Force in forming its recommendations to the Legislature and by the Legislature itself in determining appropriate actions in response to those recommendations.

Under the Reference Projection, Hawaii will meet the greenhouse gas emissions reduction goals of Act 234.

Act 234 declares as a policy that by January 1, 2020, the State of Hawaii shall reduce statewide greenhouse gas emissions to levels at or below the best estimations and updates of the inventory of greenhouse gas emissions estimates for 1990. The Act establishes that the greenhouse gas emission reduction task force shall prepare a work plan and regulatory scheme for reducing greenhouse gas emissions to achieve this statewide emissions limit. In order to provide a baseline against which to assess the effectiveness in reducing state GHG emissions by 2020 of the various work plans being considered by the Task Force, it was first necessary to estimate the level of emissions that would be achieved if no additional actions were implemented to reduce emissions (i.e., under a "business as usual" scenario, or Reference Projection).

Projections provided in the report *Reference Projection of Hawaii's Greenhouse Gas Emissions, 2007-2020* (ICF International; September 3, 2009) indicate that greenhouse gas emissions included in the state target will fall to approximately four percent below 1990 levels by 2020. According to the report, "this indicates that policies *already in place* reduce targeted GHG emissions to below the State's target by 2020" (emphasis added). That is, the emissions reduction goal of Act 234 is projected to be achieved under existing, approved legislative

Environmental Affairs • P.O. Box 266 • Puunene, Hawaii 96784 • Telephone (808) 877-2959 • Fax (808) 871-7663

requirements.

In considering the projections of GHG emissions reductions through 2020, it is important to note that the term "targeted GHG emissions" does not include GHG emissions from aviation. This is because Act 234 specifically provides that for the purposes of meeting the state GHG emissions limit, emissions from airplanes shall not be counted. While "targeted GHG emissions" provide the statutory basis for assessing compliance with Act 234 goals, assessment of only these "targeted emissions" does not fully reflect the expected trend in GHG emissions in the state. When all statewide emissions (i.e., including those from aviation) are considered, the projected reduction in GHG emissions by 2020 approaches three times the projected reduction in "targeted GHG emissions". The Reference Projection models total state GHG emissions declining to more than ten percent below 1990 emissions by 2020; again, this reduction is projected to be achieved under existing, approved legislative requirements.

The "Reference Projection" does not incorporate all existing, approved legislative requirements; as such, the reduction in GHG emissions under a true "business as usual" scenario can be expected to be much greater than is modeled under the Reference Projection.

According to the report *Proposed GHG Reduction Work Plans for Hawaii* (ICF International; November 10, 2009), "the Reference Projection includes the numerous policies already in place to reduce future energy use and emissions in the state. The Reference Projection assumes that standards and targets set out in approved legislation already in place proceeds and achieves the established goals." As noted above, the Reference Projection *as modeled* indicates a reduction in total state GHG emissions to more than ten percent below 1990 levels by 2020, with a more modest reduction in targeted GHG emissions. However, the Reference Projection modeled does not in fact include all "existing, approved legislative requirements" for reducing GHG emissions in the state as is implied. Rather, certain legislative requirements enacted and signed into law in 2009 were specifically excluded from the Reference Projection[1], and the GHG emissions reductions anticipated to be achieved through this "existing legislation" were therefore not included in the Reference Projection modeling.

Act 155 (signed into law on June 25, 2009[2]), for example, amended the existing renewable portfolio standard (RPS) to accelerate its progress and also established an energy efficiency portfolio standard (EEPS). According to information presented by the Task Force at the recent public workshops, this *existing legislation* is projected to result in additional GHG emissions reductions on the order of 1,824 kilotons of CO_2 equivalents (CO_{2eq}) by 2020, as compared to GHG emissions reductions modeled under the Reference Projection of only 538 kilotons CO_{2eq}. ***Accordingly, the modeled Reference Projection does not accurately represent the expected***

[1] This may not be readily apparent from a review of the Work Plan report itself. However, refer to page 21 of the report *Hawaii Greenhouse Gas Emission Reductions Modeling, Energy 2020 Model Inputs and Assumptions* (ICF International; July 28, 2009).

[2] Act 155 became law a full month before the document presenting inputs and assumptions to be used in the GHG emissions reduction modeling was finalized (July 28, 2009), over two months before the document *Reference Projection of Hawaii's Greenhouse Gas Emission, 2007-2020* was finalized (September 3, 2009), and over a month before the first draft of the report *Proposed GHG Reduction Work Plans for Hawaii* was completed.

decline in GHG emissions anticipated to occur under a true "business as usual" scenario, which is more than four times higher than what is attributed to the Reference Projection in the Work Plan report.

A&B recognizes that these issues do not preclude the Legislature from acting to further reduce state GHG emissions beyond the "business as usual" case. However, we believe that the very significant emissions reductions that are projected to occur under existing legislation are important to keep in mind when considering actions necessary to achieve further reductions, particularly where serious adverse consequences for the economy may result from those actions.

Having hopefully provided some perspective regarding the emissions reductions anticipated to be achieved under a true "business as usual" scenario, we would next like to present some of our specific concerns regarding the proposal to fund further emission reduction initiatives through a carbon tax.

Firstly, the range of carbon taxes being considered, beginning at $10 and increasing to $40 per ton of CO2 equivalent emissions, would represent an enormous tax burden on Hawaii's residents and businesses. A carbon tax of this magnitude would be equivalent to a new tax on petroleum fuels of roughly four to seventeen dollars per barrel (with similar taxes levied on all other fossil fuels), more than tripling the existing state tax on motor fuels. In addition to raising the cost of fuel at the pump and of electricity for our homes and businesses, higher fuel prices will drive up the price of the many goods and services delivered or provided by the transportation, agriculture, and other business sectors. Projected revenues from such a tax range from $200 to $870 million dollars annually. We believe that a new tax burden of this magnitude will assuredly have a significant negative impact on the state's economy.

Secondly, the potential economic impacts of a carbon tax on the state economy have been inadequately evaluated and quantified. The limited analysis presented in the Work Plan document assumes that 90 percent of any carbon tax collected would be returned to taxpayers as a rebate – we believe this is a highly unlikely scenario (if only ten percent of the tax will be retained, why collect the other 90 percent in the first place, particularly given the administrative costs that would be involved in such a rebate program?). Moreover, we believe that the limited analysis that was conducted is based upon some questionable assumptions that result in a severe understatement of economic impacts, particularly of economic impacts on the small businesses that make up the bulk of our economy.

Third, the Work Plan report concludes that a carbon tax would have a negligible impact on GHG emissions in the state, resulting in a reduction in emissions that amounts to less than 0.4 percent of 1990 emissions.

Fourth, although the carbon tax has been identified as a "potential source of funding for HCEI activities", the Task Force itself has to date been unable to determine exactly what the funding requirements of HCEI are. The same is true for a variety of other "possible uses" for carbon tax funds that have been floated in the various Task Force reports and/or meetings. It does not appear reasonable to levy a tax of this magnitude, ostensibly to fund a program or programs whose funding needs have yet to be determined – this amounts to a "blank check" paid for by massive amounts of taxpayer money. Moreover, we believe strongly that private investment is a far more appropriate means of funding HCEI activities.

Lastly, with GHG emissions cap-and-trade legislation still pending in Congress, the economic impact of a carbon tax in Hawaii could be greatly magnified if it is layered on top of further increases in the costs of fuels, goods, and services resulting from a federal cap-and-trade scheme. Such a scheme would likely have economic impacts in Hawaii even if the state were able to "opt out" of a national program, since the cost of goods manufactured on the mainland and imported to Hawaii would increase in response to the higher costs of doing business on the mainland.

A&B strongly encourages the Task Force to consider these factors when developing their recommendations to the Legislature, and we respectfully ask that the Legislature consider them when evaluating whatever recommendations are eventually made by the Task Force.

Thank you again for the opportunity to comment on this important issue.

Sincerely,

Sean M. O'Keefe
Director, Environmental Affairs
Alexander & Baldwin, Inc.

DEPARTMENT OF PLANNING AND PERMITTING
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MUFI HANNEMANN
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DAVID K. TANOUE
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ROBERT M. SUMITOMO
DEPUTY DIRECTOR

2009/GEN-11(RNS)

December 1, 2009

Greenhouse Gas Emissions Reduction Task Force
c/o Hawai'i State Energy Office
Department of Business, Economic Development and Tourism
P. O. Box 2359
Honolulu, Hawai'i 96813

Dear Task Force:

Subject: Comments on the Proposed Greenhouse Gas (GHG) Reduction Work Plans for Hawai'i

Thank you for the opportunity to comment on the **Proposed GHG Reduction Work Plans for Hawai'i**, dated September 30, 2009. We understand that the Task Force will review the proposed Work Plans in light of comments received since September, and adopt a Work Plan which will be used over the next two years to establish State requirements for limiting GHG emissions.

The Department of Planning and Permitting recognizes the importance of reducing GHG emissions and supports the State's efforts in establishing requirements to reduce emissions to 1990 levels by 2020.

However, after reviewing the proposed Work Plans, we feel that the sections on Building Codes [pp. 70-72] and Smart Growth Policies [pp. 77-79] in Work Plan No. 1 omit key information and do not adequately consider existing State and County policies and initiatives.

Because existing policies and initiatives, including those already undertaken and/or followed by the City and County of Honolulu, are sufficient to support the Task Force's objectives, and because actions in both of these areas are acknowledged in the proposed Work Plan to have "*a fairly minor contribution to the State's 2020 reduction target*," **we feel that the Task Force should not include either of these policy areas in its adopted Work Plan**.

If it is felt that the Task Force needs to pursue actions regarding either of these areas, **the adopted Work Plan should provide for a consultative, consensus-building process** that involves the various County governments and key public and private stakeholders. The proposed Work Plans are notably silent on what process would be used to gain agreement on either "*a State requirement for* (building codes for) *new buildings with a progressive requirement for continued updates*" or "*a* (State Smart Growth) *policy framework to guide planning policies and by-laws and transportation policy.*"

Each of these points is discussed in greater detail below:

- **Building Codes**. **There already exists "*a State requirement for* (building codes for) *new buildings with a progressive requirement for continued updates.*"**

  Sections 107-24 and 107-25, Hawaii Revised Statutes (HRS), establishes a comprehensive state building code and specifies the time period during which the State and Counties must adopt updated codes. The State is required to adopt updated codes within 18 months of publication of the updated code, and the Counties are required to adopt the updated codes within 24 months after State adoption. These updated codes are usually based on changes in a reference code such as the International Energy Conservation Code (IECC) adopted by a national or international standards organization.

  The proposed Work Plan acknowledges this HRS statute, but still recommends that "*Hawai'i follow the example set by the ACES* (American Clean Energy and Security Act of 2009) *and establish a State requirement for new buildings with a progressive requirement for continued updates as technology improves.*" The Work Plan provides no evidence that the existing statute is ineffective or suggestions as to how the existing requirements and process should be revised or replaced.

  We feel that the existing statute is adequate in establishing a state-wide building code, and provides a reasonable and timely process for regularly updating all codes. The City, which participates as a member of the State Building Code Council, has been regularly adopting updated codes as required by the HRS.

  Codes requiring greater energy efficiency are currently going through the State review and adoption process. Among the codes under review for adoption is the 2009 IECC which is recognized by the federal government as a reference standard for receipt of federal grant monies.

- **<u>Smart Growth Policy. There already exists a statewide Smart Growth "*policy framework to guide planning policies and by-laws and transportation policy.*"</u>**

  The State already has emerging new programs directed at smart growth, including the Department of Transportation's sustainable transportation proposals, Act 173 (2009), and Act 207 (2008) which creates incentives for renewable energy facilities. Also, Act 54 (2009) mandates "complete streets" construction by state and county transportation departments.

  For its part, the City and County of Honolulu has incorporated smart growth policies in all of our Development Plans and Sustainable Communities Plans as part of a revision process which began in 1997 and completed in 2004. We are moving forward to revise our rules and regulations to implement the adopted smart growth policies and have a regular revision process for incorporating and refining these policies in the existing regional land use plans.

  Smart growth policies are also reflected in our Neighborhood Transit-Oriented Development (TOD) Plans which will help to create mixed use, dense, walkable, and transit-friendly areas around each of the 21 transit stations between East Kapolei and Ala Moana Shopping Center. Refer to Ordinance No. 09-04, attached.

  There is no need for the Task Force to duplicate either of these existing land use and infrastructure policy planning initiatives which are promoting the application of "Smart Growth" principles to new land use and infrastructure development in Hawai'i.

- **<u>Adoption Process</u>**. The adopted GHG Task Force Work Plan should **<u>specify that a community-based, consensus building process will be used</u>**. If the Task Force feels that a new State building code requirement and process, or a new statewide Smart Growth policy framework needs to be adopted by 2011.

  Our experience participating in the State 2050 Sustainability Plan, revising our Development Plans and Sustainable Communities Plans, and updating our building codes has taught us that consideration of a wide range of public and private viewpoints is essential to identify problems, find effective solutions, and win acceptance and support. We are concerned that there is no legal requirement for the GHG Task Force to consult with except state agencies about the requirements the Task Force will recommend for adoption. Given the short time left for the Task Force to complete the extensive technical work needed to gather basic information and formulate appropriate requirements, we are concerned that the needed level of consultation and public comment will not occur unless it is specifically called for in the adopted GHG Work Plan.

We appreciate the opportunity to comment. If you have any questions about these comments, please feel free to contact Bob Stanfield at 768-8051 or by e-mail at bstanfield@honolulu.gov.

Very truly yours,

David K. Tanoue, Director
Department of Planning and Permitting

DKT:bkg

738868

Hawaii Farm Bureau
FEDERATION
2343 Rose Street, Honolulu, HI 96819
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e-mail hfbf@hfbf.org

December 1, 2009

Comments on a review of the work plans under consideration by the Hawaii Greenhouse Gas Emissions Reduction Task Force to recommend to the 2010 legislature

Thank you for the opportunity to submit comments on the work plans considered by the Hawaii Greenhouse Gas Emissions Reduction Task Force for recommendation to the 2010 legislature.

The Hawaii Farm Bureau Federation is a non-profit, independent, voluntary organization governed by and representing 1,600 farm and ranch families throughout the State of Hawaii. We are affiliated with the American Farm Bureau, which represents over 6 million farmer families. Our purpose is to make the community a better place to live and to keep farming profitable so that Hawaii continues to produce its own food.

After reviewing the work plans produced by the Task Force, we have two main concerns:

1. **Water Availability**

   The Task Force supports the Hawaii Clean Energy Initiative which relies heavily upon the state's ability to obtain or produce biofuels for transportation and power generation. However, unless these fuels can be produced locally, Hawaii will be dependent on imported biofuels in the same way that it is currently dependent on fossil fuels.

   Our farming members currently supply energy, food, and many other agricultural products to the islands. They would like to continue to contribute to greenhouse gas emission reduction by expanding biofuel production but in order to do so, they must have adequate irrigation water supplies and assurances that their irrigation water will not be taken away. Farmers are currently in competition with other demands for water. Among our highest priorities is state legislation to ensure that farmers will have adequate and reliable sources of water with which to farm. We don't have those assurances now.

   We hope that the Task Force will include support for legislation to ensure reliable sources of water for agriculture in their recommendations to the legislature.

2. **Proposed Carbon Tax**

   The Farm Bureau is also very concerned about a proposed state carbon tax. Even though the report from the Task Force's consultant states that Hawaii will not need a state carbon tax to meet its statutory greenhouse gas emission target, it appears that such a tax is being considered. This tax will be in addition to any future federal program costs and will impose a double tax on our residents. Local farmers and ranchers would see higher fuel, fertilizer, and energy costs. They will not be able to pass on these higher costs and they will not be able to compete with mainland and international producers who already have an economic advantage. **The unintended consequence of such a carbon tax will be to downsize Hawaii agriculture and our ability to produce food in this State**. Act 234 charged the Task Force to recommend to the 2010 legislature a ***cost-effective*** plan to reduce greenhouse gas emissions. We do not believe that the imposition of a carbon tax meets that charge.

In this economic climate, the timing of this proposed tax could not be worse. And if, as expected, the outcome of the tax is that it will have **no** significant impact on reducing greenhouse gas emissions, HFBF believes that a recommendation for the tax from this group is absolutely unwarranted. We urge the Task Force against recommending this policy.

Thank you for this opportunity to share our concerns.

Proposed GHG Reduction Work Plans for Hawaii

10 November 2009

Prepared for:

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

Prepared By:
ICF International

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Table of Contents

Acronyms & Definitions

ACES Act	American Clean Energy & Security Act of 2009
AEO	Annual Energy Outlook (published by EIA)
Bunker Fuel	Fuel supplied to ships and aircraft, both domestic and foreign.
Btu	British Thermal Units
CAC	Criteria Air Contaminants (SO_x, NO_x, PM, etc.)
CFL	Compact Fluorescent Light bulb
CHP	Combined Heat and Power
CO	Carbon Monoxide
CO_2e	Carbon Dioxide equivalent
GDP	Gross Domestic Product
GO	Gross Output
GWP	Global Warming Potential
DBEDT	Department of Business, Economic Development and Tourism
DG	Distributed Generation
DOE	United States Department of Energy
DSM	Demand Side Management
EIA	Energy Information Administration
EISA	Energy Independence and Security Act
EPA	Environmental Protection Agency
EEPS	Energy Efficiency Portfolio Standard
EERE	US DOE Energy Efficiency and Renewable Energy
GHG	Greenhouse Gas
GRP	Gross Regional Product
HECO	Hawaiian Electric Company Limited
HELCO	Hawaiian Electric Light Company Limited
HCEI	Hawaii Clean Energy Initiative
IECC	International Energy Conservation Code
IPCC	Intergovernmental Panel on Climate Change
IRP	Integrated Resource Plan
KIUC	Kaua'i Island Utility Cooperative
Kt	kilotonne (all GHG emissions are shown in kt CO2e)
kW	Kilowatt
kWh	Kilowatt-hour
LDC	Local Distribution Company
MECO	Maui Electric Company
MJ	Megajoule
Mt	Megatonne
MW	Megawatt
MWe	Megawatt electric
Mt CO_2e	Megatonne Carbon Dioxide Equivalent
MTCE	Megatonne Carbon Equivalent (as distinct from Carbon Dioxide Equivalent)
NERC	North American Electric Reliability Corporation
NHTSA	National Highway Traffic Safety Administration
NRDC	Natural Resources Defense Council
NOx	Nitrogen Oxides

PUC	Public Utilities Commission
REMI	Regional Economic Models, Inc.
RECS	Renewable Energy Certificates
RPS	Renewable Portfolio Standard
SLH	Session Laws of Hawaii
SO_x	Sulfur Oxides (including sulfur dioxide – SO2)
SSI	Systematic Solutions, Inc.

1. Executive Summary

In 2007, the Governor of Hawaii signed the Greenhouse Gas Reduction Law (Act 234) committing the State to reduce its greenhouse gas (GHG) emissions to, or below, 1990 levels by 2020. This means that emissions included in the State target[1] must be reduced to 13,660 kilotons carbon dioxide equivalent (kt CO2e) by the year 2020. The Act created a Greenhouse Gas Emissions Reduction Task Force (referred to hereinafter as the Task Force) to oversee development of a work plan to achieve this goal. This commitment is one of a long series of initiatives by the State of Hawaii to reduce its dependence on energy imports, improve efficiency and displace conventional fossil-fuels with renewable energy sources.

Hawaii's heavy dependence on oil imports has led the State to take a leadership role in the development of energy alternatives. Over the past twenty years numerous studies have reviewed the potential for efficiency and renewable resources to reduce Hawaii's oil dependence. The State already has a number of initiatives in place to support energy efficiency across sectors and increase the contribution of renewable sources.

Hawaii's most recent initiative—the Hawaii Clean Energy Initiative (HCEI)—sets an ambitious target of transforming the State's energy use to obtain 70% of Hawaii's energy from clean sources by 2030.[2] HCEI, described in greater detail in the sections which follow, encompasses a range of initiatives to increase energy efficiency, introduce renewable fuels and sources into the power and transportation sectors, and establish a variety of programs and structures required to support this transformational effort.

It is in this context that ICF International was tasked by the Hawaii Department of Business, Economic Development, and Tourism (DBEDT) with developing a Reference Projection of future emissions and three comprehensive Work Plans for state-wide GHG emissions reduction on behalf of the Task Force[3]. The goal of the Work Plans is to implement the maximum practically and technically feasible, cost-effective reductions in GHG emissions to achieve the state-wide GHG emissions reductions and limits by 2020. Overall, modeling of the three Work Plans indicates a substantial reduction of energy use and emissions would be achieved with a small but positive impact on the Hawaii economy. The results of this modeling are summarized below.

A Reference Projection under "business-as-usual" conditions was developed as a first step in modeling future GHG emissions. "Business-as-usual" in Hawaii means that the Reference Projection includes the numerous policies already in place to reduce future

[1] The state target excludes emissions associated with aviation and international bunker fuels.
[2] Senate Bill1173 HD3, Twenty-Fifth Legislature, 2009.
[3] The original scope of this project included additional tasks to develop proposed rules for regulated entities, recommendations for an information management system and proposed legislation for recommended GHG reductions, as well as presenting reports and public workshops. These tasks were deferred due to funding limitations (FY 2009 appropriations were not released) and are not addressed in the present report.

energy use and emissions in the state. The Reference Projection assumes that standards and targets set out in approved legislation already in place proceeds and achieves the established goals. This includes both State requirements such as the Renewable Portfolio Standard (RPS) as well as federal requirements such as those laid out in the Energy Independence and Security Act (EISA).

Modeling indicates that Hawaii's target of reducing its emissions to 1990 levels by 2020 are achieved in the Reference Projection under existing, approved legislative requirements. Emissions included in the target decline to 13,122 kt CO2e in the projection; falling 4% below the target level of 13,660 kt CO2e. The table below shows total emissions for the state, excluding aviation emissions which are not included in the State target.

Table ES-1: Reference Projection of Hawaii GHG Emissions 1990-2020, by Sector [4]

GHG Emissions *(kt CO2e)*	**1990**	**2007**	**2010**	**2015**	**2020**	**Avg. Annual Growth Rate 2007-2020**
Residential	30	66	63	64	66	*0.0%*
Commercial	380	329	325	327	315	*-0.4%*
Industrial	880	637	645	649	635	*0.0%*
Passenger - Residents	3,230	2,918	2,727	2,185	1,818	*-3.6%*
Passenger - Visitors	n/a	453	377	271	211	*-5.7%*
Marine	1,650	2,173	2,153	2,184	2,135	*-0.1%*
Freight	1,530	1,402	1,371	1,240	1,204	*-1.2%*
Power Sector	6,790	8,745	7,814	7,545	7,684	*-1.0%*
Waste	850	1,032	1,098	1,209	1,320	*1.9%*
Agriculture & Forestry	*(1,680)*	*(2,267)*	*(2,267)*	*(2,266)*	*(2,266)*	*0.0%*
Total	***13,660***	***15,487***	***14,307***	***13,408***	***13,122***	***-1.3%***

Given that achieving the State's target depends on the success of these existing policies and standards, it is important that a continuing focus be placed on putting systems, supports, and monitoring and verification processes in place to ensure that the targets already established in existing legislation are met.

The three Work Plans all propose further reductions in State GHG emissions beyond the levels set as the State target. The Plans incorporate existing policies, recognize developing initiatives and leverage and build on past analyses[5] that can contribute to meeting the State's climate change reduction targets. A range of policy options were reviewed based on past analyses and a list of potential policies to be modeled for Hawaii were developed for the Task Force's consideration.

[4] Detailed tables of emissions by county by year have been provided to DBEDT electronically. Additional details regarding the Reference Projection are provided in Appendix D. Note that totals presented in Appendix D include emissions from aviation.
[5] Specific past analyses are referenced in the discussion of particular policies in the body of the report.

Based on direction from DBEDT and feedback from the Task Force, ICF has structured the three Work Plans using the policy groupings described in the table below. This table provides a quick comparison of the projected emissions levels achieved by 2020.

Table ES-2: GHG Emissions Changes under Work Plans

Work Plan	Description	Emissions Level in 2020 (kt CO2e)	Amount Below 1990 Target Level (kt CO2e)	% Below 1990 Target Level
Work Plan 1	The HCEI implemented with additional proposed policies (described in more detail below)	8,377	5,283	38.7%
Work Plan 2	A state-level Carbon Tax implemented in combination with the policies included in Work Plan 1	8,327	5,333	39.0%
Work Plan 3	A federal Cap-and-Trade (C&T) system implemented in combination with the policies included in Work Plan 1	8,323	5,336	39.1%

Each of these Work Plans achieves and exceeds the GHG reduction targets set out in Act 234, resulting in State GHG emissions falling by almost 40% below the State target of reducing emissions to 1990 levels. In each case, existing, approved legislation, such as the enhanced RPS, Energy Efficiency Portfolio Standard (EEPS), and Alternative Fuel Standard, have been included in the modeling. Given the substantial reductions achieved as part of Work Plan 1, the imposition of either a carbon tax (modeled in Work Plan 2) or cap-and-trade system (modeled in Work Plan 3) results in relatively small additional reductions relative to Work Plan 1.

Each of the work plans are described briefly below.

Work Plan 1

The core set of policies included in Work Plan 1 was built around the initiatives described in the HCEI. These policies are described in the energy agreement signed by the State of Hawaii, Division of Consumer Advocacy of the Department of Commerce and Consumer Affairs, and the Hawaiian Electric Companies (subsequently referred to as the "HCEI Agreement").[6] The HCEI Agreement describes a series of initiatives aimed at achieving the State's goal of obtaining 70% of its energy from clean sources by 2030.

[6] *Memorandum of Understanding Between the state of Hawaii and the U.S. Department of Energy* available online at: http://hawaii.gov/dbedt/info/energy/hcei/hawaii_mou.pdf.

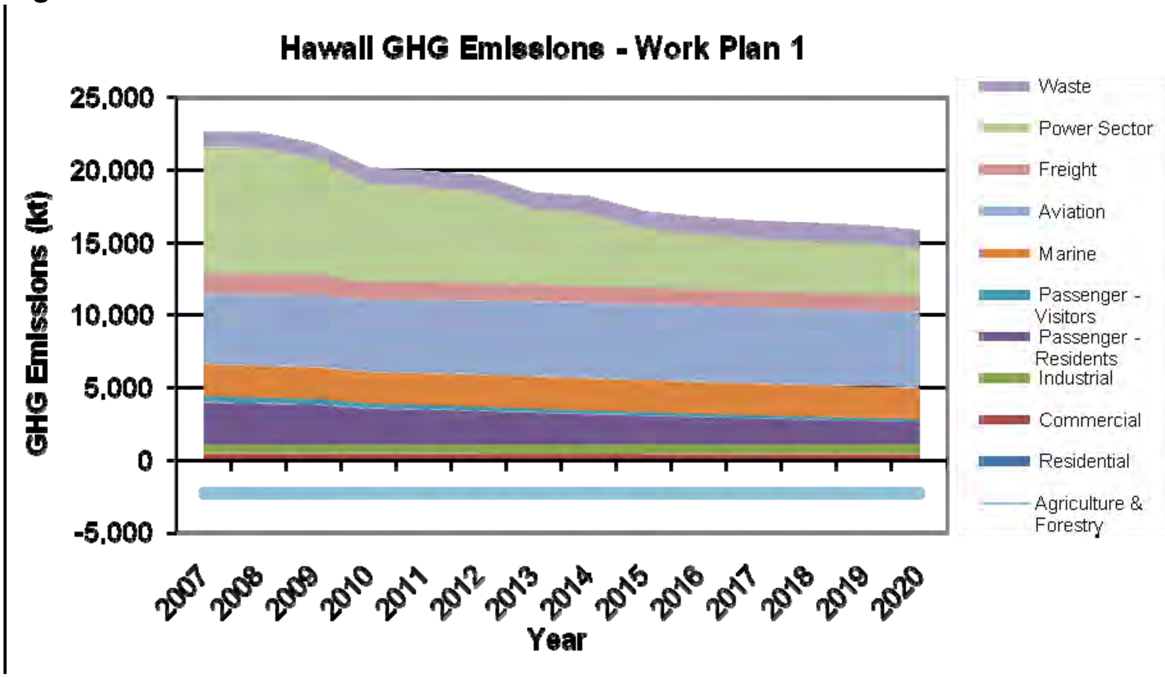
Work Plan 1 includes a number of separate policy initiatives based on recently approved legislation, the HCEI agreement between the State and Hawaii's electric utilities, and additional recommended policies, including:

Table ES-3: Summary of Work Plan 1

Policy	Status
Renewable Portfolio Standard (RPS)	Existing legislative requirement
Energy Efficiency Portfolio Standard (EEPS)	Existing legislative requirement
Increase Renewables and Use of Biofuels for Power Production	HCEI Energy Agreement
Sea Water Cooling	HCEI Energy Agreement Modeling assumes 2nd system for Waikiki
Alternative Fuel Standard (AFS)	Existing legislative requirement
Increased Vehicle Efficiency	Recommended if Federal CAFÉ rules not extended beyond 2016.
Plug In Hybrid Electric Vehicles (PHEV's)	HCEI Energy Agreement
Building Codes	Recommended
Freight Options	Though not included in the modeling, this policy is recommended as part of the Work Plan.
Urban Form (Smart Growth)	Recommended (not modeled)

As a result of the policies modeled in Work Plan 1, State GHG emissions (in CO2e terms) decline dramatically, by 5,283 kt (5 Mt) CO2e relative to the Reference Projection. Emissions included in the State target fall to 8,377 kt CO2e by 2020. This is approximately 38.7% below the State target level of 13,660 kt CO2e. The figure below shows a graphical representation of the gross GHG emissions data (including aviation and international bunker fuels) presented in Appendix D; a graphical representation of only those emissions included in the State target is shown in figure ES-2.

Figure ES-1: GHG Emissions under Work Plan 1



The vast majority of the emission reduction comes from the power system (4,400 kt), followed by transportation emissions (which decline by 400 kt).

Work Plan 2

Work Plan 2 models a State carbon tax in combination with the policies included in Work Plan 1. The carbon tax would be applied to all fossil fuels based on their carbon content. The modeling assumes a carbon tax is introduced in 2010, starting at $10 per tonne and rising to $40 per tonne CO2e by 2020.

The starting level for the carbon tax was selected to align with the proposed reserve price for permits under the American Clean Energy & Security Act of 2009 (ACES) Act[7] cap-and-trade system. This would also match the level of carbon tax now applied in British Columbia--currently the highest carbon tax in North America. The carbon tax in 2020 would be higher than the Energy Information Administration's (EIA) projected cost of $32/tonne for carbon permits in that year[8] (under the ACES Act).

Emissions included in the State target fall to 8,327 kt CO2e by 2020 under Work Plan 2. This is 5,333 kt or about 39% below the State target level of 13,660 kt CO2e. Work Plan 2 results in a relatively modest incremental reduction of 50 kt CO2e by 2020 when compared to the levels achieved by the Work Plan 1 policies on their own.

[7] Commonly referred to as the Waxman-Markey bill.
[8] US EIA, Energy Market and Economic Impacts of H.R. 2454, the American Clean Energy and Security Act of 2009, August 2009.

Overall, the impact of a carbon tax in this price range is quite modest given the significant energy and emission reductions achieved by the Work Plan 1 policies.

The introduction of the Carbon Tax as described is projected to raise about $204 million in 2010, increasing to about $870 million annually by 2020 when applied in conjunction with the Work Plan 1 policies.

Revenues received from the carbon tax can be used for a variety of purposes; however, the political acceptance of the plan is likely to depend on how taxpayers view this distribution. It is recommended that 90% of the tax be returned to consumers via the tax systems, with the balance used to finance energy efficiency or adaptation efforts, including elements of the Work Plans. It is recommended that a portion of those funds be used to target programs to groups most affected by the tax, such as low income housing and small businesses. This approach has the combined benefit of reducing GHG emissions while reducing the negative impacts of higher energy costs on those most affected and least able to respond.

Work Plan 3

Work Plan 3 models a federal cap-and-trade (C&T) system, patterned on the ACES Act, to the policies included in Work Plan 1. At this time it is unclear whether a C&T Bill will be passed by the Senate and become law, or the extent to which any such system ultimately put in place would differ from the version passed by the House. Acknowledging this uncertainty, the ACES was judged to provide the best indication available at this time of how a GHG C&T system might be implemented in the US. It has therefore been used as a guide in order to model the impacts of a federal C&T system on Hawaii.

Work Plan 3 results in a relatively modest incremental reduction of 53 kt CO2e by 2020 when compared to the levels achieved by the Work Plan 1 policies on their own.

Emissions included in the State target fall to 8,323 kt CO2e by 2020 under Work Plan 3. This is 5,336 kt or about 39.1% below the State target.

This modeling assumed, in accordance with the ACES Act, that the target for the federal C&T system will be a 17% reduction in GHG emissions from 2005 levels. Since the implementation of the policies included in Work Plan 1 result in Hawaii's GHG emissions falling by about 27% from 2005 levels, most sectors already achieve the target levels required under the federal C&T scheme. As a result, the imposition of the C&T targets results in relatively minor additional reductions in State GHG emissions.

In order to model the effects of a federal C&T system on Hawaii, it is assumed that permit prices will follow the trajectory described for the 'Basic" scenario in the most recent modeling completed by the EIA.[9] Under this scenario, permit prices start out at about $20 per tonne CO2e in 2012 and rise to approximately $32 per tonne CO2e by 2020.

The method for allocating and auctioning emission permits is one of the key elements in determining the impacts of a C&T system. The modeling assumptions applied here were in accordance with the ACES Act. Under the ACES Act, a portion of available emissions permits would be allocated and distributed at no charge to electricity distribution companies to help offset electricity rate increases caused by the imposition of a cost for carbon. According to an analysis by the World Resources Institute[10] (WRI), Hawaii would receive 5.4 million permits for electric Local Distribution Companies (LDC's) to reduce electricity rate impacts to consumers in 2016. This analysis indicates that the Hawaii power sector would need only 3.7 million permits under Work Plan 1. The LDC's would therefore be issued more permits than required to cover their projected emissions.

The rules for disposing of these excess permits are unclear in the ACES Act. The purpose of issuing these permits is to offset electricity rate increases due to the imposition of a carbon cost under the C&T systems. It is unclear in the ACES Act whether utilities or the State will have the option of using the value of these permits for other purposes (e.g., to fund planned GHG reduction policies and programs and assist consumers in reducing their energy use and hence energy costs). The economic modeling described in this report assumed that any excess permits would be sold and that the resulting revenues would be used within the Hawaii economy. These funds could be used for several purposes, including supporting the costs of the HCEI initiatives. The positive impact of this additional spending within the Hawaii economy was offset by some outflow of funds to the federal system to purchase emission permits.

Summary of Work Plan Impacts

We have summarized here the impacts of each Work Plan on (1) energy prices; (2) GHG emissions; (3) Hawaii's economy. Additional details are included throughout the report as summarized in the table at the end of the Executive Summary.

Energy Prices

The table below summarizes the impacts of each Work Plan on energy prices. While the modeling results from each Work Plan shows an increase in electricity prices, the reduction in electricity use due to increased energy efficiency results in a reduction in average residential energy bills.

[9] US EIA, Energy Market and Economic Impacts of H.R. 2454, the American Clean Energy and Security Act of 2009, August 2009
[10] Allowance Distribution to States and Energy Consumers under the American Clean Energy and Security Act (H.R. 2454, Waxman-Markey), World Resources Institute and Georgetown Climate Center, July 28, 2009.

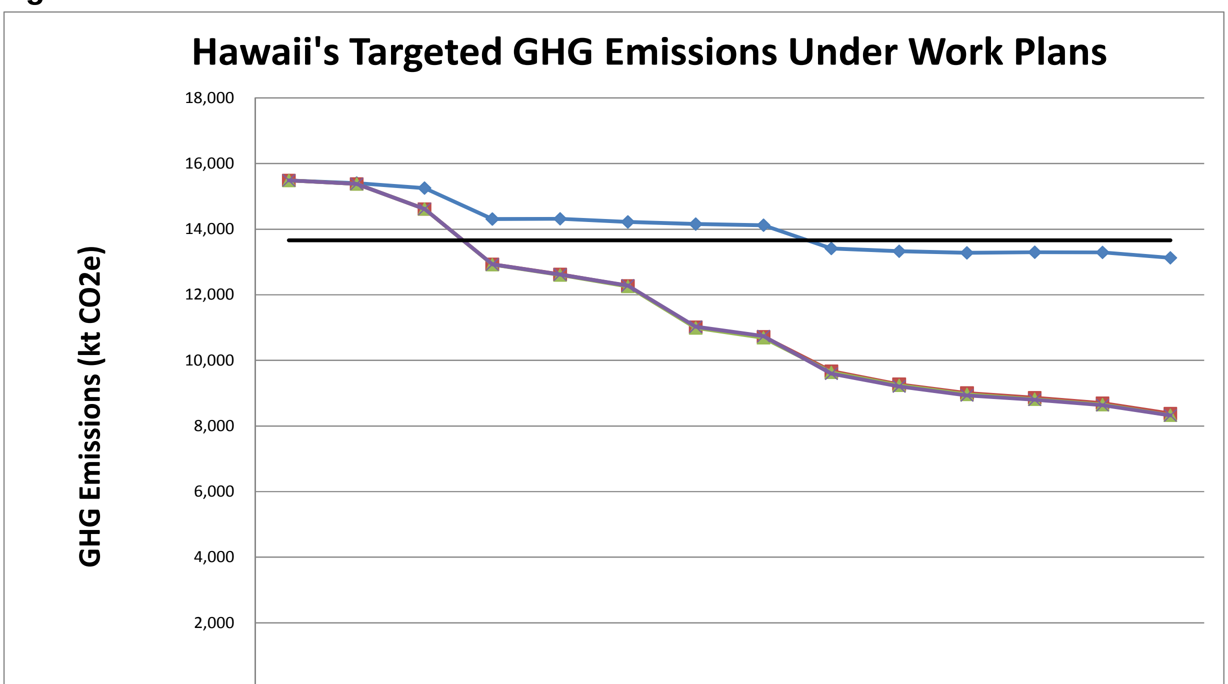
Table ES-4: Summary of Work Plan Impacts on Energy Prices

Summary of Work Plan Impacts on Energy Prices *(difference from Reference Projection, 2020)*	**Work Plan 1 (HCEI Plus recommended Policies)**	**Work Plan 2 (State Carbon Tax)**	**Work Plan 3 (Federal Cap-and-Trade)**
Increase in electricity prices[11]	22-30%	25-34%	21-29%
Change in average residential bill	~10% decrease	~10% decrease	~10% decrease
Change in other energy prices[12]	No change	3-6% increase	3-8% increase

GHG Emissions

GHG emissions fall dramatically from Reference Projection levels in all three Work Plans as shown in the figure below. ***The difference between emissions in the three work plans is barely discernable in the graph below given the overall large change from reference levels***.

Figure ES-2:



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Reference Projection	15,487	15,407	15,254	14,307	14,316	14,219	14,153	14,119	13,408	13,324	13,274	13,293	13,288	13,122
Work Plan 1	15,487	15,378	14,615	12,926	12,620	12,270	11,012	10,721	9,671	9,271	9,003	8,859	8,696	8,377
Work Plan 2	15,487	15,378	14,615	12,920	12,603	12,253	10,988	10,690	9,632	9,237	8,961	8,813	8,649	8,327
Work Plan 3	15,487	15,378	14,615	12,926	12,619	12,283	11,027	10,739	9,595	9,207	8,934	8,801	8,633	8,323
Target (1990) Emissions	13660	13660	13660	13660	13660	13660	13660	13660	13660	13660	13660	13660	13660	13660

11 The range shown reflects different electricity prices for residential, commercial and industrial sectors.
12 The range shown does not include changes in utility gas and #6 fuel, which represent a very small fraction of the total energy use in Hawaii.

Hawaii's Economy

The effects of the three work plans on the economy are compared in the figures below, which show the change in Gross Regional Product (GRP), employment and Real Disposable Income as calculated by the REMI macro-economic model. Supporting tables are presented in Appendix E.

The economic impacts of all three Work Plans are positive relative to the Reference Projection, but in all three cases the impacts are relatively small.

Figure ES-3: GRP Change under Work Plans

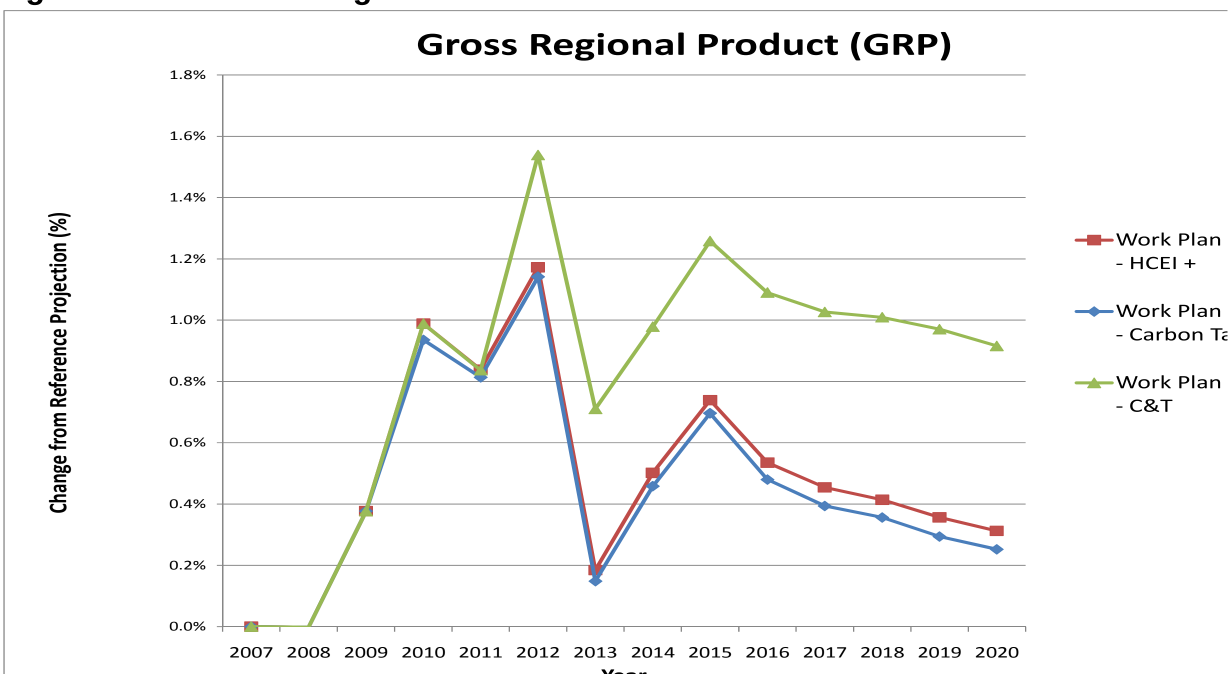


Figure ES-4: Employment Change under Work Plans

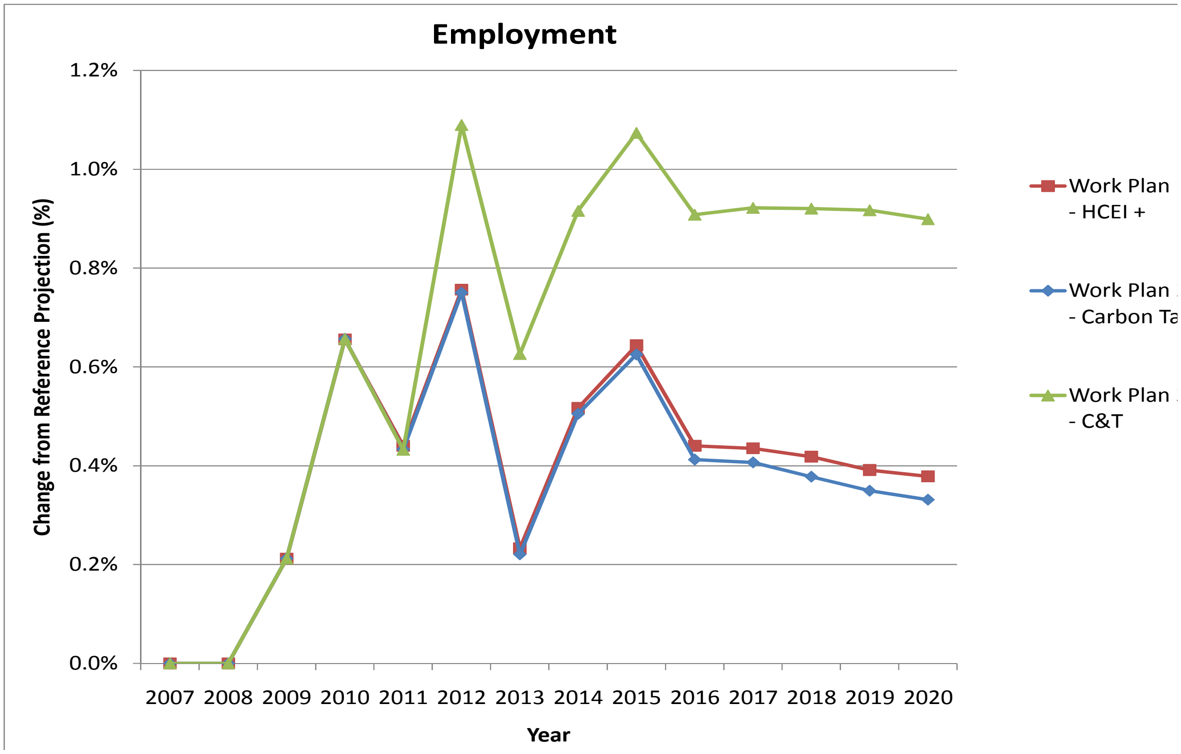
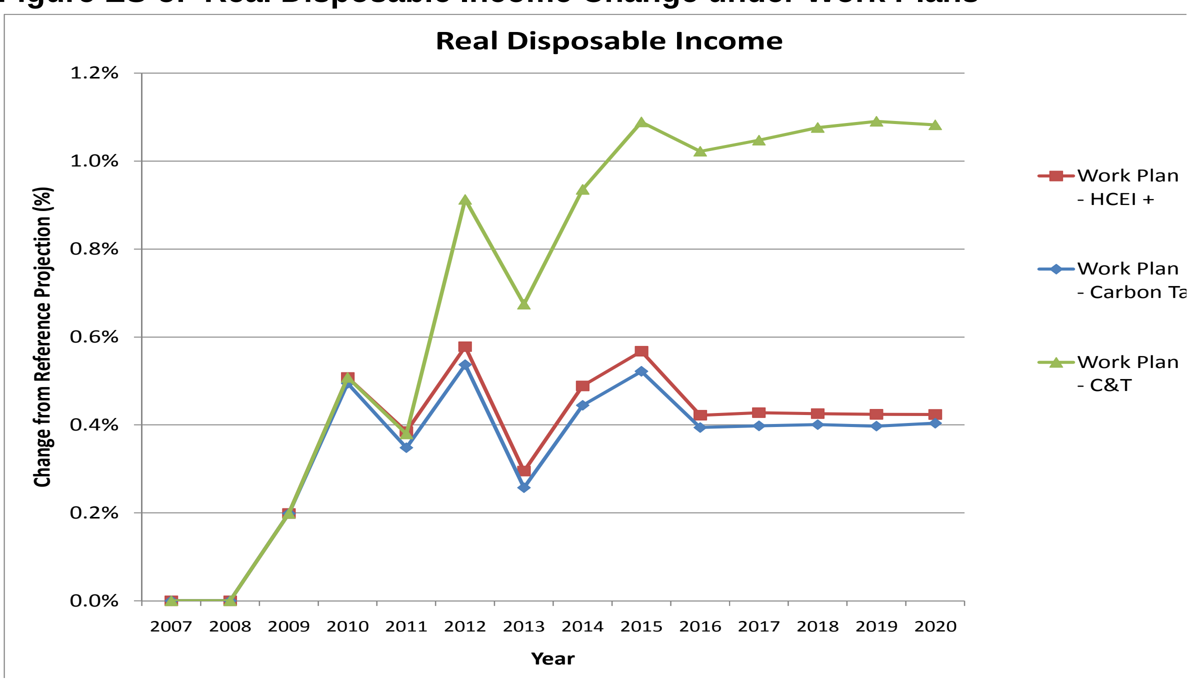


Figure ES-5: Real Disposable Income Change under Work Plans



Overall, results from the economic modeling exercise were consistent with the trends observed from the energy modeling exercise. Inputs from Energy 2020 were used in REMI's Policy Insight model to estimate the regional economic impacts up to 2020. Energy 2020 inputs used in REMI included price changes for electricity and other energy inputs (such as oil) for various sectors, as well as changes in electricity generation due to construction of new renewable generation facilities in Hawaii and changes in outputs for other sectors, such as petroleum refining.

Results from REMI validated projections of energy market changes seen in Energy 2020 results. For example, the large temporary increase in GRP and employment from 2010 to 2012 and a subsequent drop thereafter was directly related to the construction work associated with the $1.6 billion expenditure on the undersea cable and wind generation during 2010 – 2012 in Maui County. Given the significant contribution these expenditures made to local economic activity, these temporary construction and other related sector jobs tapered off once the projects were built, resulting a drop in these temporary employment effects. Additional construction projects in subsequent years lead to other spurts in local economic activity and employment.

The impacts depend to a large extent on the timing of construction projects under the plans, which are assumed to occur early in the period under consideration. By 2020, Work Plan 1 results in a 0.3% increase in GRP and 0.3% increase in employment over levels projected in the Reference Projection.

Under Work Plan 2 (carbon tax) the increase in GRP is slightly dampened while employment is somewhat higher. Under Work Plan 3 (Cap-and-Trade), both GRP and employment are higher (0.9% above the Reference Projection by 2020). These results, however, depend on the assumed distribution of allowances under any approved federal system.

Section 6 of Act 234 lists thirteen Work Plan objectives in total. The scope of this project covered the first seven of these objectives,[13] which were addressed as summarized below:

Table ES-5: Work Plan Requirements under Act 234

	Act 234 Section 6 Requirement	**Addressed in Work Plans**
1	Consult with State agencies to ensure plans are complementary, minimize duplication and can be implemented in a cost effective manner.	In consultation with DBEDT and the Task Force, ICF developed plans to align with existing and proposed policies, building on existing systems.
2	Identify recommendations on direct	Recommended policies include direct emission

[13] The original scope of this project included additional tasks to address the remaining objectives of Act 234, including developing proposed rules for regulated entities, recommendations for an information management system and proposed legislation for recommended GHG reductions, as well as presenting reports and public workshops. These tasks were deferred due to funding limitations (FY 2009 appropriations were not released) and are not addressed in this report.

	Act 234 Section 6 Requirement	Addressed in Work Plans
	emission reduction measures, alternative compliance mechanisms, market-based compliance mechanisms and potential monetary and non-monetary incentives.	reduction measures included in Work Plan 1, as well as market-based mechanisms (carbon tax and cap-and-trade) in Work Plans 2 & 3. The Plans assume that monetary incentives will be used by the utilities and Public Benefits Agency to achieve demand side management (DSM) goals. Potential non-monetary measures are discussed for the freight sector.
3	Consideration of progressive initiatives in other jurisdictions.	The range of policies considered for implementation was based on consideration of initiatives in other jurisdictions, including for example, vehicle efficiency (Pavley) standards, the use of deep water cooling, Smart Growth initiatives and international experience with carbon taxes, and experience with cap-and-trade systems such as RGGI and WCI.
4	Investigate and develop analytic tools, models or other scientific methods to evaluate potential economic and non-economic costs and benefits to the State's economy, environment and public health.	A number of modeling tools were considered for use in modeling Hawaii's energy use, emissions, and associated economic impacts. ENERGY 2020 and the REMI macro-economic model were selected as the most appropriate choices for this project. The economic costs and benefits of each work plan are described in the sections on Work Plan Modeling results; including changes in GRP, income and employment associated with each Work Plan.
5	Consideration of relative contribution of each source or category to statewide GHG emissions, the potential for adverse effects on small business and recommendations on minimum thresholds below which requirements shall not apply.	Each of the policies was screened based on consideration of their potential contribution, impacts on small businesses (which constitute the majority of businesses in Hawaii) and environmental impact. See Tables of screening criteria for each measure in Work Plan 1 and discussion of Work Plan 2 and 3 as well as in the comparison of Work Plans (section 6(iv)).
6	Identify opportunities from verifiable and enforceable voluntary actions, including but not limited to, carbon sequestration projects and best management practices.	Carbon sequestration, through afforestation and other actions, are addressed in section 6(l). We identified an opportunity to initiate an initiative to encourage and support voluntary action in the freight industry as part of Work Plan 1. However, we judged that legislative requirements already in place were sufficient for most sectors.
7	Examination of market-based mechanisms, including consideration of toxic air or criteria air contaminants, and recommendations to maximize environmental and economic benefits to the State.	Two market-based mechanisms--a carbon tax and a cap-and-trade system--are presented as part of Work Plans 2 and 3. Consideration of the impacts of all measures on criteria air contaminants and other toxic air emissions and environmental benefits to the State were included in the screening of measures (see tables in sections 6 (a) to (m)). The impacts of the Work Plans on Criteria Air Emissions and public health are addressed in Section 6(v).

The report also comments on leakage issues relating to each proposed policy (item 10 in Act 234).

2. Report Structure

The report is organized into six sections. The first section provides a short Executive Summary of the report and its findings followed by this section which describes the report structure. Section 3 provides a brief introduction to Hawaii's GHG reduction targets and the energy and policy context in which plans to meet these targets are being developed. Hawaii's current and historic pattern of GHG emissions and the energy use underlying those emissions are then described in section 4.

Section 5 of the report describes the Reference Projection of Hawaii's GHG emissions to 2020. ***The Reference Projection indicates that Hawaii's goal of reducing targeted GHG emissions to 1990 levels by 2020 will be met by existing approved legislation and policies.***

The bulk of the report lies in section 6 which presents a description of potential policies that can be used to reduce future GHG emissions in the state. This analysis builds on past analyses carried out for the State and includes the set of policies identified in the Hawaii Clean Energy Initiative (HCEI). Additional policies are identified to extend or address gaps in prior proposals and to position Hawaii to meet longer term GHG reductions. Section 6 proposes three Work Plans for Hawaii designed to *"achieve the maximum practically and technically feasible, cost-effective reduction s in GHG emissions from sources or categories of sources to achieve the state-wide GHG emission reductions and limits by 2020, as required by Act 234, section 1*"[14]. Note that section 6 describes the proposed policies, while Appendix B describes the assumptions made in order to *model* these policies.

Appendix A provides brief descriptions of the two models—ENERGY 2020 and REMI—that have been used to model the three proposed Work Plans and their energy, emissions and economic impacts. Appendix B describes the assumptions made in representing the policies in these models. Appendix C lists all of the policies reviewed for possible application as part of the Work Plans.

Appendix D provides actual model outputs from ENERGY 2020 and compares the results of each Work Plan with the Reference Projection. It provides both state and county-level results. Appendix E presents the results of macro-economic modeling, using the REMI model in conjunction with ENERGY 2020.

14 Taken from the scope of services for project.

3. Background

In 2007, the Governor of Hawaii signed the Greenhouse Gas Reduction Law (Act 234) committing the State to reduce its GHG emissions to, or below, 1990 levels by 2020. The Act created a Task Force to oversee development of a plan to achieve this goal. This commitment is one of a long series of initiatives by the State of Hawaii to reduce its dependence on energy imports, improve efficiency and displace conventional fossil-fuels with renewable energy sources.

Due to its unique location and history, Hawaii is "the most oil dependent of the 50 states" paying among the highest prices in the U.S. for electricity and fuel. The challenges faced by the State are described in the Act which introduced the HCEI:

> *"Hawaii is the state most dependent on petroleum for its energy needs. It pays the highest electricity prices in the United States, and its gasoline costs are among the highest in the country. Fuel surcharges that pass the increases in fuel costs to consumers have significantly increased the cost of over eighty per cent of the goods and services sold in Hawaii. Household fuels and utilities costs rose 36.4 per cent, from the previous year, as reflected in the Honolulu consumer price index during the second quarter of 2008. Hawaii's energy costs approach eleven per cent of its gross domestic product, whereas in most states energy costs are four per cent of gross domestic product. Between 2005 and 2008, state government consumption of electricity increased 3.9 per cent, but expenditures increased 56.8 per cent.[15]"*

Hawaii's heavy dependence on oil imports has led the State to take a leadership role in the development of energy alternatives. Over the past twenty years numerous studies have reviewed the potential for efficiency and renewable resources to reduce Hawaii's oil dependence. The State already has a number of initiatives in place, including requirements for ethanol in gasoline, a Renewable Portfolio Standard, and programs to demonstrate government leadership in energy efficiency. For example,
Hawaii leads the US in the adoption of solar energy; actively promoting solar water heating through the electric utilities and tax incentives. With over 80,000 solar water heating systems already in operation, Hawaii became the first state to require solar water heating for all new homes[16] in 2009. This leadership extends to other areas of renewable development, including hosting many studies of ocean thermal energy conversion and wave energy and the active development of its wind resources.

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[15] Act 155, HB1464 HD3 SD2 CD1, Part 1, Section 1.
[16] Hawaii Becomes First State to Require Solar Water Heaters on Homes, the daily green – green homes section, July 23, 2009, (http://www.thedailygreen.com/green-homes/latest/hawaii-solar-water-heaters-460608)

Hawaii's utilities have gone through several iterations of an Integrated Resource Planning (IRP) process. This process involves development of a plan for future power system development which acknowledges the role of demand side management. In the Hawaii process, renewable energy sources were also given priority as the plans developed in the IRP3 process included a plan to meet the RPS requirements. HECO, which serves the island of Oahu, has published a fourth iteration of its IRP (IRP4) which goes even further in introducing both energy efficiency and renewables into its system.

Hawaii's most recent initiative sets an ambitious target of transforming the State's energy use to obtain 70% of Hawaii's energy from clean sources by 2030.[17] The Hawaii Clean Energy Initiative (HCEI), described in greater detail in the sections which follow, encompasses a range of initiatives to increase energy efficiency, introduce renewable fuels and sources into the power and transportation sectors, and establish a variety of programs and structures required to support this transformational effort.

It is in this context that ICF has been asked to develop three comprehensive Work Plans for a state-wide GHG emissions reduction on behalf of the Task Force. The goal of these plans is to implement the maximum practically and technically feasible, cost-effective reductions in GHG emissions to achieve the state-wide GHG emissions reductions and limits by 2020.

This report attempts to incorporate existing policies, recognize developing initiatives and leverage and build on past analyses that can contribute to meeting the state's climate change reduction targets.

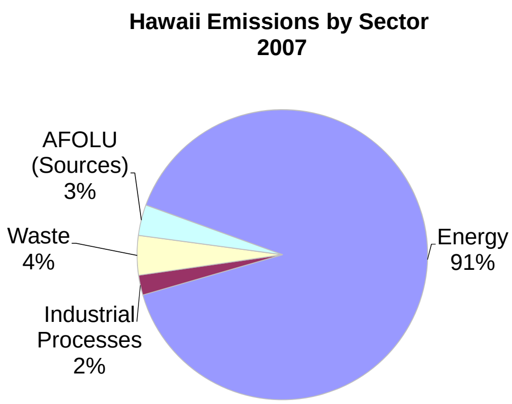
Hawaii's GHG emissions are projected to decrease slightly over the period to 2020[18], dropping by just under 1,000 kt CO2e, reflecting the effect of policies already put in place both federally and within the state. The following section describes Hawaii's historic GHG emissions and how they are projected to change over the coming decade.

[17] Act 155, HB1464 HD3 SD2 CD1.
[18] Reference Projection of Hawaii's Greenhouse Gas Emissions, 2007-2020, prepared by ICF International, Table 4; hereafter referred to as the "Reference Projection". The "Reference projection" is a "business as usual" scenario which projects future emissions based on existing, approved policies. The Reference projection for Hawaii indicates that GHG emissions will fall by about 1 Mt between 2007 and 2020.

4. Hawaii's GHG Emissions

Hawaii's GHG emissions in 1990 were 20,460 kt CO_2e including the effects of carbon sinks and emissions from aviation. By 2007, emissions had risen about 5% to 21,520 kt CO2e[19]. The State's GHG Reduction Act sets a goal of returning GHG emissions, excluding those associated with aviation, to 1990 levels by the year 2020. This translates into a target of reducing covered emissions to 13,660 kt CO_2e by 2020[20], not including emissions from aviation.

Over 90% of the GHG emissions from Hawaii in 2007 were related to energy use (see chart below[21]). Non-energy emissions resulted from agriculture, forestry and other land uses (AFOLU), waste management and industrial processes.



The modest growth in emissions between 1990 and 2007 reflects the State's on-going efforts to contain and reduce its reliance on fossil fuels. Emissions for the US as a whole grew at roughly three times faster than emissions in Hawaii.

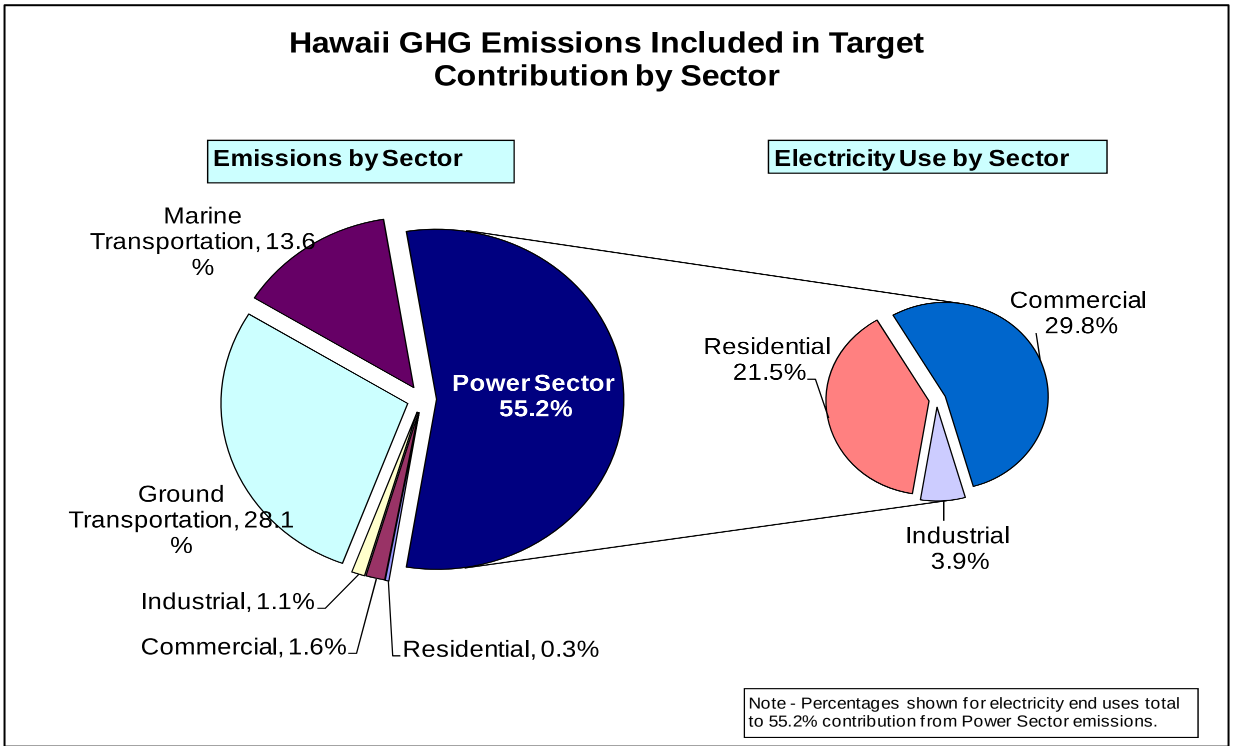
State energy emissions are dominated by two sectors, power and transportation. Hawaii is unique in the US in its heavy reliance on fossil-fired generation and in particular its reliance on oil-fired generation. Figure 1 on the following page shows

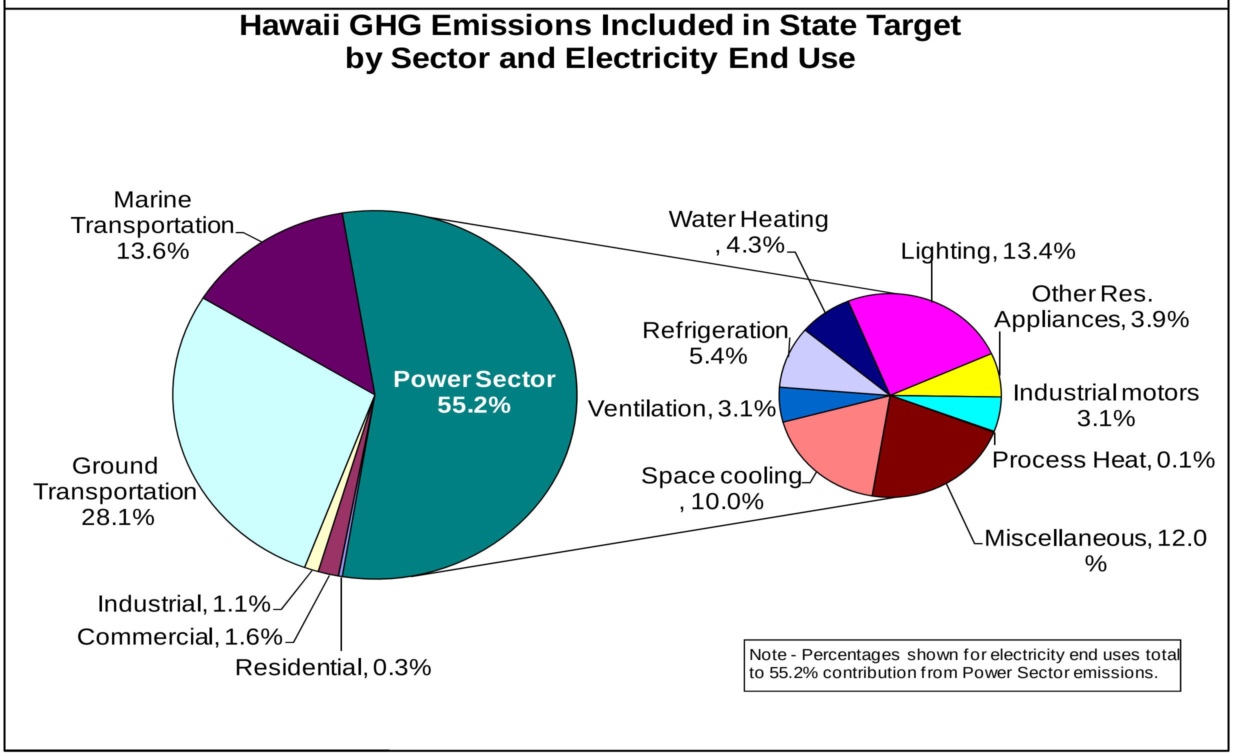
[19] From the Hawaii Greenhouse Gas Inventory: 1990 and 2007, December 10, 2008 prepared by ICF International. Note that the level of emissions for 2007 in the Reference Projection differ slightly from the inventory values, due to slight differences in representing these emissions in ENERGY2020 modeling.
[20] This represents total emissions in 1990, including sinks but excluding aviation, as indicated in Table 2 of the ICF Inventory. ICF International, Hawaii Greenhouse Gas Inventory: 1990 and 2007, December 10, 2008.
[21] Based on Hawaii Greenhouse Gas Inventory: 1990 and 2007, December 10, 2008, Table 2.

Hawaii's energy-related emissions and how power sector emissions are driven by electricity demand from each sector and end-use. The figure allocates 2007 GHG emissions based on electricity use by sector and end-use as estimated in a previous study of energy efficiency potential for HECO[22]. The distribution by sector and end-use is therefore approximate but provides a useful indication of key drivers of electricity use and resulting GHG emissions for targeting policy actions.

[22] See footnote in figure.

Figure 1: Distribution of 2007 GHG Emissions:[23]





[23] GHG emissions are from ICF Inventory (see footnote 7), distribution of electricity sales by sector and end-use is based on Assessment of Energy Efficiency and Demand Response Potential, Volume 1 - Final Report, February 2004, Global Energy Partners, LLC; prepared for Hawaii Electric Company; submitted as part of IRP3

5. Reference Projection

i. The Role of the Reference Projection

In 2007, the Governor of Hawaii signed the Greenhouse Gas Reduction Law (Act 234) committing the state to reduce its GHG emissions to, or below, 1990 levels by 2020. Act 234 ('the Act') required the Department of Business, Economic Development and Tourism (DBEDT) to update the state's inventory of GHG emissions for 1990. ICF was retained by DBEDT to assist in updating the inventory for 1990 and develop an estimate of 2007 emissions. ICF was also contracted to develop a projection of emissions to 2020 as part of an effort to develop proposes work plans to reduce emissions to targeted levels by 2020.

The inventory developed by ICF in December, 2008 indicates Hawaii's total GHG emissions in 1990 were 20,460 kt CO_2e including sinks and emissions from aviation. The Act specifically excludes emissions associated with aviation, given the limited ability of the state to influence these emissions. The state target is therefore to reduce GHG emissions to 13,660 kt CO_2e by 2020[24]; this level of emissions includes sinks and is adjusted to remove aviation.

In order to conduct a quantitative modeling exercise of the emission reduction options for achieving this target, it is necessary to have a baseline projection to the year 2020 that represents Hawaii in sufficient detail to support analysis of individual measures for reducing emissions through improved efficiency, greater reliance on low carbon and renewable fuels, and other sector and source specific emissions reduction opportunities. The Reference Projection fulfills this role in the modeling exercise – it is the baseline against which proposed policies are measured.

The Reference Projection is an analytical device, not a prediction. In this analysis, the starting year is 2007, building on the analysis conducted for the inventory. The analysis extends to 2020, the target year for bringing emissions down to 1990 levels (13,660 kt CO_2e). It starts with a calibration of the model to existing GHG levels (in 2007), and then uses assumptions with respect to the growth of population and economic activity to drive the model forward[25]. It is not a "frozen efficiency" projection, insofar as the model will continue to replace new energy using capital and equipment with capital and equipment that reflects current marginal technology choices, the assumed outlook for energy prices, and other established and ongoing trends that affect the energy intensity of the Hawaii economy.

[24] This represents total emissions in 1990, including sinks but excluding aviation, as indicated in Table 2 of the ICF Inventory. ICF International, Hawaii Greenhouse Gas Inventory: 1990 and 2007, December 10, 2008.
[25] A description of the model structure, data input to the model and assumptions used in developing the Assumptions Book are described in the Hawaii Greenhouse Gas Emission Reductions Modeling: ENERGY 2020 Model Inputs and Assumptions (Assumptions Book).

Energy-related GHG emissions, which constitute over 90% of Hawaii's GHG emissions, are computed in the model by multiplying the fuel consumed in various sectors and end-uses[26] by the corresponding GHG emission factors for each fuel. This is the same technique used to generate the energy portion of the Hawaii GHG inventory. By feeding the model historical data on fuel and electricity consumption in Hawaii, we can ensure that the model is generating a level and pattern of GHG emissions that is consistent with the historical inventories. The allocation of emissions by sector and end-use in the model, treatment of self-generation, and other issues result in some differences in the allocation of these emissions by sector, but these differences are not material to the policy evaluation process.

Non-energy sources of GHG emissions; arising from agriculture, forestry, industrial processes, and other activities, represent about 9% of Hawaii's total greenhouse gas emissions. These non-energy sources are represented in the Energy2020 model with a simpler framework than for the energy-related sources. For these sources, the model projects future emissions based on the historical relationships between emission levels and the economic output of the source sectors. This leads to a simpler calibration and projection exercise than for the energy-related sources, and emissions have been tuned to the historical levels in the inventory. For Hawaii, ICF prepared a detailed projection of these non-energy emissions as part of the inventory development process. The methodology used in this analysis is described in Appendix G of the Assumptions Book, provided separately.

A number of existing policy initiatives were included in the Reference Projection of emissions to 2020, including the federal Energy Independence and Security Act, Hawaii's Renewable Portfolio Standard (RPS), ethanol content and solar water heater requirements[27].

In the sections which follow, the tables show actual model outputs from the Reference projection. The model makes these projections based on the inputs and assumptions described in the Assumptions Book and based on the forecast of the economy described below.

ii. Demographic and Economic Drivers

Demographic and economic data is used by the model to generate demands for services. A forecast of population growth and economic activity was developed in consultation with DBEDT. For both the population and economic data, macro-economic

[26] A list of the specific sectors and end uses included in the Hawaii model are provided in Appendix B of the Assumptions Book.
[27] A full list of the policies included in the Reference Case and the assumptions made regarding these policies is provided in section 4.9 of the "Assumptions Book".

information provided by REMI was adjusted to conform to the DBEDT 2035 projections of population[28] and economic activity[29].

The population growth included in the projection is lower than levels forecast in the DBEDT2035 series. This was an assumption made in order to obtain the best possible alignment of employment and GRP figures (which play a much more significant role in driving energy use in ENERGY2020) with the DBEDT 2035 projections.

No significant shifts in housing types are anticipated in the Reference Case though changes in urban form can play a quite significant role in shaping future energy requirements.

Table 1. Economic Drivers of the Reference Projection of GHG Emissions for Hawaii - 2007 - 2020.

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Personal Income	42,519	44,060	49,456	54,530	1.9%
Population (millions)	1.29	1.37	1.42	1.49	1.1%
Gross Regional Product (GRP)	60,659	67,340	74,120	81,609	2.3%

Economic growth (gross regional product) is projected to grow at an average rate of 2.3% per year over the period to 2020. Because economic growth outstrips population growth over the modeling period, personal income per capita is projected to increase. On a per capita basis, personal income grows by 1.9% per year over the 2007 to 2020 period. This increase in personal income is projected to drive up housing and travel demand, though both may be moderated by energy prices and efficiency policies.

Fuel costs can be critical in projecting the cost of electricity. ENERGY 2020 calculates future electric prices based in part on these fuel costs, which are exogenously input to the model. The Reference Projection energy price forecast is based on the Energy Information Administration's Annual Energy Outlook 2009 Reference Case price forecast for 2009 to 2030. [30] Historic energy price data is taken from US Department of Energy State Energy Data and the DBEDT Data Book.

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[28] Resident population estimates (as opposed to de facto population estimates, which include visitors) were used in calibrating the baseline in REMI, per correspondence between Bansari Saha, ICF, and Fred Treyz, REMI, in May 2009. DBEDT 2035 Series. Population and Economic Projections for the State of Hawaii to 2035. Research and Economic Analysis Division; Department of Business, Economic Development and Tourism. January 2008

[29] The original and revised macro-economic forecast will be provided to DBEDT as part of the background files with this report.

[30] Energy Information Administration, Annual Energy Outlook 2008, Report #DOE/EIA-0383(2008), June 2008, http://www.eia.doe.gov/oiaf/aeo/

iii. Modeling Results

Total secondary energy[31] use by sector in the Reference Projection is shown in Table 2. Primary energy use by fuel type is presented in Table 3. Table 2 includes electricity use within each sector [32] but excludes fuel inputs for electricity generation. Table 3 includes all energy use, including the fuel inputs used to generate electricity.

Energy use in residential buildings increases at 0.7% per year over the period, growing more slowly than population growth. Commercial sector energy use remains essentially flat over the period despite economic growth as greater building and equipment efficiency reduces energy intensity per dollar of output. In both sectors, increased energy efficiency is driven in part by rising lighting and equipment standards under the EISA.

Both resident and visitor passenger transportation energy use decline in the period to 2020 by 2.6% and 4.9% respectively. This decrease is driven by vehicle efficiency increases as a result of the CAFÉ standard and the shifting of some trips to the new high-capacity rapid transit line. The reference case assumes the implementation of the CAFE standard included in the Energy Independence and Security Act (EISA) will bring marginal vehicle efficiency to 35.5 mpg by 2020. A variety of other efficiency improvements and renewable fuel requirements included in the EISA are described in the Assumptions Book. Visitor passenger fuel use declines more quickly than for residents as the rental vehicle fleet is turned over more frequently and is therefore dominated by newer vehicles.

Energy use in the freight transportation sector decreases marginally (0.5% per year). Forestry & Agriculture energy use declines by about 4% per year, reflecting a continuation of recent trends, but the absolute change is quite small.

[31] Primary energy is a term used to describe energy that has not been subjected to any conversion or transformation. Secondary energy represents only the energy contained in a refined fuel or in electricity delivered to an end-user. For example, it may take 10,000 Btu's of fuel oil (primary energy) to produce 1 kWh containing 3,412 Btu's (secondary energy).
[32] ENERGY 2020 models 3 multiple sub-sectors within each sector as described in Appendix B of the Assumptions Book. For convenience they have been consolidated in the results which follow. The Freight sector in the tables below includes only highway freight. All other categories are as described in the Assumptions Book.

Table 2. Total Secondary Energy Use by Sector in the Reference Projection

Total Secondary Energy Use *(TBtu/year)*	**2007**	**2010**	**2015**	**2020**	**Avg. Annual Growth Rate 2007-2020**
Residential	11.8	11.8	12.4	13.0	0.7%
Commercial	24.1	23.7	24.3	24.2	0.0%
Industrial	14.0	14.0	14.3	14.1	0.0%
Passenger - Residents	39.6	37.6	31.9	28.1	-2.6%
Passenger - Visitors	6.1	5.2	3.9	3.2	-4.9%
Marine	20.9	20.7	21.0	20.5	-0.1%
Aviation	81.1	82.6	86.8	86.6	0.5%
Freight	19.0	18.6	17.5	17.7	-0.5%
Forestry & Agriculture	0.1	0.1	0.1	0.1	-4.0%
Total	**216.8**	**214.3**	**212.2**	**207.5**	**-0.3%**

Table 3. Total Primary Energy Use by Fuel in the Reference Projection

Total Primary Energy Use (TBtu/year)	**2007**	**2010**	**2015**	**2020**	**Avg. Annual Growth Rate 2007-2020**
Biodiesel	-	7.7	15.4	15.5	N/A
Biomass	4.9	7.8	10.0	12.8	7.7%
Coal	15.6	15.8	15.8	15.6	0.0%
Electricity	32.1	31.5	33.1	34.0	0.4%
Ethanol	0.2	0.8	2.9	4.6	26.2%
Gasoline	57.5	53.3	43.2	37.2	-3.3%
Geothermal	2.2	2.2	2.2	2.2	0.0%
HS Diesel	-	-	-	-	N/A
HS Fuel Oil	84.0	70.2	68.8	70.6	-1.3%
Hydrogen	-	-	-	-	N/A
Jet Fuel	81.1	82.6	86.8	86.6	0.5%
LPG	2.4	2.3	2.4	2.3	-0.1%
LS Diesel	15.0	14.9	14.3	13.6	-0.7%
LS Fuel Oil	19.5	21.5	19.4	18.2	-0.5%
Oil, Unspecified	5.5	5.6	5.7	5.5	0.0%
Utility Gas	3.2	3.2	3.3	3.3	0.2%
Still Gas	-	-	-	-	N/A
Waste	5.0	5.0	5.1	6.1	1.6%
Total	**328.3**	**324.4**	**328.4**	**328.2**	**0.0%**

Primary energy use, which includes fuel inputs to the electricity system, shows fossil fuel use either increasing modestly; generally at less than 1% per year, or declining during the period to 2020. Jet fuel and utility gas are the only fossil fuels that show an increase over the period. Renewable fuels, such as biomass and ethanol, on the other hand, show rapid growth as their role in Hawaii's energy supply expands both to meet state requirements and those in the EISA. The table does not attempt to quantify the energy 'inputs' for such renewable sources as hydro, solar and wind. Changes in electricity production from these sources is represented in the tables describing the power sector in Section IV on the next page.

When combined with projected changes in non-energy sources of emissions, this energy use projection translates into the Reference Projection of GHG emissions shown in Table 4. The model projects that emissions included in the State target will decline at a rate of 1.3% per year, reaching 13,122kt CO_2e by 2020. Note that for this table information for 1990 has been added based on the ICF Inventory. The modeling did not cover the period back to 1990 and therefore all subsequent tables compare the modeled period from 2007 to 2020.

In general, the relative growth rate in emissions from the different sectors reflects the energy projection described above. However, the inclusion of the non-energy sources, along with some ongoing trends toward lower carbon energy forms (particularly in power generation), slightly change the emission growth rates for some sectors, as compared with the energy growth rates. Emissions from passenger vehicles (residents and visitors) and the power sector decline more quickly than energy use as higher levels of non-emitting biofuels are introduced. In the industrial sector emissions grow more quickly than energy use as process emissions are projected to increase.

Table 4. Reference Projection of Hawaiian GHG Emissions, 1990 -2020, by Sector[33]

GHG Emissions *(kt CO2e)*	**1990**	**2007**	**2010**	**2015**	**2020**	**Avg. Annual Growth Rate 2007-2020**
Residential	30	66	63	64	66	*0.0%*
Commercial	380	329	325	327	315	*-0.4%*
Industrial	880	637	645	649	635	*0.0%*
Passenger - Residents	3,230	2,918	2,727	2,185	1,818	*-3.6%*
Passenger - Visitors	n/a	453	377	271	211	*-5.7%*
Marine	1,650	2,173	2,153	2,184	2,135	*-0.1%*
Freight	1,530	1,402	1,371	1,240	1,204	*-1.2%*
Power Sector	6,790	8,745	7,814	7,545	7,684	*-1.0%*
Waste	850	1,032	1,098	1,209	1,320	*1.9%*
Agriculture & Forestry	*(1,680)*	*(2,267)*	*(2,267)*	*(2,266)*	*(2,266)*	*0.0%*
Total	***13,660***	***15,487***	***14,307***	***13,408***	***13,122***	***-1.3%***

It should be noted that the distribution of emissions and energy use for 2007 in the model do not correspond exactly to those shown in the inventory. For the most part this simply reflects differences in how energy use and emissions are distributed by economic sector and end use in the model, however there are also some minor difference resulting from the operation of the power sector and passenger transportation

[33] Detailed tables of emissions by county by year have been provided to DBEDT electronically. Additional details regarding the Reference Projection are provided in Appendix D.

mix in the model. Overall, the modeled level of emissions for 2007 are within 0.5% of inventory levels.

The contribution to total emissions from different sectors shows some change between 2007 and 2020, as shown in Table 5. Transportation (including resident and visitor passenger transportation, marine, aviation and freight) and the Power Sector continue to dominate Hawaii's GHG emissions in the Reference Projection, together accounting for over three-quarters of total emissions in 2020. However, the contribution from vehicle transportation shrinks as a proportion of the total as higher efficiency takes effect. As passenger transportation becomes more efficient, other forms of transportation start to represent a larger share of total emissions (and, hence, will need to be addressed in order to reduce state emissions).

Table 5. Sector Shares of Hawaiian GHG Emissions, excluding offsets, 2007-2020

Share of Total GHG Emissions	2007	2020
Residential	0.3%	0.3%
Commercial	1.5%	1.5%
Industrial	2.8%	3.1%
Passenger - Residents	12.9%	8.8%
Passenger - Visitors	2.0%	1.0%
Marine	9.6%	10.4%
Aviation	21.4%	25.1%
Freight	6.2%	5.9%
Power Sector	38.7%	37.4%
Waste	4.6%	6.4%

A comparison of reference projection emissions from the model with the state target indicates that, by 2020, emissions included in the state target will actually fall below 1990 levels, falling from 113% of 1990 levels in 2007 to about 98% of 1990 levels by 2020. ***This indicates that policies already in place reduce targeted GHG emissions to below the State's target by 2020.***

iv. Power Sector

The power sector is the single largest source of GHG emissions in many jurisdictions. This is particularly true in Hawaii, where the power sector is responsible for more than half of current total GHG emissions.

In part, this reflects the fact that demands for space conditioning and industry are quite low when compared with other states; and in part reflects the relatively high emission intensity of Hawaii's power system due to its historic dependence on oil as the main source of electricity.

Electricity intensity continues to grow in Hawaii. For example, between 2000 and 2007, electricity use per customer on Oahu increased 0.8% per year for residential customers and 0.3% for other accounts[34].

Electricity sales are projected to grow by about 8% over the period to 2020 for the state as a whole (0.6% per year), with the most rapid growth occurring in Oahu and Hawaii county. The residential sector again shows the highest rate of growth (0.9% per year). Industrial sector electricity use is projected to grow very modestly (0.3% per year), well below the projected level of economic growth, implying a decrease in industrial electricity intensity over the period. These rates reflect the impact of efficiency changes specified in the EISA as well as DSM levels as proposed in the IRP3 process. Electricity use for transportation increases as the mass transit system comes into service[35].

Table 6. Reference Projection of Hawaii Electricity Sales

Utility Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	3,150	3,157	3,339	3,528	0.9%
Commercial	5,467	5,390	5,569	5,604	0.2%
Industrial	855	836	881	888	0.3%
Transportation	-	-	107	152	N/A
Military	1,242	1,342	1,390	1,437	1.1%
Total	**10,714**	**10,726**	**11,286**	**11,609**	**0.6%**

Table 7. Hawaii Generation in the Reference Projection

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	8,837	7,856	7,459	7,512	-1.2%
Coal Steam	1,510	1,510	1,510	1,510	0.0%
Hydro	130	130	240	240	4.8%
Biomass	291	473	632	867	8.7%
Wind	137	312	382	420	9.0%
Other Renewable	212	841	1,468	1,469	16.0%
Purchases from industry	110	124	139	143	2.1%
Total	**11,228**	**11,247**	**11,829**	**12,162**	**0.6%**

Renewable generation is projected to grow from current levels of 7% of sales in 2007 to over 20% of sales by 2020. This does not include any additional renewables planned beyond those described in the utilities IRP3 submissions. Only one plant, CT1, coming

[34] DBEDT, Hawaii Data Book – 2007, table 17.10.
[35] Electricity consumption for planned mass transit system based on HECO forecast as described in Assumptions Book. Hawaiian Electric Company Inc., Integrated Resource Plan 2009-2028, Docket No. 2007-0084, September 30, 2008. Appendix L, Exhibit 7, August 2007 and March 2008 sales and Peak Forecast.

into service in 2009 is assumed to be fuelled with biodiesel under the Reference Projection.

Electricity prices[36] rise at a relatively modest (2-3% per year) rate in real terms, reflecting some increase in power costs associated with new renewable capacity offset by reductions in fuel costs. Other fossil fuel prices rise in accordance with the EIA's reference price projection from the AEO 2009. Ethanol and biodiesel prices are projected to decrease very slightly, however, these prices are subject to higher levels of uncertainty as will be discussed in greater detail in the Work Plan report.

Table 8. Fuel and Electricity Prices in the Reference Projection

Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential					
Electricity	79.0	85.4	100.6	101.6	2.0%
Utility Gas	43.5	43.2	43.5	44.1	0.1%
Bottled Gas	60.0	62.6	68.5	69.2	1.1%
Commercial					
Electricity	68.1	72.9	89.9	90.8	2.2%
Utility Gas	27.8	27.5	27.8	28.4	0.1%
Oil	22.4	25.0	30.9	31.5	2.7%
Bottled Gas	25.0	27.6	33.5	34.1	2.4%
Industrial					
Electricity	62.7	67.2	84.6	84.3	2.3%
Utility Gas	27.8	27.4	27.6	28.2	0.1%
#6 Fuel	9.9	12.5	18.3	19.0	5.2%
Bottled Gas	-	27.6	33.5	34.1	N/A
#2 Fuel	22.4	25.0	30.9	31.5	2.7%
Transportation					
Gasoline	28.2	30.8	36.7	37.4	2.2%
LS Diesel	25.3	27.9	33.7	34.4	2.4%
Ethanol	28.1	25.7	27.9	27.8	-0.1%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%

v. Transportation

GHG emissions in the transportation sector depend on the total vehicle-miles travelled, the fuel efficiency of the vehicles (expressed here in miles per gallon), and the carbon intensity of the fuel being consumed. In the case of passenger transportation, the vehicle miles travelled will in turn depend on the number and length of automobile trips taken, and the occupancy of the vehicles. In the case of freight transportation, the vehicle miles traveled depend primarily on the total tonne-miles of freight movement, but also on the modal split and the capacity factors of the trucks and other freight modes. Marine emissions similarly depend on shipping distances, the efficiency of the vessel and the fuel used. Aviation energy use is not included in this analysis.

[36] Electricity prices are calculated within the model based on the economic dispatch of power plants. The costs and characteristics of new generation capacity additions are based on information provided in IRP3 reports for each utility as described in the Assumptions Book (see section 4.5).

In the Reference Projection, total vehicle-miles of passenger travel declines very slightly (0.1% per year) while travel due to visitors declines at 1.8% per year. While the level of travel appears relatively stable, a number of changes are occurring beneath the surface. Increases in population and personal income over the period result in increased travel; these increases are slightly compounded by the lower cost of driving as a result of higher vehicle efficiency. Offsetting these increases are decreases in vehicle trips as the mass transit system comes into service and to a lesser extent in response to changing fuel prices.

Table 9. Vehicle-Miles Traveled in the Reference Projection

Distance Travelled (millions of vehicle miles travelled)					
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Passenger - Residents	10,284	10,114	10,117	10,153	-0.1%
Passenger - Visitors	1,520	1,402	1,296	1,206	-1.8%

The Reference Projection includes the CAFÉ provisions included in the Energy Independence and Security Act (EISA). The more aggressive standards proposed by the Obama administration were not included. As a result, improvements in the reference projection are more limited, with marginal vehicle efficiency reaching 35.8 mpg by 2020 as shown in Table 10 below. Average vehicle efficiency increases more slowly as the overall fleet turns over and newer, more efficient vehicles enter the market. The increase is more rapid for passenger vehicles for visitors as the rental vehicle fleet turns over more quickly and is therefore more heavily weighted to newer vehicles.

Table 10. Vehicle Fuel Efficiency in the Reference Projection

Marginal Vehicle Efficiency (miles/gallon)					
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	24.4	28.1	34.0	37.7	3.4%
Medium Gasoline	23.4	26.9	32.6	36.0	3.4%
Heavy Gasoline	17.4	19.4	22.3	24.6	2.7%
Heavy Diesel	17.2	19.2	21.8	24.0	2.6%
Fleet	23.1	26.8	32.2	35.8	3.4%

Average Vehicle Efficiency (miles/gallon)					
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	23.5	24.1	26.3	29.4	1.7%
Medium Gasoline	21.4	22.3	24.6	27.6	2.0%
Heavy Gasoline	16.9	17.3	18.7	20.6	1.5%
Heavy Diesel	16.9	17.2	18.6	20.4	1.5%
Fleet	22.0	22.7	25.1	28.5	2.0%

The projected level of biofuel use as a result of the Energy Independence and Security Act has been tempered to reflect the levels projected by the EIA in the Annual Energy

Outlook 2009. Ethanol use as a percentage of gasoline use reaches 11% by 2020, while bio-diesel as a percentage of diesel use rises to 3%.

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020
Ethanol/Gasoline	0%	1%	6%	11%	10.6%
Biodiesel/Diesel	0%	1%	2%	3%	3.4%

vi. Summary:

Modeling results indicate that Hawaii's target of reducing its emissions to 1990 levels by 2020 are achieved in the Reference Projection under existing, approved legislative requirements. It will therefore be important to place a continuing focus on putting systems, supports, and monitoring and verification processes in place to ensure that the challenging targets already established in existing legislation are met.

6. Proposed Work Plans

Based on direction from DBEDT and the Task Force, three Work Plans have been developed. The Work Plans include the following policy groupings:

Work Plan	Description
1.	The HCEI implemented with other proposed policies measures;
2.	A state-level Carbon Tax implemented in combination with Work Plan 1;
3.	A federal Cap-and-Trade (C&T) system implemented in combination with Work Plan 1.

Given that the State's emissions target is achieved in the Reference Projection by existing policies, each of these Work Plans exceeds the GHG reduction targets set out in Act 234.

In each case, existing approved legislation, such as the RPS, EEPS, and Alternative Fuel Standard have been included in the modeling. A list of the policies and the assumptions made in representing these policies is included in Appendix B. All Work Plans also includes the commitments specified in the HECO IRP4 process (which exceed those in the earlier IRP3 process that was reflected in the Reference Projection).

The following section describes the modeling result for each work plan, describes the series of policies proposed for inclusion in the Work Plans to reduce GHG emissions for Hawaii, and discusses issues specific to each of the plans,.

A number of studies have been conducted over the past decade to analyze policies for reducing Hawaii's dependence on oil, increasing energy efficiency and the use of renewables and reducing GHG emissions. Many energy policies are already in place in Hawaii and many others have been reviewed and analyzed in prior reports. The policies represented below combine those policies which have been, or are expected to be, implemented in the coming years with policies which address gaps in current policy framework.

The policies considered as part of this project have been evaluated against criteria specified by DBEDT in accordance with direction in Act 234. The issues to be considered for each policy, extracted and summarized from the project contract, are listed below:

- Cost effectiveness,

- Ability to meet goal,
- Key sources to be included,
- Size of affected sources,
- Ability to monitor and verify,
- Prevention of any increase in air emissions of toxic contaminants or air pollutants
- Co-benefits for CAC's and toxic air emissions,
- Local impacts on communities adversely affected by air pollution,
- Maximization of environmental benefits for Hawaii,
- Compatibility with other programs,
- Extent of leakage,
- Ability to monitor and verify and any impacts as a result of measurement and verification requirements,
- Potential adverse impacts on small business,
- Trade off between command-and-control and market-based mechanisms, and
- Threshold below which measures should not apply.

The Act specifies that potential adverse effects on 'small business' be considered. According to the State of Hawaii Data Book 2008, only 2% or reporting units had more than 100 employees and about 60% of employees worked for firms with less than 100 employees (Table 12.26) in 2007. The most recent information reported for the manufacturing sector, for 2002, indicates that only 4.7% of reporting establishments employed more than 100 employees. The distribution by employees was not reported. These statistics indicate that the majority of businesses in Hawaii fall into the 'small business' category. As a result, changes in energy costs for the commercial and industrial sectors under the proposed work plans can be viewed as representative of the impacts on small business.

A full list of policies considered as part of this project is included as Appendix C, with a description of the disposition of each policy.

The intent of this project was not to provide detailed modeling results for these individual policies, but rather to model the effects of a combined package of policies in the form of three Work Plans; however, where possible an indication of the anticipated GHG reductions has been provided. These reductions are based on modeling the policy on its own and without interactions with other policies. These estimates are intended solely to provide an indication of the relative contribution of different policies and should be treated with caution. The savings resulting from the package of policies is typically less than the sum of the estimated emission reductions from the individual policies due to interactions between them. For example, policies to introduce higher levels of biofuels and increase vehicle efficiency will clearly interact. The sum of the estimated reduction from implementing each policy on its own will be higher than the estimated reduction of implementing them together; though the combined reduction will exceed what either policy could achieve on its own. Attempting to identify the relative contribution of each policy when implemented as part of an overall policy package is difficult, if not impossible, given the number of policies involved, and is well beyond the scope of this project.

i. Work Plan 1: HCEI plus other Proposed Policies

Description

The Hawaii Clean Energy Initiative represents a significant new initiative which is intended to transform the State's energy system. This innovative initiative incorporates a number of different policies as represented in the HCEI Agreement[37]. The HCEI remains a work in progress. For modeling of the HCEI the list of policies described listed below, and described more fully in the pages that follow, are assumed to be included in the HCEI:

Table 1. Policies included in the HCEI

Policy	Status
Renewable Portfolio Standard (RPS)	Existing legislative requirement
Energy Efficiency Portfolio Standard (EEPS)	Existing legislative requirement
Increase Renewables and Use of Biofuels for Power Production	HCEI Energy Agreement
Sea Water Cooling	HCEI Energy Agreement Modeling assumes 2nd system for Waikiki
Alternative Fuel Standard (AFS)	Existing legislative requirement
Increased Vehicle Efficiency	Recommended if Federal CAFÉ rules not extended beyond 2016.
Plug In Hybrid Electric Vehicles (PHEV's)	HCEI Energy Agreement
Building Codes	Recommended
Freight Options	Recommended (not modeled)
Urban Form (Smart Growth)	Recommended (not modeled)

The following section describes a series of policies proposed for inclusion in the Work Plans to reduce GHG emissions for Hawaii.

A number of studies have been conducted over the past decade to analyze policies for reducing Hawaii's dependence on oil, increasing energy efficiency and the use of renewables and reducing GHG emissions. Many energy policies are already in place and many others have been reviewed and analyzed in prior reports. The policies represented below combine those policies which have been, or are expected to be,

[37] Energy Agreement among the State of Hawaii, Division of Consumer Advocacy of the Department of Commerce and Consumer Affairs, and the Hawaiian Electric Companies. Available on DBEDT website at: http://hawaii.gov/dbedt/info/energy/hcei

implemented in the coming years with policies which address gaps in current policy framework.

a) Hawaii Clean Energy Initiative

The Hawaii Clean Energy Initiative sets out a goal of obtaining 70% of Hawaii's energy from efficiency and clean energy sources by 2030. The broad strokes of this initiative have been laid out in the HCEI Agreement between the State and the electric utilities[38]. The HCEI Agreement describes a number of initiatives not all of which are fully developed but which provide a framework for achieving the State's goal.

The HCEI remains a work in progress which is proceeding in parallel with the work of the Task Force. As a result, it has been necessary to make some assumptions in order to model the effects of the HCEI. These assumptions are based on descriptions included in the HCEI Agreement and are described more fully in the policy summaries which follow.

The policies described in the HCEI are listed below.

1. Conversion of designated generating units to biodiesel
2. Implementation of the Energy Efficiency Portfolio standard. In the absence of established interim targets, we propose, based on the recommendation of DBEDT, to assume interim goals of 10% in 2010, 15% in 2015, and 20% in 2020.
3. Increased introduction of renewable sources in the power system to meet the requirements of the amended RPS. Several policies are listed in the HCEI which we consider to be facilitating policies that can support the addition of higher levels of 'intermittent' renewable generation to the system:
   a) Addition of an underwater cable to link Oahu, Maui, Lanai and Molokai.
   b) Development of demand reduction and load control capabilities; including the development of advanced metering infrastructure (AMI), "Smart Grid" capabilities, and rate structures to support load shifting.
   c) Provision of 'net metering' by utilities.
   Note that item b) has not been specifically included in the model. It is assumed that these capabilities will enable Hawaii's utilities to incorporate larger volumes of "intermittent" generation into their systems. In the period to 2020, the levels of these resources are not projected to rise to levels that would cause significant concern over system stability and it was therefore not necessary to anticipate or attempt to model these additional measures.
4. Seawater cooling to replace or reduce air conditioning loads. Plans are currently underway for a system for downtown Honolulu. For modeling purposes it is assumed that a second system with similar characteristics and savings will follow for Waikiki.

[38] Energy Agreement among the State of Hawaii, Division of Consumer Advocacy of the Department of Commerce and Consumer Affairs, and the Hawaiian Electric Companies. Available on DBEDT website at: http://hawaii.gov/dbedt/info/energy/hcei

5. Increased use of biodiesel and ethanol for vehicles consistent with the Alternative Fuel Standard.
6. Introduction of Plug-In Hybrid Electric Vehicles (PHEV's).
7. Increased vehicle efficiency through adoption of standards beyond EISA CAFE requirements. For modeling purposes it is assumed that standards proposed by the federal government to align with California vehicle requirements will be implemented; that average new vehicle efficiency will reach 35.5 mpg by 2016, and that standards will continue to rise in line with the proposed Pavley II[39] standard.

Discussion of the individual elements of Work Plan 1 is presented below. In the Work Plans, these policies have been modeled as a combined initiative. In some instances, the policies were modeled on a stand-alone basis and the results of this modeling are reported for the specific policy. The modeling results for the Work Plan, where the policies have been modeled as a group are then discussed in the section labeled "Work Plan 1 Modeling Results".

[39] The "Pavley" standard is named for Assemblywoman Fran Pavley, who introduced the legislation which set out requirements for GHG emissions from new vehicles in the state of California. The initial standard translates to a requirement that the fleet average for new vehicles reach 35.5 mpg by 2016. A second phase, referred to as Pavley II, would require that new vehicles average 42.5 mpg by 2020. The Pavley standard was adopted by more than a dozen states. In May, 2009, the Obama administration announced its intention to raise Corporate Average Fleet Efficiency (CAFÉ) requirements for 2016 to levels consistent with the Pavley requirements.

b) Renewable Portfolio Standard

i. Description

A Renewable Portfolio Standard (RPS) establishes a required level of contribution from renewable sources to electricity supply. Typically the policy defines qualifying sources and sets the contribution in terms of electricity sales. Currently 24 states, plus the District of Columbia, have some form of an RPS policy in place[40] according to the U.S. Department of Energy (DOE). In some jurisdictions energy efficiency and renewable energy used to supply 'non-electric' loads such as water heating, have also been included in the RPS. Typically the requirement is stated in terms of a percentage of sales.

Hawaii's RPS has been in place for a number of years and has been revised on several occasions. In 2009, amendments increased the target levels and removed some qualifying sources, such as energy efficiency, beginning in 2015. Given that the status of these revisions was undetermined at the time, the Reference Projection included the provisions of the RPS prior to its amendment in 2009. In modeling new, additional policies as part of the Work Plans these amendments have been included as part of each work package.

An RPS is also specified in ACES (Waxman-Markey) Act, which roughly aligns with the provisions in the Hawaii RPS prior to amendment. The amended Hawaii RPS exceeds the proposed federal requirement and has therefore be used as the overall constraint for modeling purposes as discussed in Appendix B.

The targets in the revised RPS, stated in terms of the percentage of net utility sales that must be met from defined renewable sources are:

- 2010 – 10%
- 2015 – 15%
- 2020 - 25%
- 2030 – 40%

The amendments eliminate contributions from displacement sources (i.e. renewable energy systems used to displace electricity use – such as solar water heaters) or energy efficiency as of January 1, 2015. The revised Act would also prevent electricity-generating public utilities from owning or operating any new generating sources of over 2 MW fired by fossil-fuels. Co-operative associations are exempted from this provision.

[40] http://apps1.eere.energy.gov/states/maps/renewable_portfolio_states.cfm#chart

ii. Analysis of Measure

Hawaii now derives a relatively high percentage of its electricity from renewable sources. Plans described in the IRP process show an increasing role for wind generation, including substantial developments in Maui and Hawaii. Each type of generation has unique operational characteristics and for wind and solar power this includes variability that can create operational challenges for the power grid given the need to match power demand and resources in real time. Studies have indicated that 20% of the total electrical energy consumption may be incorporated with minimal difficulty[41], however, the relatively small size and isolated nature of the systems on each island in Hawaii may make this more of a challenge. Increasing levels of intermittent resources raise concerns over issues caused by output variations. The level of 'intermittent' generation that can be accommodated in any power system depends on the design of the system, the type of resources available, the ability to forecast both the resource and load, and the geographic distribution of the intermittent resources, among other factors.
In order to accommodate higher levels of intermittent generation other policies will need to be put in place to allow operational flexibility and maintain system stability. The HCEI Agreement discusses several policies that could contribute to this flexibility including:

- Development of "Smart Grid" capabilities,[42]
- Expansion of demand reduction capability,[43]
- Increasing the geographic diversity of the available resources by integrating generation and loads between counties.

These and other policies, including the introduction of plug-in hybrid vehicles, could help the utilities in accommodating higher levels of intermittent generation[44].

It was assumed, based on the best available data at the time of this modeling exercise was undertaken that the installation of an undersea cable linking Oahu to Maui/Lanai and Molokai will not only allow wind generation from Maui to be brought to Oahu, but will allow power from Oahu to flow to Maui in instances where fluctuations in output occur. The Oahu electric system is roughly five times the size of the Maui system. Linking the two systems via an undersea cable the system will enable the system to absorb a higher level of intermittent sources.

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[41] Tackling Climate Change in the US, American Solar Energy Society, 2007.
[42] Smart Grid technologies can allow utilities to respond more quickly to supply changes and can link to consumer equipment in order to reduce loads in response to changing system conditions.
[43] Supported by appropriate rates and incentives, demand reduction programs can allow the utilities to control customer loads such as air-conditioners or water heaters in order to respond to short term variations in generation output;
[44] See discussion in: North American Electric Reliability Corporation (NERC), Accommodating High Levels of Variable Generation, April, 2009.

Table 2. Renewable Portfolio Standard Screening Criteria

Criteria	Discussion
Cost effectiveness	• The cost of most renewable resources currently exceeds conventional sources such as coal and to a lesser extent oil. Based on costs used in the modeling, wind is expected to cost about 10% more than power from a combined cycle oil-fired plant[45]. As oil costs rise over time renewable resources are projected to become increasingly competitive. • Once built, the variable costs of renewable sources such as wind, solar and geothermal are very low. They will therefore tend to be dispatched when available. • Biodiesel currently commands a price premium relative to conventional diesel. This implies that in order to reduce emissions the utility will need to dispatch on environmental characteristics rather than dispatching least cost resources first.
Ability to meet goal	The RPS can contribute significantly to meeting the State's GHG reduction goal.
Key sources to be included	Addresses power sector emissions, displacing fossil fuel use with renewable non-emitting sources.
Size of affected sources	Addresses power sector emissions which account for over half of State energy-related emissions.
Ability to monitor and verify	Monitoring and verification relatively straight forward. Measurement could become more complex if Renewable Energy Credits (REC's) are allowed.
Co-benefits for CAC's and toxic air emissions	Energy-related GHG and CAC emissions will be reduced in proportion to the amount of renewable energy substituted for fossil-fired generation.
Environmental benefits for Hawaii	Hawaii's energy-related GHG and CAC emissions will be reduced in proportion to the level of renewable energy used to substitute for fossil-fired

[45] Note these costs are approximate and indicate the full avoided costs. Variable operating costs are used in the model for dispatch.

Criteria	Discussion
	generation.
Compatibility with other programs	Amendments made to the RPS reduce the potential for overlap between programs. The use of electricity sales as the measure of renewable contribution does result in some potential for interaction. If other programs are successful in reducing electricity sales, the requirement for renewable energy will decline accordingly.
Extent of leakage	No leakage from the electric sector as there is no opportunity for power imports to the State.
Effects on small business	Small businesses will be affected by any costs passed on by either the power sector or the petroleum refiners. The level of impact will depend on the significance of energy costs in the small businesses overall operating costs and may be offset by efficiency efforts to lower overall costs.

iii. Application and Implementation Process or Procedure

- Is there a threshold below which reduction requirements should not apply?
  - No.
- Region/sector/end use where policy should be implemented.
  - This measure only applies to the power sector
- How to measure and verify effectiveness and any impacts of M & V (i.e. Reporting requirements, additional cost to business, etc.)
  - Measurement and verification are relatively straight forward based on renewable generation outputs and sales by utility. If a federal RPS proceeds, efforts should be made to coordinate reporting requirements with existing systems to prevent duplication

iv. Potential Impacts or Results of Implementation

The existing RPS, which required that renewable sources supply 20% of electricity sales by 2020, was included as part of the Reference projection.

When modeled as a stand-alone policy applied to the Reference Projection the enhanced RPS, which raises the target for 2020 to 25% of sales, reduces GHG emissions in 2020 by about 240 kt CO2e.

c) Energy Efficiency Portfolio Standard (EEPS)

i. Description

Energy efficiency has been and will continue to be a major "source" of new energy supply. Energy Efficiency Portfolio Standards recognize the importance of energy efficiency by treating it as a potential resource in planning future utility "supply".

An EEPS, like an RPS, sets a standard requiring utilities to achieve a given level of energy efficiency. Targets are usually set as either a percentage change in consumption relative to a baseline or as a specific target in terms of capacity (MW) or energy (GWh). The former method has some potential drawbacks in terms of setting the baseline and separating "naturally occurring" conservation and efficiency from that required to meet the EEPS.

In the initial RPS for Hawaii, energy efficiency qualified as a resource equivalent to new renewable supply. Under the revised RPS, energy efficiency no longer qualifies beyond 2014. Instead, an EEPS has been established as part of the HCEI. The HCEI sets a goal of developing clean energy sources to meet 70% of Hawaii's energy demand by 2030. According to Act 155, fully 30% of this 70% goal must be achieved through energy efficiency measures, equating to 4,300 GWh of the total electricity load in 2030 (see below).

Under the terms of the HCEI Agreement, Hawaii's electric utilities have agreed to support the State's efforts in incorporating an EEPS into State statute.

Act 155, signed into law in 2009, requires the development of an EEPS for Hawaii, establishing a state-wide energy efficiency portfolio standard that would offset forecasted load growth in the electricity sector from 2009-2030. The Act establishes a statewide target of 4,300 GWh of electricity savings by 2030 with interim targets to be set by the Public Utility Commissions (PUCs).

The Act includes a number of other provisions designed to contribute to the State's HCEI targets:

- Renewable energy including but not limited to solar water heating and sea water air conditioning, would count toward the EEPS.
- The Act provides that, on or after January 1, 2010, all new single family dwellings must have a solar water heater system.[46]

[46] A variance can be approved based on a number of conditions, including poor solar conditions, cost-prohibitive installation, etc.. This policy was included in the Reference Projection.

- The Act mandates that each State department with oversight for building construction must benchmark every existing public building that is either larger than 5,000 square feet or uses more than 8,000 KWh per year.

The Act indicates that the new Public Benefits Agency (PBA) will be responsible for implementation of the EEPS[47]. A number of potential roles for the Agency are described but the Act indicates that the PBA's duties and responsibilities will be defined by the Public Utilities Commission.

It is recommended that the role of the PBA not be restricted to only delivering electricity efficiency programs, but rather that it be allowed latitude to develop programs that can capture synergies between fuel, electricity and water efficiency.

ii. Analysis of Measure

EEPSs have been implemented in a number of US states, including New York, New Jersey and North Carolina[48]. According to the DOE/EERE twenty-one states had an EEPS in place or under development as of late 2008[49].

Table 3. EEPS Screening Criteria

Criteria	Discussion
Cost effectiveness	EEPS targets are normally set based on an assessment of energy efficiency potential in which only those measures which pass an agreed-upon definition of "cost effectiveness". This means that by definition measures included in the EEPS have a 'negative' cost in the sense that the cost of the measures are paid for through saved energy.
Ability to meet goal	Energy efficiency is expected to play a significant role in meeting the State's overall target.
Key sources to be included	Addresses electricity use across all sectors.
Size of affected sources	Electricity use accounts for over half of the State's energy-related emissions; which in turn account for roughly 90% of total emissions.
Ability to monitor and verify	There are well established protocols and processes for monitoring and verifying energy efficiency program targets. In a well managed process the costs of monitoring and verification are relatively minor in

[47] Act 155, HB1464 HD3 SD2 CD1, 2009, Part 4, Section 11.
[48] http://www.aceee.org/energy/state/policies/6pgEERS.pdf
[49] http://www.epa.gov/cleanenergy/energy-programs/state-and-local/efficiency_actions.html#eeps

Criteria	Discussion
	comparison with the energy saved.
Co-benefits for CAC's and toxic air emissions	In general energy efficiency programs have very low environmental impacts. Some products used to reduce energy consumption may require special consideration or handling to ensure that no negative environmental impacts occur. For example, programs designed to remove old refrigerators from service must consider the proper capture, recovery and disposal of refrigerants, re-lamping programs and programs encouraging increased use of CFL's should address proper disposal of lamps which contain mercury.
Environmental benefits for Hawaii	Hawaii's energy-related GHG and CAC emissions will be reduced in proportion to the reduction in fossil-fueled power generation.
Compatibility with other programs	The EEPS may interact with other initiatives such as a carbon tax or cap & trade program. As such programs raise energy costs they may result in increased investments in efficiency. This may complicate measurement of the effects of the EEPS.
Extent of leakage	N/A
Effects on small business	Only energy efficiency measures which are determined to be economical will be included as part of the EEPS. Small business could be affected by slightly increased capital costs, but should gain an overall economic advantage through energy efficiency. Small businesses are often difficult for energy efficiency programs to reach and face a number of barriers in pursuing efficiency opportunities. As a result, small business should be specifically targeted for attention by programs under the EEPS.

iii. Application and Implementation Process or Procedure

- Is there a threshold below which reduction requirements should not apply?
  - No.
- Region/sector/end use where policy should be implemented.
  - It is assumed that the Public Benefits Agency will pursue efficiency improvements across all counties. Ideally the Agency should also consider efficiency opportunities for all forms of energy; taking

advantage of co-benefits between energy forms and water savings.

- How to measure and verify effectiveness and any impacts of M & V (i.e., Reporting requirements, additional cost to business, etc.)
    - The policy is intended to apply to Hawaii's electricity generation and building sectors.

iv. Potential Impacts/Results of Implementation

Act 155 aims to reduce Hawaii's electricity consumption by 4,300 GWh by 2030. For modeling purposes it is assumed that this translates into a 20% reduction in electricity sales by 2020 and a 30% reduction by 2030.

When modeled as a stand-alone policy applied to the Reference Projection the EEPS, reduces GHG emissions in 2020 by about 1,500 kt CO_2e.

d) Additional Renewable Generation & Use of Biodiesel to Fuel Power Plants

i. Description

Hawaii's amended Renewable Portfolio Standard requires utilities within the State to obtain 25% of the electricity they sell from renewable sources by 2020 and 40% by 2030. Plans filed as part of the Integrated Resource Plans for each utility indicate how each utility intends to meet that requirement. As the percentage of renewables required is increased, it becomes increasingly challenging to integrate that level of renewable power from intermittent sources such as wind and solar into the grid and maintain system stability.

Given the State's heavy reliance on oil-fired generation, the use of biodiesel offers a means of providing "dispatchable" firm generation using renewable fuel. This policy reduces State GHG emissions and Hawaii's dependence on imported fossil fuels. According to the October 2008 HCEI Agreement, the policy's implementation hinges on a number of key objectives, including testing (e.g. operational test burns, technical feasibility analysis, etc.) and coordination with other policies (e.g. the State's Natural Resources Defense Council environmental sourcing policy and the State Biofuels Master Plan).

Biodiesel is a renewable fuel derived from naturally occurring oils found in plants, such as soybean or safflower, or animal fats that undergo a *transesterification* process in order to be used in combustion-ignition (diesel) engines. Biodiesel is produced by reacting vegetable oils or animal fats with an alcohol (typically methanol) to yield a fuel that can be used in any combination with petroleum-based fuels in standard diesel engines.[50] The capacity for producing biodiesel and other biofuels within the State is described in greater detail in the section on the Alternative Fuels policy later in the report. While the following discussion assumes the use of biodiesel fuel, the utilities are also testing the use of palm oil as a fuel. This could offer a lower cost alternative as it would not require the conversions to biodiesel.

ii. Analysis of Measure

Policies encouraging the use of biodiesel in electricity generation are relatively rare in North America as the number of oil-fired generation facilities has declined substantially in recent decades. Biodiesel is typically used in public sector climate change/clean energy initiatives as a replacement for traditional motor vehicle fuels (e.g. the "Low Carbon Fuel Standard" in the State of California). However, in the context of Hawaii,

[50] Michael D. Poteet. Biodiesel Crop Implementation in Hawaii. The State of Hawaii, Department of Agriculture. September, 2006.

where the majority of electric power is produced through the burning of refined oil, there is scope for a viable biodiesel market to supply the power system.

The HCEI Agreement describes a number of specific plants that HECO plans to install or convert to use biodiesel. Appendix B describes the specific plants, their capacity and proposed in-service dates. The Reference Case project includes a 110 MW capacity combustion turbine operating on biodiesel that is not included in the Appendix B listing. Given the Reference Projection that total generation capacity on Oahu will reach about 1,900 MW by 2015, the biodiesel facilities would represent 16% of installed grid capacity. The utility would retain flexibility to use alternative fuels should "significant" biofuel supply or price disruptions occur, though the company must obtain approval from the Public Utility Commission (PUC) before fossil fuels can be substituted.

The State's RPS specifies that up to 2015 no more than 30% of the Hawaiian Electric utilities' total RPS may come from imported biofuels consumed in utility-owned units. Under the HCEI Agreement the utility agreed to preferentially purchase locally grown biofuel. These provisions provide an incentive for biofuel production to be developed within Hawaii and imply that biofuel producers choosing to add capacity within Hawaii could benefit at the expense of mainland US suppliers. The opportunities relating to biofuels production are discussed later in the report.

Table 4. Using Biodiesel to Fuel Power Plants Screening Criteria

Criteria	Discussion
Cost effectiveness	The price of biodiesel is expected to be similar to that of regular diesel[51], therefore, the cost of switching power plants to biodiesel fuel is not projected to be significant. There may be some relatively minor associated capital expenditures involved in converting plants to use biodiesel. Overall, this policy is expected to be cost-effective in the sense that it offers a relatively low cost opportunity to convert existing capacity to use renewable fuels.
Ability to meet goal	Given that the majority of generating capacity is oil-fired this policy has significant potential to reduce emissions in the State.
Key sources to be included	Emissions due to the combustion of diesel and fuel oil for power generation are

[51] See price projections in Appendix D. HECO reported in 2005 that domestic biodiesel prices ranged from $11.90 to $23.80 per mBtu (HECO, Integrated Resource Plan, 2006-2025, October 28, 2005, page 8-18).

Criteria	Discussion
	included under this policy.
Size of affected sources	This policy addresses emissions from electricity generation, which accounted for over on-half of the GHG emissions included in the State's target in 2007.
Ability to monitor and verify	This policy is easily monitored and verifiable using standard practices and technologies.
Co-benefits for CAC's and toxic air emissions	The use of biodiesel as compared with diesel or fuel oil will reduce other air emissions, such as sulfur dioxide. MECO reports that tests of biodiesel blends showed reduced levels of SO2, polycyclic aromatic hydrocarbons and particulates[52].
Environmental benefits for Hawaii	Other than reduced air emissions, this policy may impact beneficially upon organic waste in Hawaii, as feedstocks for biodiesel production become more important.
Compatibility with other programs	The use of biodiesel in power generation will help the utilities meet the RPS goals and stimulate demand for biodiesel. Using biodiesel to fuel combined cycle and combustion turbine units will provide load following capability using a renewable source.
Extent of leakage	A portion of the biofuels used in Hawaii may come from other countries. This is a form of negative leakage in that emissions associated with the production of that biodiesel used within Hawaii will occur outside of the State, while the actual use of the fuel has been treated as having no emissions within the State.
Effects on small business	There are expected to be minimal effects on small business if biofuel prices decline relative to fossil fuel costs as projected.

iii. Application and Implementation Process or Procedure

- Region/sector/end use where policy should be implemented?

[52] Maui Electric Company, Limited, Integrated Resource Plan: 2007 -2026, Docket 04.0077, April 30, 2007, page 7-24.

- The policy is intended to apply to Hawaii's electricity generation sector.

- How to measure and verify effectiveness and any impacts of M & V (i.e. Reporting requirements, additional cost to business, etc.)?
    - No additional monitoring and verification required beyond that related to the RPS.

iv. Potential Impacts/results of Implementation

Biodiesel burns more cleanly than ordinary diesel fuel due to dramatically lower levels of sulfur found in the biodiesel. When manufactured from plant oils, biodiesel is also considered to be in net carbon balance, since it only emits as much carbon dioxide as was initially sequestered, or stored, within the plant used for fuel production.[53]

The treatment of GHG emissions from the production of biofuels (ethanol and biodiesel) is included in section 4.4.2 of the Assumptions Book (modeling inputs and assumptions). It is assumed that no anthropogenic GHG emissions result from the use of biofuels at the point of use. Biofuels which are imported to the State therefore do not contribute to Hawaii's GHG emissions. As in-state production capability is developed, the emissions associated with the production of biofuels will contribute to State emissions. This issue is discussed more fully in section 6 in the context of the combined Work Plans.

When modeled as a stand-alone policy applied to the Reference Projection the use of biodiesel to fuel generating units, in combination with the additional renewable generation proposed as part of the HCEI Agreement, reduces GHG emissions in 2020 by about 4,400kt CO2e. This assumes no GHG emissions are associated with the production of the biofuels used.

[53] Ibid.

e) Sea Water Cooling

i. Description

Space cooling accounts for about 25% of the commercial sector's electricity use and roughly 10% of the State's energy-related GHG emissions. The proposed sea water cooling system for downtown Honolulu takes advantage of the proximity of low temperature seawater deep offshore as a source of cooling.

The concept behind this system is simple: *"Cold, deep seawater is pumped through a distribution pipeline to a cooling station on the shore. The intake pipe is located at a depth where the water temperature is 39F – 45F year round."* The intake pipe connects to a cooling station which transfers the seawater's coldness to the water circulating in the local cooling system that connects to customer buildings[54].

ii. Analysis of Measure

Deep water cooling systems have been installed in Toronto, Canada[55] using fresh water from Lake Ontario and numerous systems are operating in Sweden.

Table 5. Sea Water Cooling Screening Criteria

<table>
<tr><th>Criteria</th><th>Discussion</th></tr>
<tr><td>Cost effectiveness</td><td>Can offer significant cost savings relative to conventional air conditioning.

SAMPLE BUILDING ECONOMICS[56]
<table>
<tr><th>Projected Current</th><th>Current Annual Costs</th><th>Projected HSWAC</th><th>HSWAC Annual Costs</th></tr>
<tr><td>Electricity</td><td>$765,765</td><td>Capacity Charge</td><td>$697,935</td></tr>
<tr><td>Cooling Tower and Sewer</td><td>$63,067</td><td>Non-energy Op Charge</td><td>$113,156</td></tr>
<tr><td>Water Treatment</td><td>$15,467</td><td>Energy Op Charge</td><td>$139,931</td></tr>
<tr><td>Maintenance</td><td>$40,500</td><td>Maintenance</td><td>$2,200</td></tr>
<tr><td>Labor and Admin</td><td>$28,160</td><td>Labor and Admin</td><td>$7,040</td></tr>
<tr><td>Capital Cost</td><td>$165,970</td><td>Capital for Service</td><td>$22,209</td></tr>
<tr><td>Total</td><td>$1,078,929</td><td></td><td>$982,471</td></tr>
<tr><td>Fixed Cost</td><td>$165,970</td><td></td><td>$697,935</td></tr>
<tr><td>Op Cost</td><td>$912,959</td><td></td><td>$284,536</td></tr>
<tr><td>Net Savings per</td><td>$96,458</td><td></td><td></td></tr>
</table></td></tr>
</table>

[54] http://honoluluswac.com/
[55] Enwave corporation launched its system to supply lake-water cooling in 2004 and is now the largest lake cooling system in North America serving over 30 office buildings in downtown Toronto. http://www.enwave.com/home.php
[56] Presentation: Offloading the Grid through Renewable Cooling by William Mahlum, President and CEO, Honolulu Seawater Air Conditioning. IDEA Centennial Conference: "Local Energy, Global Solution" June 28-July 1, 2009.

Criteria	Discussion
	year
Ability to meet goal	Savings can make a significant contribution, but application is limited to relatively high density urban areas with large cooling loads close to deep cool water.
Key sources to be included	Addresses a major end use driving commercial electricity use.
Size of affected sources	Electricity for commercial air-conditioning accounts for roughly 7% of total State energy-related emissions.
Ability to monitor and verify	Easy to monitor and verify.
Co-benefits for CAC's and toxic air emissions	Hawaii's energy-related GHG and CAC emissions will be reduced in proportion to the reductions in electricity generation.
Environmental benefits for Hawaii	Reduced air emission associated with power production.
Compatibility with other programs	Helps reduce electricity demand and provides a renewable cooling service.
Extent of leakage	N/A
Effects on small business	• Stabilization of consumer electric rates by delaying the need for investment in new generating capacity; • Lower operating and maintenance costs for small businesses located in buildings utilizing the seawater cooling service; • Local expenditures of millions of dollars in construction costs; • Provision of construction employment; and economic multiplier effects on money that stays in Hawaii's economy[57]

iii. Application and Implementation Process or Procedure

- Including threshold below which reduction requirements should not apply:
  - N/A

- Region of Implementation:
  - A system is planned for downtown Honolulu. A second system is contemplated for the Waikiki area.

[57] Honolulu Seawater Air Conditioning LLC, Draft Environmental Impact Statement, October 2008, prepared by TEC Inc., http://oeqc.doh.hawaii.gov/Shared%20Documents/EA_and_EIS_Online_Library/Oahu/2000s/2008-11-08-OA-DEIS-Honolulu-Seawater-Air-Conditioning.pdf

- System has potential in areas where there are significant building cooling demands adjacent to deep, cold water.

- Measurement & verification & Impacts: Monitoring and verification is relatively straight-forward and can be accomplished with well known technologies.

iv. Potential Impacts/results of Implementation include

A report evaluating the downtown Honolulu project[58], assuming a 25,000-ton cooling capacity seawater cooling system, estimates the following benefits:

- Reduction of 178,000 barrels of imported fossil fuels used per year;
- Reduction of associated emissions of air pollutants by the following amounts:
    - CO_2 – 84,000 tons/year
    - VOC – 5 tons/year
    - CO – 28 tons/year
    - PM10 – 19 tons/year
    - NOx – 168 tons/year
    - SOx – 165 tons/year

- Savings of 77 million kWh/year;
- Savings of 75 percent of energy use compared to conventional chiller equipment;
- Reduction of thermal pollution of the environment by about one third compared to electricity-powered air conditioning systems;
- Savings of nearly 292 million gallons/year of potable water;
- Reduction of up to 114 million gallons/year of wastewater;
- Elimination of cooling tower treatment chemicals for connected buildings;
- Elimination of up to 14 megawatts of new generating capacity (equivalent to one year of Hawaiian Electric Company's [HECO] projected load growth);

For modeling purposes the electricity saving estimated above were used and it was assumed that a second project would proceed for Waikiki prior to 2020. This approach takes into account the changing emission intensity of the generation system as other policies, such as the RPS, are implemented.

When modeled as a stand-alone policy applied to the Reference Projection the projects reduce GHG emissions in 2020 by about 126 kt CO_2e.

[58] Ibid.

f) Alternative Fuel Standard (AFS)

i. Description

Existing legislation requiring that 85% of gasoline must contain at least 10% ethanol was included in the Reference Projection of emissions to 2020. In 2006, Act 240 (SLH 2006) directed DBEDT to "facilitate" the development of an Alternative Fuel Standard (AFS) that would require that 10% of highway fuel come from alternative fuels by 2010, rising to 15% by 2015 and 20% by 2020. This expanded requirement has been included in modeling of future policies.

ii. Analysis of Measure

Policies requiring that a specified percentage of vehicle fuel come from renewable or alternative sources have been implemented in numerous jurisdictions internationally as well as across the US. The Energy Independence and Security Act (EISA) included national production targets for corn and cellulosic ethanol and 'advanced' biofuels. These provisions were also incorporated in the reference projection.

Hawaii's AFS differs from most standards in that it addresses different types of ethanol; providing additional credit for cellulosic ethanol compared to ethanol produced from corn feedstock.

The University of Hawaii published a study in June 2007 on the potential and economics of ethanol and biodiesel production and use in Hawaii[59]. The study estimated the potential for local production and associated prices based on quantity of land available and crop grown. Several important implementation concerns (water availability and cost, land availability, land use priorities, impacts on environmental quality, economic impacts, and costs of nascent ethanol conversion technologies) were outside the scope of the study.

Table 6. Alternative Fuel Source Screening Criteria

Criteria	Discussion
Cost effectiveness	Varies depending on price of oil. Both ethanol and biodiesel are becoming increasingly competitive. Uncertainties around feedstocks, production technologies and capacity remain; particularly with respect to biodiesel[60]. Ethanol: 2010 production costs for ethanol have

[59] University of Hawaii, "A Scenario for Accelerated Use of Renewable Resources for Transportation Fuels in Hawaii", 2007.
[60] Issues around biodiesel production are discussed in section 6 of HECO's IRP4 report. Hawaiian Electric Company Ltd., Integrated Resource Plan: 2009-2028, Docket No. 207-0084, September 2008.

Criteria	Discussion
	been estimated to be in the range of $1.45 to $1.58 per gallon of ethanol from molasses. This would be competitive with west coast spot prices (plus shipping costs) at $2.00- $4.54/gallon landed in Hawaii excluding incentives. Given differences in energy content, a price of $1.50/gallon for ethanol equates to $2.25/gallon of gasoline. This price level is therefore comparable to the level of average retail gasoline prices (excluding taxes) at $2.35/gallon in December of 2006.[61] Biodiesel: Based on estimates for Malaysian palm oil at $2.57/gallon, biodiesel costs were estimated at $2.89-$3.15/gallon[62]. The expectation is that as local crop production and conversion expertise grows costs will be reduced. In the HECO IRP4 documents, projected biodiesel prices[63] for use in electrical generation are equivalent to about $21.50 to $38.40/mBtu.[64] The same document projects diesel prices to be in the range of $16.18 to $20.30 per mBtu, however, this was based on a forecast of world oil prices in the range of $90 per barrel. Actual prices in mid-August 2009 were about $72 per barrel.
Ability to meet goal	Substitution of biofuels for petroleum-based fuels could potentially address most of Hawaii's energy use. The ability of biofuels to contribute to State goals depends in part on the ability to substitute biofuels in all applications and on the availability of an adequate supply. For vehicle transportation, ethanol has been successfully used in an 85% blend with gasoline (E85) with some vehicle modifications. Biodiesel is typically applied in a lower mix, such as B20 (20% biodiesel mixed with 80% diesel; however, it has also been used as pure biodiesel in some vehicles.

[61] Ibid., page 26.
[62] Ibid., page 31.
[63] HECO, IRP4, figure 6.2-1.
[64] Approximately $140 to $250 per barrel in 2008, equivalent to $2.55 to $4.55 per gallon. Converted to $/mBtu at a rate of 118,296 Btu/gallon.

Criteria	Discussion
	Only two biodiesel plants are now operating in Hawaii. In 2004, MECO indicated that "Five ethanol production plants (two on Kauai, one on Maui, one on the Big Island, and one on Oahu) are planned to potentially supply the State with nearly 60 million gallons per year"[65]. To-date none have been completed. If use of biofuels were limited to levels which could be produced from crops grown within the State, then the contribution of biofuels to the State's GHG targets could be more limited. Various studies of the potential to produce biofuels in Hawaii indicate a wide range of potential; depending on the type of crop used and limits placed on land use[66]. Ethanol production could range from 390 to 525 million gallons (40-49 tBtu) per year, while biodiesel production potential is estimated to be about 160-165 million gallons per year (19.5 tBtu). The Reference Projection indicates that under existing policies, Hawaii's annual demand for gasoline and diesel would be about 40 and 14 tBtu respectively. While the estimates of production potential include considerable uncertainties, in terms of the type of land that could be used to produce these fuels, the technologies involved, water supply, etc., these values indicate that the potential exists to meet much of the State's portable fuel demand from in-state production of biofuels.
Key sources to be included	Biofuels can be used in both transportation and electric power generation; which are the two key demand sectors responsible for the bulk of the State's emissions.
Size of affected sources	Over 90% of emissions could potentially be addressed to some degree by use of biofuels.
Ability to monitor and verify	Monitoring of biofuel imports and production could

[65] MECO, IRP3, Final Report, page 7-23.
[66] University of Hawaii, "Potential for Ethanol Production in Hawaii". December 2006;
State of Hawaii, Hawaii Natural Energy Institute, "Biomass and Bioenergy Resource Assessment", December 2002, and Hawaii Natural Energy Institute. "A scenario for Accelerated Use of renewable Resources for Transportation Fuels in Hawaii", June 2007.

Criteria	Discussion
	be covered through existing regulatory controls and monitoring systems for conventional fuels. Fuel distributors now report on ethanol blends in accordance with the requirements of Act 130 (2007)[67]. State standards should be established to assign full cycle emission factors to biofuels based on the source and type of production. For example, ethanol derived from corn should be assigned a different emission factor than cellulosic or sugar-based ethanol.
Co-benefits for CAC's and toxic air emissions	Use of biodiesel substantially reduces sulfur emissions. Some CAC emissions may rise with higher levels (E85) of ethanol use, however, most Criteria Air Contaminant (CAC) emissions would be lowered.
Environmental benefits for Hawaii	Could be significant. Issues relating land use and water demands would need to be managed.
Compatibility with other programs	Would help to support efforts to meet RPS, providing dispatchable renewable generation. Policies aimed at improving transportation efficiency and reducing travel demands could help reduce energy requirements within in-state production capacity.
Extent of leakage	To the extent that biofuels are imported, emissions associated with their production would occur outside of the State (reverse leakage) and should be taken into account in comparing overall effects of policy.
Effects on small business	Small businesses involved in fuel distribution, trucking and other transportation services may be affected by additional reporting requirements and any increase in fuel costs in the near term. If biofuel prices decline relative to fossil fuels as projected, this could provide more stable energy costs over time. Small business may benefit if local production facilities are established.

[67] http://hawaii.gov/dbedt/info/energy/transportation/ethanol/

iii. Application and Implementation Process or Procedure

- Is there a threshold below which reduction requirements should not apply?
  - n/a
- Region/sector/end use where policy should be implemented
  - Applies to entire State and all highway use of fuels.
- How to measure and verify effectiveness and any impacts of M & V (ie. Reporting requirements, additional cost to business, etc.)
  - Monitoring and reporting of highway fuels now in place will need to be adjusted to include reporting of ethanol and biodiesel. Ethanol will need to be identified by source in keeping with requirements of Act 240.

iv. Potential Impacts/results of Implementation

Biodiesel production is being ramped up in the State primarily for electricity production. If economies of scale develop and the State supports a vibrant biodiesel economy chain Hawaii could become a leader in biofuel use. Both biodiesel and ethanol production can build on existing local agricultural and technological know-how and add to local employment.

The potential for biodiesel, ethanol, vehicle standards and the introduction of PHEV's are related and have complementary impacts. The interactions between these policies will be discussed further in Section 6.

When modeled as a stand-alone policy applied to the Reference Projection, the AFS reduces GHG emissions in 2020 by about 190 kt CO2e. As a higher percentage of the fleet is fueled by ethanol, the average efficiency expressed in miles/gallon declines; reflecting the lower energy content per gallon of ethanol when compared to gasoline.

g) Increased Vehicle Efficiency

i. Description

Passenger vehicles represent one of the largest sources of GHG emissions in Hawaii. The efficiency of passenger vehicles was projected to increase in the Reference Projection as a result of CAFÉ requirements imposed in the EISA. This standard would have required the average new car to reach 35.5 mpg by 2020.

On May 19, 2009, the Obama administration announced its intention to establish standards for vehicle GHG emissions that broadly align with the GHG emission standards put forward by California[68], (the Pavley standard). As a result, it is anticipated that a national standard will be established which will require the fuel efficiency of new passenger cars and light trucks to reach an average fleet efficiency of 35.5 mpg by 2016.

Requirements beyond 2020 remain unclear. California and other states have set a further goal of achieving average new vehicle fleet efficiency level of 42 mpg by 2020.

This policy involves implementing new vehicle efficiency standards that will reach 35.5 mpg by 2016 and assumes that Hawaii will work with other states to adopt a requirement for continued efficiency improvements to reach 42 mpg for new vehicles by 2020 (in line with the proposed Pavley II regulations in California described earlier). This policy would require the manufacturers to meet certain efficiency standards as a condition of vehicle certification.

Beyond adopting a vehicle efficiency standard the State can take a number of other actions to encourage the more efficient choices within the existing selection of new vehicles. These include:

- A tax neutral “gas guzzler” tax, in which inefficient vehicles would be subject to a higher tax, while designated efficient vehicles would be economically incented. The policy would be set up such that the tax and benefit would, on balance, not increase overall tax revenues. The government of California, which is implementing such a policy, expects that it will benefit drivers by ultimately saving them an estimated $30 each month in avoided fuel costs.
- The State has established rules requiring that vehicles purchased by government agencies be selected to meet efficiency and alternate fuel requirements. There is a significant opportunity to influence other vehicle fleets; such as in taxi and rental vehicle fleets. Tax and other incentives have been introduced in other states and cities across the US to encourage more rapid adoption of higher efficiency vehicles and hybrids. The potential to influence rental vehicle fleets is

[68] The Pavley standard has been adopted by more than a dozen states.

particularly significant for Hawaii, where these vehicles represent a significant share of total passenger vehicles.

ii. Analysis of Measure

Table 7. Increased Vehicle Efficiency Screening Criteria

Criteria	Discussion
Cost effectiveness	This policy is very cost-effective; it is estimated that it will ultimately benefit drivers economically; however, the purchase cost will increase by approximately $500 and $1,000 in the near and mid-term, respectively[69].
Ability to meet goal	The Pavley regulation is expected to reduce GHG emissions by over 30,000 kt CO_2e in California. Due to the relative importance of personal transportation in Hawaii, a similar policy would be expected to have a large positive impact.
Key sources to be included	Combustion emissions from fossil fuels (gasoline, diesel) consumed in light vehicles.
Size of affected sources	Passenger transportation accounts for approximately 16% of emissions in Hawaii, including aviation and military emissions.
Ability to monitor and verify	This policy is relatively easy to monitor and verify, as the data necessary to monitor and verify this information is already commonly collected.
Co-benefits for CAC's and toxic air emissions	In addition to GHG emissions, the increased efficiency of combustion of fossil fuel in transportation applications due to this policy will reduce the emission of SOx, NOx and VOC's.
Environmental benefits for Hawaii	This policy will reduce such effects both CAC and GHG emissions.
Compatibility with other programs	A policy to increase vehicle efficiency to 2016 is likely be implemented by the federal government in the near term. Continued improvement in vehicle efficiency would assist in meeting the requirements of the Alternative Fuel Standards with biofuels produced within the State.
Extent of leakage	n/a
Effects on small business	Increased vehicle efficiency will provide some benefits to small business owners in terms of reduced operating costs. This impact will be

[69] Union of Concerned Scientists. The Consumer Benefits of California's Vehicle Global Warming Law: Fact Sheet. June 2005 http://www.ucsusa.org/clean_vehicles/solutions/cleaner_cars_pickups_and_suvs/consumer-benefits-of.html

Criteria	Discussion
	relatively small for most sectors but may be significant for some transportation related services.

iii. Application and Implementation Process or Procedure

a. Is there a threshold below which reduction requirements should not apply?
   - No.
b. Region/sector/end use where policy should be implemented
   - Cars and light trucks will be covered by regulation.
c. How to measure and verify effectiveness and any impacts of M & V (ie. Reporting requirements, additional cost to business, etc.)
   - Would require monitoring of vehicles shipped to Hawaii for sale.

Assumes a national standard will be established which will require the fuel efficiency of new passenger cars and light trucks to reach an average fleet efficiency of 35.5 mpg by 2016, with a continuing requirement established by the State to increase to 42 mpg by 2020; with further improvements beyond that year. Information relating to the cost of implementing this policy was based on estimates by the NHTSA[70].

iv. Potential Impacts/results of Implementation

Given the relative importance of passenger vehicle emissions to total emissions in Hawaii, it is recommended that that Hawaii actively support and pursue continued improvements to vehicle efficiency, and adopt higher vehicle emission standards (i.e. Pavley II) if federal standards do not require continued improvement beyond 2016.

When modeled as a stand-alone policy applied to the Reference Projection the increase in vehicle standards reduces GHG emissions in 2020 by about 26 kt CO2e. This reflects the relatively short (4 year) period to the end of the modeling projection over which efficiency levels would continue to increase. The impact would continue to increase after 2020 and contribute to the State's efforts to obtain 70% of its energy supply from clean sources by 2030. Modeling results also indicated a very slight shift to vehicles and away from mass transit and a slight shift to larger vehicles as vehicle efficiency improved.

[70] NHTSA, Corporate Average Fuel Economy Rulemaking, Document No. WP.29-145-13, June 2008, see also: NHTSA, Final Environmental Impact Statement, Corporate Average Fuel Economy Standards, Passenger Cars and Light Trucks, Model Years 2011 to 2015, October 2008.

h) Plug In Hybrid Electric Vehicles

i. Description

This policy promotes the use of plug-in hybrid electric vehicles using a variety of mechanisms including direct subsidy, reduced fees for taxation/license/insurance, education, non-monetary incentives (e.g., preferential parking) and appropriate infrastructure development.

Plug-in hybrid electric vehicles (PHEV) utilize electricity stored in batteries, along with an engine that can generate electricity and motive power from a separate fuel source. The use of electric drives to power such vehicles offers substantial opportunity for efficiency improvements. For example a PHEV capable of running 20 miles on battery power could reduce gasoline use by more than 45%[71] PHEV's could provide several advantages, including: i) reduce the variable costs of transportation; ii) decrease transportation sector emissions significantly; and iii) utilize off-peak power capacity. This technology remains in its early stages and is currently more costly than other vehicle types.

PHEV technology also offers a possibility of providing a form of distributed electricity storage for the power grid. When combined with "Smart Grid" technology, this offers the potential of allowing the integration of higher levels of intermittent renewable generation into the power system.

ii. Analysis of Measure

Based on relevant studies[72], the electric efficiency of the PHEV is assumed to be:

- Compact - 0.26 kWh/mile
- Mid-Size - 0.30 kWh/mile
- Mid-Size SUV/Vans - 0.38 kWh/mile
- Full Size SUV/ - 0.46 kWh/mile

The cost of a PHEV is assumed to be 66% greater than a conventional car in 2010 falling to 36% by 2020. It is assumed that all charging will be done at night during off-peak hours when wind generation is considered to be most active.

[71] NREL, Cost-Benefit Analysis of Plug-In Hybrid Electric Vehicle Technology, A. Simpson, November 2006, *Presented at the 22nd International Battery, Hybrid and Fuel Cell Electric Vehicle Symposium and Exhibition (EVS-22).*
[72] Pacific Northwest National Laboratory, Potential Impacts of High Penetration of Plug-in Hybrid Vehicles on the U.S. Power Grid, June 2007, (from DOE, EERE, PHEV Workshop). ORNL, Impact of Plug-in Hybrid Vehicles on the Electric Grid, October 2006, prepared for U.S.D.O.E.

We have assumed that a typical PHEV would have the following characteristics:

- Require 1.4 to 6.0 kW demand on connection,
- Recharge over a period of from 4 to 8 hours,
- Consume 6.5 to 10.5 kWh/vehicle each day.

The charge time and electricity consumption for a PHEV with a 20 mile range is assumed to be:

Table 8. PHEV (20 mile range) Charge Time

Vehicle Type	kWh	Recharge Time (Hours)
Compact Sedan	6.5	3.9 to 5.4
Mid Size Sedan	7.2	4.4 to 5.9
Mid Size SUV	8.7	5.4 to 7.1
Full Size SUV	10.1	6.3 to 8.2

Table 9. PHEV Screening Criteria

Criteria	Discussion
Cost effectiveness	PHEVs are not considered cost-effective based on current energy costs and existing technology. Premiums over regular vehicles are expected to be as high as 36% as far out as 2020 even for a model that can run only 20 miles before needing recharging. Recent announcements by GM regarding the planned release of the Chevy Volt, expected to be the first PHEV on the market, indicate a purchase price roughly double the cost of a gas-electric hybrid such as the Toyota Prius[73].
Ability to meet goal	In the near term, the contribution is expected to be quite low in the absence of strong financial incentives and education.
Key sources to be included	Transportation emissions.
Size of affected sources	Passenger transportation accounts for over one-quarter of the State's energy-related GHG emissions.
Ability to monitor and verify	High, through electricity use and regular vehicle fuel consumption.
Co-benefits for CAC's and toxic air emissions	Move from multiple point emissions to stationary source (i.e. power plants), where they are easier to control. Vehicle CAC emissions would be reduced in proportion to

[73] Globe and Mail Newspaper, Business section, August 12, 2009, page B2. www.theglobeandmail.com

Criteria	Discussion
	the reduction in gasoline consumption. High likelihood of charging during off-peak hours when demand is lowest and wind generation is expected to be highest.
Environmental benefits for Hawaii	Use of PHEV's would significantly lower both CAC's and GHG's compared to conventional vehicles. The size of this benefit will be proportionate to the market penetration achieved.
Compatibility with other programs	Compatible with Alternative Fuel Standards and vehicle efficiency requirements. The potential for Hawaii to supply its own portable fuel needs would be greatly enhanced if and when PHEV's achieve a significant market penetration and can be fueled in part with biofuels (i.e. E85). The resulting reduction in transportation fuel requirements could result in Hawaii becoming a net exporter of biofuels (see discussion of biofuel production potential in section 6).
Extent of leakage	n/a
Effects on small business	The effects of this policy are expected to be quite small in the timeframe to 2020. If Hawaii is a first mover in encouraging PHEV's it might provide opportunities for innovation and entrepreneurship in related services such as providing charging stations.

iii. Application and Implementation Process or Procedure

Currently, it is too early to determine whether PHEV will play a significant role to 2020, due to the high cost of vehicle purchase. The use of PHEV should be supported, but it they are not assumed to play a significant role in Hawaii over the model period.

iv. Potential Impacts/results of Implementation

When modeled as a stand-alone policy applied to the Reference Projection the introduction of PHEV's reduces GHG emissions in 2020 by about 56 kt CO2e.

i) Building Codes

i. Description

Residential and commercial sector emissions resulting from on-site direct use of energy are relatively low; comprising less than 2%, however, electricity consumption by these sectors drives electricity consumption. However, if electric sector emissions are attributed to the end use sectors based on their percentage of sales, then just over one-half of the State's energy-related GHG emissions are attributable to the residential and commercial sectors.

According to the EIA, Hawaii does not have a common building code for the State[74], with each county approving its own codes for residential and commercial buildings. For commercial buildings, "*Honolulu, Maui, and Kauai County require compliance with ASHRAE 90.1-1999. Hawaii County requires compliance with ASHRAE 90.1-1989."* By contrast, twenty-two states now require compliance with ASHRAE 90.1-2004 and California and two other states have updated their requirement to the 2007 version of the code. Hawaii's Act 107 states that the building code requires that the code established for the State shall include "the latest edition of the International Building Code"[75], however, each county has up to 2 years to adopt revisions to the State code.

The ACES Act includes a number of provisions to improve the efficiency of new buildings. The Act establishes goals for improving building codes for residential and commercial buildings and the implementation of those Codes[76]. Building codes will be developed to require 30%, 50% and eventually a 75% reduction in building energy use, starting with the implementation of the Act and phasing in until 2030. The Act defines compliance requirements for State and local agencies, which will be required to support compliance and enforcement efforts[77].

Each new building built to lower, outdated standards represents a lost opportunity. We recommend that Hawaii follow the example set by the ACES and establish a State requirement for new buildings with a progressive requirement for continued updates as technology improves.

ii. Analysis of Measure

Most US States have updated their building code requirements beyond the level required in Hawaii. Many have a requirement that the code be regularly updated based

[74] http://www.energycodes.gov/implement/state_codes/state_status.php?state_AB=HI
[75] HRS 107-25.
[76] Title II, Energy Efficiency, Sub-title A, Building Efficiency programs, Section 201.
[77] EPA Analysis of H.R. 2454, Appendix 1, page 36.

on changes in a reference code (i.e., ASHRAE 90.1or International Energy Conservation Code (IECC)).

The following table summarizes the screening criteria used to review this initiative.

Table 10. Building Codes Screening Criteria

Criteria	Discussion
Cost effectiveness	Investments in increased building efficiency typically repay any additional investment required within a few years. Establishing a code requirement overcomes market barriers which limit the adoption of 'economic' measures due to split incentives and other market imperfections.
Ability to meet goal	This measure will make a fairly minor contribution to achieving the State's 2020 reduction target; however, it is important that this policy be implemented now in order to achieve longer term GHG reductions that will be required.
Key sources to be included	Key sources to be included residential and commercial buildings, including their electricity use.
Size of affected sources	Addresses emissions from residential and commercial sectors, including power sector emissions related to sales to these sectors, which account for over half of the State's energy-related GHG emissions.
Ability to monitor and verify	Compliance will be monitored through permitting and building inspection process.
Co-benefits for CAC's and toxic air emissions	Hawaii's energy-related GHG and CAC emissions will be reduced in proportion to the reductions in electricity generation. No negative impacts are envisioned.
Environmental benefits for Hawaii	Improved building design should lead to improved air quality and comfort for building occupants. Environmental benefits will arise from reduced electricity use. Inclusion of green roofs may reduce heat island effect around urban areas.
Compatibility with other programs	Improved building design is consistent with other initiatives to reduce energy use and power sector emissions.
Extent of leakage	n/a.
Effects on small business	Small businesses may have less ability to influence the design of their facilities and are more likely to occupy space as tenants. More efficient buildings will help lower occupancy costs for all tenants,

Criteria	Discussion
	including small businesses.

iii. Application and Implementation Process or Procedure

- Is there a threshold below which reduction requirements should not apply?
  - n/a.

- Region/sector/end use where policy should be implemented
  - State wide policy

- How to measure and verify effectiveness and any impacts of M & V (i.e., Reporting requirements, additional cost to business, etc.)
  - Normal reporting on building permit activity and code compliance should be used to report on progress.
  - Follow on reporting on building performance could be provided based on sampling to compare performance of new buildings with pre-policy performance and quantify savings.

iv. Potential Impacts/results of Implementation

- Potential to reduce emissions
  - Relatively small impact in period to 2020, however, the value of the policy will continue to grow over time and will make a growing contribution to longer term goals.

- Discuss how measure/policy may interact with others

  - New buildings represent a “lost opportunity” load. If they are built to a lower standard then additional effort will be required through other programs to improve their performance at a later date. By requiring a higher standard today, these structures will offer increased value to occupants and not add to the burden of other efficiency programs.

When modeled as a stand-alone policy applied to the Reference Projection improved building codes reduce GHG emissions in 2020 by about 700 kt CO_2e. These reductions will continue to contribute over the life of these long-lived assets and will build over time to contribute to longer term objectives such as Hawaii’s Clean Energy Initiative target and longer term reductions required in GHG emissions.

j) Freight Options

i. Description

Freight transportation in Hawaii involves both marine and road transportation. Limited state-specific information was found relating to energy use related to freight activity; for example, a breakdown of energy use by vehicle type, travel distance, etc. There are, however, a number of opportunities for reducing freight energy use, in particular for road transportation. As vehicle standards are improved for passenger transportation it is expected that the remaining freight vehicle energy use will assume a larger share of total GHG emissions.

For small and medium trucks, a number of existing, demonstrated and cost-effective technologies exist today that could increase energy efficiency by 50%[1]. Reducing vehicle weights, increasing engine efficiency and aerodynamics, using hybrid motors to allow recovery of braking energy and more appropriate engine sizing can all contribute to this reduction. Examples of such technologies are already in use today. For example, in Canada the Post Office has piloted the use of hybrid vehicles:

"Canada Post's prototype Azure Dynamics hybrid vehicles consume 40 per cent less fuel than the company's current diesel vans, and 60 per cent less than Canada Post's gasoline-fuelled vans. CO2 emissions from the Azure hybrid are 91 per cent per cent lower than emissions from the diesel vans." [78]

The US 21st Century Truck Program[79], a government and industry partnership, has set a goal to move beyond these accomplishments. By 2010, they propose to develop the technologies to:

"– double the Class 8 line-haul truck fuel efficiency on a ton-miles-per-gallon basis,
– triple the Class 2b and 6 truck (delivery van) fuel efficiency on a ton-miles-per-gallon basis, and
- triple the fuel efficiency of heavy-duty transit buses on a miles-per-gallon basis."

They propose to make improvements in a range of areas relating to weight reduction, engine improvements, reducing aerodynamic drag and rolling resistance, the use of hybrid drives and regenerative braking. Further potential gains which could be achieved through exhaust heat recovery, more efficient accessories, driver education and schedule optimization are not included in the projects objectives. Seemingly minor

[78] *Kyoto and Beyond – The Low Emission Path to Innovation and Efficiency, Prepared for the David Suzuki Foundation and the Canadian Climate Action Network Canada by Ralph Torrie, Richard Parfett and Paul Steenhof of Torrie Smith Associates. October 2002.*
[79] *Technology Roadmap for the 21st Century Truck Program, Energy Efficiency and Renewable Energy - US Department of Energy, December 2000.*

areas have the potential to make significant contributions. For example, since 30-50% of engine output can be devoted to operating accessories reducing these loads could contribute to reducing these loads could contribute to improved urban air quality.

There are also a number of opportunities to reduce energy use for shipping, ranging from improving the shape and smoothness of hulls, to improved propellers and engines, fuel switching, improved logistics, route planning and navigation[80].

The introduction of a cap-and-trade system or carbon tax will provide incentive for this sector to reduce emissions; however, additional information programs could be used to reinforce and support such changes. While there are a number of policy options that can be exercised to influence freight efficiency (i.e. fleet standards, support for R&D, etc.) most were not felt to be appropriate for implementation in Hawaii.

It is recommended that DBEDT work to develop more detailed information on transportation energy use, the types of vehicles and vessels used to transport materials, and fuels used. Using this information and working with the stakeholders in the sector, it is recommended that information programs be developed to disseminate information on the most efficient technologies and their cost advantages to fleet owners and purchasers, and operational and purchasing practices that can support lower energy use and emissions. Equipment in this sector tends to be long lived, so investments made today are likely to affect emissions for decades to come. Influencing these decisions can therefore be important in contributing to long-term reduction goals.

ii. Analysis of Measure

Table 11. Freight Options Screening Criteria

Criteria	Discussion
Cost effectiveness	Many technologies available to reduce energy consumption are already cost-effective.
Ability to meet goal	Given the long asset life in this sector this policy is expected to make a relatively small contribution to the State's reduction goal for 2020.
Key sources to be included	Freight (road and marine) emissions will become an increasing share of total emissions as passenger vehicle efficiency increases over the coming decade.
Size of affected sources	Marine transportation emissions contributed 13% of State emissions while freight contributed a further 6% in 2007.
Ability to monitor and verify	Monitoring the effectiveness of measures in this

[80] See for example: Reducing GHG Emissions from U.S. Transportation - Pew Center on Global Climate Change – 2003, http://www.ethanol-gec.org/information/briefing/9.pdf and Transport and its infrastructure -IPCC – 2007, http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter5.pdf

Criteria	Discussion
	area will require more detailed data collection on this sector.
Co-benefits for CAC's and toxic air emissions	Use of more efficient and appropriately sized vehicles can contribute to reduced urban air pollution. In general, GHG and CAC emissions will be reduced proportionately as energy use is reduced.
Environmental benefits for Hawaii	As above.
Compatibility with other programs	Programs in this area can help reduce operator costs in an environment in which carbon costs are applied. Improving freight efficiency is consistent with efforts to reduce passenger vehicle emissions.
Extent of leakage	n/a
Effects on small business	Programs to encourage increased efficiency help improve industry competitiveness. Small businesses involved in freight and delivery may face unique barriers to improving energy efficiency, including limited resources, access to capital and technology. The provision of information and support can help these small businesses remain competitive while adapting to changing energy conditions and costs. Reduced shipping costs will contribute to lower costs across the economy, assisting both small business and residents.

iii. Application and Implementation Process or Procedure

- Region/sector/end use where policy should be implemented
  - This policy should apply to freight transportation across the State.

- How to measure and verify effectiveness and any impacts of M & V (i.e. Reporting requirements, additional cost to business, etc.).
  - Measurement and verification, based on fuel use, should be developed as part of the process of collecting more detailed equipment, operational and energy use for the sector.

iv. Potential Impacts/results of Implementation

- Potential to reduce emissions.
    - Short term potential estimated to be relatively small, however, long term potential is much higher. Influencing purchase decisions can help avoid lost opportunities for long-lived capital assets.

- Discuss how measure/policy may interact with others.
    - As discussed above, increasing sector efficiency can contribute to meeting cap-and-trade goals and reduce the economic impact of adding a cost for carbon (cap-and-trade or carbon tax).

k) Urban Form (Smart Growth)

i. Description

Over the past half century, urban areas throughout the US have been designed around personal vehicle use. As we enter into a period of greater concern over oil availability and climate change, some governments are taking a new look at urban planning and acting to limit continued urban sprawl. These efforts involve changing urban planning to develop more compact urban form, supporting the use of public transit, walking and biking, improving the mix of employment and housing, and promoting design and orientation which maximizes the use of alternative energy and the mitigating effects of vegetation. By encouraging a mix of land uses, increasing density and promoting the use of public transportation, transportation energy use can be significantly reduced.

Higher density housing uses far less energy than subdivisions of single family detached homes. Walkable communities, with bike paths, mixed land use, and access to effective public transit can reduce both the number of kilometers traveled and the energy used per km. Careful orientation of lots within new developments can make the use of passive and active solar heating accessible to the majority of homes.

Higher density development also pays dividends in reducing infrastructure costs. The costs of roads, water, sewer, electric and gas distribution facilities are all reduced in comparison with traditional tract subdivisions. Higher density makes options such as district heating or cooling far more attractive. When combined with mixed land use, it may also be possible to tie district cooling with local co-generation of electricity for a nearby industrial or institutional load.

Changing urban form can result in a reduction in GHG emissions associated with building energy use as well as reductions related to personal transportation. This policy will have very little impact in the next decade; however, in order to achieve the long term emission reductions required it will be critical to change urban structure. It is recommended that the State consider establishing a policy framework to guide planning policies and by-laws and transportation policy. There is also scope for applying incentives, both financial and non-monetary, to encourage developers to adopt and support “smart” development.

Hawaii starts with a more “walkable” environment than most of the US. More Hawaiian’s walk rather than drive, take public transit, cab, bicycle or take other means of transportation than the rest of the US[81].

[81] US Department of Commerce, US Census Bureau, American Community Survey, 2007, http://www.bts.gov/publications/state_transportation_statistics/state_transportation_statistics_2007/excel/table_04_01.xls Sixty seven percent of trips in Hawaii used a personal vehicle, compared to 76% for the US on average.

ii. Analysis of Measure

- Numerous other jurisdictions across North America and beyond are adopting "Smart Growth" policies[82].

- Smart Growth policies bring a range of environmental benefits, according to the US EPA :

  - "A 2000 study found that compact development in New Jersey would produce 40 percent less water pollution than more dispersed development patterns.
  - A 2005 Seattle study found that residents of neighborhoods where land uses were mixed and streets are better connected, making non-auto travel easier and more convenient, traveled 26 percent fewer vehicle miles than residents of neighborhoods that were more dispersed and less connected.
  - While individual smart growth methods can yield significant environmental improvements, a synergistic approach combining policies and programs can deliver even greater environmental benefits". [83]

Table 12. Urban Form Screening Criteria

Criteria	Discussion
Cost effectiveness	Smart Growth policies can significantly reduce infrastructure costs and make better use of available land.
Ability to meet goal	This measure will make a fairly minor contribution to achieving the State's 2020 reduction target; however, it is important that this policy be implemented now in order to achieve longer term GHG reductions that will be required.
Key sources to be included	Addresses transportation energy requirements, the residential and commercial sectors, including their electricity use, and can reduce water and waste-water energy requirements.
Size of affected sources	Broad impact across key sectors.
Ability to monitor and verify	Key indicators should be developed as part of developing "Smart Growth" policies.
Co-benefits for CAC's and toxic air emissions	Hawaii's energy-related GHG and CAC emissions will be reduced in proportion to the reductions in

[82] See for example the EPA website on Smart Growth Achievement - http://www.epa.gov/smartgrowth/awards.htm and the Smart Growth Network site - http://www.smartgrowth.org/

[83] http://www.epa.gov/smartgrowth/topics/eb.htm

Criteria	Discussion
	electricity generation. No negative impacts are envisioned
Environmental benefits for Hawaii	Improved urban form should lead to improved quality of life for residents and reduce urban “footprint”. Environmental benefits will arise from reduced use of electricity and transportation fuels.
Compatibility with other programs	A framework for “Smart Growth” would complement policies aimed at reducing transportation emissions, support the development of the high capacity mass transit system and be consistent with the “Hawaii 2050” sustainability plan[84].
Extent of leakage	n/a
Effects on small business	More ‘walkable’ communities will benefit small business, including restaurants, retailers and other service companies. Lower infrastructure costs will help reduce property tax loads.

iii. Application and Implementation Process or Procedure

- Region/sector/end use where policy should be implemented
    - Policy should apply across the State.

- How to measure and verify effectiveness and any impacts of M & V
    - Key indicators should be developed as part of developing “Smart Growth” policies.

iv. Potential Impacts/results of Implementation

- Potential to reduce emissions:

    - Urban form is a long-term driver of energy use. The potential of this policy to reduce emissions is significant but will take some time to become significant.
    - This policy will interact with several other policies, influencing future transportation needs, the choice of transportation mode and vehicle type, structure type and design, and demands placed on the power system.

[84] Hawai’i Sustainability Task Force, Hawai’i 2050 Sustainability Plan, Charting a course for Hawai’i’s sustainable future, January 2008, http://www.hawaii2050.org/images/uploads/Hawaii2050_Plan_FINAL.pdf

l) Carbon Offsets/Reductions in Waste & AFOLU Emissions

i. Description

A number of policies can be implemented to reduce non-energy emissions or increase carbon sinks within Hawaii. These types of initiatives may qualify as domestic offsets under a cap-and-trade policy or may be undertaken outside of that framework. Some of these measures, such as capturing landfill gas for power production or restoring marginal agricultural lands to native forest may have co-benefits which make their pursuit worthwhile apart from any consideration of the value of carbon reduction. Generally, however, these types of measures are only expected to be pursued if a value is placed on carbon reductions or if specific funding is provided for such initiatives.

Wastewater emissions contributed 150 kt CO2e to Hawaii's total GHG emissions in 2007. About two-thirds of this total came from Oahu[85]. Emissions from municipal solid waste in landfills contributed another 770 kt CO2e; of which about 60% came from the heavily populated City and County of Honolulu.

Offsets may be created as a result of a number of measures that can be taken to reduce these emissions, including:

- Collection and flaring of landfill gas/methane
- Recovery of landfill methane for use in power generation
- Waste diversion programs to reduce future landfill loads and improve material recovery
- Recovery and use of methane gas from waste water treatment systems
- Increased diversion of solid waste to composting, which results in the majority of potential methane emissions being converted directly to CO2[86]
- Diversion of organic waste from landfills, wastewater facilities and agricultural operations to anaerobic digestion in which the resulting methane is captured and used (converted to CO2)

Offsets may also be created by applying no-till and low-till agricultural practices to increase the levels of carbon sequestered in farmland. Ultimately, the eligibility of a given sector to generate offsets is dictated by government regulation; in this case the ACES Act.

Forestry related offsets are usually created as a result of improved forestry management practices or through afforestation (the conversion of lands previously used for other purposes to forest). A search was carried out of studies of the potential for

[85] Hawaii Greenhouse Gas Inventory: 1990 and 2007, December 10, 2008 prepared by ICF International
[86] CO2 has a global warming potential of 1; compared to methane's GWP of 23 (2001 IPCC).

carbon sequestration from afforestation and other land use change related to Hawaii. The limited number of analyses of the potential for carbon sequestration from land use changes for the U.S. focused on the continental US and did not cover Hawaii or Alaska. Research specific to Hawaii, previously presented to the Task Force by the Natural Capital Project, is discussed below in regards to the potential magnitude and costs of such initiatives. Given the incredible variability in land and climate conditions across the state of Hawaii, estimates of potential native forest restoration offset projects are currently only available for case studies.

Under the ACES Act, up to 30% of a regulated entities' compliance obligation can be met with offsets and that percentage increases over time. Both domestic and international offsets are permitted under the Act; however, at least 50% must be domestic. It is widely expected that demand for domestic offsets may outstrip supply. As a result, the price of domestic offsets is expected to exceed the price of international offset. In the EIA modeling of the ACES Act[87], domestic offset prices are projected to match permit prices, rising to $32 per tonne CO2e by 2020.

ii. Analysis of Measure

Table 13. Offsets Screening Criteria

Criteria	Discussion
Cost effectiveness	Afforestation opportunities are reported to cost between $10 a $120 per tonne CO2e[88]. These estimates are based on growing Koa and use conservative growth and cost estimates. According to the report's author,[89] costs are predicted to be lower in certain areas and under several modeled scenarios, offset prices would be less than, or competitive with the carbon prices projected under the ACES Act. If this is the case, then native forest restoration may provide a cost-effective means of achieving the desired GHG emissions reductions. A number of factors will determine which areas provide the most economic potential, including growth rates, the need for protective fencing, the level of management required, and the options available to land owners.

[87] Discussed in more detail in the discussion of Cap and Trade (part M) below.
[88] Including opportunity costs according to a presentation by Marc Conte, Ph.D., Stanford University Natural Capital Project to the June 2009 meeting of the Hawaii GHG Reduction Task Force.
[89] Personal communication with Marc Conte, Ph.D.

Criteria	Discussion
	Applying some simplifying assumptions[90] to the draft report[91] provided to the Task Force on the potential for native forest restoration, it has been estimated that 187,000 tonnes of CO2e could be sequestered annually at a cost of $18 per tonne CO2e.
Ability to meet goal	According to the inventory, all of the forested land in the State contributed about 2,700 kt of sequestration in 2007. The actual potential for additional sequestration is unknown, though as estimated above it is estimated that in the order of 187kt CO2e could be sequestered annually in Hawaii at a cost of $18 per tonne CO2e. The US Forestry Service[92] , based on a study which is underway but not yet complete, has indicated that the potential is significant but that costs of achieving this potential may be higher than in other states. According to Conte et al, forestry has the potential to sequester between 3% and 5% of Hawaiian emissions.
Key sources to be included	Does not address key emission sources (power and transportation).
Size of affected sources	Waste and wastewater emissions contribute 1,000to 1,300 kt CO2e to Hawaii's total GHG emissions. A portion of this amount could be reduced through policy initiatives. The potential for increased sequestration through afforestation is estimated at approximately between 500 kt and 900 kt annually[93].
Ability to monitor and verify	Monitoring and verification under established protocols would be required in order for projects to be recognized as offsets. Protocols have been established for most of the potential areas.

[90] Based on The Emission-Reduction Potential of Native Forest Restoration in Hawai'i, assume that 5% of Hawaiian emissions (~15 Mt) could be reduced by forestry activities, and assuming that equal reductions are achieved through each of the four options under the category Restoration with Scarification and average sequestration, and using a 25 year time frame, 187 kt CO2e are available at each of the following prices: $58, $42, $34, $18.
[91] Conte M., The Emission-Reduction Potential of Native Forest Restoration in Hawai'i. Report to the State of Hawai'i Greenhouse Gas Emissions Reduction Task Force. August 14, 2009.
[92] Correspondence with Christian P. Giardina, PhD., Restoration Team Leader and Research Ecologist
Institute of Pacific Islands Forestry, USDA Forest Service.
[93] Assuming that 3-5% of State emissions could be sequestered.

Criteria	Discussion
Co-benefits for CAC's and toxic air emissions	Co-benefits in terms of other air emissions are limited however other environmental benefits may accrue as described in the report on "The Emissions Reduction Potential of Native Forests" (see footnote 63). Native forest restoration can result in a suite of benefits (water filtration, sediment retention, storm peak mitigation, habitat provision, etc.) at no additional cost.
Environmental benefits for Hawaii	There may be environmental co-benefits from increased afforestation in terms of improving environmental services provided by the involved areas.
Compatibility with other programs	Not directly compatible with energy-related emission reduction initiatives, however, sequestration projects such as native forest restoration may offer carbon offsets at a cost competitive with emission reductions from other sources.
Extent of leakage	None.
Effects on small business	Land owners involved in agricultural operations may benefit from the development of carbon offsets or projects which support carbon sequestration. The development of some projects may provide benefits in terms of eco-tourism.

iii. Application and Implementation Process or Procedure

- Region/sector/end use where policy should be implemented
    - Opportunities exist across all counties, primarily affecting rural areas and the agricultural sector as marginal lands are converted to increased forest cover.

- How to measure and verify effectiveness and any impacts of M & V
    - .Monitoring and verification will be required in order to qualify these initiatives as offsets.

iv. Potential Impacts/results of Implementation

- Potential to reduce emissions:
    - Waste and wastewater initiatives have some potential to reduce emissions. Afforestation and other land use related policies primarily act to increase carbon sequestration rather than reduce emissions.

As discussed above the Conte study indicates that afforestation could sequester between 3% and 5% of Hawaiian emissions annually, capturing between 500 kt and 900 kt CO2e annually.

To the extent that offsets such as afforestation are developed within Hawaii and sold as offsets either in-state or in the rest of the US, these reductions would count towards reductions by the jurisdiction or regulated entity which had purchased the offset. While the offsets achieved might contribute to GHG reductions outside of the state, the economic value associated with these offsets would benefit Hawaii's economy. If 10% of the estimated potential for sequestration were reached by 2020, this could contribute $2.25 million in economic value by 2020; assuming an offset price of $30 per tonne.

Hawaii could also choose to invest in offsets as part of its overall GHG reduction strategy and 'retire' any resulting offset. While not included in the modeling, a potential program designed to capture a portion of the afforestation potential was developed. Assuming costs described in the Conte report, a program starting in 2012 and building to reach 10% of the afforestation potential by 2020 was estimated to cost about $2 million. This program assumes that the lowest cost opportunities would be pursued first under such a program.

It is recommended that the Task Force monitor and support research and analysis aimed at refining estimates of both the cost and potential for carbon sequestration from afforestation.

m) Biofuel Issues Arising from Combined Policy:

The sections above discuss the individual policies which are combined in Work Plan 1. A number of the policies included in the Work Plan interact. For example, the RPS requires a level of renewable power generation based on electricity sales, which are affected by the EEPS, the use of Sea Water Cooling, and the implementation of improved building codes. Similarly, the AFS sets a target for alternative fuels that is based on gasoline and diesel use for highway transportation; which are affected by vehicle and freight efficiency and the use of PHEV's. The model simulates the interaction of these policies to determine the net impact on energy use and emissions.

In the case of biofuels, however, some issues arise that require specific discussion. Several of the policies in the Work Plans rely on increased use of biofuels. The resulting increase in demand for ethanol and biofuels and the implications of increased in-state production were not addressed in discussing the individual policies, but arise as an issue in considering the Work Plan 1 policies as a group.

One of the key policies within the HCEI is the use of biodiesel to fuel generating plants. HECO reports on a number of issues relating to the technology and costs of this strategy in its IRP4 documents. These include technical issues relating to the use of biodiesel in plants designed to use petroleum fuels, uncertainties around future supply of imported palm oil, and the future price of the feedstock required to create biodiesel. In modeling the use of biodiesel for power production it is assumed that these technical issues can be successfully addressed and that biodiesel prices follow a trajectory in line with the projections included in HECO's IRP4 (see Appendix B).

Based on the prices assumed for this project, biodiesel continues to be more expensive on an energy equivalent basis in the initial years of the modeled period but eventually becomes less expensive than diesel (as discussed above in part d of this section). It is assumed that the units designated to use biodiesel will be dispatched based on environmental considerations rather than on a strict economic dispatch. The use of biodiesel provides the utilities with a renewable generation source with load following capability and could conceivably be expanded to replace most, if not all, fuel oil use in the system[94]; particularly if biodiesel becomes a lower cost option over time.

Modeling of Work Plan 1 assumed the level of expansion in biodiesel use described in the HCEI Agreement. If the technical barriers to biodiesel use are overcome and biodiesel prices become competitive with fossil fuel prices as projected it is possible that further GHG reductions could be achieved both through the further substitution of

[94] subject to technical constraints on the use of biodiesel in particular generating plants.

biodiesel to replace oil use, and by closing the single coal-fired plant in Oahu. The closing of the coal unit has not been assumed in the modeling[95].

As discussed in HECO's IRP4 report, there is considerable uncertainty around future biofuel prices[96]. Feedstocks account for approximately three-quarters of the cost of producing biodiesel or ethanol. Prices for palm oil and molasses have both been volatile in recent years and this may continue as demand for these products increases. As climate change affects weather patterns in different parts of the world, the feedstocks used to produce biofuels may also be affected.

The future supply and the source of biodiesel and ethanol are obviously critical to meeting the HCEI goals. A great deal of work has been done within the State reviewing the potential use of biofuels, the issues associated with their use and the potential for developing supply within the State[97]. While there are some concerns with the land use impacts relating to the development of biofuels, HECO has worked with the Natural Resources Defense Council (NRDC) to develop an environmental policy to ensure that its use of biodiesel does not create negative environmental consequences in the source country[98].

Hawaii could continue to import its supply of biofuels, however, it is assumed that in-State capacity will be expanded. The State has already put a number of policies in place to encourage development of a biofuels industry which aligns with State goals relating to both the environment and self-sufficiency. In addition, HECO's procurement policy will give preference to feedstocks grown sustainably within Hawaii. While it is unknown which specific projects will go forward, it is assumed that in-state capacity will be developed to meet almost all of the State's biodiesel requirements and approximately half[99] of its ethanol requirements by 2020.

Two biodiesel plants are now reported to be operating in the State; in Oahu and Maui[100] creating biodiesel from used cooking oil and beef tallow. These plants have a combined capacity to produce 1.75 million gallons of biodiesel per year. The Maui plant, which is "the longest continually operated biodiesel plant in the US",[101] has operated since 1996. Additional plants proposed within the State could add 140 million gallons/year capacity with the potential to increase this to 220 million gallons per year[102]. As described in

[95] Closure of the plant could be considered when contractual arrangements permit; subject to technical considerations within the power system. Alternatively consideration could be given to converting the unit to burn bio-mass. For example, the province of Ontario, in Canada, is in the process of shutting down all of its coal-fired plants, but is considering converting several of these base-load units to use biomass.
[96] See section 6, page 6-19 in HECO IRP4, September 2008.
[97] A number of studies on the potential for ethanol and biodiesel use and production are available on the DBEDT and HCEI websites. Hawaii has developed a BioEnergy Master Plan.http://hawaii.gov/dbedt/info/energy/renewable/bioenergy/index_html
[98] "Environmental Policy for the Hawaiian Electric Company's procurement of Biodiesel from Palm Oil and Locally Grown Feedstocks", NRDC and HECO, August 2007.
[99] Figure is approximate as projected biofuel requirements vary between policy cases.
[100] Operated by Pacific Biodiesel.
[101] http://www.biodiesel.com/index.php/technologies/project/pacific_biodiesel_maui_hi
[102] HECO, IRP4, Section 6.2.1, page 6.17 describes a 100 million gallon/year plant proposed by Imperium Renewables Hawaii LLP in Kalaeloa and plant proposed by Blue Earth Biofuels LLC to be built in Maui. Plans for the Imperium plant are currently on hold.

Appendix B, it is assumed that 110 million gallons/year of new production capacity is added by 2015 with capacity remaining at that level to 2020.

There is no existing capacity to produce ethanol in Hawaii, however, as was discussed in the Alternative Fuels policy the State has the capability of supplying most of its portable fuel needs from in-state production (see section 5, part N). It is assumed that ethanol plants will be developed within the State, as described in Appendix B, with the capacity of producing 40 million gallons per year of ethanol.

GHG emissions from the combustion of biofuels are treated as biogenic in the model. This means that the actual use of biofuels does not contribute to global warming. There are however, emissions created during the production of biofuels (referred to as 'upstream' emissions). These emissions are counted as anthropogenic and contribute to global warming.

By contrast, the majority of emissions associated with fossil fuels, are emitted at the point of combustion. While some portion of the 'upstream' emissions involved in the production and delivery of these fossil fuels does occur within the State, in particular the emissions associated with the refining process; the majority occur when the fossil fuel is used.

In Hawaii, almost all of the biofuels now used are imported and therefore it is assumed that no emissions occur within the State[103]. As in-state production of biofuels increases, these emissions related to the production of the fuels will be counted within the State's emissions and against its reduction target. In modeling the Work Plan policies, the in-state emissions associated with biofuels increase as production capacity within the State comes into service.

Work Plan 1 Modeling Results

All of the policies included in Work Plan 1 have been described in this section (in parts "a" through "m" above). Modeling these policies required a number of assumptions, which are described in Appendix B.

The following discusses the modeling results for the policies when modeled as a combined Work Plan. Detailed modeling results are presented in Appendix D, along with comparisons of these outcomes to the Reference Projection. Appendix E provides details on the economic changes that result from the policies.

Blue Earth Biofuels, which is partially owned by HECO, could be expanded to 120 million gallons per year (www.blueearthbiofuels.com).

[103] This distinction is only significant in terms of where the emissions are counted. The impact of the emissions associated with biofuel or fossil fuel production on global warming are the same regardless off where the emissions occur.

As the policies included in Work Plan 1 are implemented, the model projects that electricity sales will decline by over 25% from the Reference projection. The greatest reduction occurs in the residential and commercial sectors, followed by the industrial sector. Electricity use for transportation (associated with the mass transit system) stays relatively strong as demand increases for transit. The introduction of PHEV's also makes a very small contribution to electricity sales in the latter part of the period.

The drop in electricity sales is a combination of increasing levels of efficiency with 'behind the meter' solar and other distributed generation. Grid purchases of electricity from industrial generators remain fairly flat. Monitoring the contribution of these 'off grid' resources will be increasingly important over the coming years and it is suggested that the effectiveness of the net metering arrangements in providing information on this trend should be reviewed periodically.

As electricity consumption declines and new renewable units come on-line, the percentage of total power supply from oil-fired units declines. Oil-fired units, which supplied two-thirds of generation in the Reference Projection in 2020, decrease to only about one-third of total generation under Work Plan 1 policies. Coal generation is assumed to stay at current levels, while biomass generation increases by 20% and the level of wind generation almost quadruples.

Maui becomes a significant exporter of power to Oahu, with generation from the county more than doubling its own electricity requirements. Wind generation reaches 20% of total generation for the State as a whole, but is higher in Hawaii and Kauai, and reaches two-thirds of generation in Maui. This change could create some system stability issues for the utilities using current system capabilities. It is assumed that improved control and monitoring technologies and enhanced demand reduction/controls programs developed as part of the "Smart Grid" will allow this generation to be successfully integrated into the system.

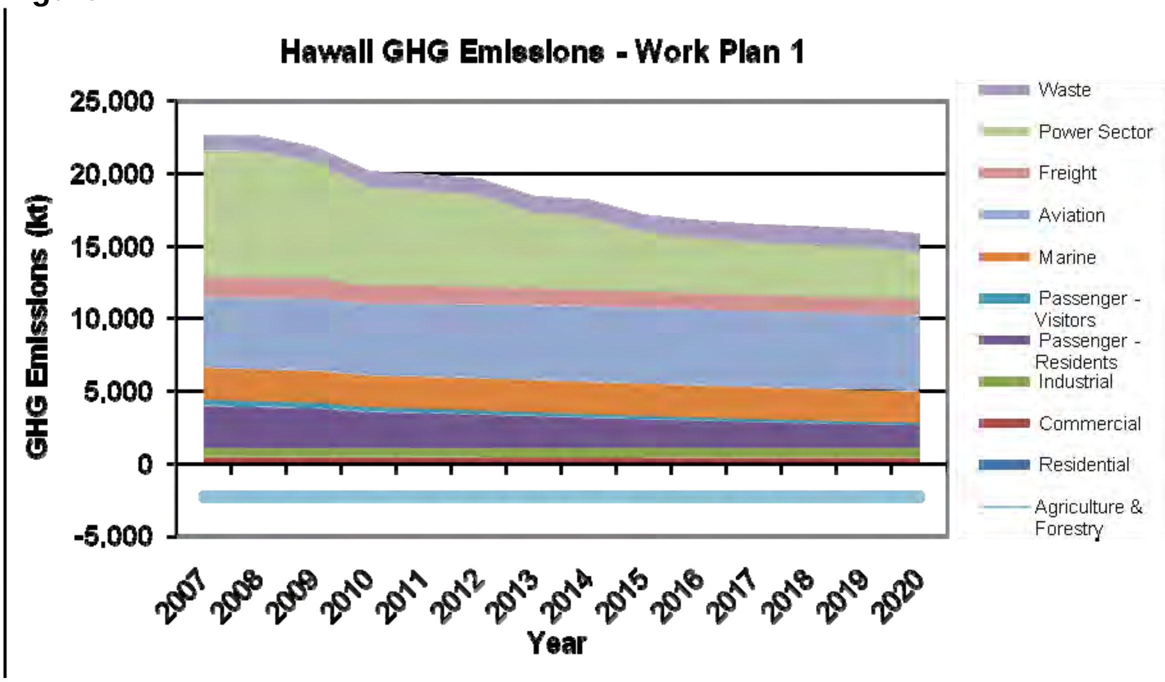
Transportation energy use declines as vehicle efficiency increases. The average new vehicle efficiency increases to over 42 mpg and average fleet efficiency improves to near 31 mpg by 2020. As vehicle efficiency improves and the cost of driving decreases, there is some shift to larger vehicles. The market share in 2020 for large vehicles grows from just under 14% in the Reference Projection to 15% under Work Plan 1. As the "cost" of driving is reduced by higher vehicle efficiency the average distance travelled by personal vehicles (vehicle miles travelled) increases very slightly for residents but declines very slightly for visitors (1% in 2020 in each case). Overall, passenger vehicle fuel use declines by about 5%, with energy use for residents dropping by 7% and 12% for visitors; reflecting the difference in average vehicle age (rental fleets tend to be newer vehicles and therefore more efficient). Vehicle efficiency changes have little effect on freight energy use which shows little change from the Reference Projection.

The level of biofuels use in transportation achieves the targeted level of 20% for both ethanol as a percentage of gasoline and for biodiesel as a percentage of diesel.

Secondary energy use declines by about 6% in 2020 compared to the Reference projection. The largest declines occur in the residential and commercial sectors, which each reduce energy use by almost 30%. Primary energy use shows the effects of these decreases in energy use combined with a shift from fossil to renewable fuel sources. The decrease in primary energy use outstrips the reduction in secondary energy use; declining by 18%. Much of the difference is due to the elimination of the conversion losses in burning fuel oil to generate electricity. Fuel oil use drops by almost two-thirds and gasoline use by 13%. By contrast, renewable energy sources show dramatic growth, with biodiesel use increasing 39%, ethanol 76% , biomass by over 20% and geothermal by 29%; all relative to the Reference Projection in 2020.

As a result of these changes, State GHG emissions (in CO2e terms) decline dramatically, falling by 5,000kt (5 Mt) CO2e relative to the Reference projection. The figure below shows gross GHG emissions data in Appendix D graphically.

Figure 2



The vast majority of the emission reduction comes from the power system (4,400 kt). Transportation emissions drop by 350 kt, with the bulk of that reduction coming from passenger (about 225 kt) and freight (over 100kt). The balance (about 26 kt) of the transportation reductions come from visitor vehicles. The reduction in freight emissions comes primarily from the increase in the use of alternative fuels as the level of energy use shows little change from the Reference Projection (as discussed above).

Emissions included in the State target fall to 8,377 kt CO2e by 2020. This is 5,283 kt or about 38.7% below the State target.

The model assumes that changes made in Hawaii will not affect the world price of oil or the price of purchased coal. Prices for electricity, however, are affected by the use of higher priced fuels and the costs of new facilities and generation. Electricity prices rise in comparison with the Reference projection; by 22-24% for residential consumer and the commercial sector and 30% for industrial users. The effect of the energy efficiency programs put in place more than offsets for these increases in rates. While the rates charged for electricity rise by 22% for residential consumers, their average use declines by 26%. The net effect of these changes is that the monthly power bill for households declines by over 20% as the reduction in energy use due to increased efficiency more than offsets the increase in rates. Utility revenues continue to increase over the period despite falling electricity use as a result of the rise in electricity rates; rising by roughly 40% over the period from 2007 to 2020.

Overall demand for all petroleum products, including both oils and synthetic gas, drops by over 25% between 2007 and 2020 after all Work Plan 1 policies are implemented. It is unclear what the impact of such a change will be for the two refineries serving Hawaii.

Implementation of Work Plan 1 is projected to have a fairly modest but positive effect on the Hawaiian economy. Employment rises by about 0.6% above the Reference Projection by 2015 and remains 0.3% above reference levels by 2020.

The commercial and broad industrial sectors are positively impacted throughout the period. Employment in the utility sector is more volatile, reflecting the assumed timing of capacity and infrastructure additions. It rises dramatically (30%) during the period to 2015 but declines between 2015 and 2020. By 2020, employment in the utility sector falls by about 17% relative to the Reference Projection (about 500 jobs), however, increases in other sectors more than compensate for this reduction as commercial employment rises by 1,600 and industrial by 1,300 jobs by 2020 relative to the Reference Case.

GRP grows more quickly in the early period, rising 1.2% above the Reference projection in 2012. Beyond 2015, the increase in growth compared the reference levels lessens, but growth remains 0.3% higher by 2020. Real personal disposable income reflects a similar pattern, rising by 0.6% over the Reference Projection by 2015 and remaining 0.4% above reference levels in 2020.

ii. Work Plan 2: State Carbon Tax plus Work Plan 1(Carbon Tax Case)

Description

A carbon tax is a tax on the carbon content of fossil fuels including coal, oil and gas.[104] Carbon taxes are generally viewed as one of two major policy options available to governments to reduce GHG emissions and encourage renewable energy development.[105] Unlike cap-and-trade, where the price of carbon is determined on the open market, a carbon tax policy creates a degree of price certainty around which business and industry can plan, allocate capital and make investment decisions. From an environmental integrity perspective, carbon taxes are frequently assailed for not imposing direct limits on GHG emissions.[106] In general, cap-and-trade systems are seen as providing greater regulatory certainty but less price certainty while a carbon tax provides greater price certainty but less definite emission reductions. In each case the design of the system can impact the strengths and weakness. A cap-and-trade system can be designed to provide more definite emission reductions while a carbon tax can be designed to limit price volatility.

In jurisdictions without carbon taxes (or cap-and-trade schemes), carbon emissions are a “negative externality.” Carbon taxes are interpreted an attempt to internalize these externalities into the cost of doing business. As such, carbon taxes are an example of a Pigovian tax, which is defined as a tax levied on a market activity to correct the market outcome, if there are negative externalities associated with the market activity.[107]

While carbon taxes have been discussed by a variety of governments around the world, they have been officially established in a relatively small number of jurisdictions.

North America

Three jurisdictions in North America have implemented a carbon tax.

- The City of Boulder, Colorado implemented a tax on carbon emissions from electricity on April 1, 2007.[108] The tax, which is charged at approximately $7 per t/CO2, costs the average household $1.33 per month. Administrators expect the tax to generate about $1 million annually until its expiration in 2012.[109]

[104] http://www.carbontax.org/
[105] The other approach is cap-and-trade. See Section i), Sub-section #1 for a discussion of cap-and-trade systems.
[106] The implementation of a carbon tax is designed to make fossil fuel consumption more expensive at the margin and does not necessarily lead to emission reductions.
[107] http://en.wikipedia.org/wiki/Pigovian_tax
[108] The tax in Boulder does not cover emissions generated from energy consumption. http://www.carbontax.org/progress/where-carbon-is-taxed/
[109] Ibid.

- The Canadian province of Quebec began collecting a carbon tax on petroleum, natural gas and coal on October 1, 2007, making it the first state/province in North America to use a carbon tax. Oil companies are required to pay 0.8 cents for each liter of gasoline distributed in Quebec and 0.938 cents for each liter of diesel fuel.
- British Columbia implemented a carbon tax of $10 t/CO2 (equating to 2.41 cents per liter on gasoline) in 2008.[110] The tax will increase each year after until 2012, reaching a final price of $30 per tonne (7.2 cents per liter at the pumps). Enacting legislation compels the Government to keep the carbon tax "revenue neutral" by reducing corporate and income taxes at an equivalent rate.

International

Seven countries outside North American have implemented a carbon tax.

- Finland was the first country in the world to use a carbon tax, enacting a policy in 1990. The current tax is approximately €18.05 t/CO2.[111]
- The Netherlands also adopted a carbon tax in 1990 but replaced it with a 50/50 carbon/energy tax in 1992.[112] The tax is referred to as the Environmental Tax on Fuels and is leveled at approximately $16 t/CO2e.[113]
- Norway implemented a carbon tax in 1991. Activities in Norway that burn fossil fuels are subject to a carbon tax in the range of $16 to $63 t/CO2.[114]
- In Denmark, a tax of approximately $17.6 per metric ton of CO_2 was adopted in 1992 as part of a broader energy tax and subsidy package.[115]
- Italy's carbon tax was introduced in December 1998 based on the conclusion of the Kyoto Conference of December 1997.
- Sweden's carbon tax has been in effect since 1991. Under the Swedish scheme, carbon is taxed at approximately $50 t/CO2[116]. No tax is applied to fuels used for electricity generation, and industries are required to pay only 50% of the tax.[117]
- Great Britain introduced a "climate change levy" in 2001 on the use of energy. Rates are 0.15p/kWh for gas ($0.003), 0.07p/kWh for liquid petroleum gas ($0.0014), 0.44/kWh ($0.0087) for electricity and 0.12p

[110] http://www.rev.gov.bc.ca/documents_library/notices/British_Columbia_Carbon_Tax.pdf
[111] http://www.carbontax.org/progress/where-carbon-is-taxed/
[112] http://yosemite.epa.gov/EE/Epalib/incent.nsf/c484aff385a753cd85256c2c0057ce35/0483a144da8fa434852564f7004f3e68
[113] Ibid.
[114] http://docs.google.com/gview?a=v&q=cache%3AABzi2vzKbn4J%3Awww.davidsuzuki.org%2Ffiles%2Fclimate%2FBriefing_Note_-_BC_Budget_2008.pdf+Norway+%22carbon+tax%22&hl=en&gl=us
[115] http://yosemite.epa.gov/EE/Epalib/incent.nsf/c484aff385a753cd85256c2c0057ce35/0483a144da8fa434852564f7004f3e68
[116] EPA, National Center for Environmental Economics, Section 11.1.5.2 Energy/carbon Taxes. http://yosemite.epa.gov/EE/Epalib/incent.nsf/c484aff385a753cd85256c2c0057ce35/0483a144da8fa434852564f7004f3e68
[117] Ibid.

($0.0024) for any other taxable commodity.[118] Revenues are used to provide offsetting cuts in employers' National Insurance Contributions and to provide support for energy efficiency and renewable energy.

Under the type of cap-and-trade structure proposed by Waxman-Markey (ACES Act), the cost of permits acquired by petroleum refiners and the power system would appear somewhat like a carbon tax to downstream energy consumers. Costs under that system will vary as the price of carbon varies in response to market conditions.

A carbon tax imposed by the State would differ from a cap-and-trade system in that the amount of the tax would be fixed and could be increased on a pre-defined schedule; providing a progressive price signal to consumers. It would also differ in that revenues received under such a system would accrue to the State, however, if a carbon tax were introduced in conjunction with a federal cap-and-trade system it would be additive and not a substitute for the cap-and-trade costs.

Revenues received from the carbon tax can be used for a variety of purposes, however the political acceptance of the plan is likely to depend on how taxpayers view this distribution. Generally the objectives in recycling revenues received from a carbon tax are to minimize the cost of carbon pricing and its effects on competitive industries, to ensure fairness and minimize regressive impacts on households and consumers, and to further emission reduction objectives. Consideration is also normally given to the effects on leakage and economic competitiveness. Considering these factors, and the political acceptance of a carbon tax, it is recommended that the majority of the revenues received be returned to taxpayers through the income tax system. Given that low income households tend to be disproportionately affected by increases in energy costs, particular attention should be paid to the distribution to minimize these negative effects. Tax revenues could also be directed to fund adaptation efforts to assist the State in preparing for the effects of global warming.

The GHG reductions achieved by a carbon tax can also be increased by using a portion of the revenues to finance additional GHG reduction efforts. It is recommended that 90% of the tax be returned to consumers via the tax systems, with the balance used to finance energy efficiency or adaptation efforts, including elements of the Work Plans. It is recommended that a portion of those funds be used to target programs to groups most affected by the tax, such as low income housing and small businesses. This approach has the combined benefit of reducing GHG emissions while reducing the negative impacts of higher energy costs on those most affected and least able to respond.

[118] Ibid.

i. Analysis of Measure

Table 14. Carbon Tax Screening Criteria

Criteria	Discussion
Cost effectiveness	The cost effectiveness of a carbon tax depends in part on how revenues collected from the tax are used. "Revenue neutral" arrangements, such as the one in British Columbia, can be quite cost effective in the sense that it provides a price signal to encourage consumers to reduce carbon use while not placing an additional burden on the economy.
Ability to meet goal	Carbon taxes do not impose emission caps, but rather provide a price signal to consumers. This price signal would be expected to motivate action to reduce emissions, but remains subject to the same market imperfections as other price signals. The contribution of a carbon tax to meeting State emission reduction goals will depend on the level of the tax and the use of any resulting revenues (discussed in part iv below and in section 6).
Key sources to be included	A carbon tax would cover all fuels and therefore address all key sources. Petroleum consumed as feedstocks should be exempted from coverage by the tax. Non-energy emissions would not be addressed by a carbon tax.
Size of affected sources	A carbon tax could cover virtually all of the 90% of GHG emissions in Hawaii related to energy use.
Ability to monitor and verify	A State-level government agency would be responsible for administering revenue collection. Existing systems for reporting oil refining and sales could be used as the basis for this system. Additional reporting could be established to report on the application of resulting revenues to ensure transparency.
Co-benefits for CAC's and toxic air emissions	The effect on CAC's and other toxic emissions would be proportionate to the level of reduction in energy use and GHG emissions achieved. The level of GHG reduction would be expected to depend on the level of the carbon tax.
Environmental benefits for Hawaii	Environmental benefits would also depend on the effectiveness of the carbon tax.
Compatibility with other programs	A carbon tax could be effective in reinforcing other initiatives to reduce energy use and GHG emissions. Revenues collected from a carbon tax could also be used to fund other climate change programs.

Criteria	Discussion
Extent of leakage	No leakage from the electric sector as there is no opportunity for power imports to the State. Unlikely to affect the level of refined oil product imports if imports of refined products are also subject to tax.
Effects on small business	Small businesses would be affected by any costs passed on by either the power or refinery sectors.

ii. Application and Implementation Process or Procedure

- Is there a threshold below which reduction requirements should not apply?
    - The carbon tax would be imposed across all fossil fuels resulting in carbon emissions, regardless of the magnitude of the emitting source.
    - Non-emitting uses of petroleum, such as feedstocks, would be exempted.
    - The level of the tax can be determined by modeling the level of tax required to motivate the targeted reduction in future emissions, however, this is likely to be tempered by political considerations of consumer acceptance. Given that the State's emissions reduction target is met through existing policies in the Reference Projection the level of tax could not be based on meeting that requirement.

- Region/sector/end use where policy should be implemented
    - In this analysis the carbon tax would be imposed by the State of Hawaii, with all resulting revenues flowing back to the State.

- How to measure and verify effectiveness and any impacts of M & V (i.e. reporting requirements, additional cost to business, etc.)
    - Enacting legislation would establish Government responsibilities with respect to revenue collection and distribution.
    - The effectiveness of these systems should be reviewed periodically by a State-appointed entity.
    - Since the level of tax collected should correlate directly to the level of energy-related emissions the level of tax collected can be used to indicate the level of energy-related carbon emissions.

iii. Potential Impacts or Results of Implementation

The implementation of a state-level carbon tax is intended to provide a price signal to encourage investments in increased energy efficiency and a shift to lower emission energy sources. While a carbon tax provides a price signal to discourage carbon emissions, it is subject to the same market imperfections as other price signals. End users should respond to higher energy prices by choosing higher levels of efficiency, however, the level of response will depend on a number of factors. As other programs increase the efficiency of their energy use (i.e., more efficient vehicles), end users may show less response to an effective increase in energy prices posed by a carbon tax.

The Carbon Tax was modeled both as a stand-alone policy applied to the Reference Projection and as Work Plan 2, where it was applied in conjunction with the Work Plan 1 policies. The effects of a carbon tax is similar to any other change in energy prices in that consumer's responses will vary depending not only on the level of the tax but also on the cost of making further efficiency improvements. Therefore such taxes tend to become less effective if applied in conjunction with programs which result in significant efficiency increases.

A carbon tax was first modeled as a stand-alone policy, without any other changes to the Reference Case. Under these conditions, an illustrative $20 carbon tax applied starting in 2012 yielded a GHG emission reduction of about 55 kt CO2e in 2020. This level of tax is approximately equal to adding 18¢ per gallon to gasoline costs.

The tax was then modeled after implementation of Work Plan 1 policies. Under these conditions the same $20 tax resulted in only a 48kt CO2e reduction in GHG emissions by 2020. Reducing the tax to $10 per ton cut the resulting emissions reduction in half, to 24kt, while increasing the tax to $30 per tonne increased the resulting impact to 66 kt CO2e.

The amount of a carbon tax can be set based on the projected cost required to achieve the level of GHG emission reduction required. For Hawaii, the State target is projected to be met by existing policies and legislative requirements in the Reference Projection. Alternatively carbon tax levels may be introduced at a level deemed to be politically acceptable. Work Plan 2, assumes a carbon tax that starts at $10 per tonne in 2010 and rises linearly to $40 per tonne by 2020. The starting level for the carbon tax was selected to align with the proposed reserve price for permits under the ACES Act cap-and-trade system. This would also match the level of carbon tax now applied in British Columbia; currently the highest carbon tax in North America. The carbon tax in 2020 higher than the EIA's projected cost of $32/tonne for carbon permits in that year (under ACES Act).

The carbon tax was applied in Work Plan 2 in conjunction with the implementation of Work Plan 1 policies.

Work Plan 2 Modeling results

Appendix D presents the modeling results for Work Plan 2 and compares these outcomes to the Reference Projection. Appendix E provides details on the economic changes that result from the policies. The following discussion summarizes these results for Work Plan 2.

The proposed level of carbon tax results in a relatively modest reduction of 52 kt CO2e by 2020 when compared to the levels achieved by the Work Plan 1 policies on their own. ***Emissions included in the State target fall to 8,327 kt CO2e. This is 5,333 kt or about 39% below the State target.***

Secondary energy use declines by 6% from the Reference Projection, however, most of this is due to reductions that occur as a result of policies included in Work Plan 1. Compared to the Work Plan 1 results, energy consumption declines very slightly, by 0.4%. Sectoral declines in energy use range from 0.1% for marine transportation to 0.7% for the commercial sector and 0.9% for industry; all compared to levels achieved under the Work Plan 1 policies. Primary energy consumption also decreases slightly and electricity sales decrease by 0.1% below Work Plan 1 levels in 2020.

The effective increase in fuel prices causes a 3-8% rise in electricity rates in 2020 and utility and bottle gas costs rise by 3-5% compared to levels under the Work Plan 1 policies in 2020.

Vehicle efficiency shows some response to the carbon price, with average new vehicle efficiency rising by 0.7% in 2020 compared to levels in the Work Plan 1 policy results.

Overall, the impact of a carbon tax in this price range is quite modest given the significant energy and emission reductions achieved by the Work Plan 1 policies.

The introduction of the Carbon Tax as described is projected to raise about $204 million in 2010, increasing to about $870 million annually by 2020 when applied in conjunction with the Work Plan 1 policies.

As with Work Plan 1, Work Plan 2 is projected to have a modest but positive effect on the Hawaiian economy. The addition of a carbon tax as part of Work Plan 2 is projected to result in GRP growth that is about 0.1% lower than in Work Plan 1, but still above levels in the Reference Projection and by 2020, growth remains about 0.3% above reference levels. Real personal disposable income reflects a similar pattern, rising by 0.5% over the Reference Projection by 2015 and remaining 0.4% above reference levels in 2020.

Overall employment rises somewhat more than in Work Plan 1, increasing by about 0.4% above reference levels by 2020. The commercial and broad industrial sectors remain above reference levels, however the utility sector shows less of a decline than in Work Plan 1 in the period from 2015 to 2020. Utility employment declines by only 14% compared to the Reference Projection, compared to 17% in Work Plan 1. As in Work

Plan 1, the decrease in employment in the utilities sector in 2020 is more than made up by increases in commercial and industrial employment.

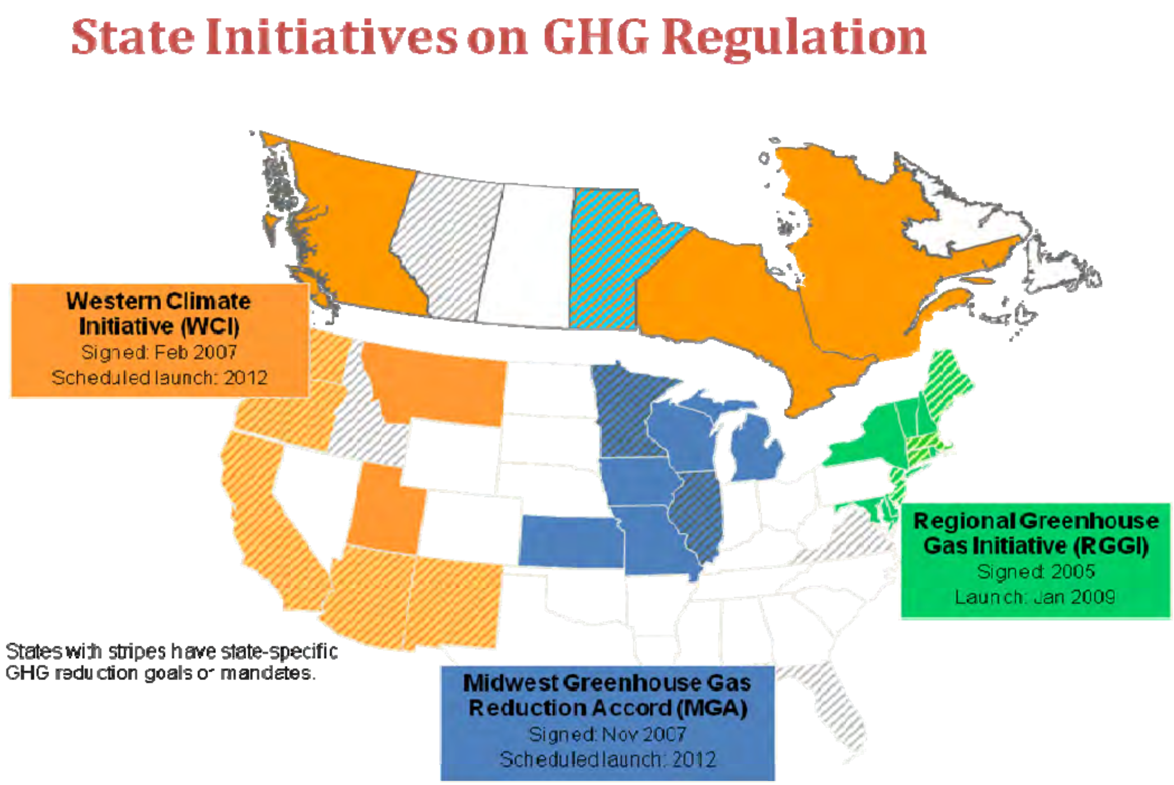
Real disposable personal income also rises by about 4% above levels in the Reference Projection by 2020.

iii. Work Plan 3: Federal Cap-and-Trade plus HCEI (C&T Case)

Description

Cap-and-trade (C&T) (also referred to as "carbon trading") systems have been successfully used to reduce the costs of complying with past air emission regulations[119]. Carbon trading schemes have operated in the European Union since 2005 and for power sector emissions in the northeastern US since the beginning of 2009. Several US states have considered or are considering cap-and-trade systems as part of their GHG reduction plans, however, concerns about "leakage" have led most of these jurisdictions to consider development of a regional system. Unlike the Regional Greenhouse Gas Initiative (RGGI) which covers power emissions in ten northeastern states, these proposals are targeting much broader sectoral coverage.

Figure 3



[119] In the 1990's, a cap-and-trade system established under the Clean Air Act was successfully used to reduce the cost of cutting sulfur dioxide (SO2) emissions.

Two regional plans are currently under consideration within US: 1) the Western Climate Initiative (WCI) which now includes seven US states and 4 Canadian provinces as partner; and 2) the Mid-West Governor's Association (MWGA), which includes seven US states and one province. These regional efforts have also struggled with issues around how to limit "leakage", where reductions made within the regulated state or province may be offset by increases in emissions in adjacent, non-participating jurisdictions. The figure below shows the regional cap-and-trade systems operating or proposed for the US federal or even continental system would significantly limit risks associated with leakage. Several federal proposals have been considered over the past several years, including bills put forward by McCain-Lieberman, Warner-Lieberman, and Dingell-Boucher. In June of this year the House passed the American Clean Energy and Security Act (ACES), also known as the Waxman-Markey bill.

The ACES Act sets out economy wide GHG reduction targets, using a 2005 base year, which start with a 3% reduction by 2012 and grow to a 20% reduction by 2020 and 83% in 2050. The centerpiece of the bill is a cap-and-trade system which would require covered sectors to reduce GHG emissions by 3 percent by 2012, 17 percent by 2020, 42 percent by 2030 and 83 percent by 2050, all relative to 2005 emissions. Note that the overall target for the Act differs slightly from the targets for the cap-and-trade component. It also proposes a number of initiatives designed to address climate change, including policies to increase efficiency across the economy, establish a national Renewable Portfolio Standard, and address non-energy emissions.

Given Hawaii's isolation from the rest of the US, 'leakage' does not represent as significant a problem as for other states which have interconnected power systems. However, the costs of a state-specific cap-and-trade system would be expected to be much higher than in a federal system with a much broader base. In addition, Section 861 of the ACES states that no State will be allowed to implement or enforce a cap-and-trade program that covers any capped emissions emitted during the years 2012 through 2017.[120]

At this time it is unclear whether a cap-and-trade bill will be passed by the Senate and become law, or the extent to which any such system ultimately put in place would differ from the version passed by the House. While we acknowledge this uncertainty, the ACES provides the best indication available at this time of how a GHG cap-and-trade system might be implemented in the US. It has therefore been used as a guide in order to model the impacts of a federal cap-and-trade system on Hawaii.

The table below provides a summary of the key elements of the ACES. Appendix B provides a description of modeling assumptions incorporated in the model to represent a federal cap-and-trade system in the model of Hawaii.

[120] http://www.opencongress.org/bill/111-h2454/show

Table 15. Summary of ACES Cap-and-Trade Proposal

American Clean Energy and Security Act of 2009 (ACES), aka House Bill 2454, aka Waxman-Markey Bill	
Summary	Centerpiece of bill is a cap-and-trade system covering approximately 85% of U.S. GHG emissions at full implementation in 2016. The bill also calls for State planning programs to reduce emissions from transportation and state/federal plans for adaptation measures. The bill would also regulate US markets for carbon and energy derivatives.
Start Date	2012
Targets	Relative to a 2005 baseline, reduction of 3 percent by 2012, 17 percent by 2020, 42 percent by 2030, and 83 percent by 2050. Targets may be "adjusted" by the EPA "to reflect changes in knowledge."
Caps	Cap-and-trade provisions would be enforced/implemented by EPA under Clean Air Act. Installations covered by the cap-and-trade system are expected to be responsible for approximately 85% of US GHG emissions in 2016.
Scope / Sectors Covered	Electrical generation sector in 2012; industrial sources in 2014; natural gas and local fossil fuel distribution in 2016.All six “Kyoto” GHGs (carbon dioxide, methane, nitrous oxide, sulphur hexafluoride, hydrofluorocarbons emitted as a byproduct and perfluorocarbons) as well as nitrogen trifluoride are regulated.
Thresholds	Installations that emit > 25,000 tCO2e per annum
Reporting	Reporting to begin in 2011. Proposed scope includes: installations that emit more than 10,000 tCO2e per annum; any vehicle fleet with emissions > 25,000 tCO2e per annum
Allowance and Credit Distribution	In 2016, when all the covered sectors are phased in, 17.5% of the allowances would be auctioned and the remainder (82.5%) would be distributed gratis (distributed at no cost). The percentage of credits that would be distributed via auction increases to 71.7% by 2030 and 85% by 2050. Auction has a floor price of $10 per allowance that increases by 5% plus inflation each year. The distribution of free allowances in 2016 (82% of total allowances) would support four primary goals: (i) Consumer Protection: fully 35% to electricity suppliers (the vast majority to electricity load distribution companies) to protect rate payers; 9% to local distribution companies of natural gas for protection against natural gas price increases; 1.5 % to states for home heating oil consumers; 15% directly to low income consumers; (ii) Transition Assistance for Industry: fully 13.5% to energy

American Clean Energy and Security Act of 2009 (ACES), aka House Bill 2454, aka Waxman-Markey Bill	
	intensive, trade exposed industries; 2% to petroleum refineries; (iii) Energy Efficiency and Clean Energy Technology: fully 7.5% to states to support renewable energy and energy efficiency efforts; 6% to promote technological advances; and (iv) Other Public Purposes: 10.5% to further other objectives.
Credit for Early Action	California or Regional Greenhouse Gas Initiative (RGGI) allowances can be exchanged for an amount of Title III allowances (meaning emission allowances issued before December 31, 2011); the amount of Title III allowances provided in exchange will be "sufficient to compensate" for the cost of obtaining and holding a RGGI or California allowance offsets generated through other programs may be used (under specific conditions and limitations) for compliance purposes.
Offsets	• In 2012, approximately 30% of an entity's allowance obligation can be satisfied with offsets; this percentage increases to 67% by 2050; the aggregate annual number of submitted offsets cannot exceed 2 billion tons. • Despite this limitation, it is unclear whether 2 billion tons of offsets will be available in the first place, either domestically or internationally. The degree of offset scarcity will become clearer as time progresses. • Half of an entity's offsets can come from domestic sources and half from international. Rules still required for generating, measuring and monitoring offsets. • If there is an insufficient volume of domestic offsets, the number of international offsets available may be increased up to 1.5 billion metric tons. • Starting in 2018, international offsets are discounted: 1.25 offsets equal 1 emission allowance. • Hawaii will likely be able to sell offsets from forestry and agricultural practices into an integrated cap & trade system.
Industry Transition Support	Eligible companies to receive rebates to compensate for additional costs incurred under the program as a way to address competitiveness imbalance. Eligibility determined by two part formula based on the company's historic direct and indirect emissions relative to industry averages. Unless modified by the President, rebates will be phased out over a 10 year period beginning in 2026.Other provisions for clean energy include curriculum development grants, worker training, and State Energy

American Clean Energy and Security Act of 2009 (ACES), aka House Bill 2454, aka Waxman-Markey Bill	
	and Environment Development (SEED) funds. The Clean Energy Deployment Administration (CEDA) is to oversee, fund to support new technologies to reduce GHG emissions and energy consumption.
Competitive Issues	Trade-exposed[121], carbon-intensive industries to receive allowances at no cost, based on a specific formula related to emissions intensity and energy use. Triggered by a determination from the President, EPA will set up an international reserve allowance program: foreign states that do not take comparable emission reduction actions would need to submit international reserve allowances (or foreign equivalents) to accompany exports of any covered GHG intensive goods and primary products to the United States; least developed nations or those that contribute no more than 0.5% of global emissions are excluded.
Interaction with other GHG programs	States may not implement or enforce a GHG emission cap that covers any (federally) capped emissions during the years 2012 through 2017; a cap does not include fleet-wide motor vehicle emission
Other key provisions	W-M would also create a series of incentives for energy efficiency, smart grids, and alternative energy sources. It would create a new national renewable portfolio standard requiring covered utilities to generate 6 percent of their capacity from renewable sources or energy efficiency savings by 2012, increasing the percentage by roughly 3 percent a year until 2021, when utilities would be required to produce 20 percent of their electricity from renewables and demonstrated energy efficiency. This standard would not pre-empt more stringent State RPS standards, and states would be permitted to require utilities to retire federal renewable energy credits received in excess of the federal standard.
Penalty for non-compliance	Excess emission penalties are equal to twice the market price for allowances in the relevant calendar year, plus covered entities must submit—in the following calendar year or other time period determined by EPA— allowances to cover the excess emissions from the previous year.
Banking	Banking of unused allowances is allowed. Limited borrowing of allowances from future periods is allowed. Allowances can be averaged over several years.
Allowance Prices	<u>EPA Estimate</u> : \$12-\$14 per tCO2e in 2015;

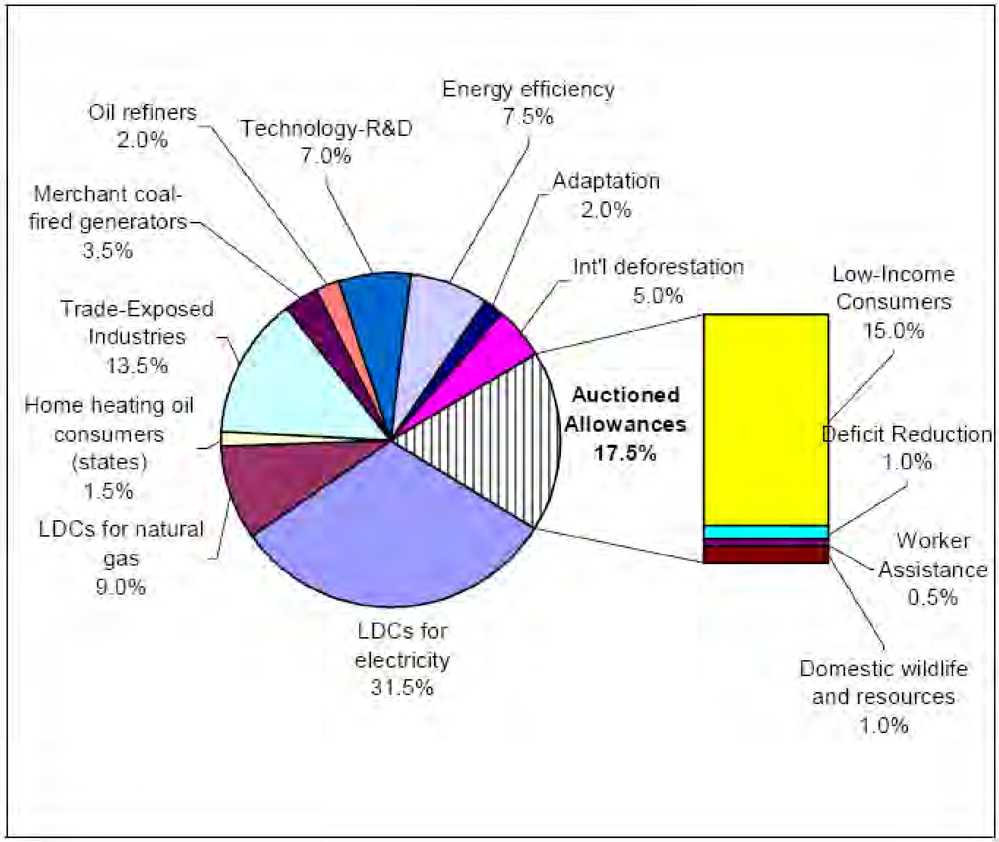
[121] Sectors identified as potentially being at competitive risk as a result of imposing carbon costs.

American Clean Energy and Security Act of 2009 (ACES), aka House Bill 2454, aka Waxman-Markey Bill	
	$16-$18 per tCO2e in 2020; $70-$80 per tCO2e in 2050 (Source: EPA Analysis of Waxman Markey, June 23, 2009) CBO Estimate: $15 per tCO2e in 2011 to $26 per tCO2e in 2019 (Source: Congressional Budget Office Cost Estimate, June 5, 2009) EIA Estimate: $19.9 to $93 per tonne CO2e in 2020. Basic Case: 2012 - Approx. $20 per tonne CO2e 2020 - $31.70 per tonne CO2e 2030 - $64.80 per tonne CO2e (Source: US EIA, Energy Market and Economic Impacts of H.R. 2454, the American Clean Energy and Security Act of 2009, August 2009).
Electricity Prices	EPA Estimate: $.084 per kwh in 2015; $0.1 per kwh in 2020; $0.145 per kwh in 2050 (Source: EPA Analysis of Waxman Markey, June 23, 2009)
GHG Emissions	EPA Estimate: 7,100,000 ktCO2e in 2015; 4,600-5,100 thousand kt CO2e in 2050 (Source: EPA Analysis of Waxman Markey, June 23, 2009)

The role of offsets is critical in determining future carbon prices. Under ACES, companies can meet up to a maximum of 30 percent of their compliance obligation in 2012 with domestic and international offsets. The remaining 70 percent must come from internal abatement and/or domestic emission allowances. While the percentage of companies' compliance obligation that can be met with offset purchases increases to 67 percent by 2050, it is doubtful that all companies will be able reach this ceiling as the US and international offset markets are likely to be completely saturated. In other words, the US and international offset markets could experience a shortage relative to aggregate global demand if targets specified in the latest version of ACES are upheld by the Senate review. Like other markets where supply is constrained and demand is strong, the effect is likely to be an increase in offset prices compared to historical averages

The allocation process used to distribute permits is also critical. By 2016, at the conclusion of full coverage phase in, approximately 18% of allowances would be auctioned. The remainder (82%) would be distributed "gratis" for various purposes. For the most part these permits would not be provided to the covered sectors. The percentage of credits that would be auctioned increases to approximately 72% by 2030 and 85% by 2050. The figure below shows how allowances under ACES would be distributed in 2016.

Figure 4: Allocation Distribution under ACES Act - 2016



ii. Analysis of Measure

Cap-and-trade systems are designed as a market mechanism to achieve specific levels of reduction at the lowest cost possible.

Table 16. Cap-and-Trade Screening Criteria

Criteria	Discussion
Cost effectiveness	While dependent on the ultimate design of the system, a cap-and-trade mechanism is designed to achieve the most cost effective opportunities first; allowing covered entities the option of purchasing emission reductions from other players in the market who have lower cost abatement opportunities.
Ability to meet goal	Cap-and-trade systems provide regulatory certainty.

Criteria	Discussion
	The level of emissions specified by the cap must be met by the regulated entities or significant penalties must be paid (which can be used to purchase reductions to obtain compliance). A cap-and-trade system does not provide price certainty since the cost of achieving the cap will vary.
Key sources to be included	All key sources in Hawaii would be included (key sources being all transportation fuels and power generation).
Size of affected sources	The sectors covered by the proposed federal plan cover the power sector and petroleum refining. As such it will cover virtually all of Hawaii's energy-related GHG emissions.
Ability to monitor and verify	A federal system will include GHG reporting, monitoring and verification.
Co-benefits for CAC's and toxic air emissions	All energy-related air emissions would be expected to decrease as energy use is decreased through reductions in demand and improvements in efficiency. Non-energy emissions such as particulates or emissions from volcanic action will be unaffected.
Environmental benefits for Hawaii	Hawaii's energy-related GHG and CAC emissions will be reduced significantly.
Compatibility with other programs	Other State initiatives to reduce GHG emissions, reduce dependence on imported oil, increase the use of renewables, etc., will all assist covered entities in Hawaii in meeting their goals. Efforts to support reforestation, no-till farming and other land use practices which reduce carbon emissions will benefit from the availability of a carbon price.
Extent of leakage	Leakage is expected to minimal. There is no concern with leakage from Hawaii's power system; however, changes in oil refining could occur if carbon prices rise sufficiently to change plant economics.
Effects on small business	Small businesses will be affected by any costs passed on by either the power sector or the petroleum refiners. These impacts are expected to be quite minor and can be offset by efficiency efforts to lower overall costs.

iii. Application and Implementation Process or Procedure

- Is there a threshold below which reduction requirements should not apply?
    - The regulation would apply to all electricity generation and all petroleum refiners with sales or distribution greater than 25,000 tonnes CO_2e per annum.
    - Gas LDC's which deliver more than 460mcf of gas (approximately 25kt CO2e) will also be covered.
    - Virtually all fossil fuel energy will be covered by 2016.

- Region/sector/end use where policy should be implemented
    - This is a federal policy. In Hawaii, we expect that virtually all energy-related emissions would be covered.

- How to measure and verify effectiveness and any impacts of M & V (i.e. Reporting requirements, additional cost to business, etc.)
    - Federal requirements will establish reporting, measurement and verification rules. The effectiveness of these systems will be reviewed periodically.
    - A number of states and regional trading systems are lobbying to ensure that reporting required under this system does not duplicate other reporting requirements already in place or which are being put in place.

iv. Potential Impacts/results of Implementation

A federal cap-and-trade system implemented patterned on the ACES would cover the vast majority of emissions in Hawaii, by covering:

1. The power sector which accounts for 55% of energy related emissions, and,
2. Petroleum refining and refined products which account for essentially all remaining energy use in the State, except for any small amounts of imported refined fuels.

A federal cap-and-trade system is assumed to come into effect in 2012, patterned on the ACES Act as described in Section 5. The cap-and-trade system has been implemented as part of this Work Plan in conjunction with the Work Plan 1 policies listed in Work Plan 1.

Permit prices for emission allowances under the ACES Act have been projected by the EPA, the Congressional Budget Office, the EIA and others. Projected prices in 2020, as described in Section 5, Part M, range from $16 to $32 in the main scenarios modeled by these Agencies. Some of the sensitivity modeling project that prices could rise as high as $93 per tonne CO2e under some conditions.

In order to model the effects of a federal cap-and-trade system on Hawaii, it is assumed that permit prices will follow the trajectory described for the 'Basic" scenario in the most recent modeling completed by the EIA. Under this scenario permit prices start out at about $20 per tonne CO2e in 2012 and rise to approximately $32 per tonne CO2e by 2020. These modeling results represent the most current assessment of permit costs by a US federal department and were felt to be conservative in the sense that they present the highest projection of carbon prices among the studies reviewed.

The method for allocating and auctioning emission permits is one of the key elements in determining the impacts of a cap-and-trade system. Under the ACES Act, a portion of available emissions permits would be allocated to be distributed at no charge to electricity distribution companies to help offset electricity rate increases caused by the imposition of a cost for carbon. An analysis of how these permits will be distributed by State, prepared by the World Resources Institute (WRI), has been used for modeling the expected distribution of these free (or 'gratis') permits. According to the WRI analysis, Hawaii would receive 5.4 million permits for electric LDC's to reduce cost impacts to consumers in 2016. Our analysis indicates that power sector emissions under the Work Plan 1 policies would be only 3.7 million tonnes CO2e in 2016. The LDC's would therefore be issued more permits than they require to cover their projected emissions.

The rules for disposing of these excess permits are unclear. The purpose of issuing these permits is to offset cost increases due to the imposition of a carbon cost under the cap-and-trade systems. It is unclear whether the utility or the State will have the option of using them for other purposes, however, a more appropriate course of action would be for the State to use the value of these permits to fund planned GHG reduction policies and programs and assist consumers in reducing their energy use and hence energy costs, rather than applying them to reduce rates. Economic modeling assumed that any excess permits would be sold and that the resulting revenues would be used within the Hawaiian economy. The positive impact of this additional spending was offset by some outflow of funds to the federal system as discussed below.

A recent analysis by the Congressional Budget Office indicates that low income households would benefit from the cap-and-trade provisions in the ACES Act (H.R.2454). According to the CBO, *"the lowest income quintile would see an average gain in purchasing power of 0.7 percent of after tax income, or about $125 measured at 2010 income levels*"[122].

In the modeling results that follow, it is assumed that the allocated permits are used to hold electricity prices to the levels projected under the Work Plan 1 policy, but not

[122] Congressional Budget Office, The Economic Effects of Legislation to Reduce Greenhouse Gas Emissions, September 2009, page 25.

reduce prices below that level. The value of any excess permits is assumed to be used to fund GHG reduction policies aimed at reducing energy consumption and costs.

The modeling does not assume that regulated entities in Hawaii will accumulate an inventory or bank of permits by 2020.

Work Plan 3 Modeling results:

Appendix D presents the modeling results for Work Plan 3, and compares these outcomes to the Reference Projection. Appendix E provides details on the economic changes that result from the policies. The following discussion summarizes these results for Work Plan 3.

It is assumed that the target for the federal cap-and-trade system will be a 17% reduction in GHG emissions from 2005 levels. The implementation of the policies included in Work Plan 1 result in Hawaii's GHG emissions falling by 27% from 2007 levels, significantly exceeding the levels required under the cap-and-trade scheme for the State as a whole. As a result, the imposition of the cap-and-trade targets results in relatively minor additional reductions in State GHG emissions.

GHG emissions in 2020 are about 27 kt CO2e lower under Work Plan 3 than in Work Plan 1. ***Emissions included in the State target fall to 8,323 kt CO2e. This is 5,336 kt or about 39.1% below the State target.***

Almost half of this additional reduction comes from passenger transportation as it responds to an effective increase in fuel costs. Secondary energy use declines slightly in the commercial, industrial and passenger transportation sectors. Forestry and agriculture emissions decline very slightly compared to Work Plan 1. Electricity sales rise very slightly (0.5%) as electricity prices rise more slowly than fossil fuel prices.

Regulated entities in Hawaii are projected to purchase about 13 million tonnes of emission permits in 2012, under the cap-and-trade system modeled. This volume would decline to just over 11 million tonnes by 2020. The State is projected to receive approximately 8.8 million permits in 2016 under the allocation of permits projected by the WRI (see Appendix A, Table A2). This implies that the State will be allocated fewer permits than are purchased at auction to cover its projected level of emissions, however, it should be noted that the WRI analysis "*does not include important allowance-funded programs operated by the federal government for technology R&D, low-income consumer assistance, adaptation, international programs and worker benefits. Nor does it take into account direct assistance to covered industrial emitters through free allowances (e.g. trade-vulnerable industries)*"[123]

[123] Allowance Distribution to States and Energy Consumers under the American Clean Energy and Security Act (H.R. 2454, Waxman-Markey), World Resources Institute and Georgetown Climate Center, July 28, 2009, page 9.

Almost all of the auctioned permits purchased are acquired by the refinery sector, which is assumed to be required to hold permits for the emissions associated with its refined products, and by the power sector. The bulk of the free or 'gratis' permits are received by the electric LDC's. After 2013, the power sector no longer needs to buy permits. As described earlier, the allocation to the power sector is estimated to be 5.4 million tonnes of emission permits in 2016 compared to projected emissions under Work Plan 1 would be only 3.7 million tonnes CO2e in 2016. The difference between the expected allocation and projected emissions (1.7 million tonnes) could have a value of over $51 million at the projected 2016 permit price of $30 per tonne CO2e.

The economic impacts of Work Plan 3 are still relatively modest, but are twice as large as those for Work Plan 1 in the early years. The effect of the large number of permits returned to the State results in GRP growth as much as 1.5% higher than in the Reference Projection by 2012, remaining 0.9% above reference levels in 2020. Real personal disposable income reflects a similar pattern; remaining about 1% higher than the Reference Projection from 2012 through to 2020.

Overall employment rises about 1% above reference levels by 2012 and remains 0.9% above reference levels in 2020. The commercial and broad industrial sectors remain above reference levels throughout the period to 2020. The utility sector shows the same rapid increase in the period to 2015, but a slightly smaller decline than in Work Plan 1 in the period to 2020; declining by 16% compared to the Reference Projection, compared to 17% in Work Plan 1. The petroleum refinery sector also shows a decrease in employment under this Work Plan, falling by 10% below levels in the Reference Projection. The absolute change in employment in this sector represents a difference in overall employment of less than 40 jobs in 2020. By contrast, employment in the Commercial sector rises by more than 5,000 jobs compared to the Reference Projection.

iv. Comparison of Work Plans

Levels of energy use and resulting emissions are relatively consistent between the three Work Plans. In part this reflects the fact that emissions are substantially reduced by the policies included in Work Plan 1. As a result, the imposition of a carbon tax or a federal cap-and-trade system has a relatively minor effect on the already much reduced levels of energy use.

The three work plans do, however, differ in their impact on energy prices and the economy. Table 17 below summarizes the effects of the three Work Plans on GHG emissions, electricity and energy prices. All three plans result in significant increases in Hawaii's already relatively high electricity rates. It is important to note, however, that while electricity rates would rise under each plan, electricity costs for the average consumer would decline as electricity efficiency programs drive average consumption down. Energy prices for fossil fuels increase in both the Work Plan 2 (carbon tax) and Work Plan 3 (Cap-and-Trade).

The effects of these plans on businesses, and in particular small businesses, will depend on the proportion of operating costs represented by energy costs, the profit margins available and the ability of the business to pass along any change in energy costs. Energy costs typically represent a relatively small share of total costs for most businesses[124], however, they can be significant to profitability, particularly when energy prices are volatile. Small businesses typically have fewer options in either controlling energy cost (i.e. through investing in efficiency improvements, negotiating energy contracts, etc.) or in passing along cost increases resulting from changing energy prices[125]. They can also be more challenging to access through traditional Demand Side Management (DSM) initiatives due to limited resources, including time, access to capital and technology. As a result, small businesses could be negatively affected if energy prices rise unless a corresponding effort is made to assist these enterprises in increasing energy efficiency. It is therefore recommended that the Public Benefits Agency specifically target energy efficiency programs to target these "hard to reach" market segments. With such an effort, small businesses should not be negatively affected by the energy price changes resulting from the Work Plans and may benefit from greater stability in energy costs in the longer term.

[124] For most businesses energy costs represent a small percentage of total costs. For example, the estimated total cost for commercial electricity (commercial consumption times the commercial rate shown in Appendix B) represents about 1.5% of gross output for the commercial sector. For all but a handful of energy intensive industries (steel mills, pulp and paper, smelting, etc.) energy costs typically represent less than 5% of total costs. For the US fruit and vegetable processing industry, for example, energy costs represent about 2.1% of the value of product shipments according to the "Energy Star Guide for Energy and Plant Managers" (Ernest Orlando Lawrence Berkeley Laboratory, Energy Efficiency Improvement and Cost Saving Opportunities for the Fruit and Vegetable Processing Industry, March 2008).

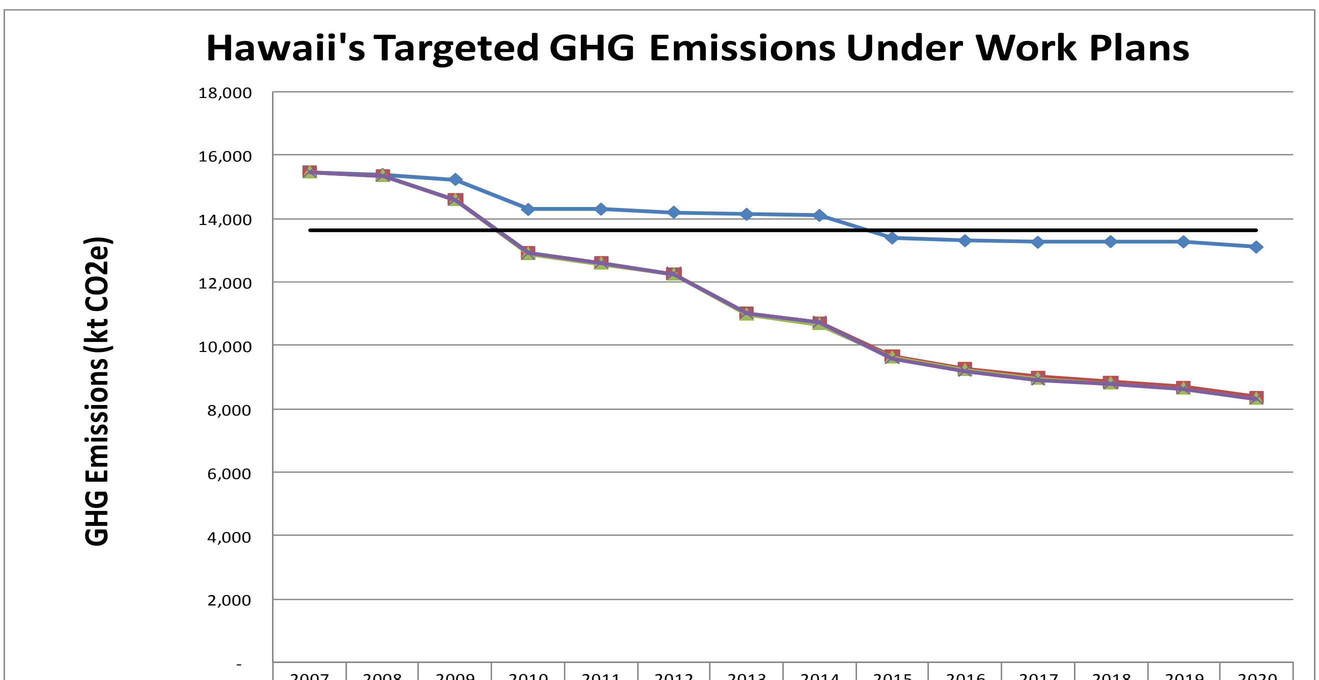
[125] Characterization and Analysis of Small Business Energy Costs, Small Business Administration's Office of Advocacy, April 2008.

Table 17. Summary of Work Plan Impacts

Summary of Work Plan Impacts *(differences from Reference Projection, 2020)*	**Work Plan 1 (HCEI plus Recommended Policies)**	**Work Plan 2 (State Carbon Tax)**	**Work Plan 3 (Federal Cap-and-Trade)**
2020 GHG Emissions included in Target (in kt CO2e) *Reference – 13,122 kt CO2e* *1990 Level – 13,660 kt CO2e*	8,377	8,327	8,323
Amount Below 1990 Target Level (in kt CO2e)	5,283	5,333	5,336
Increase in Electricity Prices[126]	22-30%	25-34%	21-29%
Change in average Residential Bill	~10% decrease	~10% decrease	~10% decrease
Change in other energy prices[127]	No change	3-6% increase	3-8% increase

GHG emissions fall dramatically from Reference Projection levels in all three Work Plans as shown in the figure below. ***The difference between emissions in the three work plans is barely discernable in the graph below given the overall large***

Figure 5



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Reference Projection	15,487	15,407	15,254	14,307	14,316	14,219	14,153	14,119	13,408	13,324	13,274	13,293	13,288	13,122
Work Plan 1	15,487	15,378	14,615	12,926	12,620	12,270	11,012	10,721	9,671	9,271	9,003	8,859	8,696	8,377
Work Plan 2	15,487	15,378	14,615	12,920	12,603	12,253	10,988	10,690	9,632	9,237	8,961	8,813	8,649	8,327
Work Plan 3	15,487	15,378	14,615	12,926	12,619	12,283	11,027	10,739	9,595	9,207	8,934	8,801	8,633	8,323
Target (1990) Emissions	13660	13660	13660	13660	13660	13660	13660	13660	13660	13660	13660	13660	13660	13660

[126] The range shown reflects different electricity prices for residential, commercial and industrial sectors.

[127] The range shown does not include changes in utility gas and #6 fuel, which represent a very small fraction of the total energy use in Hawaii.

change from reference levels.

The effects of the three work plans on the economy are compared in the two figures below, which show the change in GRP and employment as calculated by the REMI macro-economic model. Supporting tables are presented in Appendix E. As discussed in each of the Work Plans above, the effects of the Work Plans on GRP and employment are relatively small, but positive in all cases.

Overall, results from the economic modeling exercise were consistent with the trends observed from the energy modeling exercise. Inputs from Energy 2020 were used in REMI's Policy Insight model to estimate the regional economic impacts up to 2020. Energy 2020 inputs used in REMI included price changes for electricity and other energy inputs (such as oil) for various sectors, as well as changes in electricity generation due to construction of new renewable generation facilities in Hawaii and changes in outputs for other sectors, such as petroleum refining.

Results from REMI validated projections of energy market changes seen in Energy 2020 results. For example, the large temporary increase in GDP and employment from 2010 to 2012 and a subsequent drop thereafter was directly related to the construction work associated with the $1.6 billion expenditure on the undersea cable and wind generation during 2010 – 2012 in Maui county. Given the significant contribution these expenditures made to local economic activity, these temporary construction and other related sector jobs tapered off once the projects were built, resulting a drop in these temporary employment effects. Additional construction projects in subsequent years lead to other spurts in local economic activity and employment. .

The greatest impact occurs as a result of projects undertaken as part of Work Plan 1 in the period prior to 2015. Actual timing of these projects is expected to differ from the assumed timing, however, the overall effects are projected to decline in the latter part of the period.

The effects of adding a carbon tax (Work Plan 2) are slightly less positive, but remain above the levels in the Reference Projection.

The impacts of a cap-and-trade system (Work Plan 3) are projected to be positive, though still relatively minor (about 1% impact) in terms of the overall economy. The effects of the cap-and-trade system will ultimately depend on decisions on the design of the program, how permits are allocated, and how funds under "allowance funded" programs are distributed.

Figure 6

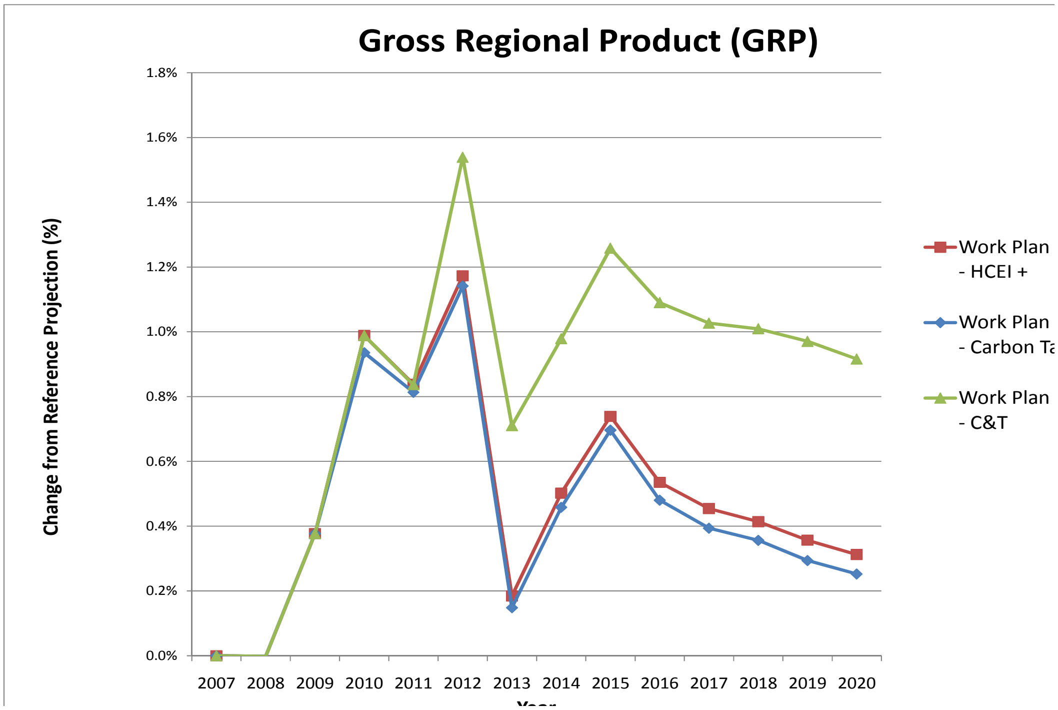


Figure 7

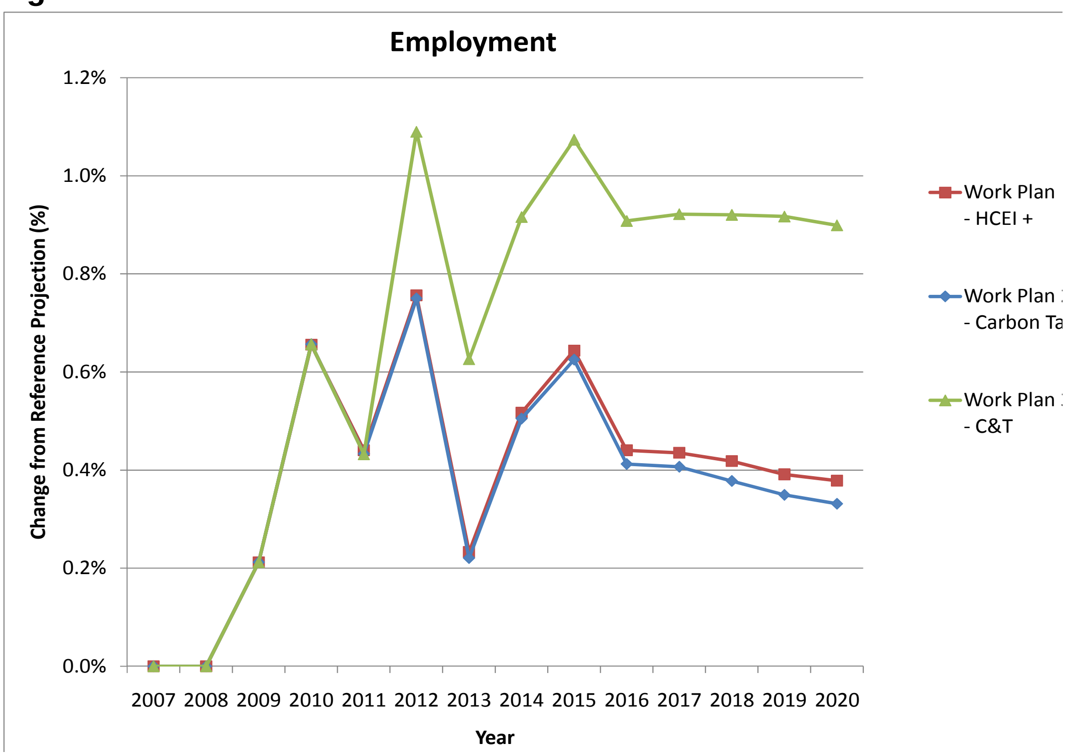
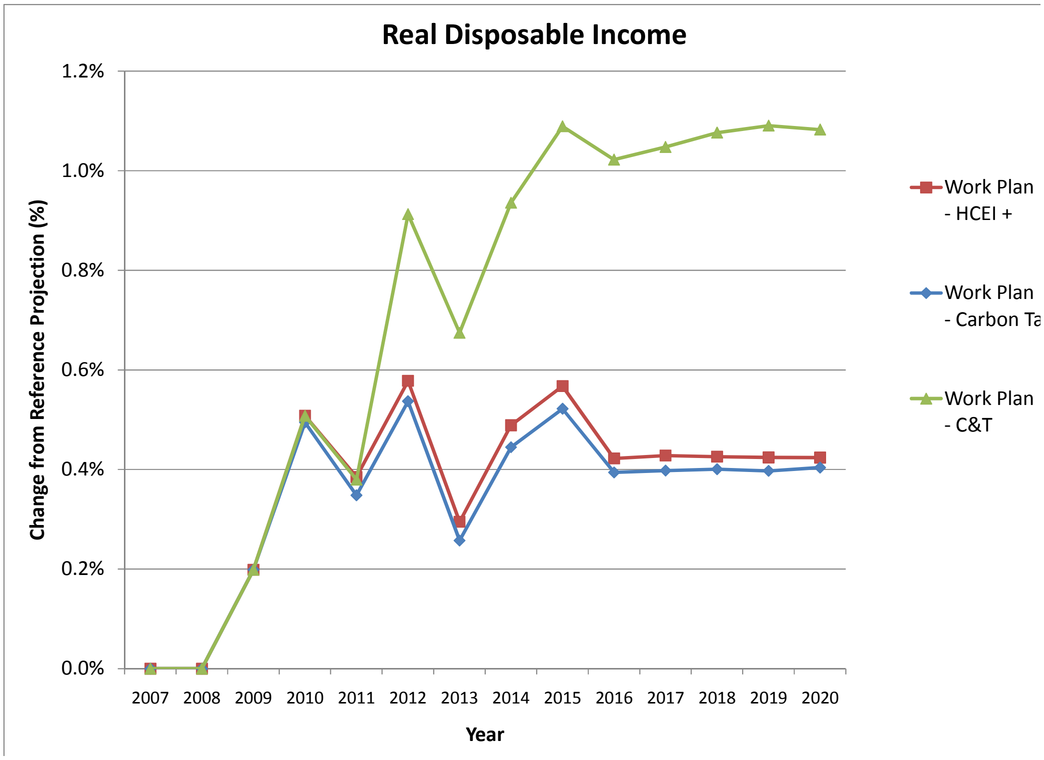


Figure 8



v. Co-Benefits for Other Air Emissions

Criteria Air Contaminants are a group of pollutants which individually or in combination are the key ingredients in smog and acid rain. The term derives from the establishment of measurement criteria for these pollutants by the U.S. Environmental Protection Agency to protect human health and welfare. The US EPA defines CAC's as including:

- Ozone,
- Particulate matter (PM),
- Carbon monoxide (CO),
- Sulphur Dioxide (SO2),
- Nitrous oxides (NOx), and
- Lead.

Measurements of air pollutants also typically include:

- Volatile Organic Compounds (VOC's)
- Ammonia (NH3)

The same fossil fuel processing and combustion that emits most of Hawaii's GHG emissions also release the majority of the common air pollutants such as NOx, SOX, VOC, CO and particulate matter. As a result, energy efficiency, renewable and clean energy initiatives proposed to lower GHG emissions would also lead to reductions in emissions of these pollutants.

Unlike GHG emissions, there are various types of remedial technologies that can be and are routinely applied to reducing emissions of common air contaminants; ranging from catalytic converters for cars to baghouses and Flue Gas Desulphurization systems for coal-fired power plants. However, measures that reduce energy-related GHG emissions by reducing the amount of fossil fuel being consumed will have a corresponding impact on energy-related CAC emissions.

- NOx emissions are relatively high from the heavy, diesel powered trucks and vehicles that dominate energy use for freight transportation. Improvements in the efficiency of freight transportation vehicles will have a disproportionately large impact in reducing NOx emissions.
- With the advent of lower sulphur transport fuels, end use energy efficiency improvements are not as effective at reducing SO2 emissions as they once were, however, lower energy use and the use of biofuels to replace petroleum fuels will further reduce energy-related sulphur emissions.
- Carbon monoxide emissions come predominantly from transportation energy use and measures to improve the efficiency of transportation vehicles are the key to reducing CO emissions.

Air contaminant emissions in combination with meteorological conditions and atmospheric chemistry can lead to urban smog, a hazardous mix of particulates, ground level ozone, nitrogen oxides and volatile organic compounds that presents cardio-pulmonary hazard to which the elderly and very young are particularly vulnerable. Many of the trace organic contaminants emitted by human activities are toxic or carcinogenic, adding to the overall public health hazard represented by air pollution. Epidemiological evidence indicates a significant positive correlation between air quality and premature death from cardio-pulmonary stress. Elevated levels of ground level ozone are not only an urban health issue but represent a growing threat to agricultural crops and public health in many semi-urban and rural areas as the temporal and spatial extent of smog and smog-like conditions continues to expand. For all these reasons, air pollution and the control of the emissions of air contaminants is a longstanding public policy issue, predating concern over climate change by many decades.

Unlike GHG's, where the concept of "carbon dioxide equivalence" allows a direct comparison of emissions of different gases based on their impact, there is no such basis for comparing emissions of the different CAC's. The main thing that the CAC's have in common is that they are all emitted into the air and they have all been identified as "criteria pollutants" for purposes of clean air regulation. Beyond that, a tonne of one

CAC (for example carbon monoxide) is qualitatively different from a tonne of another CAC (for example, nitrogen dioxide). They are emitted on different scales and have different environmental impacts from each other. Although some reports and other documents refer to “total CAC emissions” – the sum of the emissions of different CAC’s – it is like adding apples and hammers -- there is no theoretical basis or obvious practical value to such a summation.

In the case of CAC emissions that are associated with fossil fuel combustion, the quantity of emissions depends not only on the type and quantity of fuel being burned (the only factors that determine carbon dioxide emissions) but also on the level of contaminants in the fuel, the combustion conditions and technology, and the presence or absence of post-combustion mitigation technologies for removing pollutants from the combustion exhaust stream. As a result, the energy-related emissions of some CAC’s are associated with particular end use/fuel combinations more than with others.

Another critically important distinction that relates to the significance of CAC emission data as compared with GHG emission data is the connection between emissions and health and environmental impacts. In the case of GHG emissions, a tonne of CO2e emitted contributes directly to global warming, regardless of where or when it is emitted, and the pattern of GHG emissions is therefore largely reflective of the pattern of causal factors for global warming. In the case of CAC emissions, there is a long chain of events between the emissions of any particular air contaminant and the eventual impact it may have on air quality or public health in a particular place or time. Wind patterns, meteorology, atmospheric chemistry, and local weather all come into play, and make all the difference in determining air quality impacts of CAC emissions. The formation of urban smog, for example, only takes place under certain meteorological conditions, and one of its principal constituents – ground level ozone – is created (and destroyed) by chemical reactions in the atmosphere that include criteria air contaminants. Ozone itself is not emitted in any appreciable quantities by human activities.

In its report on “Indicators of Environmental Quality”[128] the Hawai’i Department of Health reported ambient levels of SO2, Particulates and CO in Honolulu well below national standards for air quality. In the case of SO2, human activities were not the main driver of ambient air levels: *“Hawai`i’s annual average SO2 concentrations are very low compared to the national standard. On persistent Kona wind days, the volcanic emissions can be transported to Oahu and are experienced as particulates”.*

[128] State of Hawaii, Department of Health, Indicators of Environmental Quality, May 2009, page 3.

Table 18

State of Hawaii - CAC Pollution Emissons - 2005					
Source of Pollutant *(Tier 1 Description)*	**CO2**	**NH3**	**NOx**	**SO2**	**VOC**
FUEL COMB. ELEC. UTIL.	1%	0%	15%	18%	1%
FUEL COMB. INDUSTRIAL	0%	1%	5%	34%	0%
FUEL COMB. OTHER	1%	0%	1%	8%	2%
PETROLEUM & RELATED INDUSTRIES	0%	0%	1%	5%	2%
OTHER INDUSTRIAL PROCESSES	0%	1%	0%	0%	0%
WASTE DISPOSAL & RECYCLING	0%	0%	2%	1%	1%
HIGHWAY VEHICLES	68%	96%	34%	3%	42%
OFF-HIGHWAY	30%	1%	41%	29%	19%
CHEMICAL & ALLIED PRODUCT MFG	0%	0%	0%	4%	0%
SOLVENT UTILIZATION	0%	0%	0%	0%	18%
STORAGE & TRANSPORT	0%	0%	0%	0%	15%
MISCELLANEOUS	0%	0%	0%	0%	0%
Total -	***100%***	***100%***	***100%***	***100%***	***100%***
Percentage of Total Emissons:					
Related to Transportation -	98%	96%	75%	31%	61%
Related to Non-Transport Fuel Combustion -	2%	2%	22%	59%	2%
Combined Transport & Fuel Combustion	100%	98%	97%	90%	64%

Source: Summary of emission for Hawaii from the US EPA - Technology Transfer Network - Clearinghouse for Inventories and Emission Factors; 2005 National Emissions Inventory Data and Documentation - section on Inventory Data - Tier Summaries ftp://ftp.epa.gov/EmisInventory/2005_nei/tier_summaries/tier_05v2

Analysis of the most recent pollution emissions data from the EPA (for 2005) indicates that the majority of man-made pollution are released from transportation activities, particularly for CO2, NH3 and NOx and VOC emissions.

The majority of SO2 emissions arise from other fuel combustion (54%) with off-road transportation contributing a further 29%. Over 60% of Volatile Organic Compounds (VOC) emissions come from transportation, however, almost 40% result from 'non-energy' related sources.

Policies which reduce energy use for transportation, power generation and other purposes will obviously provide co-benefits in terms of reduced CAC emissions. Similarly, the substitution of renewable fuels and energy sources for fossil fuel sources will reduce CAC emissions.

Gasoline use for transportation is projected to decline by 3.3% per year between 2007 and 2020 in the Reference Projection as a result of the EISA, the addition of the transit system and rising energy prices. Under the Work Plan 1, policy passenger gasoline use declines by 4.5% per year, dropping by more than 40% from 2007 levels by 2020. Diesel use shows a smaller decline reflecting the smaller efficiency gains in freight energy use and the use of diesel outside the transportation sector, but still declines by 20% between 2007 and 2020 under the Work Plan 1 policies. In general, reductions in

CAC emissions from transportation will be directly proportionate to the reduction in fossil fuel use and GHG emissions.

In the power sector, the effects of the EEPS, increased use of biodiesel and other forms of renewable generation reduce GHG emissions by almost two-thirds. Emissions of SOx, NOx, VOC's and CO would be expected to decline approximately in proportion to the reduction in fossil fuel use[129].

vi. Recommendations:

A number of proposed policies are recommended for the Task Force's consideration, but were not included in this modeling exercise:

1. Update and enhance energy performance required under Building Codes (consistent with levels approved in ACES Act) *(discussed in section* 6i)
2. Introduce Smart Growth policies to increase urban densities, support public transit/reduced vehicle use, and more walkable/pedestrian/bike friendly communities *(discussed in section* 6k).
3. Adopt Pavley II vehicle efficiency standards if federal standards for passenger vehicles do not continue to improve beyond 2016 *(discussed in section* 6g).
4. Improve data collection on freight and marine energy use and work with stakeholders to develop information and other programs to support efficiency improvements in these sectors *(discussed in section* 6j).
5. Establish a broad role for the Public Benefits Agency to enable it to capture synergies between fuel, electricity and water efficiency *(discussed in section* 6c, part i).
6. That the Public Benefits Agency specifically target energy efficiency programs to target "hard to reach" market segments that may be particularly affected by changing energy prices, such as low income households and small business *(discussed in section 6c, table 3 and section 6, part iv – Comparison of Work Plans*).

In addition a several areas have been identified that are felt to warrant additional research or should be designated for additional data collection efforts:

1. Improve or expand collection of data on the drivers of road freight energy use (tonne-miles shipped, vehicle types used, etc.) to improve understanding of fuel use and emissions in the on-road freight sector.
2. Establish or improve data collection regarding energy use by types of marine vessels, the types of fuel used by purpose, and shipping volumes by type of

[129] Reductions in SO2 emissions may actually be greater than the projected decrease in GHG emissions to the extent that biodiesel is used to substitute for diesel fuel. Some offsetting GHG emissions would occur in the production of the biodiesel, however, SO2 emissions would be virtually eliminated.

vessel and destination to provide a more detailed picture of energy use and emissions in the marine sector.
3. Off -grid power sources are projected to play a growing role in Hawaii's electricity delivery. Develop systems to track power contribution from off-grid, distributed sources.
4. Monitor and support research on the cost and potential for afforestation and agricultural initiatives within Hawaii.
5. Continue to regularly update appliance/equipment surveys to determine type and penetration of devices driving electricity use, and market shares/saturations of efficient devices.

Appendices

Appendix A: Description of Models *(ENERGY 2020 & REMI)*

ENERGY 2020

ENERGY 2020 is an integrated multi-region energy model that provides complete and detailed, all-fuel demand and supply sector simulations. These simulations can, with the addition of the macro-economic model such as REMI or similar models - include modeling of economic interactions to determine the benefits or costs to the economy of demand or supply side investments or changing energy prices brought about by environmental policies or other programs. Air emissions, such as GHGs and CAC's, are endogenously determined, thereby allowing assessment of environmental risk and co-benefit impacts.

The model is descriptive, simulating the physical and economic flows of energy users and suppliers. It simulates how they make decisions and how those decisions causally translate to energy-use and emissions. It contains a rich sector and end-use description of the processes and equipment that drive energy use and emissions. The model is based on stocks and flows, using marginal rather than average device efficiencies. It produces annual results and historical calibration to actual energy and emissions patterns is part of the model's modus operandi.

Process costs (endogenously based on energy decisions) and device costs (the marginal costs of using energy from the device) determine energy choices. These choices maximize the utility of using energy rather than representing "optimal" economic choices. The model separates price and non-price elements of decisions, and recognizes market imperfections, including the extent to which market participants know of or have access to choices. All the decisions (their components and information flows) that are relevant to consumer energy choice are endogenously simulated.

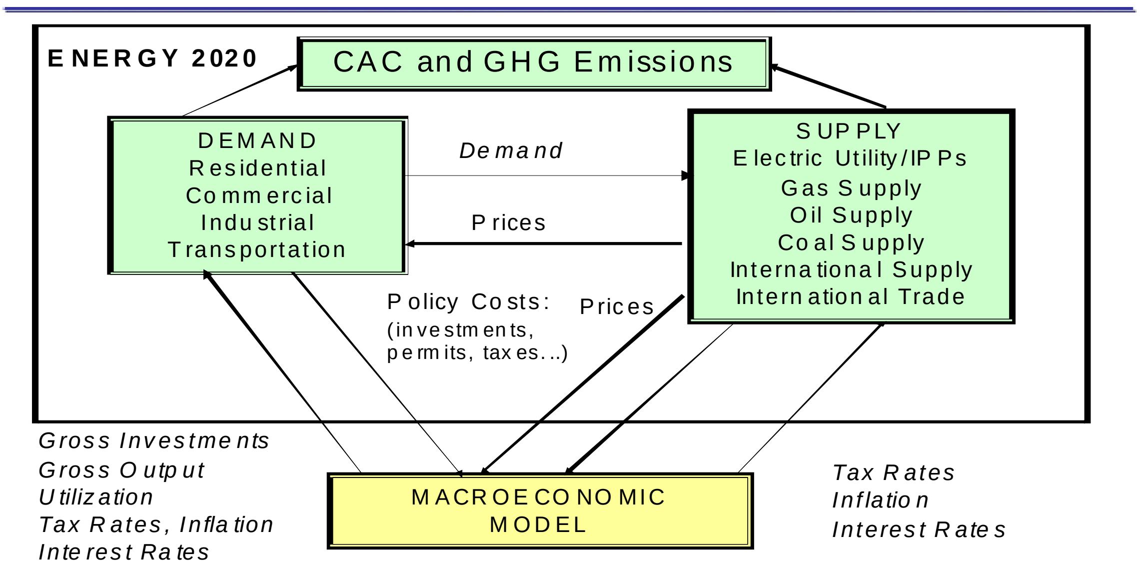
For the electricity supply sector, generation is modeled at a detailed plant-by-plant level for each energy supplier. Demand and supply are modeled for transmission "nodes", in this case corresponding to Hawaii's counties; allowing prices to be tracked by node.

The basic implementation of ENERGY 2020 for North America now contains a user-defined level of aggregation down to the 10 provincial and 50 state (and sub-state) level, including Hawaii. ENERGY 2020 contains historical information on all generating units in the US and Canada. ENERGY 2020 is parameterized with local data for each state as well as all the associated energy suppliers it simulates. Thus, it captures the unique characteristics (physical, institutional and cultural) that affect how people make choices and use energy. The specific data sources used for Hawaii are described in Section 4.5 below.

ENERGY 2020 can be linked to a detailed macroeconomic model to determine the economic impacts of energy/environmental policy and the energy and environmental impacts of proposed policies. For US regional and state-level analyses, the Regional Economic Models Incorporated[130] (REMI) macroeconomic model, used in this project, is regularly linked to ENERGY 2020. The REMI macroeconomic model includes inter-state, US and world trade flows, price and investment dynamics, and simulates the real-time impact of energy and environmental concerns on the economy and vice versa.

The figure below shows the structure of the ENERGY 2020 model and the information flows between the ENERGY2020 and REMI. The REMI macro-economic model has been used to provide a forecast of the economy to ENERGY 2020. The projected level of economic activity is then used in the model to drive requirements for new investments, processes and equipment (subject to the other interactions as described in Appendix A of the "Assumptions Book").

Model Structure & Relationships



ENERGY2020 simulates energy choices relating to these investments regarding the types of fuel and energy efficiency associated with those investments based on prices, policies and other factors. Once ENERGY 2020 has completed its simulation, outputs from ENERGY 2020, including the level of investments, energy prices, policy costs, etc., can be fed back to REMI. REMI then uses these outputs to determine the impact of changes in investments, energy prices, permit costs, etc. on the economy. The

130 Regional Economic Models, Inc. www.remi.com

changes in economic activity may result in changes to energy requirements (i.e. steel and concrete required for construction of new generating plants). The changes in economic activity are passed as inputs to ENERGY2020 which in turn models the impacts of these changes. The two models are iterated until convergence is reached (i.e. no further significant change in modeling results).

REMI Policy Insight® Model

The REMI "Policy Insight" model (henceforth referred to as the REMI model)[131] is a *dynamic* regional input-output model that can be used to model the economic impacts of potential policies, such as energy and climate change policies, on the regional economy.

The REMI model incorporates aspects of four major modeling approaches: Input-Output, General Equilibrium, Econometric, and Economic Geography. Each of these methodologies has distinct advantages as well as limitations when used alone. The REMI integrated modeling approach builds on the strengths of each of these approaches. The dynamic modeling framework in REMI provides the user the option of "forecasting how changes in the economy and adjustments to those changes will occur on a year-by-year basis".[132] The current modeling version allows projections until 2050.

> *"The REMI model has, at its core, the inter-industry relationships found in Input-Output models. As a result, the industry structure of a particular region is captured within the model, as well as transactions between industries. Changes that affect industry sectors that are highly interconnected to the rest of the economy will* often have a greater economic impact than those for industries that are not closely linked to the regional economy.
>
> *General Equilibrium is reached when supply and demand are balanced. This tends to occur in the long run, as prices, production, consumption, imports, exports, and other changes occur to stabilize the economic system. For example, if real wages in a region rise relative to the U.S., this will tend to attract economic migrants to the region until relative real wage rates equalize. The general equilibrium properties are necessary to evaluate changes such as tax policies that may have an effect on regional prices and competitiveness.*[133]

The model provides three levels of industry detail. Model versions can be created for 23, 70, or 169 industry sectors, based on the NAICS classification scheme. REMI, and indeed other regional economic models, are based on the latest NAICS classification scheme (as opposed to the older SIC-based system).

[131] REMI also maintains other models, useful for analyzing specific regional economic investments.
[132] REMI User Guide Version 6.0.
[133] www.remi.com

REMI provides close to 6,000 output variables covering all the variables that are considered important in the regional economics literature, such as changes in employment, output, labor income, and taxes.

REMI has been used extensively in combination with ENERGY 2020 to model energy and GHG reduction policies.

Appendix B: Policy Modeling Assumptions

Hawaii Clean Energy Initiative or HCEI (based on HCEI Agreement)

The tables below list the assumed power system changes assumed to be included in the Clean Energy Initiative. This includes new plant additions, conversions of existing units to biodiesel, and plant retirements. One plant, CT1 in Oahu, was assumed to come on-line using biodiesel in 2009 in the reference projection.

For the Solar/PV plans the table shows the level of capacity that is to be reached in each milestone year. For modeling purposes, it is assumed that capacity grows evenly between the milestone years. The levels shown are assumed to be inclusive of any PV anticipated in the Reference Case. The "Net Unit Metering" is additional customer side generation assumed to be added by the milestone years (2010, 2015, and 2020).

In HELCO it should be noted that the "Na Makani" wind project includes both wind and pumped storage.

Table B1:

Hawaii Clean Energy Initiative:			
HECO	**Capacity (MW)**	**In Service**	
		Quarter	**Year**
Kahuku Wind	80	4	2009
Airport DSG (Biofuel)	8	3	2010
CIP CT-1 (Biofuel)	30	2	2010
Honua Waste-to-Energy	6	4	2011
C&C Waste-to-Energy	11	2	2012
Sea Solar OTEC	10	3	2013
Military DG	50	4	2013
Molokai and/or Lanai Wind	400		2013
CIP CT-2 (Biofuel)	110		2015
DG at substation (Biofuel) - conversions	30		2015
Lockheed Martin OTEC	10		2015
MW of Capacity Added by the year indicated:	**2010**	**2015**	**2020**
Pay-As-You-Save Solar Program + PV Host	4	18	32
Mandatory Solar Roofing, SB644	1	3	6
Net Energy Metering	5	23	57
Seawater Air Conditioning	0	16	16
Unit Retirements:	**Year**		

Hawaii Clean Energy Initiative:			
Waiau 3 (110 Mw)	2011		
Waiau 4 (50MW) -10728 A23_W3	2014		
	Capacity	In Service	
HELCO	(MW)	Quarter	Year
PGV Geothermal (addition)	8	4	2010
Hamakua Biomass	25	4	2010
Hawaii County EFW	4		
Sopogy Solar	0.5	4	2008
Na Makani Wind & PSH	4.5		2015
MW of Capacity Added by the year indicated:	**2010**	**2015**	**2020**
Pay-As-You-Save Solar Program + PV Host	1	4	8
Mandatory Solar Roofing, SB644	2.2	8	15
Net Energy Metering	1.3	6	14
Unit Retirements:	**Year**		
Waimea, D8-D10 and Shipman 1 retired	2002		
Keahole D18, D19 and D20	2004		
Shipman 3	2005		
Shipman 4	2008		
Hill 5	2015		
	Capacity	In Service	
MECO	(MW)	Quarter	Year
Shell Wind	21		2015
Lanai Solar	1.2	4	2008
Oceanlinx Wave	2.7		2015
Pulehu Biomass	6		2015
LFG			
KWP II Wind	21	4	2009
MW of Capacity Added by the year indicated:	**2010**	**2015**	**2020**
Pay-As-You-Save Solar Program + PV Host	2.1	9	15
Mandatory Solar Roofing, SB644	1	3	6
Net Energy Metering	2.2	10	24
Unit Retirements:	**Year**		
GT1	2012		
On Lanai - change LL1 to LL6 to peaking units (2006); relocate LL7 and LL8 to Hana for standby generation.			

A projection of future biodiesel prices for the power system was created based on the projection provided in HECO IRP4[134]. Two projections are presented in the IRP, one starting at $250 barrel and the other at $140 per barrel. Both projections show biodiesel prices declining over the period to 2020; to $95 in one case and $140 in the other. An intermediate trajectory has been assumed for modeling purposes, with prices falling from $26.90 per mBtu to $24.30 per mBtu by 2020. This trajectory is felt to be reasonable, however, like all future energy price projections it is subject to a higher level of uncertainty.

Costs for new generating renewable generation projects were based on estimates provided in the IRP3 documents. A summary of cost characteristics for key renewable generation sources is provided below.

Costs for New Renewable Generation:

Description	Wind	Wave	Thermal Solar	Biomass	Geothermal
Overnight Construction Cost ($/kW)	$2,459	$9,058	$3,323	$4,741	$5,882
Unit Fixed O&M Costs ($/kW)	$61.20	$135.60	$63.22	$171.27	$143.92
Unit O&M Costs (cents/kWh)	2.6	-	-	7.0	16.6
** Based on costs listed in IRP3 reports.*					

Inter-Island Transmission:

A new transmission link, using an undersea cable, is assumed to be built Oahu and Maui, linking Oahu to wind resources on Maui, Lanai and Molokai. Planning for this link is still very preliminary and final engineering cost, planned in-service date, line losses, etc., are not available. As a result a number of assumptions have been made. These assumptions are intended solely as a means of representing the project for this modeling exercise. Final costs and technical specifications for the cable are expected to differ.

For modeling purposes it is assumed that the addition of this facility will cost about $1 billion to build; assuming $700-900 million for the undersea cable plus the cost of land-based infrastructure on each end. The capacity of the cable is assumed to be 400 MW; sufficient to accommodate the peak capacity of the 'large wind' projects. It is assumed that the cable comes into service in 2014 and that there is a 1% loss through this transfer. All of these figures are estimated based on discussions with DBEDT as engineering studies have not been completed to-date or are not yet public.

Renewable Power Standard (RPS)

The amended RPS, passed by the legislature in 2009 sets the following targets:

[134] HECO, IRP4, figure 6.2-1, Imputed Biodiesel prices.

- 10% of electricity sales to be met from renewable sources by 2010
- 15% by 2015,
- 25% by 2020,
- 40% by 2030.

This requirement is entered into the model as a constraint. The model selects among available generation types based on relative costs to select a generation mix which will meet the constraint.

EEPS

For modeling purposes, the following Energy Efficiency Portfolio Standard targets are assumed:

- 10% reduction in electricity sales to be achieved by 2010
- 15% by 2015, and
- 20% by 2020.

- The EEPS has been modeled by assuming a linear reduction towards the established targets. In the absence of specific program information on how this target will be achieved, the change was introduced through increases to process and device efficiencies across the residential, commercial and industrial sectors. The costs of actual equipment upgrades associated with these efficiency gains are captured in the model, however, program and administration costs are not modeled. The costs associated with implementing such a program have not been included at this time.
- **Efficiency Improvement** – It is assumed that the increase in efficiency would be implemented across all sectors (residential, commercial and industrial) and all end uses. Through an iterative process, operating this policy on a stand-alone basis, we determined a level of efficiency gain for marginal devices for each year that would achieve the targeted reduction in energy use. The increase in efficiency was introduced into the model through a multiplier applied evenly across processes and devices.

- **Economies of Scale** – It is assumed that as more efficient devices are required, the cost of devices would benefit from economies of scale; shifting the cost curve for the efficiency improvement down.

- **Retrofits** - No retrofits, or premature retirements of existing equipment, were assumed in the modeling. The efficiency improvements required to meet the policy target were assumed to take place at the margin. In ENERGY 2020 devices and processes are each continually replaced with assumed lifetimes of less than 20 years so at least 5% of the devices and processes are replaced each year.

- **Process Efficiency Impacts on Device Investments** – Changes in process efficiency generally reflect changes in the level of energy service required (e.g. the amount of lighting reduced due to day-lighting or improved design or water heating needs reduced due to more efficient end-use devices). To the extent the process efficiency increases, this tends to lower the level of device investment required in these end uses; as lower lighting requirements are reflected in fewer new fixtures being required. For modeling purposes, it is assumed that 30% of the efficiency gains attained under the complementary policy will come from process efficiency gains, while 70% come from device efficiency gains.

A number of DSM programs designed to improve energy efficiency are already in place or proposed by Hawaii's utilities, however, the specific type of programs and the costs of these programs are not known at this time. For modeling purposes it is assumed that the programs will be administered by the Public Benefits Agency. The cost of achieving the required reductions have been modeled based on the cost of "best practice" programs[135]. Of these costs, 30% are assumed to be associated with administration of the programs[136].

Vehicle Efficiency

The policy assumes that vehicle efficiency increases are accelerated beyond the requirements in the EISA CAFÉ standard. It is assumed that the Obama administration follows through on its intention to increase the average efficiency of the new vehicle fleet to 35.5 mpg by 2016. It is further assumed that a policy is put in place by either the federal or State government to continue this improvement in vehicle efficiencies in order to require that the average new vehicle (cars and light trucks) achieve 42.5 mpg by 2020.

The assumed improvement between 2016 and 2020 is based on emission reductions currently contemplated by the California ARB in its scoping plan[137]. This would increase the average efficiency of new cars and light trucks to 42.5 mpg by 2020[138] The change

[135] American Council for an Energy-Efficient Economy (ACEEE), "Examining the Potential for Energy Efficiency to Help Address the Natural Gas Crisis in the Midwest", Jan. 2005 and discussions with Marty Kushler of ACEEE. The analysis uses the following assumptions for the levelized annual cost effectiveness of state energy efficiency programs:

	Average	Residential	Commercial	Industrial
$/kWh saved	$0.030	$0.044	$0.024	$0.020
$/therm/saved	$0.200	$0.300	$0.150	$0.100

[136] Assumptions are illustrative, based on ICF experience in design of DSM programs for corporate clients. Actual program costs, incentive levels and savings will depend on actual program design.
[137] California Air Resources Board, Climate Change Draft Scoping Plan: a Framework for change, June 2008 Discussion Draft, Pursuant to AB 32: The California Global Warming Solutions Act of 2006
[138] California Air Resources Board, Comparison of Greenhouse Gas Reductions for the United States and Canada under U.S. CAFÉ Standards and California Air Resources Board Greenhouse Gas Regulations – An Enhanced Technical Assessment, 25 February 25, 2008.

in vehicle costs required to meet this standard are based on estimates by the California Air Resources Board[139].

PHEV's

The following modeling assumptions have been used to model Plug-in Hybrid Electric Vehicles (PHEV). These assumptions are based on available research reports as there are no PHEV's commercially available in North America at this time.

These assumptions assume that when these vehicles become commercially available they will be designed with a 20 to 30 mile capability (PHEV20 or PHEV30); which is to say that they can operate for 20-30 miles before the gasoline engine is required. This represents a balance between meeting the majority of daily driving requirements using the electric drive while minimizing the premium paid in comparison with conventional vehicles (CV). Adding electric range to PHEV's is projected to significantly add to vehicle costs.

Based on the best available data, the modeling assumes the following PHEV characteristics:

- Efficiency:
  Fossil - 5.4 L/100 km.
  Electric:
  - Compact - 0.26 kWh/mile
  - Mid-Size - 0.30 kWh/mile
  - Mid-Size SUV/Vans - 0.38 kWh/mile
  - Full Size SUV/ - 0.46 kWh/mile

- Cost:
  - Base (conventional) – $ 23, 392
  - PHEV 30 - $ 42,618 (82% premium; falling to 43% by 2020)
  - PHEV 20 - $ 38,935 (66% premium; falling to 36% by 2020).

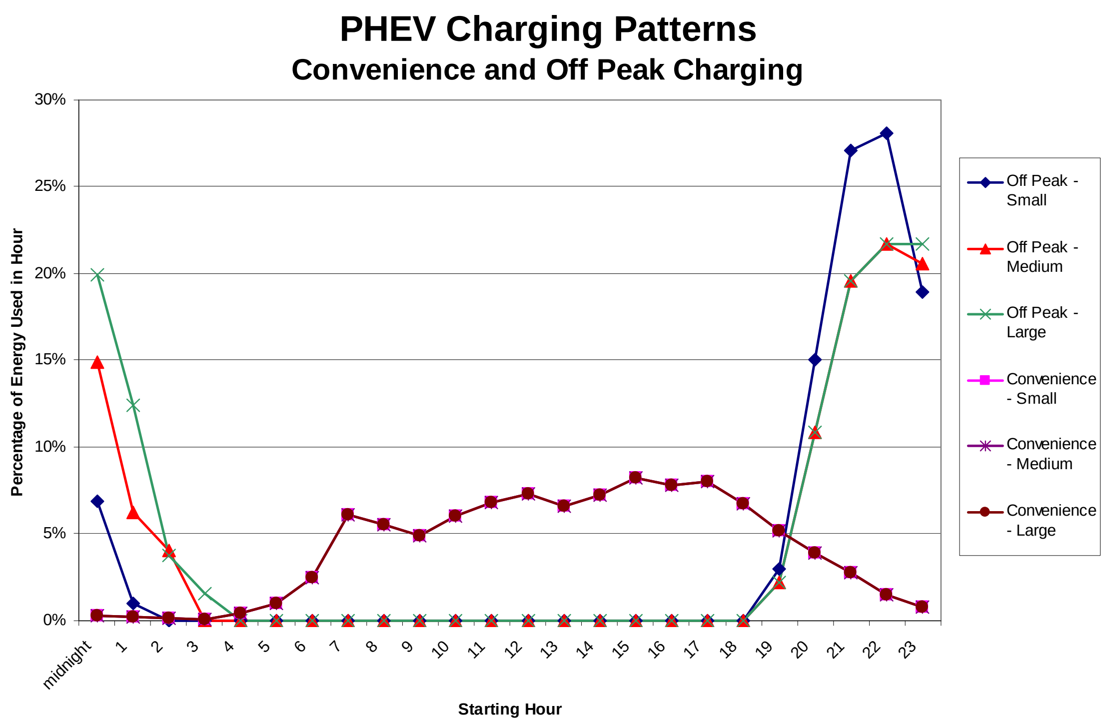
- Load Shape:
  - For modeling purposes it is assumed that charging will be done at 120 Volts in order to minimize distribution system stresses and provide greater flexibility in where charging can occur.
  - Load shape could vary depending on assumptions:
    - If charging when convenient then shape would be expected to reflect inverse of pattern of vehicle use.

[139] California Environmental Protection Agency, Air Resources Board, Regulations to Control Greenhouse Gas Emissions from Motor Vehicles, Final Statement of Reasons, August 4, 2005.

- If charging is assumed to be overnight – or when power costs are lowest then the load shape would reflect overnight use. There is also potential to use demand reduction or other technologies to shape the recharging pattern in response to rates or distribution/generation system needs.

o For modeling purposes it is assumed that charging will follow the off peak load shape in the graph below.

Graph shows percentage of daily charging requirements by hour.



In its Annual Energy Outlook for 2009, the EIA projects that Plug In Hybrid's will achieve between a 0.6% and a 2.0% market share of new vehicle sales by 2030. At that rate of penetration, it will take some time before PHEV's represent a significant portion of the average fleet. Given the expectation that energy costs may be higher in Hawaii, and recognizing the State's efforts to promote PHEV's as part of their overall HCEI strategy, it is assumed that State drivers may be early adopters of this new technology. For modeling purposes, it is assumed that PHEV's become available as of 2012 and that policies introduced by the State are successful in achieving a 2% penetration among new vehicles by 2020.

Alternative Fuel Standard

The Alternative Fuels Standard has been modeled with targets set as follows (per Act 240 SLH 2006):

- 2010 – 10% of highway fuel to come from alternative, renewable fuel,
- 2015 – 15%,
- 2020 – 20%.

Biofuels used in Hawaii are currently imported except for some biodiesel produced in-state. A number of initiatives have been undertaken to encourage in-state production of biofuels and several proposals have been put forward to build biodiesel and ethanol plants in the State. To-date no new plants have been approved, however, for modeling purposes it is assumed that new biofuels plants will be constructed over the coming decade. The following assumptions have been made based on past analyses[140] and current proposals.

For **Biodiesel** it is assumed that one of the plants currently being considered proceeds and comes into service in Maui in 2011, starting with a production capacity of 40 million U.S. gallons/year of production (13.1 tBtu/year). The plant is assumed to expand to 110 million gallons/year by 2015. Capital costs for the plant are assumed to be $100 million (with $50 million invested in the first phase and $50 million for expansion). The plant is assumed to employ 50 operational staff during its first phase, expanding to 80 employees when it reaches full capacity.

These assumptions are based on current plans for Blue Earth Biofuels (partially owned by HECO), which is assumed to be delayed due to the economic slowdown. A second proposed plant, with a further 100 million gallons/year capacity is assumed not to proceed as this would exceed expected biodiesel demand within the State.

For **Ethanol** it is assumed that three plants will be built within the State:[141]

1. In Oahu, a 15 million gallon/year (mmgy) plant costing $45 million is assumed to come on-line in 2012, employing 31 operating staff.
2. In Maui a 15 mmgy plant is assumed to come on-line in 2011 at a cost of $33 million; employing 31.
3. In Kauai a 10 mmgy plant is assumed to come on-line in 2014 at a cost of $25 million; employing 22.

[140] A number of studies on the potential for ethanol and biodiesel use and production are available on the DBEDT and HCEI websites. Hawaii has developed a BioEnergy Master Plan.

[141] The size and characteristics of these plants is based on an earlier report carried out for DBEDT: "*Economic Impact Assessment for Ethanol Production and use in Hawaii*", November 2003, see table 3, page 5, prepared by BBI International.

Together these plants would produce 40 million gallons per year, sufficient to meet about 76% of projected ethanol demand in 2020 in the Reference Projection or about 44% of higher demand as a result of the Alternative Fuel policy.

Sea Water Cooling

The addition of sea-water air conditioning (SWAC) is modeled for the Honolulu area (Oahu) with the system coming into service in mid-2011. The system is assumed to reduce commercial sector electricity use by 77 million kWh and shave approximately 14MW off peak load (implied annual load factor is 63%). The capital cost of the system is estimated at $200 million (US nominal $). To be conservative the modeling assumes that the savings start in 2011 at 50% of total savings and grow to the amounts above over 2 years.

For modeling purposes, a second system is assumed to proceed for Waikiki, starting in 2015 and using the same assumptions.

Overall O&M costs are assumed to be lower than those for a conventional system.

Building Codes

The policy assumes that the levels of new building performance improvement described in the ACES Act (Waxman-Markey) will be adopted, either at the federal level with implementation of the Act, or by the State government as part of its GHG reduction strategy.

Under this policy all new residential and commercial buildings would be required to meet standards that would result in the improvements in energy performance described below. For modeling purposes, we have assumed that while some buildings may not reach full compliance with the improved standards, others will outperform the standard; resulting in the improvements being met on average across the population of new buildings.

The following required levels of improvement are all based on current building standards (i.e. they are not compounded).

- 30% efficiency improvement starting in 2011
- 50% efficiency improvement starting in 2015
- 5% efficiency improvement starting in 2017
- A further 5% efficiency improvement every three years thereafter.

Carbon Tax

The carbon tax is assumed to start in 2010 at $10 per tonne CO2e and rise linearly to $40 per tonne by 2020.

The tax is applied to all fossil fuels based on the emission factor for each fuel. Feedstocks used in manufacturing are assumed to be exempted from the tax.

For macro-economic modeling it is assumed that 90% of resulting revenues are returned to consumers through the tax system with the balance being treated as government sector expenditures for modeling purposes.

Cap & Trade

The assumed federal cap-and-trade system is based on the current version of the ACES (Waxman-Markey).

<u>Timing & Coverage:</u>

- Reductions from 2005 emission levels:
  - 3% by 2012
  - 17% by 2020
  - 42% by 2030
  - 83% by 2050

<u>Coverage:</u>
- All 6 Kyoto gases plus TF3 (nitrogen tri-fluoride)
- Starting in 2012 the following sectors are covered:
  - Electricity,
  - Gas processing, Petroleum refiners & importers,
  - Coal to liquid plants
- Timing of regulation
  - Power and petroleum sectors affected in 2012.
  - Other industrial sectors affected in 2014.
  - Gas LDCs for uncovered sources affected in 2016.

<u>Point of Regulation:</u>
- Point of Emission (downstream) for facilities that emit >25kt
- Point of Production (upstream) for CO2 emitted from combustion of fuel produced

Offsets:

- Must submit 1.25 credits in lieu of each emission allowance (1.25 tons of offsets for 1 tone of emissions).
- Offsets can be used to meet 30% of compliance initially, rising to 67% of compliance in 2050.
- Even split between domestic and international offsets – up to 50% may be international.
- Compensatory allowances offered for GHG destruction and feedstock use.
- Hawaii will likely be able to sell offsets from forestry and agricultural practices into an integrated cap & trade system.
- Due to the multitude of variables involved, it is unclear what the maximum potential for forest and agricultural carbon sequestration in Hawaii is; however, according to the U.S. Forest Service, Hawaii has a total land area of 4,111 thousand acres, of which 1,748 is currently forested[142] Furthermore, updated field inventory work is to be completed by 2010, pending funding[143]. Estimates of potential and cost of afforestation for Hawaii are discussed in Section 5, part L of the report.
- Fully managed forestry projects with low capital cost are predicted to result in values of carbon of approximately \$20 to \$60 per tonne of CO_2e, decreasing over time.[144]

Permit Allocation:

- In 2016 - 17.5% of permits will be auctioned
- By 2030 – 72% to be auctioned
- Floor price for permits set at \$10/ton in 2012 (in 2009\$) increasing at 5% per year plus CPI.
- Initial allocation (2016):
    - 17.5% auctioned
    - 31.5% to electric LDC's
    - 9.0% to natural gas LDC's
    - 1.5% for home heating oil (through states)
    - 13.5% for trade exposed sectors
    - 3.5% for merchant coal-fired generators.

[142] Forest Resources of the United States, 2002. Gen. Tech Rep. NC-241. St. Paul MN: U.S. Dept. of Agric.; Forest Service; 2004 141p.
[143] Smith, B. W., Miles, P.D., Perry, C. H. and Pugh S. A. Forest Resources of the United States, 2007. A Technical Document Supporting the Forest Service 2010 RPA Assessment.
[144] Conte, M. Presentation to the DBEDT GHG Task Force.

- 2% to oil refiners.
- 7% to technology R&D.
- 7.5% to energy efficiency programs
- 2% to be spent on adaptation programs.
- 5% to be spent on international deforestation

- Revenues from the 17.5% to be auctioned are to be allocated as follows:
  - 15% to got to Low Income consumers
  - 1% for deficit reduction
  - 0.5% for worker assistance.
  - 1% for domestic wildlife and resources.

- By 2030 71.7% to be auctioned, with only 2.3% allocated to trade exposed sectors.
  - Revenues to be allocated to low income consumers (15%), consumer rebates (36%) and other programs (20.7%).

For modeling purposes the allocation of permits for electric, gas and home heating oil is based on an analysis carried out for each U.S. state by the World Resources Institute, as shown in the table below.

Table B2:

Estimate of Number of Allowances Distributed to Hawaii in 2016		
		Hawaii
Allocations to States (not including Heating Fuels)	**Renewable Energy + Energy Efficiency (SEED)**	2,478,293
	Energy Efficient Building Codes	163,739
	Building Retrofit	19,160
	Domestic Adaptation (Climate Change Resilience)	197,275
	Wildlife and Natural Resources Adaptation	281,659
Allocations to Benefit Energy Consumers	**Home Heating Oil and Propane (to States)**	155,856
	Electricity LDC (main allocation + to small LDCs)	5,423,998
	Natural Gas LDC	139,911
Allocations to Benefit Consumers Broken out by Sector	**Residential - Elec. LDC**	1,606,434
	Residential - Nat. Gas. LDC	26,860
	Commercial - Elec. LDC	1,762,200
	Commercial - Nat. Gas LDC	95,521
	Residential or Commercial - Heating Oils	155,856
	Industrial - Elec. LDC	1,963,928
	Industrial - Nat. Gas LDC	17,530
	Transportation - Elec. LDC	-
	Transportation - Nat. Gas LDC	-
	Any Sector - Small LDCs	91,436
Portions of State and LDC Allocations Dedicated to Energy Efficiency and Renewable Energy	**Energy Efficiency through Nat. Gas LDCs**	46,637
	Energy Efficency - Home Heating Oils through States	77,928
	Energy Efficiency - through States (SEED + EE Building Codes + Building Retrofit)	678,558
	Renewable Energy - through States	495,659
	Energy Efficiency OR Renewable Energy (or Other) - through States	1,486,976
	Energy Efficiency OR Renewable Energy (or Other) - through Small LDCs	91,436
Source:	*Allowance Distribution to States and Energy Consumers under the American Clean Energy and Security Act (H.R. 2454, Waxman-Markey), World Resources Institute and Georgetown Climate Center, July 28, 2009.*	

Refineries are designated to receive 2% of allocations in 2016. Refining capacity in Hawaii represents approximately 0.4% of total US capacity[145]. It is assumed that permits will be allocated to refinery facilities in proportion to their share of national operable capacity.

[145] EIA, Refinery Capacity Report, 2009, released Jun 25, 2009, http://www.eia.doe.gov/oil_gas/petroleum/data_publications/refinery_capacity_data/refcapacity.html

Merchant coal plants are designated to receive 3.5% of allocations in 2016 under ACES Act. Coal use for power production in Hawaii represents about 0.3% of total US coal use by independent power producers, and 0.1% of total coal use for power production[146]. For modeling purposes, it is assumed that permits will be allocated to merchant coal plants based on their respective share of national coal consumption.

The ACES Act does not specify permit allocations by year. For modeling purposes the trajectory of allocations used by the EIA in its modeling of the Act has been assumed.[147]

Banking & Borrowing:

- Unlimited banking permitted.
- Borrowing allowed from future years (up to 5 years). May borrow up to 15% of compliance obligation.
- No penalty to borrow one year in advance. Beyond that a penalty/interest is applied equal to 8% per year.

[146] EIA, Consumption of Coal for Electricity Generation by State by Sector, report released August 14, 2009, http://www.eia.doe.gov/cneaf/electricity/epm/table2_5_a.html
[147] Energy Information Administration, Energy Market and Economic Impacts of H.R. 2454, the American Clean Energy and Security Act of 2009, August 2009, SR/OIAF/2009-05, Figure 27, page 36.

Appendix C: Summary of Policy Screening Results

Potential Policy	Comments/Disposition
Cross cutting policies	
1. Carbon tax	Included in Work Plan(s)
2. Cap & Trade – state-level, regional or national.	Included in Work Plan(s)
3. Energy Efficiency Portfolio standard (EEPS) – state or national.	Included in Work Plan
4. Public Benefits Agency to promote energy efficiency.	Facilitates accomplishment of EEPS.
5. Aggregate Purchasing – to support/develop markets.	Not modeled. Could be used to encourage early adoption of higher efficiency vehicles and equipment.
6. Incentives: a) Monetary – direct incentives, tax treatment, etc. b) Non-monetary – influence non-price decision making.	Not modeled. Assumed to be covered through utility and Public Benefits Agency DSM initiatives.
7. Information and education – both broad and targeted.	Element of several policies.
8. Fuel and energy prices (i.e. barrel tax).	Not included in policy modeling. Carbon tax would have similar effect.

Potential Policy	Comments/Disposition
Electricity consumption and generation	
1. Decoupling utility revenues from sales.	Not included in modeling. Modeling assumes EEPS targets are met but does not address agency which will be responsible for implementation.
2. Energy Efficiency Portfolio Standard – state or national, electricity or all regulated fuels. *(Passed in May 2009)*	Included in Work Plan
3. Require all economic DSM to be pursued before new supply.	Not included in model. Potential addressed by EEPS.
4. Building codes and standards (lighting, equipment, & appliances)	Included in Work Plan(s)
5. Renewable Portfolio Standard (RPS) –	Included in Work Plan(s)

Potential Policy	Comments/Disposition
state/national.	
6. Increase use of non-electric renewables – solar water heating, biomass, sea water cooling, etc. *(Current Hawaii law requires solar for new construction post 2010, provides incentives, etc.).*	Included in Reference Case (i.e., solar water heating) and in Work Plan(s)
7. Increase efficiency of generation, T&D – including co-generation, distributed generation, etc. *(IRP's include pursuit of CHP)*	Increased use of co-generation addressed in Reference Case.
8. Net metering and feed-in tariff.	

Potential Policy	Comments/Disposition
Transportation policies:	
➢ Vehicles	
1. Require increase in vehicle efficiency.	Included in Work Plan(s)
2. Encourage purchase of more efficient vehicles within existing selection.	Discussed in policy but not included in modeling.
3. Promote increased operational efficiency of existing vehicles.	Not modeled. Could be addressed in proposed Freight initiative.
4. Encourage more rapid turnover of older vehicle stock.	Not modeled. Limited economic value in Hawaii context.
5. Promote higher occupancy vehicle usage (car/van pooling)	Not modeled as costs of providing HOV lanes unknown.
6. Promote early adoption of Plug-in Hybrid Electric Vehicles (PHEV's)	Included in Work Plan(s)
7. Renewable Fuel Standard.	Included as Alternative Fuel Standard
8. Low Carbon Fuel Standard.	Addressed by Alternative Fuel Standard (legislative requirement).
9. Shift to lower emission modes – mass transit, biking, walking *(include effects of high capacity transit system)*	High Capacity Mass Transit included in Reference Projection. Other mode shifting to be addressed in Work Plan.
10. Land Use Planning to encourage higher density, mixed communities, etc. (i.e., Smart Growth).	Included in Work Plan(s)
11. Promote appropriately sized vehicles for freight and commercial applications.	Policy development recommended but not included in modeling.

Potential Policy	Comments/Disposition
➢ Marine:	
1. Promote fuel switching to lower emission fuels	Addressed in part by Alternative Fuel Standard (legislative requirement).
2. Biofuels	Addressed by Alternative Fuel Standard (legislative requirement).
3. Increase engine and operational efficiency	Addressed indirectly by Carbon Tax and/or Cap and Trade.
4. On-shore supply of power	Not addressed at this time. International bunker not included in State target.

Potential Policy	Comments/Disposition
Built Environment policies:	
1. Building Code improvements (i.e., Green and Net zero buildings) – new and renovations.	Included in Work Plan(s)
2. Promote processes to involve all stakeholders in new building design.	Not addressed at this time. Complements Building Code recommendations.
3. Support development of deep water cooling for high density commercial areas.	Included in Work Plan(s)
4. Equipment and appliance standards.	Covered by EEPS and EISA.
5. Existing buildings – re-commissioning, operator training, best practice standards and operating procedures for facilities staff, hotels, etc.	Included in EEPS (may be carried out by PBA).

Potential Policy	Comments/Disposition
Industry policies:	
1. Promote improved process design and operational efficiencies.	Included in EEPS.
2. Fuel switching and increased use of non-emitting energy sources.	Addressed in part by Alternative Fuel Standard.
3. Review opportunities for reducing industrial process emission *(500kt in 2007 inventory)*. These are predominantly ODS substitutes.	Not included in modeling. Limited information on sources and drivers of process emissions.

Appendix D: Policy Case Modeling Outputs – ENERGY 2020

<u>Notes</u>:

1. *The following ENERGY 2020 model outputs include feedback from REMI Macro-economic model.*
2. *Total emissions in 1990 were 20,450 kt CO2e.*
3. *The following pages should be printed on 8 ½ x 14 inch paper.*

The tables which follow in this Appendix present ENERGY 2020 modeling outputs for key indicators for milestone years for the State as a whole. For each variable, results for the Reference Projection are presented on the left hand side, with the corresponding values for the Work Plan shown to the right. The resulting absolute and percentage change is then shown for each variable. In the following tables all references to 'GHG Emissions (kt)' refer to "kt CO2e".

Please note that the economic drivers shown are the initial values used in ENERGY 2020 and remain unchanged between the Reference Projection and Work Plans. Appendix E, which presents the results of the REMI macro-economic modeling, shows how these values change as a result of the Work Plans.

More detailed outputs, including year-by-year results for each county and for the State, have been provided to DBEDT electronically.

Reference Projection vs. Work Plan 1: State Total

Reference Case

GHG Emissions (kt)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	66.0	62.9	63.9	66.1	0.0%
Commercial	329.4	325.2	327.2	314.5	-0.4%
Industrial	637.1	645.0	649.0	635.0	0.0%
Passenger - Residents	2,917.6	2,726.6	2,185.3	1,818.5	-3.6%
Passenger - Visitors	452.6	376.8	271.1	211.1	
Marine	2,172.6	2,153.1	2,183.9	2,135.2	-0.1%
Aviation	4,839.4	4,929.2	5,179.8	5,166.9	0.5%
Freight	1,401.9	1,371.4	1,239.7	1,203.8	-1.2%
Power Sector	8,745.1	7,814.1	7,545.2	7,683.6	-1.0%
Waste	1,031.6	1,098.2	1,209.3	1,320.4	1.9%
Agriculture & Forestry	(2,267.0)	(2,266.8)	(2,266.3)	(2,265.8)	0.0%
Total	**20,326.2**	**19,235.9**	**18,588.1**	**18,289.3**	**-0.8%**

Total Primary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Biodiesel	-	7.7	15.4	15.5	N/A
Biomass	4.9	7.8	10.0	12.8	7.7%
Coal	15.6	15.8	15.8	15.6	0.0%
Electricity	32.1	31.5	33.1	34.0	0.4%
Ethanol	0.2	0.8	2.9	4.6	26.2%
Gasoline	57.5	53.3	43.2	37.2	-3.3%
Geothermal	2.2	2.2	2.2	2.2	0.0%
HS Diesel	-	-	-	-	N/A
HS Fuel Oil	84.0	70.2	68.8	70.6	-1.3%
Hydrogen	-	-	-	-	N/A
Jet Fuel	81.1	82.6	86.8	86.6	0.5%
LPG	2.4	2.3	2.4	2.3	-0.1%
LS Diesel	15.0	14.9	14.3	13.6	-0.7%
LS Fuel Oil	19.5	21.5	19.4	18.2	-0.5%
Oil, Unspecified	5.5	5.6	5.7	5.5	0.0%
Utility Gas	3.2	3.2	3.3	3.3	0.2%
Still Gas	-	-	-	-	N/A
Waste	5.0	5.0	5.1	6.1	1.6%
Total	**328.3**	**324.4**	**328.4**	**328.2**	**0.0%**

Work Plan 1

GHG Emissions (kt)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Abs. Change from Ref @ 2020	% Change from Ref @ 2020
Residential	66.0	61.9	61.3	62.2	-0.4%	(3.9)	-5.9%
Commercial	329.4	321.5	315.1	299.3	-0.7%	(15.3)	-4.9%
Industrial	637.1	645.3	676.0	663.3	0.3%	28.4	4.5%
Passenger - Residents	2,917.6	2,504.4	1,983.3	1,593.7	-4.5%	(224.8)	-12.4%
Passenger - Visitors	452.6	349.2	246.6	185.3	-6.6%	(25.8)	-12.2%
Marine	2,172.6	2,155.2	2,191.9	2,145.2	-0.1%	9.9	0.5%
Aviation	4,839.4	4,934.1	5,199.3	5,191.2	0.5%	24.4	0.5%
Freight	1,401.9	1,259.4	1,144.2	1,098.7	-1.9%	(105.1)	-8.7%
Power Sector	8,745.1	6,783.8	4,096.5	3,268.8	-7.3%	(4,414.9)	-57.5%
Waste	1,031.6	1,112.0	1,219.9	1,324.6	1.9%	4.3	0.3%
Agriculture & Forestry	(2,267.0)	(2,266.4)	(2,264.1)	(2,263.7)	0.0%	2.1	-0.1%
Total	**20,326.2**	**17,860.5**	**14,870.0**	**13,568.6**	**-3.1%**	(4,720.7)	-25.8%

Total Primary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Biodiesel	-	8.9	21.3	21.6	N/A	6.1	39.2%
Biomass	4.9	7.8	13.1	15.6	9.4%	2.8	22.1%
Coal	15.6	15.8	15.7	15.6	0.0%	(0.1)	-0.3%
Electricity	32.1	29.3	26.1	23.5	-2.4%	(10.5)	-30.8%
Ethanol	0.2	5.4	6.8	8.1	31.8%	3.5	76.2%
Gasoline	57.5	48.7	38.7	32.4	-4.3%	(4.8)	-12.9%
Geothermal	2.2	2.9	2.9	2.9	2.0%	0.6	28.9%
HS Diesel	-	-	-	-	N/A	-	#DIV/0!
HS Fuel Oil	84.0	59.2	38.1	27.7	-8.2%	(42.9)	-60.8%
Hydrogen	-	-	-	-	N/A	-	#DIV/0!
Jet Fuel	81.1	82.7	87.2	87.0	0.5%	0.4	0.5%
LPG	2.4	2.3	2.3	2.3	-0.3%	(0.1)	-2.9%
LS Diesel	15.0	14.3	13.4	12.4	-1.5%	(1.2)	-8.9%
LS Fuel Oil	19.5	19.3	5.4	4.2	-11.1%	(14.0)	-76.7%
Oil, Unspecified	5.5	5.6	6.0	5.9	0.4%	0.3	5.9%
Utility Gas	3.2	3.1	3.1	3.0	-0.4%	(0.2)	-7.2%
Still Gas	-	-	-	-	N/A	-	
Waste	5.0	5.0	5.1	6.1	1.6%	-	0.0%
Total	**328.3**	**310.3**	**285.3**	**268.3**	**-1.5%**	(59.9)	-18.2%

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Proposed GHG Reduction Work Plans for Hawaii

Reference Projection vs. Work Plan 1: State Total

Reference Case

Total Secondary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	11.8	11.8	12.4	13.0	0.7%
Commercial	24.1	23.7	24.3	24.2	0.0%
Industrial	14.0	14.0	14.3	14.1	0.0%
Passenger - Residents	39.6	37.6	31.9	28.1	-2.6%
Passenger - Visitors	6.1	5.2	3.9	3.2	-4.9%
Marine	20.9	20.7	21.0	20.5	-0.1%
Aviation	81.1	82.6	86.8	86.6	0.5%
Freight	19.0	18.6	17.5	17.7	-0.5%
Forestry & Agriculture	0.1	0.1	0.1	0.1	-4.0%
Total	**216.8**	**214.3**	**212.2**	**207.5**	**-0.3%**

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Personal Income	42,519	44,060	49,456	54,530	1.9%
Population (millions)	1	1	1	1	1.1%
Gross Regional Product (GRP)	60,659	67,340	74,120	81,609	2.3%

Generation Capacity (MW)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	2,004	2,143	2,206	2,209	0.8%
Coal Steam	180	180	180	180	0.0%
Hydro	24	24	45	45	5.0%
Biomass	60	195	217	249	11.6%
Wind	64	127	153	167	7.7%
Other Renewable	31	141	252	252	17.5%
Total	**2,363**	**2,810**	**3,053**	**3,102**	**2.1%**

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	8,837	7,856	7,459	7,512	-1.2%
Coal Steam	1,510	1,510	1,510	1,510	0.0%
Hydro	130	130	240	240	4.8%
Biomass	291	473	632	867	8.7%
Wind	137	312	382	420	9.0%
Other Renewable	212	841	1,468	1,469	16.0%
Purchases from industry	110	124	139	143	2.1%
Total	**11,228**	**11,247**	**11,829**	**12,162**	**0.6%**

Work Plan 1

Total Secondary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential	11.8	10.7	9.6	8.9	-2.2%	(4.1)	-31.6%
Commercial	24.1	22.6	20.1	17.8	-2.3%	(6.4)	-26.4%
Industrial	14.0	13.8	14.1	13.7	-0.2%	(0.4)	-2.8%
Passenger - Residents	39.6	37.5	31.5	26.9	-2.9%	(1.2)	-4.3%
Passenger - Visitors	6.1	5.2	3.8	2.9	-5.5%	(0.2)	-7.3%
Marine	20.9	20.7	21.1	20.6	-0.1%	0.1	0.5%
Aviation	81.1	82.7	87.2	87.0	0.5%	0.4	0.5%
Freight	19.0	18.8	17.7	17.9	-0.5%	0.2	1.1%
Forestry & Agriculture	0.1	0.1	0.1	0.1	-4.3%	(0.0)	-4.1%
Total	**216.8**	**212.2**	**205.0**	**195.9**	**-0.8%**	(11.6)	-5.6%

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Personal Income	42,519	44,060	49,456	54,530	1.9%	-	0%
Population (millions)	1	1	1	1	1.1%	-	0%
Gross Regional Product (GRP)	60,659	67,340	74,120	81,609	2.3%	-	0%

Generation Capacity (MW)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Gas/Oil	2,004	2,143	2,095	2,097	0.3%	(111.5)	-5.0%
Coal Steam	180	180	180	180	0.0%	-	0.0%
Hydro	24	24	45	45	5.0%	-	0.0%
Biomass	60	195	260	298	13.1%	48.8	19.6%
Wind	64	308	718	733	20.7%	565.6	338.9%
Other Renewable	31	160	331	351	20.5%	98.9	39.2%
Total	**2,363**	**3,010**	**3,628**	**3,703**	**3.5%**	601.9	19.4%

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Gas/Oil	8,837	6,554	3,254	2,114	-10.4%	(5,397.7)	-71.9%
Coal Steam	1,510	1,510	1,510	1,510	0.0%	-	0.0%
Hydro	130	130	240	240	4.8%	-	0.0%
Biomass	291	473	843	1,065	10.5%	198.0	22.8%
Wind	137	821	1,901	1,938	22.6%	1,517.8	361.1%
Other Renewable	212	956	1,801	1,951	18.6%	481.6	32.8%
Purchases from industry	110	131	139	141	1.9%	(2.3)	-1.6%
Total	**11,228**	**10,575**	**9,688**	**8,959**	**-1.7%**	(3,202.6)	-26.3%

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Proposed GHG Reduction Work Plans for Hawaii

Reference Projection vs. Work Plan 1: State Total

Reference Case

Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	3,150	3,157	3,339	3,528	0.9%
Commercial	5,467	5,390	5,569	5,604	0.2%
Industrial	855	836	881	888	0.3%
Transportation	-	-	107	152	N/A
Military	1,242	1,342	1,390	1,437	1.1%
Total	**10,714**	**10,726**	**11,286**	**11,609**	**0.6%**

Distance Travelled (millions of vehicle miles travelled)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Passenger - Residents	10,284	10,114	10,117	10,153	-0.1%
Passenger - Visitors	1,520	1,402	1,296	1,206	-1.8%

Vehicle Energy Consumption (TBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Resident Light	24.1	23.1	20.8	19.7	-1.5%
Resident Medium	12.8	12.7	11.9	11.8	-0.6%
Resident Heavy	2.9	3.0	3.2	3.6	1.6%
Visitor Light	3.7	3.2	2.5	2.2	-3.9%
Visitor Medium	2.0	1.7	1.5	1.3	-3.0%
Visitor Heavy	0.5	0.4	0.4	0.4	-0.9%
Freight Light	13.9	13.6	12.8	13.0	-0.5%
Freight Medium	1.0	1.0	0.9	0.9	-0.5%
Freight Heavy	4.1	4.0	3.8	3.8	-0.5%
Total	**65.0**	**62.8**	**57.8**	**56.9**	**-1.0%**

Average Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	23.5	24.1	26.3	29.4	1.7%
Medium Gasoline	21.4	22.3	24.6	27.6	2.0%
Heavy Gasoline	16.9	17.3	18.7	20.6	1.5%
Heavy Diesel	16.9	17.2	18.6	20.4	1.5%
Fleet	22.0	22.7	25.1	28.5	2.0%

Work Plan 1

Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential	3,150	2,854	2,536	2,334	-2.3%	(1,194.0)	-33.8%
Commercial	5,467	5,096	4,380	3,809	-2.7%	(1,794.9)	-32.0%
Industrial	855	794	783	741	-1.1%	(147.1)	-16.6%
Transportation	-	-	140	211	N/A	59.3	39.1%
Military	1,242	1,342	1,390	1,437	1.1%	-	0.0%
Total	**10,714**	**10,086**	**9,228**	**8,533**	**-1.7%**	(3,076.6)	-26.5%

Distance Travelled (millions of vehicle miles travelled)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Passenger - Residents	10,284	10,122	10,165	10,207	-0.1%	54.7	0.5%
Passenger - Visitors	1,520	1,404	1,294	1,198	-1.8%	(7.2)	-0.6%

Vehicle Energy Consumption (TBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Resident Light	24.1	23.1	20.5	18.9	-1.9%	(0.8)	-4.3%
Resident Medium	12.8	12.7	11.8	11.3	-0.9%	(0.5)	-4.3%
Resident Heavy	2.9	3.0	3.1	3.4	1.2%	(0.2)	-4.3%
Visitor Light	3.7	3.2	2.5	2.1	-4.4%	(0.2)	-7.3%
Visitor Medium	2.0	1.7	1.4	1.2	-3.5%	(0.1)	-7.3%
Visitor Heavy	0.5	0.4	0.4	0.4	-1.4%	(0.0)	-7.3%
Freight Light	13.9	13.7	13.0	13.1	-0.5%	0.1	1.1%
Freight Medium	1.0	1.0	0.9	0.9	-0.5%	0.0	1.1%
Freight Heavy	4.1	4.1	3.8	3.9	-0.5%	0.0	1.1%
Total	**65.0**	**62.9**	**57.4**	**55.3**	**-1.2%**	(1.6)	-2.8%

Average Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	23.5	24.1	26.6	30.2	2.0%	0.8	2.9%
Medium Gasoline	21.4	22.3	24.8	28.4	2.2%	0.8	2.8%
Heavy Gasoline	16.9	17.3	19.0	21.5	1.9%	0.9	4.4%
Heavy Diesel	16.9	17.2	18.9	21.4	1.9%	1.0	5.1%
Fleet	22.0	22.7	25.8	30.8	2.6%	2.3	8.0%

Reference Projection vs. Work Plan 1: State Total

Reference Case

Marginal Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	24.4	28.1	34.0	37.7	3.4%
Medium Gasoline	23.4	26.9	32.6	36.0	3.4%
Heavy Gasoline	17.4	19.4	22.3	24.6	2.7%
Heavy Diesel	17.2	19.2	21.8	24.0	2.6%
Fleet	23.1	26.8	32.2	35.8	3.4%

Average Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	57.1	56.3	54.7	52.7	-0.6%
Medium Gasoline	33.2	33.4	33.6	33.6	0.1%
Heavy Gasoline	9.6	10.3	11.8	13.7	2.7%

Marginal Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	55.8	52.7	48.7	49.1	-1.0%
Medium Gasoline	34.8	33.8	33.7	33.7	-0.3%
Heavy Gasoline	9.4	13.5	17.6	17.2	4.8%

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020
Renewables as % of Electric Sales	7%	16%	24%	26%	18.6%
Ethanol/Gasoline	0%	1%	6%	11%	10.6%
Biodiesel/Diesel	0%	1%	2%	3%	3.4%

Work Plan 1

Marginal Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	24.4	28.5	36.2	42.0	4.3%	4.4	12%
Medium Gasoline	23.4	27.3	34.6	40.2	4.3%	4.2	12%
Heavy Gasoline	17.4	19.8	23.9	27.7	3.7%	3.1	12%
Heavy Diesel	17.2	19.5	23.3	27.0	3.5%	3.0	12%
Fleet	23.1	27.2	35.8	42.5	4.8%	6.7	19%

Average Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	57.1	56.3	54.1	51.4	-0.8%	(1.4)	-3%
Medium Gasoline	33.2	33.4	33.5	33.6	0.1%	(0.0)	0%
Heavy Gasoline	9.6	10.3	12.3	15.0	3.5%	1.4	10%

Marginal Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	55.8	52.7	46.2	46.3	-1.4%	(2.8)	-6%
Medium Gasoline	34.8	33.8	33.6	33.6	-0.3%	(0.1)	0%
Heavy Gasoline	9.4	13.5	20.2	20.1	6.0%	2.8	16%

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020	Difference from Ref @ 2020	Difference from Ref @ 2020
Renewables as % of Electric Sales	7%	24%	52%	61%	53.7%	0.4	136%
Ethanol/Gasoline	0%	10%	15%	20%	19.6%	0.1	82%
Biodiesel/Diesel	0%	10%	15%	20%	20.0%	0.2	492%

Proposed GHG Reduction Work Plans for Hawaii

Reference Projection vs. Work Plan 1: State Total

Reference Case

Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential					
Electricity	79.0	85.4	100.6	101.6	2.0%
Utility Gas	43.5	43.2	43.5	44.1	0.1%
Bottled Gas	60.0	62.6	68.5	69.2	1.1%
Commercial					
Electricity	68.1	72.9	89.9	90.8	2.2%
Utility Gas	27.8	27.5	27.8	28.4	0.1%
Oil	22.4	25.0	30.9	31.5	2.7%
Bottled Gas	25.0	27.6	33.5	34.1	2.4%
Industrial					
Electricity	62.7	67.2	84.6	84.3	2.3%
Utility Gas	27.8	27.4	27.6	28.2	0.1%
#6 Fuel	9.9	12.5	18.3	19.0	5.2%
Bottled Gas	-	27.6	33.5	34.1	N/A
#2 Fuel	22.4	25.0	30.9	31.5	2.7%
Transportation					
Gasoline	28.2	30.8	36.7	37.4	2.2%
LS Diesel	25.3	27.9	33.7	34.4	2.4%
Ethanol	28.1	25.7	27.9	27.8	-0.1%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%

Compliance Summary	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Emissions Included in Target	15,487	14,307	13,408	13,122	-1.3%
Offsets	-	-	-	-	N/A
Compliance Total	15,487	14,307	13,408	13,122	-1.3%
Percent of 1990 Emissions	113%	105%	98%	96%	-1.3%
Allowance Price (2008 $/Tonne)	-	-	-	-	N/A
Percentage of Offsets Allowed	-	-	-	-	N/A
Permits bought from Auction (Mt)	-	-	-	-	N/A
Bought (Sold) from Outside State					

1990 Emissions Included in Target - 13,660 kt CO2e
(excludes emissions from international bunker fuels and aviation)

Work Plan 1

Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential						-	
Electricity	79.0	85.3	118.0	123.5	3.5%	21.9	21.6%
Utility Gas	43.5	43.1	43.5	44.1	0.1%	(0.0)	-0.1%
Bottled Gas	60.0	62.6	68.5	69.2	1.1%	-	0.0%
						-	
Commercial						-	
Electricity	68.1	73.0	106.0	112.6	3.9%	21.8	24.0%
Utility Gas	27.8	27.5	27.8	28.4	0.1%	(0.0)	0.0%
Oil	22.4	25.0	30.9	31.5	2.7%	-	0.0%
Bottled Gas	25.0	27.6	33.5	34.1	2.4%	-	0.0%
Industrial						-	
Electricity	62.7	67.2	102.8	109.6	4.4%	25.3	30.0%
Utility Gas	27.8	27.4	27.6	28.2	0.1%	0.0	0.0%
#6 Fuel	9.9	12.5	18.3	19.0	5.2%	-	0.0%
Bottled Gas	-	27.6	33.5	34.1	N/A	-	0.0%
#2 Fuel	22.4	25.0	30.9	31.5	2.7%	-	0.0%
Transportation						-	
Gasoline	28.2	30.8	36.7	37.4	2.2%	-	0.0%
LS Diesel	25.3	27.9	33.7	34.4	2.4%	-	0.0%
Ethanol	28.1	25.7	27.9	27.8	-0.1%	-	0.0%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%	-	0.0%

Compliance Summary	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Emissions Included in Target	15,487	12,926	9,671	8,377	-4.6%	(4,745.1)	-36.2%
Offsets	-	-	-	-	N/A	-	n.a.
Compliance Total	15,487	12,926	9,671	8,377	-4.6%	(4,745.1)	-36.2%
Percent of 1990 Emissions	113%	95%	71%	61%	-4.6%	(0.3)	-36.2%
Allowance Price (2008 $/Tonne)	$0	$0	$28	$35	N/A	35.2	n.a.
Percentage of Offsets Allowed	-	-	30%	34%	N/A	0.3	n.a.
Permits bought from Auction (Mt)	-	-	11.8	11.1	N/A	11.1	n.a.
Bought (Sold) from Outside State						-	n.a.

1990 Emissions Included in Target - 13,660 kt CO2e
(excludes emissions from international bunker fuels and aviation)

Proposed GHG Reduction Work Plans for Hawaii

Reference Projection vs. Work Plan 2: State Total

Reference Case

GHG Emissions (kt)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	66.0	62.9	63.9	66.1	0.0%
Commercial	329.4	325.2	327.2	314.5	-0.4%
Industrial	637.1	645.0	649.0	635.0	0.0%
Passenger - Residents	2,917.6	2,726.6	2,185.3	1,818.5	-3.6%
Passenger - Visitors	452.6	376.8	271.1	211.1	
Marine	2,172.6	2,153.1	2,183.9	2,135.2	-0.1%
Aviation	4,839.4	4,929.2	5,179.8	5,166.9	0.5%
Freight	1,401.9	1,371.4	1,239.7	1,203.8	-1.2%
Power Sector	8,745.1	7,814.1	7,545.2	7,683.6	-1.0%
Waste	1,031.6	1,098.2	1,209.3	1,320.4	1.9%
Agriculture & Forestry	(2,267.0)	(2,266.8)	(2,266.3)	(2,265.8)	0.0%
Total	**20,326.2**	**19,235.9**	**18,588.1**	**18,289.3**	**-0.8%**

Total Primary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Biodiesel	-	7.7	15.4	15.5	N/A
Biomass	4.9	7.8	10.0	12.8	7.7%
Coal	15.6	15.8	15.8	15.6	0.0%
Electricity	32.1	31.5	33.1	34.0	0.4%
Ethanol	0.2	0.8	2.9	4.6	26.2%
Gasoline	57.5	53.3	43.2	37.2	-3.3%
Geothermal	2.2	2.2	2.2	2.2	0.0%
HS Diesel	-	-	-	-	N/A
HS Fuel Oil	84.0	70.2	68.8	70.6	-1.3%
Hydrogen	-	-	-	-	N/A
Jet Fuel	81.1	82.6	86.8	86.6	0.5%
LPG	2.4	2.3	2.4	2.3	-0.1%
LS Diesel	15.0	14.9	14.3	13.6	-0.7%
LS Fuel Oil	19.5	21.5	19.4	18.2	-0.5%
Oil, Unspecified	5.5	5.6	5.7	5.5	0.0%
Utility Gas	3.2	3.2	3.3	3.3	0.2%
Still Gas	-	-	-	-	N/A
Waste	5.0	5.0	5.1	6.1	1.6%
Total	**328.3**	**324.4**	**328.4**	**328.2**	**0.0%**

Work Plan 2

GHG Emissions (kt)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Abs. Change from Ref @ 2020	% Change from Ref @ 2020
Residential	66.0	61.9	61.3	62.3	-0.4%	(3.8)	-5.8%
Commercial	329.4	321.1	313.7	296.7	-0.8%	(17.9)	-5.7%
Industrial	637.1	644.8	672.1	657.0	0.2%	22.0	3.5%
Passenger - Residents	2,917.6	2,502.4	1,974.7	1,581.5	-4.6%	(237.0)	-13.0%
Passenger - Visitors	452.6	348.5	244.7	183.4	-6.7%	(27.7)	-13.1%
Marine	2,172.6	2,154.3	2,184.8	2,135.9	-0.1%	0.6	0.0%
Aviation	4,839.4	4,933.7	5,189.1	5,179.0	0.5%	12.1	0.2%
Freight	1,401.9	1,258.2	1,139.8	1,091.5	-1.9%	(112.4)	-9.3%
Power Sector	8,745.1	6,783.3	4,086.6	3,258.4	-7.3%	(4,425.2)	-57.6%
Waste	1,031.6	1,111.5	1,219.6	1,324.1	1.9%	3.7	0.3%
Agriculture & Forestry	(2,267.0)	(2,266.4)	(2,265.3)	(2,263.9)	0.0%	1.9	-0.1%
Total	**20,326.2**	**17,853.2**	**14,821.0**	**13,505.8**	**-3.1%**	(4,783.6)	-26.2%

Total Primary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Biodiesel	-	8.9	21.3	21.6	N/A	6.1	39.1%
Biomass	4.9	7.8	13.1	15.6	9.4%	2.8	22.1%
Coal	15.6	15.8	15.7	15.6	0.0%	(0.1)	-0.5%
Electricity	32.1	29.3	26.1	23.5	-2.4%	(10.5)	-30.9%
Ethanol	0.2	5.4	6.8	8.0	31.7%	3.4	75.0%
Gasoline	57.5	48.7	38.5	32.2	-4.4%	(5.0)	-13.5%
Geothermal	2.2	2.9	2.9	2.9	2.0%	0.6	28.9%
HS Diesel	-	-	-	-	N/A	-	
HS Fuel Oil	84.0	59.2	37.9	27.5	-8.2%	(43.1)	-61.1%
Hydrogen	-	-	-	-	N/A	-	#DIV/0!
Jet Fuel	81.1	82.7	87.0	86.8	0.5%	0.2	0.2%
LPG	2.4	2.3	2.3	2.3	-0.3%	(0.1)	-3.5%
LS Diesel	15.0	14.3	13.3	12.3	-1.5%	(1.3)	-9.5%
LS Fuel Oil	19.5	19.3	5.4	4.2	-11.1%	(14.0)	-76.7%
Oil, Unspecified	5.5	5.6	6.0	5.8	0.3%	0.3	4.8%
Utility Gas	3.2	3.1	3.1	3.0	-0.4%	(0.3)	-7.8%
Still Gas	-	-	-	-	N/A	-	
Waste	5.0	5.0	5.1	6.1	1.6%	-	0.0%
Total	**328.3**	**310.2**	**284.6**	**267.4**	**-1.6%**	(60.8)	-18.5%

Reference Projection vs. Work Plan 2: State Total

Reference Case

Total Secondary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	11.8	11.8	12.4	13.0	0.7%
Commercial	24.1	23.7	24.3	24.2	0.0%
Industrial	14.0	14.0	14.3	14.1	0.0%
Passenger - Residents	39.6	37.6	31.9	28.1	-2.6%
Passenger - Visitors	6.1	5.2	3.9	3.2	-4.9%
Marine	20.9	20.7	21.0	20.5	-0.1%
Aviation	81.1	82.6	86.8	86.6	0.5%
Freight	19.0	18.6	17.5	17.7	-0.5%
Forestry & Agriculture	0.1	0.1	0.1	0.1	-4.0%
Total	**216.8**	**214.3**	**212.2**	**207.5**	**-0.3%**

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Personal Income	42,519	44,060	49,456	54,530	1.9%
Population (millions)	1	1	1	1	1.1%
Gross Regional Product (GRP)	60,659	67,340	74,120	81,609	2.3%

Generation Capacity (MW)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	2,004	2,143	2,206	2,209	0.8%
Coal Steam	180	180	180	180	0.0%
Hydro	24	24	45	45	5.0%
Biomass	60	195	217	249	11.6%
Wind	64	127	153	167	7.7%
Other Renewable	31	141	252	252	17.5%
Total	**2,363**	**2,810**	**3,053**	**3,102**	**2.1%**

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	8,837	7,856	7,459	7,512	-1.2%
Coal Steam	1,510	1,510	1,510	1,510	0.0%
Hydro	130	130	240	240	4.8%
Biomass	291	473	632	867	8.7%
Wind	137	312	382	420	9.0%
Other Renewable	212	841	1,468	1,469	16.0%
Purchases from industry	110	124	139	143	2.1%
Total	**11,228**	**11,247**	**11,829**	**12,162**	**0.6%**

Work Plan 2

Total Secondary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential	11.8	10.7	9.6	8.9	-2.2%	(4.1)	-31.7%
Commercial	24.1	22.6	20.0	17.7	-2.3%	(6.5)	-26.7%
Industrial	14.0	13.8	14.0	13.6	-0.2%	(0.5)	-3.4%
Passenger - Residents	39.6	37.5	31.3	26.7	-3.0%	(1.4)	-5.0%
Passenger - Visitors	6.1	5.2	3.7	2.9	-5.6%	(0.3)	-8.3%
Marine	20.9	20.7	21.0	20.6	-0.1%	0.0	0.0%
Aviation	81.1	82.7	87.0	86.8	0.5%	0.2	0.2%
Freight	19.0	18.7	17.6	17.8	-0.5%	0.1	0.5%
Forestry & Agriculture	0.1	0.1	0.1	0.1	-4.4%	(0.0)	-5.5%
Total	**216.8**	**212.1**	**204.5**	**195.1**	**-0.8%**	(12.4)	-6.0%

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Personal Income	42,519	44,060	49,456	54,530	1.9%	-	0%
Population (millions)	1	1	1	1	1.1%	-	0%
Gross Regional Product (GRP)	60,659	67,340	74,120	81,609	2.3%	-	0%

Generation Capacity (MW)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Gas/Oil	2,004	2,143	2,095	2,097	0.3%	(111.5)	-5.0%
Coal Steam	180	180	180	180	0.0%	-	0.0%
Hydro	24	24	45	45	5.0%	-	0.0%
Biomass	60	195	260	298	13.1%	48.8	19.6%
Wind	64	308	718	733	20.7%	565.6	338.9%
Other Renewable	31	160	331	351	20.5%	98.9	39.2%
Total	**2,363**	**3,010**	**3,628**	**3,703**	**3.5%**	601.9	19.4%

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Gas/Oil	8,837	6,553	3,241	2,102	-10.5%	(5,410.3)	-72.0%
Coal Steam	1,510	1,510	1,510	1,510	0.0%	-	0.0%
Hydro	130	130	240	240	4.8%	-	0.0%
Biomass	291	473	843	1,065	10.5%	198.0	22.8%
Wind	137	821	1,901	1,938	22.6%	1,517.8	361.1%
Other Renewable	212	956	1,801	1,951	18.6%	481.6	32.8%
Purchases from industry	110	131	139	140	1.9%	(2.9)	-2.0%
Total	**11,228**	**10,575**	**9,676**	**8,946**	**-1.7%**	(3,215.8)	-26.4%

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Proposed GHG Reduction Work Plans for Hawaii

Reference Projection vs. Work Plan 2: State Total

Reference Case

Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	3,150	3,157	3,339	3,528	0.9%
Commercial	5,467	5,390	5,569	5,604	0.2%
Industrial	855	836	881	888	0.3%
Transportation	-	-	107	152	N/A
Military	1,242	1,342	1,390	1,437	1.1%
Total	**10,714**	**10,726**	**11,286**	**11,609**	**0.6%**

Distance Travelled (millions of vehicle miles travelled)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Passenger - Residents	10,284	10,114	10,117	10,153	-0.1%
Passenger - Visitors	1,520	1,402	1,296	1,206	-1.8%

Vehicle Energy Consumption (TBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Resident Light	24.1	23.1	20.8	19.7	-1.5%
Resident Medium	12.8	12.7	11.9	11.8	-0.6%
Resident Heavy	2.9	3.0	3.2	3.6	1.6%
Visitor Light	3.7	3.2	2.5	2.2	-3.9%
Visitor Medium	2.0	1.7	1.5	1.3	-3.0%
Visitor Heavy	0.5	0.4	0.4	0.4	-0.9%
Freight Light	13.9	13.6	12.8	13.0	-0.5%
Freight Medium	1.0	1.0	0.9	0.9	-0.5%
Freight Heavy	4.1	4.0	3.8	3.8	-0.5%
Total	**65.0**	**62.8**	**57.8**	**56.9**	**-1.0%**

Average Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	23.5	24.1	26.3	29.4	1.7%
Medium Gasoline	21.4	22.3	24.6	27.6	2.0%
Heavy Gasoline	16.9	17.3	18.7	20.6	1.5%
Heavy Diesel	16.9	17.2	18.6	20.4	1.5%
Fleet	22.0	22.7	25.1	28.5	2.0%

Work Plan 2

Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential	3,150	2,854	2,534	2,332	-2.3%	(1,196.5)	-33.9%
Commercial	5,467	5,094	4,373	3,802	-2.8%	(1,802.4)	-32.2%
Industrial	855	794	782	740	-1.1%	(148.6)	-16.7%
Transportation	-	-	139	210	N/A	58.4	38.5%
Military	1,242	1,342	1,390	1,437	1.1%	-	0.0%
Total	**10,714**	**10,084**	**9,218**	**8,520**	**-1.7%**	(3,089.1)	-26.6%

Distance Travelled (millions of vehicle miles travelled)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Passenger - Residents	10,284	10,122	10,160	10,201	-0.1%	48.1	0.5%
Passenger - Visitors	1,520	1,404	1,294	1,197	-1.8%	(8.2)	-0.7%

Vehicle Energy Consumption (TBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Resident Light	24.1	23.1	20.4	18.7	-1.9%	(1.0)	-5.0%
Resident Medium	12.8	12.7	11.7	11.3	-1.0%	(0.6)	-5.0%
Resident Heavy	2.9	3.0	3.1	3.4	1.2%	(0.2)	-5.0%
Visitor Light	3.7	3.2	2.4	2.0	-4.5%	(0.2)	-8.3%
Visitor Medium	2.0	1.7	1.4	1.2	-3.6%	(0.1)	-8.3%
Visitor Heavy	0.5	0.4	0.4	0.4	-1.5%	(0.0)	-8.3%
Freight Light	13.9	13.7	12.9	13.0	-0.5%	0.1	0.5%
Freight Medium	1.0	1.0	0.9	0.9	-0.5%	0.0	0.5%
Freight Heavy	4.1	4.0	3.8	3.8	-0.5%	0.0	0.5%
Total	**65.0**	**62.9**	**57.1**	**54.9**	**-1.3%**	(2.0)	-3.5%

Average Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	23.5	24.2	26.7	30.4	2.0%	1.1	3.7%
Medium Gasoline	21.4	22.3	24.9	28.6	2.2%	1.0	3.6%
Heavy Gasoline	16.9	17.3	19.0	21.6	1.9%	1.0	4.7%
Heavy Diesel	16.9	17.2	19.0	21.4	1.9%	1.1	5.2%
Fleet	22.0	22.7	25.9	31.0	2.7%	2.5	8.7%

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Proposed GHG Reduction Work Plans for Hawaii

Reference Projection vs. Work Plan 2: State Total

Reference Case

Marginal Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	24.4	28.1	34.0	37.7	3.4%
Medium Gasoline	23.4	26.9	32.6	36.0	3.4%
Heavy Gasoline	17.4	19.4	22.3	24.6	2.7%
Heavy Diesel	17.2	19.2	21.8	24.0	2.6%
Fleet	23.1	26.8	32.2	35.8	3.4%

Average Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	57.1	56.3	54.7	52.7	-0.6%
Medium Gasoline	33.2	33.4	33.6	33.6	0.1%
Heavy Gasoline	9.6	10.3	11.8	13.7	2.7%

Marginal Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	55.8	52.7	48.7	49.1	-1.0%
Medium Gasoline	34.8	33.8	33.7	33.7	-0.3%
Heavy Gasoline	9.4	13.5	17.6	17.2	4.8%

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020
Renewables as % of Electric Sales	7%	16%	24%	26%	18.6%
Ethanol/Gasoline	0%	1%	6%	11%	10.6%
Biodiesel/Diesel	0%	1%	2%	3%	3.4%

Work Plan 2

Marginal Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	24.4	28.8	36.8	42.9	4.4%	5.2	14%
Medium Gasoline	23.4	27.5	35.2	41.0	4.4%	5.0	14%
Heavy Gasoline	17.4	19.8	24.0	27.9	3.7%	3.3	13%
Heavy Diesel	17.2	19.6	23.4	27.1	3.6%	3.1	13%
Fleet	23.1	27.4	36.2	43.1	4.9%	7.3	20%

Average Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	57.1	56.3	54.1	51.3	-0.8%	(1.4)	-3%
Medium Gasoline	33.2	33.4	33.5	33.6	0.1%	(0.0)	0%
Heavy Gasoline	9.6	10.3	12.3	15.1	3.5%	1.4	10%

Marginal Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	55.8	52.7	46.1	46.3	-1.4%	(2.8)	-6%
Medium Gasoline	34.8	33.8	33.6	33.6	-0.3%	(0.1)	0%
Heavy Gasoline	9.4	13.5	20.3	20.1	6.1%	2.9	17%

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020	Difference from Ref @ 2020	Difference from Ref @ 2020
Renewables as % of Electric Sales	7%	24%	52%	61%	53.8%	0.4	136%
Ethanol/Gasoline	0%	10%	15%	20%	19.6%	0.1	82%
Biodiesel/Diesel	0%	10%	15%	20%	20.0%	0.2	492%

Reference Projection vs. Work Plan 2: State Total

Reference Case

Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential					
Electricity	79.0	85.4	100.6	101.6	2.0%
Utility Gas	43.5	43.2	43.5	44.1	0.1%
Bottled Gas	60.0	62.6	68.5	69.2	1.1%
Commercial					
Electricity	68.1	72.9	89.9	90.8	2.2%
Utility Gas	27.8	27.5	27.8	28.4	0.1%
Oil	22.4	25.0	30.9	31.5	2.7%
Bottled Gas	25.0	27.6	33.5	34.1	2.4%
Industrial					
Electricity	62.7	67.2	84.6	84.3	2.3%
Utility Gas	27.8	27.4	27.6	28.2	0.1%
#6 Fuel	9.9	12.5	18.3	19.0	5.2%
Bottled Gas	-	27.6	33.5	34.1	N/A
#2 Fuel	22.4	25.0	30.9	31.5	2.7%
Transportation					
Gasoline	28.2	30.8	36.7	37.4	2.2%
LS Diesel	25.3	27.9	33.7	34.4	2.4%
Ethanol	28.1	25.7	27.9	27.8	-0.1%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%

Compliance Summary	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Emissions Included in Target	15,487	14,307	13,408	13,122	-1.3%
Offsets	-	-	-	-	N/A
Compliance Total	15,487	14,307	13,408	13,122	-1.3%
Percent of 1990 Emissions	113%	105%	98%	96%	-1.3%
Allowance Price (2008 $/Tonne)	-	-	-	-	N/A
Percentage of Offsets Allowed	-	-	-	-	N/A
Permits bought from Auction (Mt)	-	-	-	-	N/A
Bought (Sold) from Outside State					

1990 Emissions Included in Target - 13,660 kt CO2e
(excludes emissions from international bunker fuels and aviation)

Work Plan 2

Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential						-	
Electricity	79.0	85.3	121.6	126.8	3.7%	25.2	24.8%
Utility Gas	43.5	43.7	44.5	45.5	0.3%	1.4	3.1%
Bottled Gas	60.0	63.3	69.8	70.9	1.3%	1.8	2.6%
						-	
Commercial						-	
Electricity	68.1	73.0	109.6	115.9	4.2%	25.0	27.6%
Utility Gas	27.8	28.0	28.9	29.8	0.5%	1.4	4.9%
Oil	22.4	25.7	32.3	33.4	3.1%	1.9	6.0%
Bottled Gas	25.0	28.3	34.8	35.9	2.8%	1.8	5.2%
Industrial						-	
Electricity	62.7	67.2	106.4	113.0	4.6%	28.7	34.0%
Utility Gas	27.8	27.9	28.7	29.6	0.5%	1.4	5.0%
#6 Fuel	9.9	13.2	19.8	21.0	6.0%	2.0	10.3%
Bottled Gas	-	28.3	34.8	35.9	N/A	1.8	5.2%
#2 Fuel	22.4	25.7	32.3	33.4	3.1%	1.9	6.0%
Transportation						-	
Gasoline	28.2	31.5	38.1	39.2	2.5%	1.8	4.8%
LS Diesel	25.3	28.6	35.2	36.3	2.8%	1.9	5.5%
Ethanol	28.1	25.7	27.9	27.8	-0.1%	-	0.0%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%	-	0.0%

Compliance Summary	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Emissions Included in Target	15,487	12,920	9,632	8,327	-4.7%	(4,795.7)	-36.5%
Offsets	-	-	-	-	N/A	-	n.a.
Compliance Total	15,487	12,920	9,632	8,327	-4.7%	(4,795.7)	-36.5%
Percent of 1990 Emissions	113%	95%	71%	61%	-4.7%	(0.4)	-36.5%
Allowance Price (2008 $/Tonne)	$0	$0	$28	$35	N/A	35.2	n.a.
Percentage of Offsets Allowed	-	-	30%	34%	N/A	0.3	n.a.
Permits bought from Auction (Mt)	-	-	11.8	11.1	N/A	11.1	n.a.
Bought (Sold) from Outside State						-	n.a.

1990 Emissions Included in Target - 13,660 kt CO2e
(excludes emissions from international bunker fuels and aviation)

Proposed GHG Reduction Work Plans for Hawaii

Reference Projection vs. Work Plan 3: State Total

Reference Case

GHG Emissions (kt)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	66.0	62.9	63.9	66.1	0.0%
Commercial	329.4	325.2	327.2	314.5	-0.4%
Industrial	637.1	645.0	649.0	635.0	0.0%
Passenger - Residents	2,917.6	2,726.6	2,185.3	1,818.5	-3.6%
Passenger - Visitors	452.6	376.8	271.1	211.1	
Marine	2,172.6	2,153.1	2,183.9	2,135.2	-0.1%
Aviation	4,839.4	4,929.2	5,179.8	5,166.9	0.5%
Freight	1,401.9	1,371.4	1,239.7	1,203.8	-1.2%
Power Sector	8,745.1	7,814.1	7,545.2	7,683.6	-1.0%
Waste	1,031.6	1,098.2	1,209.3	1,320.4	1.9%
Agriculture & Forestry	(2,267.0)	(2,266.8)	(2,266.3)	(2,265.8)	0.0%
Total	**20,326.2**	**19,235.9**	**18,588.1**	**18,289.3**	**-0.8%**

Total Primary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Biodiesel	-	7.7	15.4	15.5	N/A
Biomass	4.9	7.8	10.0	12.8	7.7%
Coal	15.6	15.8	15.8	15.6	0.0%
Electricity	32.1	31.5	33.1	34.0	0.4%
Ethanol	0.2	0.8	2.9	4.6	26.2%
Gasoline	57.5	53.3	43.2	37.2	-3.3%
Geothermal	2.2	2.2	2.2	2.2	0.0%
HS Diesel	-	-	-	-	N/A
HS Fuel Oil	84.0	70.2	68.8	70.6	-1.3%
Hydrogen	-	-	-	-	N/A
Jet Fuel	81.1	82.6	86.8	86.6	0.5%
LPG	2.4	2.3	2.4	2.3	-0.1%
LS Diesel	15.0	14.9	14.3	13.6	-0.7%
LS Fuel Oil	19.5	21.5	19.4	18.2	-0.5%
Oil, Unspecified	5.5	5.6	5.7	5.5	0.0%
Utility Gas	3.2	3.2	3.3	3.3	0.2%
Still Gas	-	-	-	-	N/A
Waste	5.0	5.0	5.1	6.1	1.6%
Total	**328.3**	**324.4**	**328.4**	**328.2**	**0.0%**

Work Plan 3

GHG Emissions (kt)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Abs. Change from Ref @ 2020	% Change from Ref @ 2020
Residential	66.0	61.9	60.3	59.2	-0.8%	(6.9)	-10.4%
Commercial	329.4	321.5	310.1	289.0	-1.0%	(25.5)	-8.1%
Industrial	637.1	645.3	671.6	655.0	0.2%	20.1	3.2%
Passenger - Residents	2,917.6	2,504.4	1,977.5	1,584.8	-4.6%	(233.7)	-12.9%
Passenger - Visitors	452.6	349.2	244.4	183.1	-6.7%	(28.0)	-13.2%
Marine	2,172.6	2,155.2	2,189.8	2,142.4	-0.1%	7.1	0.3%
Aviation	4,839.4	4,934.1	5,197.8	5,190.7	0.5%	23.8	0.5%
Freight	1,401.9	1,259.4	1,145.4	1,097.7	-1.9%	(106.1)	-8.8%
Power Sector	8,745.1	6,783.8	4,034.1	3,243.4	-7.3%	(4,440.2)	-57.8%
Waste	1,031.6	1,112.0	1,226.1	1,332.4	2.0%	12.0	0.9%
Agriculture & Forestry	(2,267.0)	(2,266.4)	(2,264.0)	(2,263.6)	0.0%	2.2	-0.1%
Total	**20,326.2**	**17,860.5**	**14,793.0**	**13,514.2**	**-3.1%**	(4,775.1)	-26.1%

Total Primary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Biodiesel	-	8.9	21.3	21.6	N/A	6.1	39.2%
Biomass	4.9	7.8	13.1	15.7	9.4%	2.9	22.7%
Coal	15.6	15.8	15.7	15.6	0.0%	(0.0)	-0.3%
Electricity	32.1	29.3	26.2	23.7	-2.3%	(10.3)	-30.2%
Ethanol	0.2	5.4	6.8	8.1	31.7%	3.5	75.3%
Gasoline	57.5	48.7	38.6	32.2	-4.3%	(5.0)	-13.3%
Geothermal	2.2	2.9	2.9	2.9	2.0%	0.6	28.9%
HS Diesel	-	-	-	-	N/A	-	
HS Fuel Oil	84.0	59.2	29.8	20.8	-10.2%	(49.8)	-70.5%
Hydrogen	-	-	-	-	N/A	-	
Jet Fuel	81.1	82.7	87.1	87.0	0.5%	0.4	0.5%
LPG	2.4	2.3	2.3	2.3	-0.3%	(0.1)	-2.5%
LS Diesel	15.0	14.3	13.4	12.4	-1.5%	(1.2)	-8.9%
LS Fuel Oil	19.5	19.3	13.5	11.2	-4.2%	(6.9)	-38.2%
Oil, Unspecified	5.5	5.6	6.0	5.8	0.4%	0.3	5.1%
Utility Gas	3.2	3.1	2.9	2.7	-1.4%	(0.6)	-18.3%
Still Gas	-	-	-	-	N/A	-	
Waste	5.0	5.0	5.1	6.1	1.6%	-	0.0%
Total	**328.3**	**310.3**	**284.8**	**268.1**	**-1.5%**	(60.1)	-18.3%

Reference Projection vs. Work Plan 3: State Total

Reference Case

Total Secondary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	11.8	11.8	12.4	13.0	0.7%
Commercial	24.1	23.7	24.3	24.2	0.0%
Industrial	14.0	14.0	14.3	14.1	0.0%
Passenger - Residents	39.6	37.6	31.9	28.1	-2.6%
Passenger - Visitors	6.1	5.2	3.9	3.2	-4.9%
Marine	20.9	20.7	21.0	20.5	-0.1%
Aviation	81.1	82.6	86.8	86.6	0.5%
Freight	19.0	18.6	17.5	17.7	-0.5%
Forestry & Agriculture	0.1	0.1	0.1	0.1	-4.0%
Total	**216.8**	**214.3**	**212.2**	**207.5**	**-0.3%**

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Personal Income	42,519	44,060	49,456	54,530	1.9%
Population (millions)	1	1	1	1	1.1%
Gross Regional Product (GRP)	60,659	67,340	74,120	81,609	2.3%

Generation Capacity (MW)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	2,004	2,143	2,206	2,209	0.8%
Coal Steam	180	180	180	180	0.0%
Hydro	24	24	45	45	5.0%
Biomass	60	195	217	249	11.6%
Wind	64	127	153	167	7.7%
Other Renewable	31	141	252	252	17.5%
Total	**2,363**	**2,810**	**3,053**	**3,102**	**2.1%**

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	8,837	7,856	7,459	7,512	-1.2%
Coal Steam	1,510	1,510	1,510	1,510	0.0%
Hydro	130	130	240	240	4.8%
Biomass	291	473	632	867	8.7%
Wind	137	312	382	420	9.0%
Other Renewable	212	841	1,468	1,469	16.0%
Purchases from industry	110	124	139	143	2.1%
Total	**11,228**	**11,247**	**11,829**	**12,162**	**0.6%**

Work Plan 3

Total Secondary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential	11.8	10.7	9.6	8.9	-2.1%	(4.1)	-31.4%
Commercial	24.1	22.6	20.0	17.7	-2.3%	(6.5)	-26.9%
Industrial	14.0	13.8	14.0	13.5	-0.2%	(0.5)	-3.6%
Passenger - Residents	39.6	37.5	31.4	26.8	-3.0%	(1.3)	-4.8%
Passenger - Visitors	6.1	5.2	3.7	2.9	-5.6%	(0.3)	-8.4%
Marine	20.9	20.7	21.1	20.6	-0.1%	0.1	0.3%
Aviation	81.1	82.7	87.1	87.0	0.5%	0.4	0.5%
Freight	19.0	18.8	17.7	17.9	-0.5%	0.2	1.0%
Forestry & Agriculture	0.1	0.1	0.1	0.1	-4.4%	(0.0)	-5.4%
Total	**216.8**	**212.2**	**204.8**	**195.5**	**-0.8%**	(12.1)	-5.8%

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Personal Income	42,519	44,060	49,456	54,530	1.9%	-	0%
Population (millions)	1	1	1	1	1.1%	-	0%
Gross Regional Product (GRP)	60,659	67,340	74,120	81,609	2.3%	-	0%

Generation Capacity (MW)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Gas/Oil	2,004	2,143	2,095	2,097	0.3%	(111.5)	-5.0%
Coal Steam	180	180	180	180	0.0%	-	0.0%
Hydro	24	24	45	45	5.0%	-	0.0%
Biomass	60	195	260	298	13.1%	48.8	19.6%
Wind	64	308	718	733	20.7%	565.6	338.9%
Other Renewable	31	160	331	351	20.5%	98.9	39.2%
Total	**2,363**	**3,010**	**3,628**	**3,703**	**3.5%**	601.9	19.4%

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Gas/Oil	8,837	6,554	3,298	2,188	-10.2%	(5,324.0)	-70.9%
Coal Steam	1,510	1,510	1,510	1,510	0.0%	-	0.0%
Hydro	130	130	240	240	4.8%	-	0.0%
Biomass	291	473	843	1,070	10.5%	203.2	23.4%
Wind	137	821	1,901	1,938	22.6%	1,517.8	361.1%
Other Renewable	212	956	1,801	1,951	18.6%	481.6	32.8%
Purchases from industry	110	131	138	138	1.8%	(5.4)	-3.8%
Total	**11,228**	**10,575**	**9,731**	**9,035**	**-1.7%**	(3,126.8)	-25.7%

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Reference Projection vs. Work Plan 3: State Total

Reference Case

Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	3,150	3,157	3,339	3,528	0.9%
Commercial	5,467	5,390	5,569	5,604	0.2%
Industrial	855	836	881	888	0.3%
Transportation	-	-	107	152	N/A
Military	1,242	1,342	1,390	1,437	1.1%
Total	**10,714**	**10,726**	**11,286**	**11,609**	**0.6%**

Distance Travelled (millions of vehicle miles travelled)					
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Passenger - Residents	10,284	10,114	10,117	10,153	-0.1%
Passenger - Visitors	1,520	1,402	1,296	1,206	-1.8%

Vehicle Energy Consumption (TBtu)					
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Resident Light	24.1	23.1	20.8	19.7	-1.5%
Resident Medium	12.8	12.7	11.9	11.8	-0.6%
Resident Heavy	2.9	3.0	3.2	3.6	1.6%
Visitor Light	3.7	3.2	2.5	2.2	-3.9%
Visitor Medium	2.0	1.7	1.5	1.3	-3.0%
Visitor Heavy	0.5	0.4	0.4	0.4	-0.9%
Freight Light	13.9	13.6	12.8	13.0	-0.5%
Freight Medium	1.0	1.0	0.9	0.9	-0.5%
Freight Heavy	4.1	4.0	3.8	3.8	-0.5%
Total	**65.0**	**62.8**	**57.8**	**56.9**	**-1.0%**

Average Vehicle Efficiency (miles/gallon)					
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	23.5	24.1	26.3	29.4	1.7%
Medium Gasoline	21.4	22.3	24.6	27.6	2.0%
Heavy Gasoline	16.9	17.3	18.7	20.6	1.5%
Heavy Diesel	16.9	17.2	18.6	20.4	1.5%
Fleet	22.0	22.7	25.1	28.5	2.0%

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Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential	3,150	2,854	2,550	2,359	-2.2%	(1,168.8)	-33.1%
Commercial	5,467	5,096	4,394	3,834	-2.7%	(1,769.6)	-31.6%
Industrial	855	794	784	743	-1.1%	(145.0)	-16.3%
Transportation	-	-	141	214	N/A	62.1	41.0%
Military	1,242	1,342	1,390	1,437	1.1%	-	0.0%
Total	**10,714**	**10,086**	**9,259**	**8,588**	**-1.7%**	(3,021.2)	-26.0%

Distance Travelled (millions of vehicle miles travelled)							
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Passenger - Residents	10,284	10,122	10,184	10,248	0.0%	95.6	0.9%
Passenger - Visitors	1,520	1,404	1,294	1,199	-1.8%	(7.1)	-0.6%

Vehicle Energy Consumption (TBtu)							
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Resident Light	24.1	23.1	20.5	18.8	-1.9%	(0.9)	-4.8%
Resident Medium	12.8	12.7	11.7	11.3	-1.0%	(0.6)	-4.8%
Resident Heavy	2.9	3.0	3.1	3.4	1.2%	(0.2)	-4.8%
Visitor Light	3.7	3.2	2.4	2.0	-4.5%	(0.2)	-8.4%
Visitor Medium	2.0	1.7	1.4	1.2	-3.6%	(0.1)	-8.4%
Visitor Heavy	0.5	0.4	0.4	0.4	-1.5%	(0.0)	-8.4%
Freight Light	13.9	13.7	13.0	13.1	-0.5%	0.1	1.0%
Freight Medium	1.0	1.0	0.9	0.9	-0.5%	0.0	1.0%
Freight Heavy	4.1	4.1	3.8	3.9	-0.5%	0.0	1.0%
Total	**65.0**	**62.9**	**57.3**	**55.0**	**-1.3%**	(1.8)	-3.2%

Average Vehicle Efficiency (miles/gallon)							
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	23.5	24.1	26.7	30.5	2.0%	1.1	3.8%
Medium Gasoline	21.4	22.3	24.9	28.7	2.3%	1.0	3.7%
Heavy Gasoline	16.9	17.3	19.0	21.6	1.9%	1.0	4.8%
Heavy Diesel	16.9	17.2	19.0	21.4	1.9%	1.1	5.2%
Fleet	22.0	22.7	25.9	31.0	2.7%	2.5	8.9%

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Proposed GHG Reduction Work Plans for Hawaii

Reference Projection vs. Work Plan 3: State Total

Reference Case

Marginal Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	24.4	28.1	34.0	37.7	3.4%
Medium Gasoline	23.4	26.9	32.6	36.0	3.4%
Heavy Gasoline	17.4	19.4	22.3	24.6	2.7%
Heavy Diesel	17.2	19.2	21.8	24.0	2.6%
Fleet	23.1	26.8	32.2	35.8	3.4%

Average Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	57.1	56.3	54.7	52.7	-0.6%
Medium Gasoline	33.2	33.4	33.6	33.6	0.1%
Heavy Gasoline	9.6	10.3	11.8	13.7	2.7%

Marginal Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	55.8	52.7	48.7	49.1	-1.0%
Medium Gasoline	34.8	33.8	33.7	33.7	-0.3%
Heavy Gasoline	9.4	13.5	17.6	17.2	4.8%

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020
Renewables as % of Electric Sales	7%	16%	24%	26%	18.6%
Ethanol/Gasoline	0%	1%	6%	11%	10.6%
Biodiesel/Diesel	0%	1%	2%	3%	3.4%

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Marginal Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	24.4	28.5	36.9	43.1	4.5%	5.4	14%
Medium Gasoline	23.4	27.3	35.3	41.2	4.4%	5.2	14%
Heavy Gasoline	17.4	19.8	24.0	27.9	3.7%	3.3	13%
Heavy Diesel	17.2	19.5	23.4	27.1	3.5%	3.1	13%
Fleet	23.1	27.2	36.3	43.2	4.9%	7.5	21%

Average Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	57.1	56.3	54.1	51.3	-0.8%	(1.4)	-3%
Medium Gasoline	33.2	33.4	33.5	33.6	0.1%	(0.0)	0%
Heavy Gasoline	9.6	10.3	12.3	15.1	3.5%	1.4	10%

Marginal Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	55.8	52.7	46.1	46.3	-1.4%	(2.8)	-6%
Medium Gasoline	34.8	33.8	33.6	33.6	-0.3%	(0.1)	0%
Heavy Gasoline	9.4	13.5	20.3	20.1	6.1%	2.9	17%

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020	Difference from Ref @ 2020	Difference from Ref @ 2020
Renewables as % of Electric Sales	7%	24%	52%	61%	53.3%	0.3	135%
Ethanol/Gasoline	0%	10%	15%	20%	19.6%	0.1	82%
Biodiesel/Diesel	0%	10%	15%	20%	20.0%	0.2	492%

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Reference Projection vs. Work Plan 3: State Total

Reference Case

Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential					
Electricity	79.0	85.4	100.6	101.6	2.0%
Utility Gas	43.5	43.2	43.5	44.1	0.1%
Bottled Gas	60.0	62.6	68.5	69.2	1.1%
Commercial					
Electricity	68.1	72.9	89.9	90.8	2.2%
Utility Gas	27.8	27.5	27.8	28.4	0.1%
Oil	22.4	25.0	30.9	31.5	2.7%
Bottled Gas	25.0	27.6	33.5	34.1	2.4%
Industrial					
Electricity	62.7	67.2	84.6	84.3	2.3%
Utility Gas	27.8	27.4	27.6	28.2	0.1%
#6 Fuel	9.9	12.5	18.3	19.0	5.2%
Bottled Gas	-	27.6	33.5	34.1	N/A
#2 Fuel	22.4	25.0	30.9	31.5	2.7%
Transportation					
Gasoline	28.2	30.8	36.7	37.4	2.2%
LS Diesel	25.3	27.9	33.7	34.4	2.4%
Ethanol	28.1	25.7	27.9	27.8	-0.1%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%

Compliance Summary	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Emissions Included in Target	15,487	14,307	13,408	13,122	-1.3%
Offsets	-	-	-	-	N/A
Compliance Total	15,487	14,307	13,408	13,122	-1.3%
Percent of 1990 Emissions	113%	105%	98%	96%	-1.3%
Allowance Price (2008 $/Tonne)	-	-	-	-	N/A
Percentage of Offsets Allowed	-	-	-	-	N/A
Permits bought from Auction (Mt)	-	-	-	-	N/A
Bought (Sold) from Outside State					

1990 Emissions Included in Target - 13,660 kt CO2e
(excludes emissions from international bunker fuels and aviation)

Work Plan 3

Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential						-	
Electricity	79.0	85.3	118.8	122.7	3.4%	21.1	20.8%
Utility Gas	43.5	43.1	57.8	58.9	2.4%	14.8	33.5%
Bottled Gas	60.0	62.6	70.2	71.4	1.3%	2.3	3.3%
						-	
Commercial						-	
Electricity	68.1	73.0	106.9	111.8	3.9%	21.0	23.1%
Utility Gas	27.8	27.5	42.1	43.2	3.4%	14.8	52.2%
Oil	22.4	25.0	32.7	33.9	3.2%	2.4	7.6%
Bottled Gas	25.0	27.6	35.2	36.4	2.9%	2.3	6.6%
Industrial						-	
Electricity	62.7	67.2	103.6	108.9	4.3%	24.6	29.2%
Utility Gas	27.8	27.4	42.0	43.0	3.4%	14.9	52.8%
#6 Fuel	9.9	12.5	22.2	24.0	7.1%	5.0	26.6%
Bottled Gas	-	27.6	35.2	36.4	N/A	2.3	6.6%
#2 Fuel	22.4	25.0	32.7	33.9	3.2%	2.4	7.6%
Transportation						-	
Gasoline	28.2	30.8	38.5	39.7	2.6%	2.3	6.2%
LS Diesel	25.3	27.9	35.6	36.8	2.9%	2.4	7.0%
Ethanol	28.1	25.7	27.9	27.8	-0.1%	-	0.0%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%	-	0.0%

Compliance Summary	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Emissions Included in Target	15,487	12,926	9,595	8,323	-4.7%	(4,799.0)	-36.6%
Offsets	-	-	-	-	N/A	-	n.a.
Compliance Total	15,487	12,926	9,595	8,323	-4.7%	(4,799.0)	-36.6%
Percent of 1990 Emissions	113%	95%	70%	61%	-4.7%	(0.4)	-36.6%
Allowance Price (2008 $/Tonne)	$0	$0	$28	$35	N/A	35.2	n.a.
Percentage of Offsets Allowed	-	-	30%	34%	N/A	0.3	n.a.
Permits bought from Auction (Mt)	-	-	11.8	11.1	N/A	11.1	n.a.
Bought (Sold) from Outside State						-	n.a.

1990 Emissions Included in Target - 13,660 kt CO2e
(excludes emissions from international bunker fuels and aviation)

County Level Results

ENERGY 2020 Energy & Emissions Modeling

County Level Policy Modeling Results:

The following pages display the modeling results for each county. ***In general, these results reflect the same pattern of changes relative to the Reference Projection as for the State as a whole***. For example, approximately the same level of marginal vehicle efficiency is achieved in each County, all counties achieve the targeted level of biofuel use in transportation, and all see significant decreases in electricity and energy consumption. Electricity sales decline by from 24% to 37% across the Counties under Work Plan 1 compared to the State average of 26.5%. The change in primary energy use from the Reference Projection in 2020 (16% to 29%), differs between the Counties depending on the initial mix of generating resources and the sectors driving energy use. For the State as a whole, primary energy use declined 18%.

Where the County-level results differ, they differ in the relative size of the change rather than in the direction of the change. These differences are primarily driven by differences in the existing and projected electricity supply mix *(as described in the section on Work Plan 1 Modeling Results, page 88).* Differences in the development of the power sector in turn affect levels of secondary and primary energy use and emissions.

For example, the development of wind resources on Maui, Molokai and Lanai, combined with the assumed undersea cable linking these resources to Oahu, results in Maui county becoming a net exporter of renewable power. This results in a greater reduction of GHG emissions for Maui (38% reduction from the Reference Projection by 2020) than for Oahu (21%). Kauai is projected to reach the point where essentially 100% of its electricity needs are supplied from renewable sources, including biodiesel, by 2020, which contributes to reducing that County's GHG emissions by 31%. The County of Hawaii is similarly projected to achieve a higher contribution from renewable sources, supplying 75% of its electricity from renewable sources by 2020. Combined with other reductions in energy use and emissions, this results in projected County GHG emissions falling below zero. In other words, the level of carbon emitted is projected to be less than the level absorbed by carbon sinks on the island.

As was the case for the State as a whole, emissions at the County level change very little under Work Plan 2 and Work Plan 3. The changes which do occur are directionally consistent with the changes at the State level.

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Proposed GHG Reduction Work Plans for Hawaii

Reference Projection vs. Work Plan 1: Oahu

Reference Case

GHG Emissions (kt)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	42.3	41.1	41.1	42.2	0.0%
Commercial	204.9	206.1	209.5	200.4	-0.2%
Industrial	115.9	123.3	136.6	138.7	1.4%
Passenger - Residents	1,890.2	1,853.7	1,523.5	1,287.1	-2.9%
Passenger - Visitors	133.1	116.2	82.6	64.2	-5.5%
Marine	2,172.6	2,153.1	2,183.9	2,135.2	-0.1%
Aviation	4,839.4	4,929.2	5,179.8	5,166.9	0.5%
Freight	816.6	843.7	799.0	785.2	-0.3%
Power Sector	6,952.9	6,226.2	6,068.0	6,218.0	-0.9%
Waste	714.0	729.9	756.4	782.8	0.7%
Agriculture & Forestry	(316.9)	(319.5)	(323.9)	(328.3)	0.3%
Total	**17,565.1**	**16,903.1**	**16,656.5**	**16,492.4**	**-0.5%**

Total Primary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Biodiesel	-	7.7	15.3	15.4	N/A
Biomass	-	2.8	2.8	2.8	N/A
Coal	13.8	13.8	13.8	13.8	0.0%
Electricity	22.4	22.3	23.6	24.0	0.5%
Ethanol	0.1	0.5	1.9	3.1	27.2%
Gasoline	35.1	34.4	28.9	25.3	-2.5%
Geothermal	-	0.0	0.0	0.0	N/A
HS Diesel	-	-	-	-	N/A
HS Fuel Oil	79.3	69.3	67.8	69.4	-1.0%
Hydrogen	-	-	-	-	N/A
Jet Fuel	81.1	82.6	86.8	86.6	0.5%
LPG	0.7	0.7	0.7	0.7	0.2%
LS Diesel	11.3	11.3	11.1	10.7	-0.4%
LS Fuel Oil	0.2	0.9	0.8	0.9	11.9%
Oil, Unspecified	3.3	3.4	3.5	3.4	0.4%
Utility Gas	2.9	2.9	3.0	2.9	0.1%
Still Gas	-	-	-	-	N/A
Waste	5.0	5.0	5.0	5.0	0.0%
Total	**255.2**	**257.6**	**265.1**	**264.2**	**0.3%**

Work Plan 1

GHG Emissions (kt)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Abs. Change from Ref @ 2020	% Change from Ref @ 2020
Residential	42.3	40.5	39.2	39.0	-0.6%	(3.2)	-8%
Commercial	204.9	202.6	200.2	187.6	-0.7%	(12.8)	-6%
Industrial	115.9	123.1	155.6	158.0	2.4%	19.3	14%
Passenger - Residents	1,890.2	1,703.0	1,385.0	1,131.8	-3.9%	(155.3)	-12%
Passenger - Visitors	133.1	110.3	79.8	62.2	-5.7%	(2.0)	-3%
Marine	2,172.6	2,155.2	2,191.9	2,145.2	-0.1%	9.9	0%
Aviation	4,839.4	4,934.1	5,199.3	5,191.2	0.5%	24.4	0%
Freight	816.6	770.0	737.2	720.5	-1.0%	(64.7)	-8%
Power Sector	6,952.9	5,556.1	3,676.0	2,862.1	-6.6%	(3,355.8)	-54%
Waste	714.0	730.5	760.2	785.2	0.7%	2.3	0%
Agriculture & Forestry	(316.9)	(319.5)	(323.8)	(328.2)	0.3%	0.2	0%
Total	**17,565.1**	**16,006.0**	**14,100.7**	**12,954.8**	**-2.3%**	(3,537.6)	-21%

Total Primary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Biodiesel	-	8.6	20.8	21.0	N/A	5.6	36%
Biomass	-	2.8	4.4	4.4	N/A	1.5	53%
Coal	13.8	13.8	13.8	13.8	0.0%	-	N/A
Electricity	22.4	20.8	18.7	16.9	-2.1%	(7.0)	-29%
Ethanol	0.1	3.5	4.6	5.6	33.0%	2.4	78%
Gasoline	35.1	31.4	26.0	22.3	-3.4%	(3.0)	-12%
Geothermal	-	0.0	0.0	0.0	N/A	0.0	625%
HS Diesel	-	-	-	-	N/A	-	N/A
HS Fuel Oil	79.3	59.1	38.1	27.7	-7.8%	(41.7)	-60%
Hydrogen	-	-	-	-	N/A	-	N/A
Jet Fuel	81.1	82.7	87.2	87.0	0.5%	0.4	0%
LPG	0.7	0.7	0.7	0.7	-0.2%	(0.0)	-5%
LS Diesel	11.3	10.9	10.6	10.0	-0.9%	(0.7)	-7%
LS Fuel Oil	0.2	2.8	-	-	-100.0%	(0.9)	-100%
Oil, Unspecified	3.3	3.4	3.8	3.7	0.9%	0.2	7%
Utility Gas	2.9	2.9	2.8	2.7	-0.5%	(0.2)	-7%
Still Gas	-	-	-	-	N/A	-	N/A
Waste	5.0	5.0	5.0	5.0	0.0%	-	N/A
Total	**255.2**	**248.3**	**236.5**	**220.7**	**-1.1%**	(43.5)	-16%

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Proposed GHG Reduction Work Plans for Hawaii

Reference Projection vs. Work Plan 1: Oahu

Reference Case

Total Secondary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	8.0	7.9	8.2	8.5	0.5%
Commercial	16.7	16.6	17.1	16.9	0.1%
Industrial	4.6	4.8	5.1	5.1	0.7%
Passenger - Residents	25.7	25.5	22.4	20.0	-1.9%
Passenger - Visitors	1.8	1.6	1.2	0.9	-4.8%
Marine	20.9	20.7	21.0	20.5	-0.1%
Aviation	81.1	82.6	86.8	86.6	0.5%
Freight	11.1	11.5	11.4	11.7	0.4%
Forestry & Agriculture	0.1	0.1	0.1	0.1	-3.4%
Total	**170.0**	**171.3**	**173.2**	**170.4**	**0.0%**

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Personal Income	31,302	32,001	35,929	38,963	1.7%
Population (millions)	1	1	1	1	0.9%
Gross Regional Product (GRP)	47,103	52,953	58,286	64,021	2.4%

Generation Capacity (MW)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	1,383	1,459	1,459	1,459	0.4%
Coal Steam	180	180	180	180	0.0%
Hydro	14	14	14	14	0.0%
Biomass	60	195	195	195	9.5%
Wind	-	54	54	54	N/A
Other Renewable	-	110	220	221	N/A
Total	**1,637**	**2,012**	**2,122**	**2,122**	**2.0%**

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	6,342	5,468	5,278	5,457	-1.1%
Coal Steam	1,510	1,510	1,510	1,510	0.0%
Hydro	70	70	70	70	0.0%
Biomass	291	473	474	474	3.8%
Wind	-	148	148	148	N/A
Other Renewable	-	627	1,255	1,255	N/A
Purchases from industry	12	2	-	-	-100.0%
Total	**8,226**	**8,298**	**8,734**	**8,914**	**0.6%**

Work Plan 1

Total Secondary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential	8.0	7.2	6.5	6.0	-2.2%	(2.5)	-30%
Commercial	16.7	15.8	14.0	12.4	-2.2%	(4.5)	-27%
Industrial	4.6	4.6	5.1	5.0	0.5%	(0.1)	-3%
Passenger - Residents	25.7	25.5	22.1	19.3	-2.2%	(0.8)	-4%
Passenger - Visitors	1.8	1.6	1.2	0.9	-5.1%	(0.0)	-4%
Marine	20.9	20.7	21.1	20.6	-0.1%	0.1	0%
Aviation	81.1	82.7	87.2	87.0	0.5%	0.4	0%
Freight	11.1	11.5	11.5	11.8	0.5%	0.2	2%
Forestry & Agriculture	0.1	0.1	0.1	0.1	-3.9%	(0.0)	-6%
Total	**170.0**	**169.8**	**168.6**	**163.1**	**-0.3%**	(7.3)	-4%

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Personal Income	31,302	32,001	35,929	38,963	1.7%	-	0%
Population (millions)	1	1	1	1	0.9%	-	0%
Gross Regional Product (GRP)	47,103	52,953	58,286	64,021	2.4%	-	0%

Generation Capacity (MW)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Gas/Oil	1,383	1,459	1,364	1,364	-0.1%	(94.9)	-7%
Coal Steam	180	180	180	180	0.0%	-	0%
Hydro	14	14	14	14	0.0%	-	0%
Biomass	60	195	212	212	10.2%	17.2	9%
Wind	-	156	156	156	N/A	102.1	190%
Other Renewable	-	118	289	299	N/A	78.3	35%
Total	**1,637**	**2,122**	**2,215**	**2,225**	**2.4%**	102.7	5%

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Gas/Oil	6,342	4,665	2,595	1,604	-10.0%	(3,852.6)	-71%
Coal Steam	1,510	1,510	1,510	1,510	0.0%	-	0%
Hydro	70	70	70	70	0.0%	-	0%
Biomass	291	473	572	572	5.3%	98.3	21%
Wind	-	413	413	413	N/A	264.9	179%
Other Renewable	-	675	1,519	1,594	N/A	339.0	27%
Purchases from industry	12	11	15	18	3.2%	17.9	N/A
Total	**8,226**	**7,817**	**6,694**	**5,781**	**-2.7%**	(3,132.4)	-35%

Proposed GHG Reduction Work Plans for Hawaii

Reference Projection vs. Work Plan 1: Oahu

Reference Case

Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	2,132	2,112	2,210	2,294	0.6%
Commercial	3,910	3,902	4,030	4,024	0.2%
Industrial	560	556	591	594	0.5%
Transportation	-	-	107	152	N/A
Military	1,221	1,320	1,367	1,414	1.1%
Total	**7,823**	**7,891**	**8,306**	**8,477**	**0.6%**

Distance Travelled (millions of vehicle miles travelled)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Passenger - Residents	7,031	7,143	7,418	7,577	0.6%
Passenger - Visitors	454	464	447	422	-0.6%

Vehicle Energy Consumption (TBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Resident Light	15.6	15.7	14.6	14.1	-0.8%
Resident Medium	8.3	8.6	8.4	8.5	0.1%
Resident Heavy	1.9	2.1	2.2	2.6	2.3%
Visitor Light	1.1	1.0	0.8	0.7	-3.8%
Visitor Medium	0.6	0.5	0.4	0.4	-2.9%
Visitor Heavy	0.1	0.1	0.1	0.1	-0.8%
Freight Light	-	-	-	-	N/A
Freight Medium	-	-	-	-	N/A
Freight Heavy	-	-	-	-	N/A
Total	**27.6**	**28.0**	**26.5**	**26.3**	**-0.4%**

Average Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	23.5	24.2	26.4	29.5	1.7%
Medium Gasoline	21.6	22.4	24.7	27.8	2.0%
Heavy Gasoline	16.9	17.3	18.7	20.6	1.5%
Heavy Diesel	16.9	17.2	18.5	20.3	1.4%
Fleet	22.1	22.8	25.2	28.6	2.0%

Work Plan 1

Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential	2,132	1,915	1,705	1,566	-2.3%	(727.5)	-32%
Commercial	3,910	3,673	3,169	2,765	-2.6%	(1,259.2)	-31%
Industrial	560	528	524	491	-1.0%	(102.7)	-17%
Transportation	-	-	131	195	N/A	43.1	28%
Military	1,221	1,320	1,367	1,414	1.1%	-	0%
Total	**7,823**	**7,436**	**6,895**	**6,431**	**-1.5%**	(2,046.4)	-24%

Distance Travelled (millions of vehicle miles travelled)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Passenger - Residents	7,031	7,147	7,459	7,632	0.6%	54.6	1%
Passenger - Visitors	454	465	445	415	-0.7%	(7.3)	-2%

Vehicle Energy Consumption (TBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Resident Light	15.6	15.7	14.4	13.5	-1.1%	(0.5)	-4%
Resident Medium	8.3	8.6	8.3	8.1	-0.2%	(0.3)	-4%
Resident Heavy	1.9	2.1	2.2	2.5	2.0%	(0.1)	-4%
Visitor Light	1.1	1.0	0.8	0.6	-4.1%	(0.0)	-4%
Visitor Medium	0.6	0.5	0.4	0.4	-3.2%	(0.0)	-4%
Visitor Heavy	0.1	0.1	0.1	0.1	-1.1%	(0.0)	-4%
Freight Light	-	-	-	-	N/A	-	N/A
Freight Medium	-	-	-	-	N/A	-	N/A
Freight Heavy	-	-	-	-	N/A	-	N/A
Total	**27.6**	**28.0**	**26.2**	**25.3**	**-0.7%**	(1.0)	-4%

Average Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	23.5	24.2	26.6	30.3	2.0%	0.8	3%
Medium Gasoline	21.6	22.4	24.9	28.5	2.2%	0.7	3%
Heavy Gasoline	16.9	17.3	19.0	21.5	1.9%	0.9	4%
Heavy Diesel	16.9	17.3	18.8	21.3	1.8%	0.9	5%
Fleet	22.1	22.8	25.9	31.0	2.6%	2.4	8%

Proposed GHG Reduction Work Plans for Hawaii

Reference Projection vs. Work Plan 1: Oahu

Reference Case

Marginal Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	24.4	28.1	34.0	37.7	3.4%
Medium Gasoline	23.4	26.9	32.6	36.0	3.4%
Heavy Gasoline	17.4	19.4	22.3	24.6	2.7%
Heavy Diesel	17.2	19.2	21.8	24.0	2.6%
Fleet	23.1	26.9	32.2	35.8	3.4%

Average Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	57.3	56.4	55.1	53.3	-0.5%
Medium Gasoline	33.3	33.5	33.6	33.7	0.1%
Heavy Gasoline	9.4	10.1	11.3	12.9	2.5%

Marginal Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	55.7	52.5	49.9	49.9	-0.8%
Medium Gasoline	34.9	33.9	33.8	33.8	-0.3%
Heavy Gasoline	9.3	13.6	16.4	16.3	4.4%

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020
Renewables as % of Electric Sales	5%	17%	23%	23%	18.3%
Ethanol/Gasoline	0%	1%	6%	11%	10.6%
Biodiesel/Diesel	0%	0%	2%	3%	3.1%

Work Plan 1

Marginal Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	24.4	28.5	36.2	42.0	4.3%	4.4	12%
Medium Gasoline	23.4	27.3	34.6	40.2	4.3%	4.2	12%
Heavy Gasoline	17.4	19.8	23.9	27.7	3.7%	3.1	12%
Heavy Diesel	17.2	19.5	23.3	27.0	3.5%	3.0	12%
Fleet	23.1	27.3	35.8	42.6	4.8%	6.8	19%

Average Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	57.3	56.4	54.5	51.6	-0.8%	(1.7)	-3%
Medium Gasoline	33.3	33.5	33.6	33.7	0.1%	(0.0)	0%
Heavy Gasoline	9.4	10.1	11.9	14.7	3.5%	1.7	13%

Marginal Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	55.7	52.5	46.1	46.2	-1.4%	(3.7)	-7%
Medium Gasoline	34.9	33.9	33.7	33.7	-0.3%	(0.1)	0%
Heavy Gasoline	9.3	13.6	20.2	20.1	6.1%	3.8	23%

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020	Difference from Ref @ 2020	Difference from Ref @ 2020
Renewables as % of Electric Sales	5%	22%	37%	41%	36.6%	0.2	79%
Ethanol/Gasoline	0%	10%	15%	20%	19.6%	0.1	82%
Biodiesel/Diesel	0%	10%	15%	20%	20.0%	0.2	545%

Proposed GHG Reduction Work Plans for Hawaii

Reference Projection vs. Work Plan 1: Oahu

Reference Case

Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential					
Electricity	66.3	71.4	90.2	90.2	2.4%
Utility Gas	43.1	42.8	43.1	43.6	0.1%
Bottled Gas	60.0	62.6	68.5	69.2	1.1%
Commercial					
Electricity	55.0	59.2	79.5	79.5	2.9%
Utility Gas	28.1	27.8	28.0	28.6	0.1%
Oil	22.4	25.0	30.9	31.5	2.7%
Bottled Gas	25.0	27.6	33.5	34.1	2.4%
Industrial					
Electricity	51.7	55.6	76.5	76.5	3.1%
Utility Gas	28.1	27.8	28.0	28.6	0.1%
#6 Fuel	9.9	12.5	18.3	19.0	5.2%
Bottled Gas	-	-	-	-	N/A
#2 Fuel	22.4	25.0	30.9	31.5	2.7%
Transportation					
Gasoline	28.2	30.8	36.7	37.4	2.2%
LS Diesel	25.3	27.9	33.7	34.4	2.4%
Ethanol	28.1	25.7	27.9	27.8	-0.1%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%

Work Plan 1

Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential						-	N/A
Electricity	66.3	71.4	97.4	103.2	3.5%	13.1	14%
Utility Gas	43.1	42.8	43.1	43.6	0.1%	-	0%
Bottled Gas	60.0	62.6	68.5	69.2	1.1%	-	0%
						-	N/A
Commercial						-	N/A
Electricity	55.0	59.2	86.1	92.6	4.1%	13.1	16%
Utility Gas	28.1	27.8	28.0	28.6	0.1%	-	0%
Oil	22.4	25.0	30.9	31.5	2.7%	-	0%
Bottled Gas	25.0	27.6	33.5	34.1	2.4%	-	0%
Industrial						-	N/A
Electricity	51.7	55.6	83.1	89.6	4.3%	13.1	17%
Utility Gas	28.1	27.8	28.0	28.6	0.1%	-	0%
#6 Fuel	9.9	12.5	18.3	19.0	5.2%	-	0%
Bottled Gas	-	-	-	-	N/A	-	N/A
#2 Fuel	22.4	25.0	30.9	31.5	2.7%	-	0%
Transportation						-	N/A
Gasoline	28.2	30.8	36.7	37.4	2.2%	-	0%
LS Diesel	25.3	27.9	33.7	34.4	2.4%	-	0%
Ethanol	28.1	25.7	27.9	27.8	-0.1%	-	0%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%	-	0%

Reference Projection vs. Work Plan 1: Maui

Reference Case

GHG Emissions (kt)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	6.3	6.1	6.2	6.3	0.0%
Commercial	54.1	51.5	50.1	47.0	-1.1%
Industrial	436.4	433.3	415.9	394.7	-0.8%
Passenger - Residents	373.4	311.0	230.4	181.9	-5.4%
Passenger - Visitors	120.7	97.3	69.1	52.8	-6.2%
Marine	-	-	-	-	N/A
Aviation	-	-	-	-	N/A
Freight	196.5	182.2	150.3	138.2	-2.7%
Power Sector	858.1	800.0	808.3	721.2	-1.3%
Waste	124.5	149.3	190.7	232.2	4.9%
Agriculture & Forestry	(307.0)	(306.5)	(305.7)	(304.9)	-0.1%
Total	**1,863.2**	**1,724.2**	**1,615.3**	**1,469.4**	**-1.8%**

Total Primary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Biodiesel	-	0.0	0.0	0.0	N/A
Biomass	4.1	4.2	4.1	6.9	4.0%
Coal	1.8	2.0	1.9	1.8	0.1%
Electricity	4.3	3.9	4.1	4.2	-0.2%
Ethanol	0.1	0.1	0.3	0.5	14.3%
Gasoline	8.1	6.7	5.0	4.0	-5.3%
Geothermal	-	0.0	0.0	0.0	N/A
HS Diesel	-	-	-	-	N/A
HS Fuel Oil	0.6	-	-	-	-100.0%
Hydrogen	-	-	-	-	N/A
Jet Fuel	-	-	-	-	N/A
LPG	0.7	0.7	0.7	0.6	-0.4%
LS Diesel	1.3	1.2	1.1	1.0	-1.7%
LS Fuel Oil	11.1	10.9	11.0	9.5	-1.2%
Oil, Unspecified	1.0	1.0	0.9	0.9	-1.4%
Utility Gas	0.1	0.1	0.1	0.1	1.1%
Still Gas	-	-	-	-	N/A
Waste	-	-	-	-	N/A
Total	**33.0**	**30.8**	**29.2**	**29.5**	**-0.9%**

Work Plan 1

GHG Emissions (kt)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Abs. Change from Ref @ 2020	% Change from Ref @ 2020
Residential	6.3	6.1	6.1	7.0	0.8%	0.7	11%
Commercial	54.1	51.8	48.5	46.4	-1.2%	(0.6)	-1%
Industrial	436.4	433.5	416.2	395.2	-0.8%	0.4	0%
Passenger - Residents	373.4	286.4	209.4	159.1	-6.4%	(22.8)	-13%
Passenger - Visitors	120.7	89.4	61.2	44.0	-7.5%	(8.8)	-17%
Marine	-	-	-	-	N/A	-	N/A
Aviation	-	-	-	-	N/A	-	N/A
Freight	196.5	174.1	139.8	125.9	-3.4%	(12.3)	-9%
Power Sector	858.1	646.9	163.5	197.8	-10.7%	(523.4)	-73%
Waste	124.5	161.9	195.2	235.0	5.0%	2.9	1%
Agriculture & Forestry	(307.0)	(306.2)	(305.7)	(304.9)	-0.1%	-	0%
Total	**1,863.2**	**1,543.8**	**934.2**	**905.5**	**-5.4%**	(563.9)	-38%

Total Primary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Biodiesel	-	0.1	0.2	0.2	N/A	0.2	481%
Biomass	4.1	4.2	4.0	7.2	4.4%	0.3	5%
Coal	1.8	2.0	1.9	1.8	-0.1%	(0.1)	-3%
Electricity	4.3	3.7	3.1	2.8	-3.3%	(1.4)	-34%
Ethanol	0.1	0.7	0.8	0.9	19.2%	0.4	72%
Gasoline	8.1	6.2	4.4	3.4	-6.4%	(0.6)	-15%
Geothermal	-	0.0	0.0	0.0	N/A	0.0	625%
HS Diesel	-	-	-	-	N/A	-	N/A
HS Fuel Oil	0.6	-	-	-	-100.0%	-	N/A
Hydrogen	-	-	-	-	N/A	-	N/A
Jet Fuel	-	-	-	-	N/A	-	N/A
LPG	0.7	0.7	0.6	0.6	-0.4%	0.0	0%
LS Diesel	1.3	1.2	1.0	0.9	-2.9%	(0.2)	-15%
LS Fuel Oil	11.1	8.8	2.2	2.4	-11.1%	(7.1)	-75%
Oil, Unspecified	1.0	1.0	0.9	0.8	-1.6%	(0.0)	-3%
Utility Gas	0.1	0.1	0.1	0.1	1.0%	(0.0)	-1%
Still Gas	-	-	-	-	N/A	-	N/A
Waste	-	-	-	-	N/A	-	N/A
Total	**33.0**	**28.6**	**19.3**	**21.0**	**-3.4%**	(8.5)	-29%

Reference Projection vs. Work Plan 1: Maui

Reference Case

Total Secondary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	1.6	1.7	1.8	1.9	1.3%
Commercial	3.3	3.1	3.1	3.1	-0.4%
Industrial	7.1	7.1	6.9	6.6	-0.6%
Passenger - Residents	5.1	4.3	3.3	2.8	-4.6%
Passenger - Visitors	1.6	1.3	1.0	0.8	-5.4%
Marine	-	-	-	-	N/A
Aviation	-	-	-	-	N/A
Freight	2.7	2.5	2.1	2.0	-2.3%
Forestry & Agriculture	0.0	0.0	0.0	0.0	-6.1%
Total	**21.4**	**19.9**	**18.2**	**17.1**	**-1.7%**

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Personal Income	4,119	4,348	5,069	5,746	2.6%
Population (millions)	0	0	0	0	1.3%
Gross Regional Product (GRP)	6,723	7,289	7,719	8,420	1.7%

Generation Capacity (MW)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	264	266	312	315	1.4%
Coal Steam	-	-	-	-	N/A
Hydro	-	-	-	-	N/A
Biomass	-	-	0	25	N/A
Wind	30	33	44	44	2.9%
Other Renewable	-	0	0	1	N/A
Total	**294**	**299**	**356**	**384**	**2.1%**

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	1,199	1,141	1,157	1,012	-1.3%
Coal Steam	-	-	-	-	N/A
Hydro	-	-	-	-	N/A
Biomass	-	-	0	182	N/A
Wind	57	65	94	94	4.0%
Other Renewable	-	1	1	1	N/A
Purchases from industry	94	123	136	138	3.0%
Total	**1,350**	**1,329**	**1,388**	**1,428**	**0.4%**

Work Plan 1

Total Secondary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential	1.6	1.5	1.3	1.2	-2.5%	(0.7)	-39%
Commercial	3.3	3.1	2.7	2.4	-2.4%	(0.7)	-22%
Industrial	7.1	7.0	6.7	6.3	-0.9%	(0.3)	-4%
Passenger - Residents	5.1	4.3	3.3	2.6	-5.0%	(0.1)	-5%
Passenger - Visitors	1.6	1.3	1.0	0.7	-6.1%	(0.1)	-10%
Marine	-	-	-	-	N/A	-	N/A
Aviation	-	-	-	-	N/A	-	N/A
Freight	2.7	2.6	2.1	2.0	-2.2%	0.0	1%
Forestry & Agriculture	0.0	0.0	0.0	0.0	-6.0%	0.0	1%
Total	**21.4**	**19.8**	**17.0**	**15.2**	**-2.6%**	(1.9)	-11%

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Personal Income	4,119	4,348	5,069	5,746	2.6%	-	0%
Population (millions)	0	0	0	0	1.3%	-	0%
Gross Regional Product (GRP)	6,723	7,289	7,719	8,420	1.7%	-	0%

Generation Capacity (MW)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Gas/Oil	264	266	310	312	1.3%	(2.5)	-1%
Coal Steam	-	-	-	-	N/A	-	N/A
Hydro	-	-	-	-	N/A	-	N/A
Biomass	-	-	0	31	N/A	6.2	25%
Wind	30	72	483	483	23.8%	438.9	1006%
Other Renewable	-	2	2	12	N/A	11.5	1759%
Total	**294**	**340**	**795**	**838**	**8.4%**	454.2	118%

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Gas/Oil	1,199	940	264	282	-10.6%	(730.8)	-72%
Coal Steam	-	-	-	-	N/A	-	N/A
Hydro	-	-	-	-	N/A	-	N/A
Biomass	-	-	2	218	N/A	35.6	20%
Wind	57	192	1,272	1,272	27.0%	1,178.0	1252%
Other Renewable	-	8	8	83	N/A	81.6	7758%
Purchases from industry	94	120	121	117	1.7%	(21.4)	-15%
Total	**1,350**	**1,260**	**1,666**	**1,971**	**3.0%**	543.1	38%

Proposed GHG Reduction Work Plans for Hawaii

Reference Projection vs. Work Plan 1: Maui

Reference Case

Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	449	465	500	541	1.4%
Commercial	716	685	697	695	-0.2%
Industrial	132	125	136	138	0.3%
Transportation	-	-	-	-	N/A
Military	1	1	1	1	0.9%
Total	**1,298**	**1,276**	**1,334**	**1,375**	**0.4%**

Distance Travelled (millions of vehicle miles travelled)					
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Passenger - Residents	1,240	1,121	1,007	945	-2.1%
Passenger - Visitors	426	375	337	304	-2.6%

Vehicle Energy Consumption (TBtu)					
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Resident Light	3.1	2.6	2.2	1.9	-3.5%
Resident Medium	1.6	1.4	1.2	1.2	-2.6%
Resident Heavy	0.4	0.3	0.3	0.4	-0.5%
Visitor Light	1.0	0.8	0.7	0.6	-4.3%
Visitor Medium	0.5	0.5	0.4	0.3	-3.4%
Visitor Heavy	0.1	0.1	0.1	0.1	-1.3%
Freight Light	-	-	-	-	N/A
Freight Medium	-	-	-	-	N/A
Freight Heavy	-	-	-	-	N/A
Total	**6.7**	**5.8**	**4.9**	**4.4**	**-3.2%**

Average Vehicle Efficiency (miles/gallon)					
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	23.3	23.9	26.1	28.9	1.7%
Medium Gasoline	21.1	21.9	24.2	27.1	1.9%
Heavy Gasoline	16.8	17.2	18.7	20.5	1.5%
Heavy Diesel	16.9	17.2	18.5	20.3	1.4%
Fleet	21.8	22.4	25.0	28.4	2.1%

Work Plan 1

Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential	449	425	359	319	-2.6%	(221.9)	-41%
Commercial	716	666	569	495	-2.8%	(200.0)	-29%
Industrial	132	120	121	117	-0.9%	(21.4)	-15%
Transportation	-	-	3	6	N/A	5.8	N/A
Military	1	1	1	1	0.9%	-	0%
Total	**1,298**	**1,211**	**1,054**	**938**	**-2.5%**	(437.5)	-32%

Distance Travelled (millions of vehicle miles travelled)							
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Passenger - Residents	1,240	1,124	1,011	946	-2.1%	0.8	0%
Passenger - Visitors	426	375	336	302	-2.6%	(2.5)	-1%

Vehicle Energy Consumption (TBtu)							
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Resident Light	3.1	2.6	2.1	1.8	-3.9%	(0.1)	-5%
Resident Medium	1.6	1.4	1.2	1.1	-3.0%	(0.1)	-5%
Resident Heavy	0.4	0.3	0.3	0.3	-0.9%	(0.0)	-5%
Visitor Light	1.0	0.8	0.6	0.5	-5.0%	(0.1)	-10%
Visitor Medium	0.5	0.5	0.4	0.3	-4.2%	(0.0)	-10%
Visitor Heavy	0.1	0.1	0.1	0.1	-2.1%	(0.0)	-10%
Freight Light	-	-	-	-	N/A	-	N/A
Freight Medium	-	-	-	-	N/A	-	N/A
Freight Heavy	-	-	-	-	N/A	-	N/A
Total	**6.7**	**5.8**	**4.8**	**4.2**	**-3.6%**	(0.3)	-6%

Average Vehicle Efficiency (miles/gallon)							
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	23.3	23.9	26.3	29.8	1.9%	0.9	3%
Medium Gasoline	21.1	21.9	24.5	27.9	2.2%	0.8	3%
Heavy Gasoline	16.8	17.2	19.0	21.5	1.9%	1.0	5%
Heavy Diesel	16.9	17.2	18.9	21.3	1.8%	1.0	5%
Fleet	21.8	22.4	25.7	30.4	2.6%	2.1	7%

Reference Projection vs. Work Plan 1: Maui

Reference Case

Marginal Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	24.4	28.1	34.0	37.7	3.4%
Medium Gasoline	23.4	26.9	32.6	36.0	3.4%
Heavy Gasoline	17.4	19.4	22.3	24.6	2.7%
Heavy Diesel	17.2	19.2	21.8	24.0	2.6%
Fleet	23.0	26.6	32.2	35.8	3.5%

Average Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	56.8	55.9	53.4	50.8	-0.9%
Medium Gasoline	32.9	33.0	33.1	33.1	0.1%
Heavy Gasoline	10.3	11.1	13.5	16.1	3.5%

Marginal Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	56.5	52.1	46.3	46.5	-1.5%
Medium Gasoline	34.4	33.2	33.2	33.2	-0.3%
Heavy Gasoline	9.1	14.8	20.5	20.4	6.4%

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020
Renewables as % of Electric Sales	4%	5%	7%	20%	15.8%
Ethanol/Gasoline	1%	1%	6%	11%	9.9%
Biodiesel/Diesel	0%	1%	2%	4%	3.5%

Work Plan 1

Marginal Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	24.4	28.5	36.2	42.0	4.3%	4.4	12%
Medium Gasoline	23.4	27.3	34.6	40.2	4.3%	4.2	12%
Heavy Gasoline	17.4	19.8	23.9	27.7	3.7%	3.1	12%
Heavy Diesel	17.2	19.5	23.3	27.0	3.5%	3.0	12%
Fleet	23.0	26.9	35.9	42.2	4.8%	6.4	18%

Average Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	56.8	55.9	53.1	50.2	-0.9%	(0.6)	-1%
Medium Gasoline	32.9	33.0	33.1	33.1	0.1%	(0.0)	0%
Heavy Gasoline	10.3	11.1	13.9	16.6	3.8%	0.6	4%

Marginal Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	56.5	52.1	45.4	45.6	-1.6%	(0.8)	-2%
Medium Gasoline	34.4	33.1	33.2	33.2	-0.3%	(0.0)	0%
Heavy Gasoline	9.1	14.8	21.4	21.2	6.7%	0.8	4%

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020	Difference from Ref @ 2020	Difference from Ref @ 2020
Renewables as % of Electric Sales	4%	16%	122%	168%	163.4%	1.5	731%
Ethanol/Gasoline	1%	10%	15%	20%	18.9%	0.1	82%
Biodiesel/Diesel	0%	10%	15%	20%	20.0%	0.2	467%

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Reference Projection vs. Work Plan 1: Maui

Reference Case

Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential					
Electricity	102.4	110.3	122.2	121.4	1.3%
Utility Gas	41.3	41.0	41.3	41.9	0.1%
Bottled Gas	60.0	62.6	68.5	69.2	1.1%
Commercial					
Electricity	99.8	107.5	119.9	119.1	1.4%
Utility Gas	24.8	24.5	24.8	25.4	0.2%
Oil	22.4	25.0	30.9	31.5	2.7%
Bottled Gas	25.0	27.6	33.5	34.1	2.4%
Industrial					
Electricity	82.2	88.5	103.4	102.6	1.7%
Utility Gas	24.8	24.5	24.8	25.4	0.2%
#6 Fuel	9.9	12.5	18.3	19.0	5.2%
Bottled Gas	-	-	-	-	N/A
#2 Fuel	22.4	25.0	30.9	31.5	2.7%
Transportation					
Gasoline	28.2	30.8	36.7	37.4	2.2%
LS Diesel	25.3	27.9	33.7	34.4	2.4%
Ethanol	28.1	25.7	27.9	27.8	-0.1%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%

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Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential						-	N/A
Electricity	102.4	110.3	197.0	208.8	5.6%	87.3	72%
Utility Gas	41.3	41.0	41.3	41.9	0.1%	-	0%
Bottled Gas	60.0	62.6	68.5	69.2	1.1%	-	0%
						-	N/A
Commercial						-	N/A
Electricity	99.8	107.5	194.4	206.5	5.7%	87.3	73%
Utility Gas	24.8	24.5	24.8	25.4	0.2%	-	0%
Oil	22.4	25.0	30.9	31.5	2.7%	-	0%
Bottled Gas	25.0	27.6	33.5	34.1	2.4%	-	0%
Industrial						-	N/A
Electricity	82.2	88.5	177.4	189.9	6.7%	87.4	85%
Utility Gas	24.8	24.5	24.8	25.4	0.2%	-	0%
#6 Fuel	9.9	12.5	18.3	19.0	5.2%	-	0%
Bottled Gas	-	-	-	-	N/A	-	N/A
#2 Fuel	22.4	25.0	30.9	31.5	2.7%	-	0%
Transportation						-	N/A
Gasoline	28.2	30.8	36.7	37.4	2.2%	-	0%
LS Diesel	25.3	27.9	33.7	34.4	2.4%	-	0%
Ethanol	28.1	25.7	27.9	27.8	-0.1%	-	0%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%	-	0%

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Reference Projection vs. Work Plan 1: Hawaii

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GHG Emissions (kt)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	12.4	11.1	12.3	13.6	0.7%
Commercial	51.0	48.7	49.0	48.9	-0.3%
Industrial	30.0	32.9	39.8	44.2	3.0%
Passenger - Residents	435.4	375.1	291.4	240.5	-4.5%
Passenger - Visitors	132.4	108.0	79.7	64.3	-5.4%
Marine	-	-	-	-	N/A
Aviation	-	-	-	-	N/A
Freight	300.2	267.2	226.3	221.3	-2.3%
Power Sector	669.9	532.1	574.1	612.6	-0.7%
Waste	130.1	149.0	180.5	211.9	3.8%
Agriculture & Forestry	(1,406.3)	(1,405.6)	(1,404.3)	(1,403.0)	0.0%
Total	**355.2**	**118.5**	**48.9**	**54.3**	**-13.4%**

Total Primary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Biodiesel	-	0.0	0.0	0.1	N/A
Biomass	-	-	-	-	N/A
Coal	-	-	-	-	N/A
Electricity	4.0	3.9	4.1	4.4	0.8%
Ethanol	-	0.1	0.4	0.7	N/A
Gasoline	9.9	8.4	6.5	5.6	-4.3%
Geothermal	2.2	2.2	2.2	2.2	0.0%
HS Diesel	-	-	-	-	N/A
HS Fuel Oil	4.1	0.9	1.0	1.2	-9.3%
Hydrogen	-	-	-	-	N/A
Jet Fuel	-	-	-	-	N/A
LPG	0.7	0.6	0.7	0.7	0.3%
LS Diesel	1.8	1.8	1.6	1.5	-1.5%
LS Fuel Oil	4.7	6.3	6.7	7.1	3.3%
Oil, Unspecified	1.1	1.0	1.1	1.1	0.4%
Utility Gas	0.2	0.2	0.2	0.2	1.1%
Still Gas	-	-	-	-	N/A
Waste	-	-	-	-	N/A
Total	**28.6**	**25.4**	**24.5**	**24.8**	**-1.1%**

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GHG Emissions (kt)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Abs. Change from Ref @ 2020	% Change from Ref @ 2020
Residential	12.4	10.8	11.7	12.4	0.0%	(1.2)	-9%
Commercial	51.0	48.4	48.3	47.6	-0.5%	(1.4)	-3%
Industrial	30.0	33.2	47.6	52.9	4.4%	8.7	20%
Passenger - Residents	435.4	344.4	263.4	209.2	-5.5%	(31.3)	-13%
Passenger - Visitors	132.4	99.0	70.8	54.3	-6.6%	(10.0)	-16%
Marine	-	-	-	-	N/A	-	N/A
Aviation	-	-	-	-	N/A	-	N/A
Freight	300.2	244.0	208.5	198.9	-3.1%	(22.5)	-10%
Power Sector	669.9	388.6	219.1	134.0	-11.6%	(478.6)	-78%
Waste	130.1	149.6	182.6	211.0	3.8%	(1.0)	0%
Agriculture & Forestry	(1,406.3)	(1,405.6)	(1,402.2)	(1,401.1)	0.0%	2.0	0%
Total	**355.2**	**(87.5)**	**(350.2)**	**(480.9)**	**-202.4%**	(535.3)	-985%

Total Primary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Biodiesel	-	0.2	0.2	0.3	N/A	0.3	428%
Biomass	-	-	2.2	2.2	N/A	2.2	N/A
Coal	-	-	-	-	N/A	-	N/A
Electricity	4.0	3.6	3.1	2.8	-2.8%	(1.6)	-37%
Ethanol	-	0.8	1.0	1.2	N/A	0.5	73%
Gasoline	9.9	7.6	5.8	4.8	-5.4%	(0.8)	-14%
Geothermal	2.2	2.8	2.8	2.8	1.8%	0.6	27%
HS Diesel	-	-	-	-	N/A	-	N/A
HS Fuel Oil	4.1	0.1	-	-	-100.0%	(1.2)	-100%
Hydrogen	-	-	-	-	N/A	-	N/A
Jet Fuel	-	-	-	-	N/A	-	N/A
LPG	0.7	0.6	0.6	0.7	0.1%	(0.0)	-3%
LS Diesel	1.8	1.6	1.4	1.2	-2.9%	(0.3)	-17%
LS Fuel Oil	4.7	5.1	3.0	1.8	-7.0%	(5.3)	-74%
Oil, Unspecified	1.1	1.0	1.2	1.2	1.2%	0.1	10%
Utility Gas	0.2	0.2	0.2	0.2	0.4%	(0.0)	-9%
Still Gas	-	-	-	-	N/A	-	N/A
Waste	-	-	-	-	N/A	-	N/A
Total	**28.6**	**23.8**	**21.6**	**19.3**	**-3.0%**	(5.5)	-22%

Proposed GHG Reduction Work Plans for Hawaii

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Total Secondary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	1.7	1.7	1.9	2.0	1.3%
Commercial	2.8	2.7	2.8	2.9	0.3%
Industrial	1.4	1.4	1.4	1.5	0.6%
Passenger - Residents	5.9	5.2	4.2	3.6	-3.7%
Passenger - Visitors	1.8	1.5	1.2	1.0	-4.6%
Marine	-	-	-	-	N/A
Aviation	-	-	-	-	N/A
Freight	4.0	3.6	3.2	3.2	-1.7%
Forestry & Agriculture	0.0	0.0	0.0	0.0	-5.0%
Total	**17.6**	**16.0**	**14.6**	**14.3**	**-1.6%**

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Personal Income	5,570	5,996	6,560	7,625	2.4%
Population (millions)	0	0	0	0	2.0%
Gross Regional Product (GRP)	4,215	4,406	5,167	5,946	2.7%

Generation Capacity (MW)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	236	297	297	297	1.8%
Coal Steam	-	-	-	-	N/A
Hydro	4	4	4	4	0.0%
Biomass	-	-	0	0	N/A
Wind	34	37	41	55	3.9%
Other Renewable	31	31	31	31	0.0%
Total	**305**	**368**	**373**	**387**	**1.8%**

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	892	855	914	965	0.6%
Coal Steam	-	-	-	-	N/A
Hydro	21	21	21	21	0.0%
Biomass	-	-	0	0	N/A
Wind	80	88	100	139	4.3%
Other Renewable	212	213	213	213	0.0%
Purchases from industry	-	-	-	-	N/A
Total	**1,205**	**1,178**	**1,249**	**1,339**	**0.8%**

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Total Secondary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential	1.7	1.5	1.4	1.3	-2.0%	(0.7)	-35%
Commercial	2.8	2.5	2.2	2.0	-2.6%	(0.9)	-31%
Industrial	1.4	1.3	1.5	1.5	0.8%	0.0	2%
Passenger - Residents	5.9	5.2	4.1	3.5	-4.0%	(0.2)	-5%
Passenger - Visitors	1.8	1.5	1.1	0.9	-5.2%	(0.1)	-8%
Marine	-	-	-	-	N/A	-	N/A
Aviation	-	-	-	-	N/A	-	N/A
Freight	4.0	3.6	3.2	3.2	-1.7%	(0.0)	0%
Forestry & Agriculture	0.0	0.0	0.0	0.0	-5.0%	-	0%
Total	**17.6**	**15.7**	**13.6**	**12.4**	**-2.7%**	(1.9)	-13%

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Personal Income	5,570	5,996	6,560	7,625	2.4%	-	0%
Population (millions)	0	0	0	0	2.0%	-	0%
Gross Regional Product (GRP)	4,215	4,406	5,167	5,946	2.7%	-	0%

Generation Capacity (MW)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Gas/Oil	236	297	282	282	1.4%	(14.1)	-5%
Coal Steam	-	-	-	-	N/A	-	N/A
Hydro	4	4	4	4	0.0%	-	0%
Biomass	-	-	25	25	N/A	25.2	75661%
Wind	34	54	54	68	5.6%	13.0	24%
Other Renewable	31	40	40	40	1.9%	8.8	28%
Total	**305**	**395**	**406**	**420**	**2.5%**	32.9	9%

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Gas/Oil	892	649	369	226	-10.0%	(739.6)	-77%
Coal Steam	-	-	-	-	N/A	-	N/A
Hydro	21	21	21	21	0.0%	-	0%
Biomass	-	-	144	144	N/A	143.9	54700%
Wind	80	145	145	182	6.5%	42.7	31%
Other Renewable	212	272	272	272	1.9%	59.1	28%
Purchases from industry	-	-	-	-	N/A	-	N/A
Total	**1,205**	**1,087**	**951**	**845**	**-2.7%**	(493.8)	-37%

Reference Projection vs. Work Plan 1: Hawaii

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Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	450	455	490	539	1.4%
Commercial	557	535	568	610	0.7%
Industrial	162	152	151	151	-0.6%
Transportation	-	-	-	-	N/A
Military	4	4	4	5	1.2%
Total	**1,173**	**1,146**	**1,213**	**1,304**	**0.8%**

Distance Travelled (millions of vehicle miles travelled)					
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Passenger - Residents	1,468	1,360	1,259	1,228	-1.4%
Passenger - Visitors	470	411	374	352	-2.2%

Vehicle Energy Consumption (TBtu)					
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Resident Light	3.6	3.2	2.7	2.6	-2.6%
Resident Medium	1.9	1.7	1.6	1.5	-1.7%
Resident Heavy	0.4	0.4	0.4	0.5	0.5%
Visitor Light	1.1	0.9	0.8	0.7	-3.5%
Visitor Medium	0.6	0.5	0.4	0.4	-2.6%
Visitor Heavy	0.1	0.1	0.1	0.1	-0.5%
Freight Light	-	-	-	-	N/A
Freight Medium	-	-	-	-	N/A
Freight Heavy	-	-	-	-	N/A
Total	**7.7**	**6.9**	**6.0**	**5.8**	**-2.2%**

Average Vehicle Efficiency (miles/gallon)					
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	23.3	23.9	26.3	29.3	1.8%
Medium Gasoline	21.2	22.0	24.5	27.5	2.0%
Heavy Gasoline	16.9	17.2	18.8	20.7	1.6%
Heavy Diesel	16.8	17.2	18.6	20.3	1.5%
Fleet	21.8	22.5	25.1	28.4	2.1%

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Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential	450	402	362	331	-2.3%	(207.9)	-39%
Commercial	557	504	421	352	-3.5%	(258.1)	-42%
Industrial	162	144	135	127	-1.9%	(24.1)	-16%
Transportation	-	-	4	8	N/A	7.8	N/A
Military	4	4	4	5	1.2%	-	0%
Total	**1,173**	**1,054**	**926**	**822**	**-2.7%**	(482.4)	-37%

Distance Travelled (millions of vehicle miles travelled)							
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Passenger - Residents	1,468	1,361	1,262	1,228	-1.4%	0.6	0%
Passenger - Visitors	470	411	375	354	-2.2%	1.8	1%

Vehicle Energy Consumption (TBtu)							
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Resident Light	3.6	3.2	2.7	2.4	-3.0%	(0.1)	-5%
Resident Medium	1.9	1.7	1.5	1.5	-2.1%	(0.1)	-5%
Resident Heavy	0.4	0.4	0.4	0.4	0.1%	(0.0)	-5%
Visitor Light	1.1	0.9	0.7	0.6	-4.1%	(0.1)	-8%
Visitor Medium	0.6	0.5	0.4	0.4	-3.2%	(0.0)	-8%
Visitor Heavy	0.1	0.1	0.1	0.1	-1.1%	(0.0)	-8%
Freight Light	-	-	-	-	N/A	-	N/A
Freight Medium	-	-	-	-	N/A	-	N/A
Freight Heavy	-	-	-	-	N/A	-	N/A
Total	**7.7**	**6.9**	**5.9**	**5.4**	**-2.7%**	(0.3)	-6%

Average Vehicle Efficiency (miles/gallon)							
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	23.3	24.0	26.6	30.2	2.0%	1.0	3%
Medium Gasoline	21.2	22.1	24.8	28.4	2.3%	0.9	3%
Heavy Gasoline	16.9	17.3	19.1	21.7	2.0%	1.0	5%
Heavy Diesel	16.8	17.2	18.9	21.4	1.9%	1.0	5%
Fleet	21.8	22.5	25.8	30.6	2.6%	2.2	8%

Reference Projection vs. Work Plan 1: Hawaii

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Marginal Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	24.4	28.1	34.0	37.7	3.4%
Medium Gasoline	23.4	26.9	32.6	36.0	3.4%
Heavy Gasoline	17.4	19.4	22.3	24.6	2.7%
Heavy Diesel	17.2	19.2	21.8	24.0	2.6%
Fleet	23.1	26.3	32.1	35.6	3.4%

Average Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	56.6	56.1	54.0	51.7	-0.7%
Medium Gasoline	33.2	33.3	33.5	33.6	0.1%
Heavy Gasoline	10.2	10.6	12.5	14.7	2.8%

Marginal Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	56.0	54.2	47.8	47.9	-1.2%
Medium Gasoline	34.6	33.8	33.7	33.6	-0.2%
Heavy Gasoline	9.3	12.0	18.6	18.5	5.4%

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020
Renewables as % of Electric Sales	27%	28%	28%	29%	1.9%
Ethanol/Gasoline	0%	1%	6%	11%	11.0%
Biodiesel/Diesel	0%	1%	2%	4%	3.8%

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Marginal Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	24.4	28.5	36.2	42.0	4.3%	4.4	12%
Medium Gasoline	23.4	27.3	34.6	40.2	4.3%	4.2	12%
Heavy Gasoline	17.4	19.8	23.9	27.7	3.7%	3.1	12%
Heavy Diesel	17.2	19.5	23.3	27.0	3.5%	3.0	12%
Fleet	23.1	26.7	35.6	41.8	4.7%	6.2	18%

Average Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	56.6	56.1	53.5	50.9	-0.8%	(0.8)	-2%
Medium Gasoline	33.2	33.3	33.5	33.6	0.1%	(0.0)	0%
Heavy Gasoline	10.2	10.6	13.0	15.5	3.2%	0.8	6%

Marginal Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	56.0	54.2	46.5	46.7	-1.4%	(1.2)	-3%
Medium Gasoline	34.6	33.8	33.6	33.6	-0.2%	(0.0)	0%
Heavy Gasoline	9.3	12.0	19.9	19.7	5.9%	1.2	7%

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020	Difference from Ref @ 2020	Difference from Ref @ 2020
Renewables as % of Electric Sales	27%	42%	63%	75%	48.6%	0.5	163%
Ethanol/Gasoline	0%	10%	15%	20%	20.0%	0.1	82%
Biodiesel/Diesel	0%	10%	15%	20%	20.0%	0.2	429%

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Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential					
Electricity	106.0	114.1	118.2	116.0	0.7%
Utility Gas	48.1	47.8	48.1	48.7	0.1%
Bottled Gas	60.0	62.6	68.5	69.2	1.1%
Commercial					
Electricity	96.7	104.1	109.9	107.6	0.8%
Utility Gas	24.8	24.5	24.8	25.4	0.2%
Oil	22.4	25.0	30.9	31.5	2.7%
Bottled Gas	25.0	27.6	33.5	34.1	2.4%
Industrial					
Electricity	84.7	91.2	98.5	96.2	1.0%
Utility Gas	24.8	24.5	24.8	25.4	0.2%
#6 Fuel	9.9	12.5	18.3	19.0	5.2%
Bottled Gas	-	27.6	33.5	34.1	N/A
#2 Fuel	22.4	25.0	30.9	31.5	2.7%
Transportation					
Gasoline	28.2	30.8	36.7	37.4	2.2%
LS Diesel	25.3	27.9	33.7	34.4	2.4%
Ethanol	28.1	25.7	27.9	27.8	-0.1%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%

Work Plan 1

Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential						-	N/A
Electricity	106.0	114.1	131.3	131.5	1.7%	15.5	13%
Utility Gas	48.1	47.8	48.1	48.7	0.1%	-	0%
Bottled Gas	60.0	62.6	68.5	69.2	1.1%	-	0%
						-	N/A
Commercial						-	N/A
Electricity	96.7	104.1	122.5	124.5	2.0%	16.9	16%
Utility Gas	24.8	24.5	24.8	25.4	0.2%	-	0%
Oil	22.4	25.0	30.9	31.5	2.7%	-	0%
Bottled Gas	25.0	27.6	33.5	34.1	2.4%	-	0%
Industrial						-	N/A
Electricity	84.7	91.2	111.1	111.8	2.2%	15.6	16%
Utility Gas	24.8	24.5	24.8	25.4	0.2%	-	0%
#6 Fuel	9.9	12.5	18.3	19.0	5.2%	-	0%
Bottled Gas	-	27.6	33.5	34.1	N/A	-	0%
#2 Fuel	22.4	25.0	30.9	31.5	2.7%	-	0%
Transportation						-	N/A
Gasoline	28.2	30.8	36.7	37.4	2.2%	-	0%
LS Diesel	25.3	27.9	33.7	34.4	2.4%	-	0%
Ethanol	28.1	25.7	27.9	27.8	-0.1%	-	0%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%	-	0%

Proposed GHG Reduction Work Plans for Hawaii

Reference Projection vs. Work Plan 1: Kauai

Reference Case

GHG Emissions (kt)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	5.0	4.6	4.3	4.0	-1.6%
Commercial	19.4	18.8	18.5	18.2	-0.5%
Industrial	54.7	55.6	56.6	57.3	0.4%
Passenger - Residents	218.5	186.8	140.1	109.0	-5.2%
Passenger - Visitors	66.3	55.3	39.6	29.9	-5.9%
Marine	-	-	-	-	N/A
Aviation	-	-	-	-	N/A
Freight	88.6	78.4	64.1	59.1	-3.1%
Power Sector	264.1	255.8	94.8	131.8	-5.2%
Waste	63.0	70.0	81.7	93.4	3.1%
Agriculture & Forestry	(236.9)	(235.2)	(232.4)	(229.6)	-0.2%
Total	**542.7**	**490.1**	**267.4**	**273.2**	**-5.1%**

Total Primary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Biodiesel	-	0.0	0.0	0.0	N/A
Biomass	0.7	0.8	3.0	3.1	11.7%
Coal	-	-	-	-	N/A
Electricity	1.4	1.3	1.4	1.5	0.1%
Ethanol	-	0.1	0.2	0.3	N/A
Gasoline	4.4	3.8	2.8	2.3	-4.9%
Geothermal	-	0.0	0.0	0.0	N/A
HS Diesel	-	-	-	-	N/A
HS Fuel Oil	-	-	-	-	N/A
Hydrogen	-	-	-	-	N/A
Jet Fuel	-	-	-	-	N/A
LPG	0.4	0.4	0.3	0.3	-0.6%
LS Diesel	0.7	0.6	0.5	0.4	-4.0%
LS Fuel Oil	3.6	3.5	0.9	0.7	-12.2%
Oil, Unspecified	0.2	0.2	0.1	0.1	-3.7%
Utility Gas	0.0	0.0	0.0	0.0	-0.2%
Still Gas	-	-	-	-	N/A
Waste	-	-	0.1	1.1	N/A
Total	**11.4**	**10.5**	**9.5**	**9.7**	**-1.2%**

Work Plan 1

GHG Emissions (kt)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Abs. Change from Ref @ 2020	% Change from Ref @ 2020
Residential	5.0	4.5	4.2	3.8	-2.1%	(0.2)	-6%
Commercial	19.4	18.7	18.1	17.7	-0.7%	(0.5)	-3%
Industrial	54.7	55.6	56.6	57.3	0.4%	(0.0)	0%
Passenger - Residents	218.5	170.6	125.4	93.5	-6.3%	(15.5)	-14%
Passenger - Visitors	66.3	50.5	34.8	24.8	-7.3%	(5.1)	-17%
Marine	-	-	-	-	N/A	-	N/A
Aviation	-	-	-	-	N/A	-	N/A
Freight	88.6	71.3	58.7	53.5	-3.8%	(5.7)	-10%
Power Sector	264.1	192.2	37.8	74.8	-9.2%	(57.0)	-43%
Waste	63.0	69.9	82.0	93.5	3.1%	0.0	0%
Agriculture & Forestry	(236.9)	(235.2)	(232.4)	(229.6)	-0.2%	-	0%
Total	**542.7**	**398.2**	**185.3**	**189.3**	**-7.8%**	(84.0)	-31%

Total Primary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Biodiesel	-	0.1	0.1	0.1	N/A	0.1	385%
Biomass	0.7	0.8	2.5	1.8	7.2%	(1.3)	-41%
Coal	-	-	-	-	N/A	-	N/A
Electricity	1.4	1.2	1.1	1.1	-2.2%	(0.4)	-26%
Ethanol	-	0.4	0.4	0.5	N/A	0.2	72%
Gasoline	4.4	3.4	2.5	1.9	-6.1%	(0.3)	-15%
Geothermal	-	0.0	0.0	0.0	N/A	0.0	625%
HS Diesel	-	-	-	-	N/A	-	N/A
HS Fuel Oil	-	-	-	-	N/A	-	N/A
Hydrogen	-	-	-	-	N/A	-	N/A
Jet Fuel	-	-	-	-	N/A	-	N/A
LPG	0.4	0.4	0.3	0.3	-0.9%	(0.0)	-3%
LS Diesel	0.7	0.5	0.4	0.3	-5.4%	(0.1)	-17%
LS Fuel Oil	3.6	2.6	0.2	0.0	-31.7%	(0.6)	-96%
Oil, Unspecified	0.2	0.2	0.1	0.1	-3.7%	(0.0)	0%
Utility Gas	0.0	0.0	0.0	0.0	-1.2%	(0.0)	-12%
Still Gas	-	-	-	-	N/A	-	N/A
Waste	-	-	0.1	1.1	N/A	-	0%
Total	**11.4**	**9.6**	**7.9**	**7.3**	**-3.3%**	(2.4)	-25%

Reference Projection vs. Work Plan 1: Kauai

Reference Case

Total Secondary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	0.5	0.5	0.5	0.6	1.5%
Commercial	1.4	1.3	1.3	1.3	-0.4%
Industrial	0.9	0.8	0.9	0.9	0.0%
Passenger - Residents	3.0	2.6	2.0	1.7	-4.4%
Passenger - Visitors	0.9	0.8	0.6	0.5	-5.1%
Marine	-	-	-	-	N/A
Aviation	-	-	-	-	N/A
Freight	1.2	1.1	0.9	0.9	-2.4%
Forestry & Agriculture	0.0	0.0	0.0	0.0	-5.8%
Total	**7.8**	**7.0**	**6.2**	**5.7**	**-2.3%**

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Personal Income	1,529	1,716	1,898	2,196	2.8%
Population (millions)	0	0	0	0	1.0%
Gross Regional Product (GRP)	2,618	2,692	2,949	3,222	1.6%

Generation Capacity (MW)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	122	122	139	139	1.0%
Coal Steam	-	-	-	-	N/A
Hydro	5	5	26	26	13.1%
Biomass	-	-	22	29	N/A
Wind	-	4	14	14	N/A
Other Renewable	-	0	0	0	N/A
Total	**127**	**131**	**201**	**208**	**3.9%**

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	404	392	110	78	-11.9%
Coal Steam	-	-	-	-	N/A
Hydro	39	39	148	148	10.8%
Biomass	-	-	158	211	N/A
Wind	-	10	39	39	N/A
Other Renewable	-	0	0	0	N/A
Purchases from industry	4	-	3	5	1.7%
Total	**447**	**442**	**458**	**481**	**0.6%**

Work Plan 1

Total Secondary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential	0.5	0.5	0.4	0.5	-0.4%	(0.1)	-22%
Commercial	1.4	1.2	1.1	1.0	-2.3%	(0.3)	-21%
Industrial	0.9	0.8	0.9	0.9	-0.1%	(0.0)	0%
Passenger - Residents	3.0	2.6	2.0	1.6	-4.8%	(0.1)	-6%
Passenger - Visitors	0.9	0.8	0.6	0.4	-5.8%	(0.0)	-9%
Marine	-	-	-	-	N/A	-	N/A
Aviation	-	-	-	-	N/A	-	N/A
Freight	1.2	1.1	0.9	0.9	-2.3%	0.0	0%
Forestry & Agriculture	0.0	0.0	0.0	0.0	-5.8%	-	0%
Total	**7.8**	**6.9**	**5.8**	**5.2**	**-3.1%**	(0.5)	-9%

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Personal Income	1,529	1,716	1,898	2,196	2.8%	-	0%
Population (millions)	0	0	0	0	1.0%	-	0%
Gross Regional Product (GRP)	2,618	2,692	2,949	3,222	1.6%	-	0%

Generation Capacity (MW)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Gas/Oil	122	122	139	139	1.0%	-	0%
Coal Steam	-	-	-	-	N/A	-	N/A
Hydro	5	5	26	26	13.1%	-	0%
Biomass	-	-	22	29	N/A	0.2	1%
Wind	-	26	26	26	N/A	11.6	81%
Other Renewable	-	0	0	0	N/A	0.3	586%
Total	**127**	**153**	**213**	**221**	**4.3%**	12.1	6%

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Gas/Oil	404	299	26	3	-31.5%	(74.8)	-96%
Coal Steam	-	-	-	-	N/A	-	N/A
Hydro	39	39	148	148	10.8%	-	0%
Biomass	-	-	125	131	N/A	(79.9)	-38%
Wind	-	71	71	71	N/A	32.1	82%
Other Renewable	-	2	2	2	N/A	1.8	700%
Purchases from industry	4	0	4	6	3.4%	1.2	24%
Total	**447**	**412**	**377**	**362**	**-1.6%**	(119.5)	-25%

Reference Projection vs. Work Plan 1: Kauai

Reference Case

Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	120	125	139	155	2.0%
Commercial	283	269	274	275	-0.2%
Industrial	1	2	3	5	14.6%
Transportation	-	-	-	-	N/A
Military	16	17	18	18	1.0%
Total	**420**	**414**	**433**	**453**	**0.6%**

Distance Travelled (millions of vehicle miles travelled)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Passenger - Residents	545	490	433	402	-2.3%
Passenger - Visitors	170	152	138	127	-2.2%

Vehicle Energy Consumption (TBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Resident Light	1.8	1.6	1.3	1.2	-3.3%
Resident Medium	1.0	0.9	0.8	0.7	-2.4%
Resident Heavy	0.2	0.2	0.2	0.2	-0.3%
Visitor Light	0.5	0.5	0.4	0.3	-4.0%
Visitor Medium	0.3	0.3	0.2	0.2	-3.1%
Visitor Heavy	0.1	0.1	0.1	0.1	-1.0%
Freight Light	-	-	-	-	N/A
Freight Medium	-	-	-	-	N/A
Freight Heavy	-	-	-	-	N/A
Total	**3.9**	**3.4**	**2.9**	**2.6**	**-2.9%**

Average Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	23.3	23.9	26.1	28.9	1.7%
Medium Gasoline	21.3	22.0	24.3	27.1	1.9%
Heavy Gasoline	16.9	17.2	18.7	20.5	1.5%
Heavy Diesel	16.9	17.2	18.8	20.6	1.5%
Fleet	21.9	22.5	24.9	28.1	1.9%

Work Plan 1

Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential	120	112	110	118	-0.1%	(36.7)	-24%
Commercial	283	253	221	197	-2.7%	(77.5)	-28%
Industrial	1	2	4	6	16.6%	1.2	24%
Transportation	-	-	1	3	N/A	2.6	N/A
Military	16	17	18	18	1.0%	-	0%
Total	**420**	**385**	**353**	**342**	**-1.6%**	(110.4)	-24%

Distance Travelled (millions of vehicle miles travelled)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Passenger - Residents	545	490	433	401	-2.3%	(1.3)	0%
Passenger - Visitors	170	152	138	128	-2.2%	0.8	1%

Vehicle Energy Consumption (TBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Resident Light	1.8	1.6	1.3	1.1	-3.7%	(0.1)	-6%
Resident Medium	1.0	0.9	0.7	0.7	-2.8%	(0.0)	-6%
Resident Heavy	0.2	0.2	0.2	0.2	-0.7%	(0.0)	-6%
Visitor Light	0.5	0.5	0.4	0.3	-4.7%	(0.0)	-9%
Visitor Medium	0.3	0.3	0.2	0.2	-3.8%	(0.0)	-9%
Visitor Heavy	0.1	0.1	0.1	0.1	-1.7%	(0.0)	-9%
Freight Light	-	-	-	-	N/A	-	N/A
Freight Medium	-	-	-	-	N/A	-	N/A
Freight Heavy	-	-	-	-	N/A	-	N/A
Total	**3.9**	**3.4**	**2.9**	**2.5**	**-3.4%**	(0.2)	-6%

Average Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	23.3	23.9	26.4	29.8	1.9%	0.9	3%
Medium Gasoline	21.3	22.0	24.5	28.0	2.1%	0.8	3%
Heavy Gasoline	16.9	17.2	19.0	21.4	1.9%	0.9	5%
Heavy Diesel	16.9	17.3	19.2	21.7	2.0%	1.1	6%
Fleet	21.9	22.5	25.5	29.8	2.4%	1.7	6%

Proposed GHG Reduction Work Plans for Hawaii

Reference Projection vs. Work Plan 1: Kauai

Reference Case

Marginal Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	24.4	28.1	34.0	37.7	3.4%
Medium Gasoline	23.4	26.9	32.6	36.0	3.4%
Heavy Gasoline	17.4	19.4	22.3	24.6	2.7%
Heavy Diesel	17.2	19.2	21.8	24.0	2.6%
Fleet	23.0	26.6	32.1	35.6	3.4%

Average Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	56.6	55.8	54.0	52.0	-0.6%
Medium Gasoline	33.2	33.4	33.6	33.7	0.1%
Heavy Gasoline	10.2	10.8	12.5	14.3	2.7%

Marginal Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	55.3	52.3	48.3	48.4	-1.0%
Medium Gasoline	34.9	33.9	33.7	33.7	-0.3%
Heavy Gasoline	9.8	13.8	18.0	17.9	4.7%

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020
Renewables as % of Electric Sales	9%	12%	80%	88%	78.7%
Ethanol/Gasoline	0%	1%	6%	11%	11.0%
Biodiesel/Diesel	0%	1%	2%	4%	4.1%

Work Plan 1

Marginal Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	24.4	28.5	36.2	42.0	4.3%	4.4	12%
Medium Gasoline	23.4	27.3	34.6	40.2	4.3%	4.2	12%
Heavy Gasoline	17.4	19.8	23.9	27.7	3.7%	3.1	12%
Heavy Diesel	17.2	19.5	23.3	27.0	3.5%	3.0	12%
Fleet	23.0	27.0	35.1	41.2	4.6%	5.6	16%

Average Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	56.6	55.7	53.6	51.5	-0.7%	(0.5)	-1%
Medium Gasoline	33.2	33.4	33.5	33.6	0.1%	(0.0)	0%
Heavy Gasoline	10.2	10.9	12.9	14.9	3.0%	0.6	4%

Marginal Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	55.3	51.9	47.3	47.5	-1.2%	(0.9)	-2%
Medium Gasoline	34.9	33.8	33.7	33.7	-0.3%	(0.0)	0%
Heavy Gasoline	9.8	14.3	19.0	18.8	5.1%	0.9	5%

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020	Difference from Ref @ 2020	Difference from Ref @ 2020
Renewables as % of Electric Sales	9%	29%	98%	103%	93.6%	0.1	17%
Ethanol/Gasoline	0%	10%	15%	20%	20.0%	0.1	82%
Biodiesel/Diesel	0%	10%	15%	20%	20.0%	0.2	389%

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Proposed GHG Reduction Work Plans for Hawaii

Reference Projection vs. Work Plan 1: Kauai

Reference Case

Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential					
Electricity	115.1	124.0	127.7	151.1	2.1%
Utility Gas	46.8	46.5	46.8	47.3	0.1%
Bottled Gas	60.0	62.6	68.5	69.2	1.1%
Commercial					
Electricity	111.5	120.1	124.4	147.9	2.2%
Utility Gas	-	-	-	-	N/A
Oil	22.4	25.0	30.9	31.5	2.7%
Bottled Gas	25.0	27.6	33.5	34.1	2.4%
Industrial					
Electricity	104.9	112.9	144.2	150.6	2.8%
Utility Gas	-	-	-	-	N/A
#6 Fuel	-	12.5	18.3	19.0	N/A
Bottled Gas	-	27.6	33.5	34.1	N/A
#2 Fuel	22.4	25.0	30.9	31.5	2.7%
Transportation					
Gasoline	28.2	30.8	36.7	37.4	2.2%
LS Diesel	25.3	27.9	33.7	34.4	2.4%
Ethanol	28.1	25.7	27.9	27.8	-0.1%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%

Work Plan 1

Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential						-	N/A
Electricity	115.1	124.0	136.0	139.8	1.5%	(11.3)	-7%
Utility Gas	46.8	46.5	46.8	47.3	0.1%	-	0%
Bottled Gas	60.0	62.6	68.5	69.2	1.1%	-	0%
						-	N/A
Commercial						-	N/A
Electricity	111.5	120.1	132.7	136.5	1.6%	(11.3)	-8%
Utility Gas	-	-	-	-	N/A	-	N/A
Oil	22.4	25.0	30.9	31.5	2.7%	-	0%
Bottled Gas	25.0	27.6	33.5	34.1	2.4%	-	0%
Industrial						-	N/A
Electricity	104.9	112.9	146.3	138.3	2.2%	(12.3)	-8%
Utility Gas	-	-	-	-	N/A	-	N/A
#6 Fuel	-	12.5	18.3	19.0	N/A	-	0%
Bottled Gas	-	27.6	33.5	34.1	N/A	-	0%
#2 Fuel	22.4	25.0	30.9	31.5	2.7%	-	0%
Transportation						-	N/A
Gasoline	28.2	30.8	36.7	37.4	2.2%	-	0%
LS Diesel	25.3	27.9	33.7	34.4	2.4%	-	0%
Ethanol	28.1	25.7	27.9	27.8	-0.1%	-	0%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%	-	0%

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Reference Projection vs. Work Plan 2: Oahu

Reference Case

GHG Emissions (kt)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	42.3	41.1	41.1	42.2	0.0%
Commercial	204.9	206.1	209.5	200.4	-0.2%
Industrial	115.9	123.3	136.6	138.7	1.4%
Passenger - Residents	1,890.2	1,853.7	1,523.5	1,287.1	-2.9%
Passenger - Visitors	133.1	116.2	82.6	64.2	-5.5%
Marine	2,172.6	2,153.1	2,183.9	2,135.2	-0.1%
Aviation	4,839.4	4,929.2	5,179.8	5,166.9	0.5%
Freight	816.6	843.7	799.0	785.2	-0.3%
Power Sector	6,952.9	6,226.2	6,068.0	6,218.0	-0.9%
Waste	714.0	729.9	756.4	782.8	0.7%
Agriculture & Forestry	(316.9)	(319.5)	(323.9)	(328.3)	0.3%
Total	**17,565.1**	**16,903.1**	**16,656.5**	**16,492.4**	**-0.5%**

Total Primary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Biodiesel	-	7.7	15.3	15.4	N/A
Biomass	-	2.8	2.8	2.8	N/A
Coal	13.8	13.8	13.8	13.8	0.0%
Electricity	22.4	22.3	23.6	24.0	0.5%
Ethanol	0.1	0.5	1.9	3.1	27.2%
Gasoline	35.1	34.4	28.9	25.3	-2.5%
Geothermal	-	0.0	0.0	0.0	N/A
HS Diesel	-	-	-	-	N/A
HS Fuel Oil	79.3	69.3	67.8	69.4	-1.0%
Hydrogen	-	-	-	-	N/A
Jet Fuel	81.1	82.6	86.8	86.6	0.5%
LPG	0.7	0.7	0.7	0.7	0.2%
LS Diesel	11.3	11.3	11.1	10.7	-0.4%
LS Fuel Oil	0.2	0.9	0.8	0.9	11.9%
Oil, Unspecified	3.3	3.4	3.5	3.4	0.4%
Utility Gas	2.9	2.9	3.0	2.9	0.1%
Still Gas	-	-	-	-	N/A
Waste	5.0	5.0	5.0	5.0	0.0%
Total	**255.2**	**257.6**	**265.1**	**264.2**	**0.3%**

Work Plan 2

GHG Emissions (kt)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Abs. Change from Ref @ 2020	% Change from Ref @ 2020
Residential	42.3	40.5	39.3	39.1	-0.6%	(3.1)	-7%
Commercial	204.9	202.4	199.3	186.0	-0.7%	(14.4)	-7%
Industrial	115.9	122.8	153.8	155.2	2.3%	16.5	12%
Passenger - Residents	1,890.2	1,701.5	1,378.9	1,123.1	-3.9%	(164.0)	-13%
Passenger - Visitors	133.1	110.2	79.4	61.8	-5.7%	(2.3)	-4%
Marine	2,172.6	2,154.3	2,184.8	2,135.9	-0.1%	0.6	0%
Aviation	4,839.4	4,933.7	5,189.1	5,179.0	0.5%	12.1	0%
Freight	816.6	769.0	733.3	714.3	-1.0%	(70.9)	-9%
Power Sector	6,952.9	5,555.6	3,666.1	2,851.8	-6.6%	(3,366.2)	-54%
Waste	714.0	730.1	759.7	784.5	0.7%	1.6	0%
Agriculture & Forestry	(316.9)	(319.5)	(323.8)	(328.2)	0.3%	0.1	0%
Total	**17,565.1**	**16,000.5**	**14,059.8**	**12,902.4**	**-2.3%**	(3,590.0)	-22%

Total Primary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Biodiesel	-	8.6	20.8	21.0	N/A	5.6	36%
Biomass	-	2.8	4.4	4.4	N/A	1.5	53%
Coal	13.8	13.8	13.8	13.8	0.0%	-	0%
Electricity	22.4	20.7	18.7	16.9	-2.2%	(7.1)	-29%
Ethanol	0.1	3.5	4.6	5.5	32.9%	2.4	77%
Gasoline	35.1	31.4	25.9	22.1	-3.5%	(3.2)	-13%
Geothermal	-	0.0	0.0	0.0	N/A	0.0	625%
HS Diesel	-	-	-	-	N/A	-	n/a
HS Fuel Oil	79.3	59.1	37.9	27.5	-7.8%	(41.9)	-60%
Hydrogen	-	-	-	-	N/A	-	n/a
Jet Fuel	81.1	82.7	87.0	86.8	0.5%	0.2	0%
LPG	0.7	0.7	0.7	0.7	-0.3%	(0.0)	-6%
LS Diesel	11.3	10.9	10.6	9.9	-1.0%	(0.8)	-7%
LS Fuel Oil	0.2	2.8	-	-	-100.0%	(0.9)	-100%
Oil, Unspecified	3.3	3.4	3.7	3.6	0.8%	0.2	6%
Utility Gas	2.9	2.9	2.8	2.7	-0.5%	(0.2)	-8%
Still Gas	-	-	-	-	N/A	-	n/a
Waste	5.0	5.0	5.0	5.0	0.0%	-	0%
Total	**255.2**	**248.2**	**235.9**	**219.9**	**-1.1%**	(44.3)	-17%

Proposed GHG Reduction Work Plans for Hawaii

Reference Projection vs. Work Plan 2: Oahu

Reference Case

Total Secondary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	8.0	7.9	8.2	8.5	0.5%
Commercial	16.7	16.6	17.1	16.9	0.1%
Industrial	4.6	4.8	5.1	5.1	0.7%
Passenger - Residents	25.7	25.5	22.4	20.0	-1.9%
Passenger - Visitors	1.8	1.6	1.2	0.9	-4.8%
Marine	20.9	20.7	21.0	20.5	-0.1%
Aviation	81.1	82.6	86.8	86.6	0.5%
Freight	11.1	11.5	11.4	11.7	0.4%
Forestry & Agriculture	0.1	0.1	0.1	0.1	-3.4%
Total	**170.0**	**171.3**	**173.2**	**170.4**	**0.0%**

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Personal Income	31,302	32,001	35,929	38,963	1.7%
Population (millions)	1	1	1	1	0.9%
Gross Regional Product (GRP)	47,103	52,953	58,286	64,021	2.4%

Generation Capacity (MW)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	1,383	1,459	1,459	1,459	0.4%
Coal Steam	180	180	180	180	0.0%
Hydro	14	14	14	14	0.0%
Biomass	60	195	195	195	9.5%
Wind	-	54	54	54	N/A
Other Renewable	-	110	220	221	N/A
Total	**1,637**	**2,012**	**2,122**	**2,122**	**2.0%**

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	6,342	5,468	5,278	5,457	-1.1%
Coal Steam	1,510	1,510	1,510	1,510	0.0%
Hydro	70	70	70	70	0.0%
Biomass	291	473	474	474	3.8%
Wind	-	148	148	148	N/A
Other Renewable	-	627	1,255	1,255	N/A
Purchases from industry	12	2	-	-	-100.0%
Total	**8,226**	**8,298**	**8,734**	**8,914**	**0.6%**

Work Plan 2

Total Secondary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential	8.0	7.2	6.4	6.0	-2.2%	(2.5)	-30%
Commercial	16.7	15.8	14.0	12.4	-2.3%	(4.6)	-27%
Industrial	4.6	4.6	5.0	4.9	0.4%	(0.2)	-4%
Passenger - Residents	25.7	25.5	22.0	19.1	-2.2%	(0.9)	-5%
Passenger - Visitors	1.8	1.6	1.1	0.9	-5.2%	(0.0)	-5%
Marine	20.9	20.7	21.0	20.6	-0.1%	0.0	0%
Aviation	81.1	82.7	87.0	86.8	0.5%	0.2	0%
Freight	11.1	11.5	11.4	11.7	0.4%	0.1	1%
Forestry & Agriculture	0.1	0.1	0.1	0.1	-4.0%	(0.0)	-7%
Total	**170.0**	**169.7**	**168.1**	**162.4**	**-0.4%**	(8.0)	-5%

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Personal Income	31,302	32,001	35,929	38,963	1.7%	-	0%
Population (millions)	1	1	1	1	0.9%	-	0%
Gross Regional Product (GRP)	47,103	52,953	58,286	64,021	2.4%	-	0%

Generation Capacity (MW)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Gas/Oil	1,383	1,459	1,364	1,364	-0.1%	(94.9)	-7%
Coal Steam	180	180	180	180	0.0%	-	0%
Hydro	14	14	14	14	0.0%	-	0%
Biomass	60	195	212	212	10.2%	17.2	9%
Wind	-	156	156	156	N/A	102.1	190%
Other Renewable	-	118	289	299	N/A	78.3	35%
Total	**1,637**	**2,122**	**2,215**	**2,225**	**2.4%**	102.7	5%

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Gas/Oil	6,342	4,665	2,583	1,592	-10.1%	(3,865.2)	-71%
Coal Steam	1,510	1,510	1,510	1,510	0.0%	-	0%
Hydro	70	70	70	70	0.0%	-	0%
Biomass	291	473	572	572	5.3%	98.3	21%
Wind	-	413	413	413	N/A	264.9	179%
Other Renewable	-	675	1,519	1,594	N/A	339.0	27%
Purchases from industry	12	11	15	18	3.1%	17.7	n/a
Total	**8,226**	**7,816**	**6,681**	**5,768**	**-2.7%**	(3,145.2)	-35%

Reference Projection vs. Work Plan 2: Oahu

Reference Case

Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	2,132	2,112	2,210	2,294	0.6%
Commercial	3,910	3,902	4,030	4,024	0.2%
Industrial	560	556	591	594	0.5%
Transportation	-	-	107	152	N/A
Military	1,221	1,320	1,367	1,414	1.1%
Total	**7,823**	**7,891**	**8,306**	**8,477**	**0.6%**

Distance Travelled (millions of vehicle miles travelled)					
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Passenger - Residents	7,031	7,143	7,418	7,577	0.6%
Passenger - Visitors	454	464	447	422	-0.6%

Vehicle Energy Consumption (TBtu)					
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Resident Light	15.6	15.7	14.6	14.1	-0.8%
Resident Medium	8.3	8.6	8.4	8.5	0.1%
Resident Heavy	1.9	2.1	2.2	2.6	2.3%
Visitor Light	1.1	1.0	0.8	0.7	-3.8%
Visitor Medium	0.6	0.5	0.4	0.4	-2.9%
Visitor Heavy	0.1	0.1	0.1	0.1	-0.8%
Freight Light	-	-	-	-	N/A
Freight Medium	-	-	-	-	N/A
Freight Heavy	-	-	-	-	N/A
Total	**27.6**	**28.0**	**26.5**	**26.3**	**-0.4%**

Average Vehicle Efficiency (miles/gallon)					
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	23.5	24.2	26.4	29.5	1.7%
Medium Gasoline	21.6	22.4	24.7	27.8	2.0%
Heavy Gasoline	16.9	17.3	18.7	20.6	1.5%
Heavy Diesel	16.9	17.2	18.5	20.3	1.4%
Fleet	22.1	22.8	25.2	28.6	2.0%

Work Plan 2

Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential	2,132	1,915	1,703	1,564	-2.4%	(729.7)	-32%
Commercial	3,910	3,671	3,163	2,758	-2.6%	(1,265.8)	-31%
Industrial	560	528	523	490	-1.0%	(103.8)	-17%
Transportation	-	-	130	194	N/A	42.2	28%
Military	1,221	1,320	1,367	1,414	1.1%	-	0%
Total	**7,823**	**7,434**	**6,886**	**6,420**	**-1.5%**	(2,057.2)	-24%

Distance Travelled (millions of vehicle miles travelled)							
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Passenger - Residents	7,031	7,146	7,455	7,625	0.6%	48.0	1%
Passenger - Visitors	454	465	445	415	-0.7%	(7.9)	-2%

Vehicle Energy Consumption (TBtu)							
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Resident Light	15.6	15.7	14.4	13.4	-1.1%	(0.7)	-5%
Resident Medium	8.3	8.6	8.2	8.1	-0.2%	(0.4)	-5%
Resident Heavy	1.9	2.1	2.2	2.4	2.0%	(0.1)	-5%
Visitor Light	1.1	1.0	0.7	0.6	-4.1%	(0.0)	-5%
Visitor Medium	0.6	0.5	0.4	0.4	-3.2%	(0.0)	-5%
Visitor Heavy	0.1	0.1	0.1	0.1	-1.1%	(0.0)	-5%
Freight Light	-	-	-	-	N/A	-	n/a
Freight Medium	-	-	-	-	N/A	-	n/a
Freight Heavy	-	-	-	-	N/A	-	n/a
Total	**27.6**	**28.0**	**26.1**	**25.1**	**-0.7%**	(1.2)	-5%

Average Vehicle Efficiency (miles/gallon)							
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	23.5	24.3	26.7	30.5	2.0%	1.1	4%
Medium Gasoline	21.6	22.5	25.0	28.7	2.2%	1.0	3%
Heavy Gasoline	16.9	17.3	19.0	21.5	1.9%	0.9	5%
Heavy Diesel	16.9	17.3	18.8	21.3	1.8%	1.0	5%
Fleet	22.1	22.9	26.0	31.2	2.7%	2.6	9%

Reference Projection vs. Work Plan 2: Oahu

Reference Case

Marginal Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	24.4	28.1	34.0	37.7	3.4%
Medium Gasoline	23.4	26.9	32.6	36.0	3.4%
Heavy Gasoline	17.4	19.4	22.3	24.6	2.7%
Heavy Diesel	17.2	19.2	21.8	24.0	2.6%
Fleet	23.1	26.9	32.2	35.8	3.4%

Average Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	57.3	56.4	55.1	53.3	-0.5%
Medium Gasoline	33.3	33.5	33.6	33.7	0.1%
Heavy Gasoline	9.4	10.1	11.3	12.9	2.5%

Marginal Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	55.7	52.5	49.9	49.9	-0.8%
Medium Gasoline	34.9	33.9	33.8	33.8	-0.3%
Heavy Gasoline	9.3	13.6	16.4	16.3	4.4%

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020
Renewables as % of Electric Sales	5%	17%	23%	23%	18.3%
Ethanol/Gasoline	0%	1%	6%	11%	10.6%
Biodiesel/Diesel	0%	0%	2%	3%	3.1%

Work Plan 2

Marginal Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	24.4	28.8	36.8	42.9	4.4%	5.2	14%
Medium Gasoline	23.4	27.5	35.2	41.0	4.4%	5.0	14%
Heavy Gasoline	17.4	19.8	24.0	27.9	3.7%	3.3	13%
Heavy Diesel	17.2	19.6	23.4	27.1	3.6%	3.1	13%
Fleet	23.1	27.5	36.2	43.2	4.9%	7.4	21%

Average Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	57.3	56.4	54.5	51.6	-0.8%	(1.7)	-3%
Medium Gasoline	33.3	33.5	33.6	33.7	0.1%	(0.0)	0%
Heavy Gasoline	9.4	10.1	11.9	14.7	3.5%	1.8	14%

Marginal Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	55.7	52.5	46.0	46.2	-1.4%	(3.8)	-8%
Medium Gasoline	34.9	33.9	33.7	33.7	-0.3%	(0.1)	0%
Heavy Gasoline	9.3	13.6	20.3	20.1	6.1%	3.9	24%

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020	Difference from Ref @ 2020	Difference from Ref @ 2020
Renewables as % of Electric Sales	5%	22%	37%	41%	36.6%	0.2	80%
Ethanol/Gasoline	0%	10%	15%	20%	19.6%	0.1	82%
Biodiesel/Diesel	0%	10%	15%	20%	20.0%	0.2	545%

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Proposed GHG Reduction Work Plans for Hawaii

Reference Projection vs. Work Plan 2: Oahu

Reference Case

Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential					
Electricity	66.3	71.4	90.2	90.2	2.4%
Utility Gas	43.1	42.8	43.1	43.6	0.1%
Bottled Gas	60.0	62.6	68.5	69.2	1.1%
Commercial					
Electricity	55.0	59.2	79.5	79.5	2.9%
Utility Gas	28.1	27.8	28.0	28.6	0.1%
Oil	22.4	25.0	30.9	31.5	2.7%
Bottled Gas	25.0	27.6	33.5	34.1	2.4%
Industrial					
Electricity	51.7	55.6	76.5	76.5	3.1%
Utility Gas	28.1	27.8	28.0	28.6	0.1%
#6 Fuel	9.9	12.5	18.3	19.0	5.2%
Bottled Gas	-	-	-	-	N/A
#2 Fuel	22.4	25.0	30.9	31.5	2.7%
Transportation					
Gasoline	28.2	30.8	36.7	37.4	2.2%
LS Diesel	25.3	27.9	33.7	34.4	2.4%
Ethanol	28.1	25.7	27.9	27.8	-0.1%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%

Work Plan 2

Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential						-	n/a
Electricity	66.3	71.4	101.2	106.4	3.7%	16.3	18.0%
Utility Gas	43.1	43.3	44.1	45.0	0.3%	1.4	3.2%
Bottled Gas	60.0	63.3	69.8	70.9	1.3%	1.8	2.6%
						-	n/a
Commercial						-	n/a
Electricity	55.0	59.2	89.9	95.8	4.4%	16.3	20.5%
Utility Gas	28.1	28.3	29.1	30.0	0.5%	1.4	4.9%
Oil	22.4	25.7	32.3	33.4	3.1%	1.9	6.0%
Bottled Gas	25.0	28.3	34.8	35.9	2.8%	1.8	5.2%
Industrial						-	n/a
Electricity	51.7	55.6	86.8	92.8	4.6%	16.3	21.3%
Utility Gas	28.1	28.3	29.1	30.0	0.5%	1.4	4.9%
#6 Fuel	9.9	13.2	19.8	21.0	6.0%	2.0	10.3%
Bottled Gas	-	-	-	-	N/A	-	n/a
#2 Fuel	22.4	25.7	32.3	33.4	3.1%	1.9	6.0%
Transportation						-	n/a
Gasoline	28.2	31.5	38.1	39.2	2.5%	1.8	4.8%
LS Diesel	25.3	28.6	35.2	36.3	2.8%	1.9	5.5%
Ethanol	28.1	25.7	27.9	27.8	-0.1%	-	0.0%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%	-	0.0%

Reference Projection vs. Work Plan 2: Maui

Reference Case

GHG Emissions (kt)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	6.3	6.1	6.2	6.3	0.0%
Commercial	54.1	51.5	50.1	47.0	-1.1%
Industrial	436.4	433.3	415.9	394.7	-0.8%
Passenger - Residents	373.4	311.0	230.4	181.9	-5.4%
Passenger - Visitors	120.7	97.3	69.1	52.8	-6.2%
Marine	-	-	-	-	N/A
Aviation	-	-	-	-	N/A
Freight	196.5	182.2	150.3	138.2	-2.7%
Power Sector	858.1	800.0	808.3	721.2	-1.3%
Waste	124.5	149.3	190.7	232.2	4.9%
Agriculture & Forestry	(307.0)	(306.5)	(305.7)	(304.9)	-0.1%
Total	**1,863.2**	**1,724.2**	**1,615.3**	**1,469.4**	**-1.8%**

Total Primary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Biodiesel	-	0.0	0.0	0.0	N/A
Biomass	4.1	4.2	4.1	6.9	4.0%
Coal	1.8	2.0	1.9	1.8	0.1%
Electricity	4.3	3.9	4.1	4.2	-0.2%
Ethanol	0.1	0.1	0.3	0.5	14.3%
Gasoline	8.1	6.7	5.0	4.0	-5.3%
Geothermal	-	0.0	0.0	0.0	N/A
HS Diesel	-	-	-	-	N/A
HS Fuel Oil	0.6	-	-	-	-100.0%
Hydrogen	-	-	-	-	N/A
Jet Fuel	-	-	-	-	N/A
LPG	0.7	0.7	0.7	0.6	-0.4%
LS Diesel	1.3	1.2	1.1	1.0	-1.7%
LS Fuel Oil	11.1	10.9	11.0	9.5	-1.2%
Oil, Unspecified	1.0	1.0	0.9	0.9	-1.4%
Utility Gas	0.1	0.1	0.1	0.1	1.1%
Still Gas	-	-	-	-	N/A
Waste	-	-	-	-	N/A
Total	**33.0**	**30.8**	**29.2**	**29.5**	**-0.9%**

Work Plan 2

GHG Emissions (kt)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Abs. Change from Ref @ 2020	% Change from Ref @ 2020
Residential	6.3	6.1	6.1	7.0	0.8%	0.7	11%
Commercial	54.1	51.7	48.3	45.9	-1.3%	(1.1)	-2%
Industrial	436.4	433.3	414.7	392.4	-0.8%	(2.3)	-1%
Passenger - Residents	373.4	286.2	208.6	158.0	-6.4%	(23.9)	-13%
Passenger - Visitors	120.7	89.2	60.6	43.4	-7.6%	(9.4)	-18%
Marine	-	-	-	-	N/A	-	n/a
Aviation	-	-	-	-	N/A	-	n/a
Freight	196.5	174.0	139.5	125.5	-3.4%	(12.7)	-9%
Power Sector	858.1	646.9	163.5	197.8	-10.7%	(523.4)	-73%
Waste	124.5	161.8	195.3	235.1	5.0%	2.9	1%
Agriculture & Forestry	(307.0)	(306.2)	(305.9)	(305.1)	0.0%	(0.2)	0%
Total	**1,863.2**	**1,543.0**	**930.7**	**900.2**	**-5.4%**	(569.2)	-39%

Total Primary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Biodiesel	-	0.1	0.2	0.2	N/A	0.2	476%
Biomass	4.1	4.2	4.0	7.2	4.4%	0.3	5%
Coal	1.8	2.0	1.9	1.8	-0.2%	(0.1)	-4%
Electricity	4.3	3.7	3.1	2.8	-3.3%	(1.4)	-34%
Ethanol	0.1	0.7	0.8	0.8	19.1%	0.4	71%
Gasoline	8.1	6.2	4.4	3.4	-6.5%	(0.6)	-16%
Geothermal	-	0.0	0.0	0.0	N/A	0.0	625%
HS Diesel	-	-	-	-	N/A	-	n/a
HS Fuel Oil	0.6	-	-	-	-100.0%	-	n/a
Hydrogen	-	-	-	-	N/A	-	n/a
Jet Fuel	-	-	-	-	N/A	-	n/a
LPG	0.7	0.7	0.6	0.6	-0.4%	(0.0)	0%
LS Diesel	1.3	1.2	1.0	0.9	-2.9%	(0.2)	-15%
LS Fuel Oil	11.1	8.8	2.2	2.4	-11.1%	(7.1)	-75%
Oil, Unspecified	1.0	1.0	0.9	0.8	-1.6%	(0.0)	-3%
Utility Gas	0.1	0.1	0.1	0.1	1.0%	(0.0)	-1%
Still Gas	-	-	-	-	N/A	-	n/a
Waste	-	-	-	-	N/A	-	n/a
Total	**33.0**	**28.6**	**19.2**	**20.9**	**-3.4%**	(8.5)	-29%

Proposed GHG Reduction Work Plans for Hawaii

Reference Projection vs. Work Plan 2: Maui

Reference Case

Total Secondary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	1.6	1.7	1.8	1.9	1.3%
Commercial	3.3	3.1	3.1	3.1	-0.4%
Industrial	7.1	7.1	6.9	6.6	-0.6%
Passenger - Residents	5.1	4.3	3.3	2.8	-4.6%
Passenger - Visitors	1.6	1.3	1.0	0.8	-5.4%
Marine	-	-	-	-	N/A
Aviation	-	-	-	-	N/A
Freight	2.7	2.5	2.1	2.0	-2.3%
Forestry & Agriculture	0.0	0.0	0.0	0.0	-6.1%
Total	**21.4**	**19.9**	**18.2**	**17.1**	**-1.7%**

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Personal Income	4,119	4,348	5,069	5,746	2.6%
Population (millions)	0	0	0	0	1.3%
Gross Regional Product (GRP)	6,723	7,289	7,719	8,420	1.7%

Generation Capacity (MW)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	264	266	312	315	1.4%
Coal Steam	-	-	-	-	N/A
Hydro	-	-	-	-	N/A
Biomass	-	-	0	25	N/A
Wind	30	33	44	44	2.9%
Other Renewable	-	0	0	1	N/A
Total	**294**	**299**	**356**	**384**	**2.1%**

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	1,199	1,141	1,157	1,012	-1.3%
Coal Steam	-	-	-	-	N/A
Hydro	-	-	-	-	N/A
Biomass	-	-	0	182	N/A
Wind	57	65	94	94	4.0%
Other Renewable	-	1	1	1	N/A
Purchases from industry	94	123	136	138	3.0%
Total	**1,350**	**1,329**	**1,388**	**1,428**	**0.4%**

Work Plan 2

Total Secondary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential	1.6	1.5	1.3	1.2	-2.5%	(0.7)	-39%
Commercial	3.3	3.1	2.7	2.4	-2.4%	(0.7)	-23%
Industrial	7.1	7.0	6.7	6.3	-0.9%	(0.3)	-5%
Passenger - Residents	5.1	4.3	3.3	2.6	-5.0%	(0.2)	-6%
Passenger - Visitors	1.6	1.3	0.9	0.7	-6.2%	(0.1)	-11%
Marine	-	-	-	-	N/A	-	n/a
Aviation	-	-	-	-	N/A	-	n/a
Freight	2.7	2.6	2.1	2.0	-2.2%	0.0	1%
Forestry & Agriculture	0.0	0.0	0.0	0.0	-6.0%	0.0	1%
Total	**21.4**	**19.8**	**17.0**	**15.2**	**-2.6%**	(2.0)	-12%

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Personal Income	4,119	4,348	5,069	5,746	2.6%	-	0%
Population (millions)	0	0	0	0	1.3%	-	0%
Gross Regional Product (GRP)	6,723	7,289	7,719	8,420	1.7%	-	0%

Generation Capacity (MW)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Gas/Oil	264	266	310	312	1.3%	(2.5)	-1%
Coal Steam	-	-	-	-	N/A	-	n/a
Hydro	-	-	-	-	N/A	-	n/a
Biomass	-	-	0	31	N/A	6.2	25%
Wind	30	72	483	483	23.8%	438.9	1006%
Other Renewable	-	2	2	12	N/A	11.5	1759%
Total	**294**	**340**	**795**	**838**	**8.4%**	454.2	118%

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Gas/Oil	1,199	940	264	282	-10.6%	(730.8)	-72%
Coal Steam	-	-	-	-	N/A	-	n/a
Hydro	-	-	-	-	N/A	-	n/a
Biomass	-	-	2	218	N/A	35.6	20%
Wind	57	192	1,272	1,272	27.0%	1,178.0	1252%
Other Renewable	-	8	8	83	N/A	81.6	7758%
Purchases from industry	94	120	121	117	1.7%	(21.8)	-16%
Total	**1,350**	**1,260**	**1,666**	**1,971**	**3.0%**	542.7	38%

Reference Projection vs. Work Plan 2: Maui

Reference Case

Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	449	465	500	541	1.4%
Commercial	716	685	697	695	-0.2%
Industrial	132	125	136	138	0.3%
Transportation	-	-	-	-	N/A
Military	1	1	1	1	0.9%
Total	**1,298**	**1,276**	**1,334**	**1,375**	**0.4%**

Distance Travelled (millions of vehicle miles travelled)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Passenger - Residents	1,240	1,121	1,007	945	-2.1%
Passenger - Visitors	426	375	337	304	-2.6%

Vehicle Energy Consumption (TBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Resident Light	3.1	2.6	2.2	1.9	-3.5%
Resident Medium	1.6	1.4	1.2	1.2	-2.6%
Resident Heavy	0.4	0.3	0.3	0.4	-0.5%
Visitor Light	1.0	0.8	0.7	0.6	-4.3%
Visitor Medium	0.5	0.5	0.4	0.3	-3.4%
Visitor Heavy	0.1	0.1	0.1	0.1	-1.3%
Freight Light	-	-	-	-	N/A
Freight Medium	-	-	-	-	N/A
Freight Heavy	-	-	-	-	N/A
Total	**6.7**	**5.8**	**4.9**	**4.4**	**-3.2%**

Average Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	23.3	23.9	26.1	28.9	1.7%
Medium Gasoline	21.1	21.9	24.2	27.1	1.9%
Heavy Gasoline	16.8	17.2	18.7	20.5	1.5%
Heavy Diesel	16.9	17.2	18.5	20.3	1.4%
Fleet	21.8	22.4	25.0	28.4	2.1%

Work Plan 2

Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential	449	425	359	319	-2.6%	(222.0)	-41%
Commercial	716	666	569	495	-2.8%	(200.6)	-29%
Industrial	132	120	121	117	-1.0%	(21.8)	-16%
Transportation	-	-	3	6	N/A	5.8	n/a
Military	1	1	1	1	0.9%	-	0%
Total	**1,298**	**1,211**	**1,053**	**936**	**-2.5%**	(438.7)	-32%

Distance Travelled (millions of vehicle miles travelled)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Passenger - Residents	1,240	1,124	1,011	946	-2.1%	0.6	0%
Passenger - Visitors	426	375	336	301	-2.6%	(2.9)	-1%

Vehicle Energy Consumption (TBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Resident Light	3.1	2.6	2.1	1.8	-4.0%	(0.1)	-6%
Resident Medium	1.6	1.4	1.2	1.1	-3.1%	(0.1)	-6%
Resident Heavy	0.4	0.3	0.3	0.3	-1.0%	(0.0)	-6%
Visitor Light	1.0	0.8	0.6	0.5	-5.1%	(0.1)	-11%
Visitor Medium	0.5	0.5	0.4	0.3	-4.3%	(0.0)	-11%
Visitor Heavy	0.1	0.1	0.1	0.1	-2.2%	(0.0)	-11%
Freight Light	-	-	-	-	N/A	-	n/a
Freight Medium	-	-	-	-	N/A	-	n/a
Freight Heavy	-	-	-	-	N/A	-	n/a
Total	**6.7**	**5.8**	**4.7**	**4.1**	**-3.7%**	(0.3)	-7%

Average Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	23.3	23.9	26.5	30.1	2.0%	1.1	4%
Medium Gasoline	21.1	21.9	24.5	28.1	2.2%	1.0	4%
Heavy Gasoline	16.8	17.2	19.0	21.6	1.9%	1.0	5%
Heavy Diesel	16.9	17.2	18.9	21.3	1.8%	1.1	5%
Fleet	21.8	22.4	25.8	30.6	2.7%	2.3	8%

Proposed GHG Reduction Work Plans for Hawaii

Reference Projection vs. Work Plan 2: Maui

Reference Case

Marginal Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	24.4	28.1	34.0	37.7	3.4%
Medium Gasoline	23.4	26.9	32.6	36.0	3.4%
Heavy Gasoline	17.4	19.4	22.3	24.6	2.7%
Heavy Diesel	17.2	19.2	21.8	24.0	2.6%
Fleet	23.0	26.6	32.2	35.8	3.5%

Average Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	56.8	55.9	53.4	50.8	-0.9%
Medium Gasoline	32.9	33.0	33.1	33.1	0.1%
Heavy Gasoline	10.3	11.1	13.5	16.1	3.5%

Marginal Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	56.5	52.1	46.3	46.5	-1.5%
Medium Gasoline	34.4	33.2	33.2	33.2	-0.3%
Heavy Gasoline	9.1	14.8	20.5	20.4	6.4%

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020
Renewables as % of Electric Sales	4%	5%	7%	20%	15.8%
Ethanol/Gasoline	1%	1%	6%	11%	9.9%
Biodiesel/Diesel	0%	1%	2%	4%	3.5%

Work Plan 2

Marginal Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	24.4	28.8	36.8	42.8	4.4%	5.2	14%
Medium Gasoline	23.4	27.5	35.2	41.0	4.4%	5.0	14%
Heavy Gasoline	17.4	19.8	24.0	27.9	3.7%	3.3	13%
Heavy Diesel	17.2	19.6	23.4	27.1	3.6%	3.1	13%
Fleet	23.0	27.2	36.3	42.8	4.9%	7.0	20%

Average Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	56.8	55.9	53.0	50.2	-0.9%	(0.6)	-1%
Medium Gasoline	32.9	33.0	33.1	33.1	0.1%	(0.0)	0%
Heavy Gasoline	10.3	11.1	13.9	16.6	3.8%	0.6	4%

Marginal Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	56.5	52.1	45.4	45.6	-1.6%	(0.9)	-2%
Medium Gasoline	34.4	33.1	33.2	33.2	-0.3%	(0.0)	0%
Heavy Gasoline	9.1	14.8	21.4	21.2	6.7%	0.9	4%

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020	Difference from Ref @ 2020	Difference from Ref @ 2020
Renewables as % of Electric Sales	4%	16%	122%	168%	163.6%	1.5	733%
Ethanol/Gasoline	1%	10%	15%	20%	18.9%	0.1	82%
Biodiesel/Diesel	0%	10%	15%	20%	20.0%	0.2	467%

Reference Projection vs. Work Plan 2: Maui

Reference Case

Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential					
Electricity	102.4	110.3	122.2	121.4	1.3%
Utility Gas	41.3	41.0	41.3	41.9	0.1%
Bottled Gas	60.0	62.6	68.5	69.2	1.1%
Commercial					
Electricity	99.8	107.5	119.9	119.1	1.4%
Utility Gas	24.8	24.5	24.8	25.4	0.2%
Oil	22.4	25.0	30.9	31.5	2.7%
Bottled Gas	25.0	27.6	33.5	34.1	2.4%
Industrial					
Electricity	82.2	88.5	103.4	102.6	1.7%
Utility Gas	24.8	24.5	24.8	25.4	0.2%
#6 Fuel	9.9	12.5	18.3	19.0	5.2%
Bottled Gas	-	-	-	-	N/A
#2 Fuel	22.4	25.0	30.9	31.5	2.7%
Transportation					
Gasoline	28.2	30.8	36.7	37.4	2.2%
LS Diesel	25.3	27.9	33.7	34.4	2.4%
Ethanol	28.1	25.7	27.9	27.8	-0.1%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%

Work Plan 2

Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential						-	n/a
Electricity	102.4	110.3	200.6	213.2	5.8%	91.8	76%
Utility Gas	41.3	41.5	42.3	43.3	0.3%	1.4	3%
Bottled Gas	60.0	63.3	69.8	70.9	1.3%	1.8	3%
						-	n/a
Commercial						-	n/a
Electricity	99.8	107.5	198.0	210.9	5.9%	91.8	77%
Utility Gas	24.8	25.0	25.8	26.8	0.6%	1.4	6%
Oil	22.4	25.7	32.3	33.4	3.1%	1.9	6%
Bottled Gas	25.0	28.3	34.8	35.9	2.8%	1.8	5%
Industrial						-	n/a
Electricity	82.2	88.5	181.0	194.4	6.8%	91.8	89%
Utility Gas	24.8	25.0	25.8	26.8	0.6%	1.4	6%
#6 Fuel	9.9	13.2	19.8	21.0	6.0%	2.0	10%
Bottled Gas	-	-	-	-	N/A	-	n/a
#2 Fuel	22.4	25.7	32.3	33.4	3.1%	1.9	6%
Transportation						-	n/a
Gasoline	28.2	31.5	38.1	39.2	2.5%	1.8	5%
LS Diesel	25.3	28.6	35.2	36.3	2.8%	1.9	5%
Ethanol	28.1	25.7	27.9	27.8	-0.1%	-	0%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%	-	0%

Proposed GHG Reduction Work Plans for Hawaii

Reference Projection vs. Work Plan 2: Hawaii

Reference Case

GHG Emissions (kt)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	12.4	11.1	12.3	13.6	0.7%
Commercial	51.0	48.7	49.0	48.9	-0.3%
Industrial	30.0	32.9	39.8	44.2	3.0%
Passenger - Residents	435.4	375.1	291.4	240.5	-4.5%
Passenger - Visitors	132.4	108.0	79.7	64.3	-5.4%
Marine	-	-	-	-	N/A
Aviation	-	-	-	-	N/A
Freight	300.2	267.2	226.3	221.3	-2.3%
Power Sector	669.9	532.1	574.1	612.6	-0.7%
Waste	130.1	149.0	180.5	211.9	3.8%
Agriculture & Forestry	(1,406.3)	(1,405.6)	(1,404.3)	(1,403.0)	0.0%
Total	**355.2**	**118.5**	**48.9**	**54.3**	**-13.4%**

Total Primary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Biodiesel	-	0.0	0.0	0.1	N/A
Biomass	-	-	-	-	N/A
Coal	-	-	-	-	N/A
Electricity	4.0	3.9	4.1	4.4	0.8%
Ethanol	-	0.1	0.4	0.7	N/A
Gasoline	9.9	8.4	6.5	5.6	-4.3%
Geothermal	2.2	2.2	2.2	2.2	0.0%
HS Diesel	-	-	-	-	N/A
HS Fuel Oil	4.1	0.9	1.0	1.2	-9.3%
Hydrogen	-	-	-	-	N/A
Jet Fuel	-	-	-	-	N/A
LPG	0.7	0.6	0.7	0.7	0.3%
LS Diesel	1.8	1.8	1.6	1.5	-1.5%
LS Fuel Oil	4.7	6.3	6.7	7.1	3.3%
Oil, Unspecified	1.1	1.0	1.1	1.1	0.4%
Utility Gas	0.2	0.2	0.2	0.2	1.1%
Still Gas	-	-	-	-	N/A
Waste	-	-	-	-	N/A
Total	**28.6**	**25.4**	**24.5**	**24.8**	**-1.1%**

Work Plan 2

GHG Emissions (kt)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Abs. Change from Ref @ 2020	% Change from Ref @ 2020
Residential	12.4	10.8	11.7	12.4	0.0%	(1.2)	-9%
Commercial	51.0	48.4	48.1	47.2	-0.6%	(1.7)	-4%
Industrial	30.0	33.2	47.1	52.0	4.3%	7.8	18%
Passenger - Residents	435.4	344.2	262.3	207.6	-5.5%	(32.9)	-14%
Passenger - Visitors	132.4	98.8	70.2	53.6	-6.7%	(10.6)	-17%
Marine	-	-	-	-	N/A	-	n/a
Aviation	-	-	-	-	N/A	-	n/a
Freight	300.2	243.9	208.3	198.4	-3.1%	(22.9)	-10%
Power Sector	669.9	388.6	219.1	134.0	-11.6%	(478.6)	-78%
Waste	130.1	149.6	182.6	211.0	3.8%	(0.9)	0%
Agriculture & Forestry	(1,406.3)	(1,405.6)	(1,403.3)	(1,401.1)	0.0%	2.0	0%
Total	**355.2**	**(88.2)**	**(353.9)**	**(484.9)**	**-202.4%**	(539.2)	-992%

Total Primary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Biodiesel	-	0.2	0.2	0.3	N/A	0.2	424%
Biomass	-	-	2.2	2.2	N/A	2.2	n/a
Coal	-	-	-	-	N/A	-	n/a
Electricity	4.0	3.6	3.1	2.8	-2.8%	(1.6)	-37%
Ethanol	-	0.8	1.0	1.2	N/A	0.5	72%
Gasoline	9.9	7.6	5.7	4.8	-5.5%	(0.8)	-15%
Geothermal	2.2	2.8	2.8	2.8	1.8%	0.6	27%
HS Diesel	-	-	-	-	N/A	-	n/a
HS Fuel Oil	4.1	0.1	-	-	-100.0%	(1.2)	-100%
Hydrogen	-	-	-	-	N/A	-	n/a
Jet Fuel	-	-	-	-	N/A	-	n/a
LPG	0.7	0.6	0.6	0.7	0.0%	(0.0)	-4%
LS Diesel	1.8	1.6	1.4	1.2	-2.9%	(0.3)	-18%
LS Fuel Oil	4.7	5.1	3.0	1.8	-7.0%	(5.3)	-74%
Oil, Unspecified	1.1	1.0	1.2	1.2	1.1%	0.1	9%
Utility Gas	0.2	0.2	0.2	0.2	0.3%	(0.0)	-9%
Still Gas	-	-	-	-	N/A	-	n/a
Waste	-	-	-	-	N/A	-	n/a
Total	**28.6**	**23.8**	**21.6**	**19.2**	**-3.0%**	(5.5)	-22%

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Reference Projection vs. Work Plan 2: Hawaii

Reference Case

Total Secondary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	1.7	1.7	1.9	2.0	1.3%
Commercial	2.8	2.7	2.8	2.9	0.3%
Industrial	1.4	1.4	1.4	1.5	0.6%
Passenger - Residents	5.9	5.2	4.2	3.6	-3.7%
Passenger - Visitors	1.8	1.5	1.2	1.0	-4.6%
Marine	-	-	-	-	N/A
Aviation	-	-	-	-	N/A
Freight	4.0	3.6	3.2	3.2	-1.7%
Forestry & Agriculture	0.0	0.0	0.0	0.0	-5.0%
Total	**17.6**	**16.0**	**14.6**	**14.3**	**-1.6%**

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Personal Income	5,570	5,996	6,560	7,625	2.4%
Population (millions)	0	0	0	0	2.0%
Gross Regional Product (GRP)	4,215	4,406	5,167	5,946	2.7%

Generation Capacity (MW)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	236	297	297	297	1.8%
Coal Steam	-	-	-	-	N/A
Hydro	4	4	4	4	0.0%
Biomass	-	-	0	0	N/A
Wind	34	37	41	55	3.9%
Other Renewable	31	31	31	31	0.0%
Total	**305**	**368**	**373**	**387**	**1.8%**

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	892	855	914	965	0.6%
Coal Steam	-	-	-	-	N/A
Hydro	21	21	21	21	0.0%
Biomass	-	-	0	0	N/A
Wind	80	88	100	139	4.3%
Other Renewable	212	213	213	213	0.0%
Purchases from industry	-	-	-	-	N/A
Total	**1,205**	**1,178**	**1,249**	**1,339**	**0.8%**

Work Plan 2

Total Secondary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential	1.7	1.5	1.4	1.3	-2.0%	(0.7)	-35%
Commercial	2.8	2.5	2.2	2.0	-2.6%	(0.9)	-32%
Industrial	1.4	1.3	1.5	1.5	0.7%	0.0	1%
Passenger - Residents	5.9	5.2	4.1	3.4	-4.1%	(0.2)	-6%
Passenger - Visitors	1.8	1.5	1.1	0.9	-5.3%	(0.1)	-9%
Marine	-	-	-	-	N/A	-	n/a
Aviation	-	-	-	-	N/A	-	n/a
Freight	4.0	3.6	3.2	3.2	-1.7%	(0.0)	0%
Forestry & Agriculture	0.0	0.0	0.0	0.0	-5.0%	-	0%
Total	**17.6**	**15.7**	**13.5**	**12.3**	**-2.7%**	(1.9)	-14%

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Personal Income	5,570	5,996	6,560	7,625	2.4%	-	0%
Population (millions)	0	0	0	0	2.0%	-	0%
Gross Regional Product (GRP)	4,215	4,406	5,167	5,946	2.7%	-	0%

Generation Capacity (MW)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Gas/Oil	236	297	282	282	1.4%	(14.1)	-5%
Coal Steam	-	-	-	-	N/A	-	n/a
Hydro	4	4	4	4	0.0%	-	0%
Biomass	-	-	25	25	N/A	25.2	75661%
Wind	34	54	54	68	5.6%	13.0	24%
Other Renewable	31	40	40	40	1.9%	8.8	28%
Total	**305**	**395**	**406**	**420**	**2.5%**	32.9	9%

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Gas/Oil	892	649	369	226	-10.0%	(739.6)	-77%
Coal Steam	-	-	-	-	N/A	-	n/a
Hydro	21	21	21	21	0.0%	-	0%
Biomass	-	-	144	144	N/A	143.9	54700%
Wind	80	145	145	182	6.5%	42.7	31%
Other Renewable	212	272	272	272	1.9%	59.1	28%
Purchases from industry	-	-	-	-	N/A	-	n/a
Total	**1,205**	**1,087**	**951**	**845**	**-2.7%**	(493.8)	-37%

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Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	450	455	490	539	1.4%
Commercial	557	535	568	610	0.7%
Industrial	162	152	151	151	-0.6%
Transportation	-	-	-	-	N/A
Military	4	4	4	5	1.2%
Total	**1,173**	**1,146**	**1,213**	**1,304**	**0.8%**

Distance Travelled (millions of vehicle miles travelled)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Passenger - Residents	1,468	1,360	1,259	1,228	-1.4%
Passenger - Visitors	470	411	374	352	-2.2%

Vehicle Energy Consumption (TBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Resident Light	3.6	3.2	2.7	2.6	-2.6%
Resident Medium	1.9	1.7	1.6	1.5	-1.7%
Resident Heavy	0.4	0.4	0.4	0.5	0.5%
Visitor Light	1.1	0.9	0.8	0.7	-3.5%
Visitor Medium	0.6	0.5	0.4	0.4	-2.6%
Visitor Heavy	0.1	0.1	0.1	0.1	-0.5%
Freight Light	-	-	-	-	N/A
Freight Medium	-	-	-	-	N/A
Freight Heavy	-	-	-	-	N/A
Total	**7.7**	**6.9**	**6.0**	**5.8**	**-2.2%**

Average Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	23.3	23.9	26.3	29.3	1.8%
Medium Gasoline	21.2	22.0	24.5	27.5	2.0%
Heavy Gasoline	16.9	17.2	18.8	20.7	1.6%
Heavy Diesel	16.8	17.2	18.6	20.3	1.5%
Fleet	21.8	22.5	25.1	28.4	2.1%

Work Plan

Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential	450	402	362	331	-2.3%	(208.1)	-39%
Commercial	557	504	420	351	-3.5%	(258.4)	-42%
Industrial	162	144	134	127	-1.9%	(24.2)	-16%
Transportation	-	-	4	8	N/A	7.8	n/a
Military	4	4	4	5	1.2%	-	0%
Total	**1,173**	**1,054**	**925**	**821**	**-2.7%**	(482.9)	-37%

Distance Travelled (millions of vehicle miles travelled)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Passenger - Residents	1,468	1,361	1,262	1,228	-1.4%	0.7	0%
Passenger - Visitors	470	411	375	354	-2.2%	1.8	1%

Vehicle Energy Consumption (TBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Resident Light	3.6	3.2	2.7	2.4	-3.0%	(0.2)	-6%
Resident Medium	1.9	1.7	1.5	1.4	-2.1%	(0.1)	-6%
Resident Heavy	0.4	0.4	0.4	0.4	0.0%	(0.0)	-6%
Visitor Light	1.1	0.9	0.7	0.6	-4.2%	(0.1)	-9%
Visitor Medium	0.6	0.5	0.4	0.4	-3.3%	(0.0)	-9%
Visitor Heavy	0.1	0.1	0.1	0.1	-1.2%	(0.0)	-9%
Freight Light	-	-	-	-	N/A	-	n/a
Freight Medium	-	-	-	-	N/A	-	n/a
Freight Heavy	-	-	-	-	N/A	-	n/a
Total	**7.7**	**6.9**	**5.9**	**5.4**	**-2.7%**	(0.4)	-7%

Average Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	23.3	24.0	26.7	30.5	2.1%	1.2	4%
Medium Gasoline	21.2	22.1	24.9	28.6	2.3%	1.1	4%
Heavy Gasoline	16.9	17.3	19.2	21.8	2.0%	1.1	5%
Heavy Diesel	16.8	17.2	18.9	21.4	1.9%	1.1	5%
Fleet	21.8	22.5	25.9	30.8	2.7%	2.4	8%

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Marginal Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	24.4	28.1	34.0	37.7	3.4%
Medium Gasoline	23.4	26.9	32.6	36.0	3.4%
Heavy Gasoline	17.4	19.4	22.3	24.6	2.7%
Heavy Diesel	17.2	19.2	21.8	24.0	2.6%
Fleet	23.1	26.3	32.1	35.6	3.4%

Average Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	56.6	56.1	54.0	51.7	-0.7%
Medium Gasoline	33.2	33.3	33.5	33.6	0.1%
Heavy Gasoline	10.2	10.6	12.5	14.7	2.8%

Marginal Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	56.0	54.2	47.8	47.9	-1.2%
Medium Gasoline	34.6	33.8	33.7	33.6	-0.2%
Heavy Gasoline	9.3	12.0	18.6	18.5	5.4%

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020
Renewables as % of Electric Sales	27%	28%	28%	29%	1.9%
Ethanol/Gasoline	0%	1%	6%	11%	11.0%
Biodiesel/Diesel	0%	1%	2%	4%	3.8%

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Marginal Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	24.4	28.8	36.8	42.8	4.4%	5.2	14%
Medium Gasoline	23.4	27.5	35.2	41.0	4.4%	5.0	14%
Heavy Gasoline	17.4	19.8	24.0	27.9	3.7%	3.3	13%
Heavy Diesel	17.2	19.6	23.4	27.1	3.6%	3.1	13%
Fleet	23.1	26.9	36.1	42.4	4.8%	6.8	19%

Average Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	56.6	56.1	53.5	50.9	-0.8%	(0.8)	-2%
Medium Gasoline	33.2	33.3	33.5	33.6	0.1%	(0.0)	0%
Heavy Gasoline	10.2	10.6	13.0	15.5	3.3%	0.8	6%

Marginal Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	56.0	54.2	46.5	46.7	-1.4%	(1.2)	-3%
Medium Gasoline	34.6	33.8	33.6	33.6	-0.2%	(0.0)	0%
Heavy Gasoline	9.3	12.0	19.9	19.8	5.9%	1.3	7%

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020	Difference from Ref @ 2020	Difference from Ref @ 2020
Renewables as % of Electric Sales	27%	42%	63%	75%	48.6%	0.5	163%
Ethanol/Gasoline	0%	10%	15%	20%	20.0%	0.1	82%
Biodiesel/Diesel	0%	10%	15%	20%	20.0%	0.2	429%

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Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential					
Electricity	106.0	114.1	118.2	116.0	0.7%
Utility Gas	48.1	47.8	48.1	48.7	0.1%
Bottled Gas	60.0	62.6	68.5	69.2	1.1%
Commercial					
Electricity	96.7	104.1	109.9	107.6	0.8%
Utility Gas	24.8	24.5	24.8	25.4	0.2%
Oil	22.4	25.0	30.9	31.5	2.7%
Bottled Gas	25.0	27.6	33.5	34.1	2.4%
Industrial					
Electricity	84.7	91.2	98.5	96.2	1.0%
Utility Gas	24.8	24.5	24.8	25.4	0.2%
#6 Fuel	9.9	12.5	18.3	19.0	5.2%
Bottled Gas	-	27.6	33.5	34.1	N/A
#2 Fuel	22.4	25.0	30.9	31.5	2.7%
Transportation					
Gasoline	28.2	30.8	36.7	37.4	2.2%
LS Diesel	25.3	27.9	33.7	34.4	2.4%
Ethanol	28.1	25.7	27.9	27.8	-0.1%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%

Work Plan 2

Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential						-	n/a
Electricity	106.0	114.1	134.1	134.9	1.9%	18.9	16%
Utility Gas	48.1	48.3	49.1	50.1	0.3%	1.4	3%
Bottled Gas	60.0	63.3	69.8	70.9	1.3%	1.8	3%
						-	n/a
Commercial						-	n/a
Electricity	96.7	104.1	125.2	127.9	2.2%	20.2	19%
Utility Gas	24.8	25.0	25.8	26.8	0.6%	1.4	6%
Oil	22.4	25.7	32.3	33.4	3.1%	1.9	6%
Bottled Gas	25.0	28.3	34.8	35.9	2.8%	1.8	5%
Industrial						-	n/a
Electricity	84.7	91.2	113.8	115.2	2.4%	18.9	20%
Utility Gas	24.8	25.0	25.8	26.8	0.6%	1.4	6%
#6 Fuel	9.9	13.2	19.8	21.0	6.0%	2.0	10%
Bottled Gas	-	28.3	34.8	35.9	N/A	1.8	5%
#2 Fuel	22.4	25.7	32.3	33.4	3.1%	1.9	6%
Transportation						-	n/a
Gasoline	28.2	31.5	38.1	39.2	2.5%	1.8	5%
LS Diesel	25.3	28.6	35.2	36.3	2.8%	1.9	5%
Ethanol	28.1	25.7	27.9	27.8	-0.1%	-	0%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%	-	0%

Reference Projection vs. Work Plan 2: Kauai

Reference Case

GHG Emissions (kt)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	5.0	4.6	4.3	4.0	-1.6%
Commercial	19.4	18.8	18.5	18.2	-0.5%
Industrial	54.7	55.6	56.6	57.3	0.4%
Passenger - Residents	218.5	186.8	140.1	109.0	-5.2%
Passenger - Visitors	66.3	55.3	39.6	29.9	-5.9%
Marine	-	-	-	-	N/A
Aviation	-	-	-	-	N/A
Freight	88.6	78.4	64.1	59.1	-3.1%
Power Sector	264.1	255.8	94.8	131.8	-5.2%
Waste	63.0	70.0	81.7	93.4	3.1%
Agriculture & Forestry	(236.9)	(235.2)	(232.4)	(229.6)	-0.2%
Total	**542.7**	**490.1**	**267.4**	**273.2**	**-5.1%**

Total Primary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Biodiesel	-	0.0	0.0	0.0	N/A
Biomass	0.7	0.8	3.0	3.1	11.7%
Coal	-	-	-	-	N/A
Electricity	1.4	1.3	1.4	1.5	0.1%
Ethanol	-	0.1	0.2	0.3	N/A
Gasoline	4.4	3.8	2.8	2.3	-4.9%
Geothermal	-	0.0	0.0	0.0	N/A
HS Diesel	-	-	-	-	N/A
HS Fuel Oil	-	-	-	-	N/A
Hydrogen	-	-	-	-	N/A
Jet Fuel	-	-	-	-	N/A
LPG	0.4	0.4	0.3	0.3	-0.6%
LS Diesel	0.7	0.6	0.5	0.4	-4.0%
LS Fuel Oil	3.6	3.5	0.9	0.7	-12.2%
Oil, Unspecified	0.2	0.2	0.1	0.1	-3.7%
Utility Gas	0.0	0.0	0.0	0.0	-0.2%
Still Gas	-	-	-	-	N/A
Waste	-	-	0.1	1.1	N/A
Total	**11.4**	**10.5**	**9.5**	**9.7**	**-1.2%**

Work Plan 2

GHG Emissions (kt)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Abs. Change from Ref @ 2020	% Change from Ref @ 2020
Residential	5.0	4.5	4.2	3.8	-2.1%	(0.3)	-6%
Commercial	19.4	18.7	18.1	17.6	-0.8%	(0.6)	-4%
Industrial	54.7	55.6	56.6	57.3	0.4%	(0.0)	0%
Passenger - Residents	218.5	170.5	124.9	92.9	-6.4%	(16.1)	-15%
Passenger - Visitors	66.3	50.4	34.5	24.5	-7.4%	(5.4)	-18%
Marine	-	-	-	-	N/A	-	n/a
Aviation	-	-	-	-	N/A	-	n/a
Freight	88.6	71.3	58.7	53.3	-3.8%	(5.8)	-10%
Power Sector	264.1	192.2	37.8	74.8	-9.2%	(57.0)	-43%
Waste	63.0	69.9	82.0	93.5	3.1%	0.1	0%
Agriculture & Forestry	(236.9)	(235.2)	(232.4)	(229.6)	-0.2%	-	0%
Total	**542.7**	**397.9**	**184.4**	**188.1**	**-7.8%**	(85.2)	-31%

Total Primary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Biodiesel	-	0.1	0.1	0.1	N/A	0.1	380%
Biomass	0.7	0.8	2.5	1.8	7.2%	(1.3)	-41%
Coal	-	-	-	-	N/A	-	n/a
Electricity	1.4	1.2	1.1	1.1	-2.2%	(0.4)	-26%
Ethanol	-	0.4	0.4	0.5	N/A	0.2	71%
Gasoline	4.4	3.4	2.5	1.9	-6.1%	(0.3)	-15%
Geothermal	-	0.0	0.0	0.0	N/A	0.0	625%
HS Diesel	-	-	-	-	N/A	-	n/a
HS Fuel Oil	-	-	-	-	N/A	-	n/a
Hydrogen	-	-	-	-	N/A	-	n/a
Jet Fuel	-	-	-	-	N/A	-	n/a
LPG	0.4	0.4	0.3	0.3	-0.9%	(0.0)	-4%
LS Diesel	0.7	0.5	0.4	0.3	-5.4%	(0.1)	-18%
LS Fuel Oil	3.6	2.6	0.2	0.0	-31.7%	(0.6)	-96%
Oil, Unspecified	0.2	0.2	0.1	0.1	-3.7%	(0.0)	0%
Utility Gas	0.0	0.0	0.0	0.0	-1.2%	(0.0)	-12%
Still Gas	-	-	-	-	N/A	-	n/a
Waste	-	-	0.1	1.1	N/A	-	0%
Total	**11.4**	**9.5**	**7.9**	**7.3**	**-3.3%**	(2.4)	-25%

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Reference Projection vs. Work Plan 2: Kauai

Reference Case

Total Secondary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	0.5	0.5	0.5	0.6	1.5%
Commercial	1.4	1.3	1.3	1.3	-0.4%
Industrial	0.9	0.8	0.9	0.9	0.0%
Passenger - Residents	3.0	2.6	2.0	1.7	-4.4%
Passenger - Visitors	0.9	0.8	0.6	0.5	-5.1%
Marine	-	-	-	-	N/A
Aviation	-	-	-	-	N/A
Freight	1.2	1.1	0.9	0.9	-2.4%
Forestry & Agriculture	0.0	0.0	0.0	0.0	-5.8%
Total	**7.8**	**7.0**	**6.2**	**5.7**	**-2.3%**

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Personal Income	1,529	1,716	1,898	2,196	2.8%
Population (millions)	0	0	0	0	1.0%
Gross Regional Product (GRP)	2,618	2,692	2,949	3,222	1.6%

Generation Capacity (MW)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	122	122	139	139	1.0%
Coal Steam	-	-	-	-	N/A
Hydro	5	5	26	26	13.1%
Biomass	-	-	22	29	N/A
Wind	-	4	14	14	N/A
Other Renewable	-	0	0	0	N/A
Total	**127**	**131**	**201**	**208**	**3.9%**

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	404	392	110	78	-11.9%
Coal Steam	-	-	-	-	N/A
Hydro	39	39	148	148	10.8%
Biomass	-	-	158	211	N/A
Wind	-	10	39	39	N/A
Other Renewable	-	0	0	0	N/A
Purchases from industry	4	-	3	5	1.7%
Total	**447**	**442**	**458**	**481**	**0.6%**

Work Plan 2

Total Secondary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential	0.5	0.5	0.4	0.5	-0.4%	(0.1)	-22%
Commercial	1.4	1.2	1.1	1.0	-2.3%	(0.3)	-21%
Industrial	0.9	0.8	0.9	0.9	-0.1%	(0.0)	0%
Passenger - Residents	3.0	2.6	2.0	1.6	-4.9%	(0.1)	-6%
Passenger - Visitors	0.9	0.8	0.5	0.4	-5.8%	(0.0)	-10%
Marine	-	-	-	-	N/A	-	n/a
Aviation	-	-	-	-	N/A	-	n/a
Freight	1.2	1.1	0.9	0.9	-2.4%	0.0	0%
Forestry & Agriculture	0.0	0.0	0.0	0.0	-5.8%	-	0%
Total	**7.8**	**6.9**	**5.8**	**5.2**	**-3.1%**	(0.5)	-10%

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Personal Income	1,529	1,716	1,898	2,196	2.8%	-	0%
Population (millions)	0	0	0	0	1.0%	-	0%
Gross Regional Product (GRP)	2,618	2,692	2,949	3,222	1.6%	-	0%

Generation Capacity (MW)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Gas/Oil	122	122	139	139	1.0%	-	0%
Coal Steam	-	-	-	-	N/A	-	n/a
Hydro	5	5	26	26	13.1%	-	0%
Biomass	-	-	22	29	N/A	0.2	1%
Wind	-	26	26	26	N/A	11.6	81%
Other Renewable	-	0	0	0	N/A	0.3	586%
Total	**127**	**153**	**213**	**221**	**4.3%**	12.1	6%

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Gas/Oil	404	299	26	3	-31.5%	(74.8)	-96%
Coal Steam	-	-	-	-	N/A	-	n/a
Hydro	39	39	148	148	10.8%	-	0%
Biomass	-	-	125	131	N/A	(79.9)	-38%
Wind	-	71	71	71	N/A	32.1	82%
Other Renewable	-	2	2	2	N/A	1.8	700%
Purchases from industry	4	0	4	6	3.4%	1.2	24%
Total	**447**	**412**	**377**	**362**	**-1.6%**	(119.5)	-25%

Reference Projection vs. Work Plan 2: Kauai

Reference Case

Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	120	125	139	155	2.0%
Commercial	283	269	274	275	-0.2%
Industrial	1	2	3	5	14.6%
Transportation	-	-	-	-	N/A
Military	16	17	18	18	1.0%
Total	**420**	**414**	**433**	**453**	**0.6%**

Distance Travelled (millions of vehicle miles travelled)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Passenger - Residents	545	490	433	402	-2.3%
Passenger - Visitors	170	152	138	127	-2.2%

Vehicle Energy Consumption (TBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Resident Light	1.8	1.6	1.3	1.2	-3.3%
Resident Medium	1.0	0.9	0.8	0.7	-2.4%
Resident Heavy	0.2	0.2	0.2	0.2	-0.3%
Visitor Light	0.5	0.5	0.4	0.3	-4.0%
Visitor Medium	0.3	0.3	0.2	0.2	-3.1%
Visitor Heavy	0.1	0.1	0.1	0.1	-1.0%
Freight Light	-	-	-	-	N/A
Freight Medium	-	-	-	-	N/A
Freight Heavy	-	-	-	-	N/A
Total	**3.9**	**3.4**	**2.9**	**2.6**	**-2.9%**

Average Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	23.3	23.9	26.1	28.9	1.7%
Medium Gasoline	21.3	22.0	24.3	27.1	1.9%
Heavy Gasoline	16.9	17.2	18.7	20.5	1.5%
Heavy Diesel	16.9	17.2	18.8	20.6	1.5%
Fleet	21.9	22.5	24.9	28.1	1.9%

Work Plan 2

Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential	120	112	110	118	-0.1%	(36.6)	-24%
Commercial	283	253	220	197	-2.7%	(77.5)	-28%
Industrial	1	2	4	6	16.6%	1.2	24%
Transportation	-	-	1	3	N/A	2.6	n/a
Military	16	17	18	18	1.0%	-	0%
Total	**420**	**385**	**353**	**343**	**-1.6%**	(110.4)	-24%

Distance Travelled (millions of vehicle miles travelled)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Passenger - Residents	545	490	433	401	-2.3%	(1.2)	0%
Passenger - Visitors	170	152	138	128	-2.2%	0.8	1%

Vehicle Energy Consumption (TBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Resident Light	1.8	1.6	1.3	1.1	-3.8%	(0.1)	-6%
Resident Medium	1.0	0.9	0.7	0.7	-2.9%	(0.0)	-6%
Resident Heavy	0.2	0.2	0.2	0.2	-0.8%	(0.0)	-6%
Visitor Light	0.5	0.5	0.4	0.3	-4.8%	(0.0)	-10%
Visitor Medium	0.3	0.3	0.2	0.2	-3.9%	(0.0)	-10%
Visitor Heavy	0.1	0.1	0.1	0.1	-1.8%	(0.0)	-10%
Freight Light	-	-	-	-	N/A	-	n/a
Freight Medium	-	-	-	-	N/A	-	n/a
Freight Heavy	-	-	-	-	N/A	-	n/a
Total	**3.9**	**3.4**	**2.8**	**2.5**	**-3.5%**	(0.2)	-7%

Average Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	23.3	24.0	26.5	30.0	2.0%	1.1	4%
Medium Gasoline	21.3	22.0	24.6	28.2	2.2%	1.0	4%
Heavy Gasoline	16.9	17.2	19.0	21.5	1.9%	1.0	5%
Heavy Diesel	16.9	17.3	19.2	21.7	2.0%	1.2	6%
Fleet	21.9	22.5	25.6	30.0	2.5%	1.9	7%

Reference Projection vs. Work Plan 2: Kauai

Reference Case

Marginal Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	24.4	28.1	34.0	37.7	3.4%
Medium Gasoline	23.4	26.9	32.6	36.0	3.4%
Heavy Gasoline	17.4	19.4	22.3	24.6	2.7%
Heavy Diesel	17.2	19.2	21.8	24.0	2.6%
Fleet	23.0	26.6	32.1	35.6	3.4%

Average Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	56.6	55.8	54.0	52.0	-0.6%
Medium Gasoline	33.2	33.4	33.6	33.7	0.1%
Heavy Gasoline	10.2	10.8	12.5	14.3	2.7%

Marginal Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	55.3	52.3	48.3	48.4	-1.0%
Medium Gasoline	34.9	33.9	33.7	33.7	-0.3%
Heavy Gasoline	9.8	13.8	18.0	17.9	4.7%

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020
Renewables as % of Electric Sales	9%	12%	80%	88%	78.7%
Ethanol/Gasoline	0%	1%	6%	11%	11.0%
Biodiesel/Diesel	0%	1%	2%	4%	4.1%

Work Plan 2

Marginal Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	24.4	28.8	36.8	42.8	4.4%	5.2	14%
Medium Gasoline	23.4	27.5	35.2	41.0	4.4%	5.0	14%
Heavy Gasoline	17.4	19.8	24.0	27.9	3.7%	3.3	13%
Heavy Diesel	17.2	19.6	23.4	27.1	3.6%	3.1	13%
Fleet	23.0	27.2	35.5	41.7	4.7%	6.2	17%

Average Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	56.6	55.7	53.6	51.5	-0.7%	(0.6)	-1%
Medium Gasoline	33.2	33.4	33.5	33.6	0.1%	(0.0)	0%
Heavy Gasoline	10.2	10.9	12.9	14.9	3.0%	0.6	4%

Marginal Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	55.3	51.9	47.3	47.5	-1.2%	(0.9)	-2%
Medium Gasoline	34.9	33.8	33.7	33.7	-0.3%	(0.0)	0%
Heavy Gasoline	9.8	14.3	19.0	18.9	5.1%	0.9	5%

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020	Difference from Ref @ 2020	Difference from Ref @ 2020
Renewables as % of Electric Sales	9%	29%	98%	103%	93.6%	0.1	17%
Ethanol/Gasoline	0%	10%	15%	20%	20.0%	0.1	82%
Biodiesel/Diesel	0%	10%	15%	20%	20.0%	0.2	389%

Reference Projection vs. Work Plan 2: Kauai

Reference Case

Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential					
Electricity	115.1	124.0	127.7	151.1	2.1%
Utility Gas	46.8	46.5	46.8	47.3	0.1%
Bottled Gas	60.0	62.6	68.5	69.2	1.1%
Commercial					
Electricity	111.5	120.1	124.4	147.9	2.2%
Utility Gas	-	-	-	-	N/A
Oil	22.4	25.0	30.9	31.5	2.7%
Bottled Gas	25.0	27.6	33.5	34.1	2.4%
Industrial					
Electricity	104.9	112.9	144.2	150.6	2.8%
Utility Gas	-	-	-	-	N/A
#6 Fuel	-	12.5	18.3	19.0	N/A
Bottled Gas	-	27.6	33.5	34.1	N/A
#2 Fuel	22.4	25.0	30.9	31.5	2.7%
Transportation					
Gasoline	28.2	30.8	36.7	37.4	2.2%
LS Diesel	25.3	27.9	33.7	34.4	2.4%
Ethanol	28.1	25.7	27.9	27.8	-0.1%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%

Work Plan 2

Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential						-	n/a
Electricity	115.1	124.0	139.0	140.5	1.5%	(10.6)	-7%
Utility Gas	46.8	47.0	47.8	48.7	0.3%	1.4	3%
Bottled Gas	60.0	63.3	69.8	70.9	1.3%	1.8	3%
						-	n/a
Commercial						-	n/a
Electricity	111.5	120.1	135.8	137.3	1.6%	(10.6)	-7%
Utility Gas	-	-	-	-	N/A	-	n/a
Oil	22.4	25.7	32.3	33.4	3.1%	1.9	6%
Bottled Gas	25.0	28.3	34.8	35.9	2.8%	1.8	5%
Industrial						-	n/a
Electricity	104.9	112.9	149.3	139.0	2.2%	(11.6)	-8%
Utility Gas	-	-	1.1	1.4	N/A	1.4	n/a
#6 Fuel	-	13.2	19.8	21.0	N/A	2.0	10%
Bottled Gas	-	28.3	34.8	35.9	N/A	1.8	5%
#2 Fuel	22.4	25.7	32.3	33.4	3.1%	1.9	6%
Transportation						-	n/a
Gasoline	28.2	31.5	38.1	39.2	2.5%	1.8	5%
LS Diesel	25.3	28.6	35.2	36.3	2.8%	1.9	5%
Ethanol	28.1	25.7	27.9	27.8	-0.1%	-	0%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%	-	0%

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Proposed GHG Reduction Work Plans for Hawaii

Reference Projection vs. Work Plan 3: Oahu

Reference Case

GHG Emissions (kt)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	42.3	41.1	41.1	42.2	0.0%
Commercial	204.9	206.1	209.5	200.4	-0.2%
Industrial	115.9	123.3	136.6	138.7	1.4%
Passenger - Residents	1,890.2	1,853.7	1,523.5	1,287.1	-2.9%
Passenger - Visitors	133.1	116.2	82.6	64.2	-5.5%
Marine	2,172.6	2,153.1	2,183.9	2,135.2	-0.1%
Aviation	4,839.4	4,929.2	5,179.8	5,166.9	0.5%
Freight	816.6	843.7	799.0	785.2	-0.3%
Power Sector	6,952.9	6,226.2	6,068.0	6,218.0	-0.9%
Waste	714.0	729.9	756.4	782.8	0.7%
Agriculture & Forestry	(316.9)	(319.5)	(323.9)	(328.3)	0.3%
Total	**17,565.1**	**16,903.1**	**16,656.5**	**16,492.4**	**-0.5%**

Work Plan 3

GHG Emissions (kt)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Abs. Change from Ref @ 2020	% Change from Ref @ 2020
Residential	42.3	40.5	38.4	36.6	-1.1%	(5.6)	-13%
Commercial	204.9	202.6	195.8	178.9	-1.0%	(21.5)	-11%
Industrial	115.9	123.1	152.2	151.7	2.1%	13.0	9%
Passenger - Residents	1,890.2	1,703.0	1,381.1	1,125.8	-3.9%	(161.3)	-13%
Passenger - Visitors	133.1	110.3	79.4	61.8	-5.7%	(2.3)	-4%
Marine	2,172.6	2,155.2	2,189.8	2,142.4	-0.1%	7.1	0%
Aviation	4,839.4	4,934.1	5,197.8	5,190.7	0.5%	23.8	0%
Freight	816.6	770.0	737.5	718.9	-1.0%	(66.3)	-8%
Power Sector	6,952.9	5,556.1	3,022.4	2,320.4	-8.1%	(3,897.5)	-63%
Waste	714.0	730.5	764.2	790.1	0.8%	7.2	1%
Agriculture & Forestry	(316.9)	(319.5)	(323.7)	(328.1)	0.3%	0.2	0%
Total	**17,565.1**	**16,006.0**	**13,434.8**	**12,389.2**	**-2.6%**	(4,103.2)	-25%

Reference Case

Total Primary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Biodiesel	-	7.7	15.3	15.4	N/A
Biomass	-	2.8	2.8	2.8	N/A
Coal	13.8	13.8	13.8	13.8	0.0%
Electricity	22.4	22.3	23.6	24.0	0.5%
Ethanol	0.1	0.5	1.9	3.1	27.2%
Gasoline	35.1	34.4	28.9	25.3	-2.5%
Geothermal	-	0.0	0.0	0.0	N/A
HS Diesel	-	-	-	-	N/A
HS Fuel Oil	79.3	69.3	67.8	69.4	-1.0%
Hydrogen	-	-	-	-	N/A
Jet Fuel	81.1	82.6	86.8	86.6	0.5%
LPG	0.7	0.7	0.7	0.7	0.2%
LS Diesel	11.3	11.3	11.1	10.7	-0.4%
LS Fuel Oil	0.2	0.9	0.8	0.9	11.9%
Oil, Unspecified	3.3	3.4	3.5	3.4	0.4%
Utility Gas	2.9	2.9	3.0	2.9	0.1%
Still Gas	-	-	-	-	N/A
Waste	5.0	5.0	5.0	5.0	0.0%
Total	**255.2**	**257.6**	**265.1**	**264.2**	**0.3%**

Work Plan 3

Total Primary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Biodiesel	-	8.6	20.8	21.0	N/A	5.6	36%
Biomass	-	2.8	4.4	4.4	N/A	1.5	53%
Coal	13.8	13.8	13.8	13.8	0.0%	-	0%
Electricity	22.4	20.8	18.8	17.1	-2.1%	(6.9)	-29%
Ethanol	0.1	3.5	4.6	5.5	32.9%	2.4	77%
Gasoline	35.1	31.4	26.0	22.2	-3.5%	(3.2)	-12%
Geothermal	-	0.0	0.0	0.0	N/A	0.0	625%
HS Diesel	-	-	-	-	N/A	-	n/a
HS Fuel Oil	79.3	59.1	29.8	20.8	-9.8%	(48.6)	-70%
Hydrogen	-	-	-	-	N/A	-	n/a
Jet Fuel	81.1	82.7	87.1	87.0	0.5%	0.4	0%
LPG	0.7	0.7	0.7	0.7	0.0%	(0.0)	-3%
LS Diesel	11.3	10.9	10.6	10.0	-0.9%	(0.8)	-7%
LS Fuel Oil	0.2	2.8	-	-	-100.0%	(0.9)	-100%
Oil, Unspecified	3.3	3.4	3.8	3.7	0.8%	0.2	6%
Utility Gas	2.9	2.9	2.7	2.4	-1.4%	(0.5)	-18%
Still Gas	-	-	-	-	N/A	-	n/a
Waste	5.0	5.0	5.0	5.0	0.0%	-	0%
Total	**255.2**	**248.3**	**228.0**	**213.5**	**-1.4%**	(50.7)	-19%

Proposed GHG Reduction Work Plans for Hawaii

Reference Projection vs. Work Plan 3: Oahu

Reference Case

Total Secondary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	8.0	7.9	8.2	8.5	0.5%
Commercial	16.7	16.6	17.1	16.9	0.1%
Industrial	4.6	4.8	5.1	5.1	0.7%
Passenger - Residents	25.7	25.5	22.4	20.0	-1.9%
Passenger - Visitors	1.8	1.6	1.2	0.9	-4.8%
Marine	20.9	20.7	21.0	20.5	-0.1%
Aviation	81.1	82.6	86.8	86.6	0.5%
Freight	11.1	11.5	11.4	11.7	0.4%
Forestry & Agriculture	0.1	0.1	0.1	0.1	-3.4%
Total	**170.0**	**171.3**	**173.2**	**170.4**	**0.0%**

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Personal Income	31,302	32,001	35,929	38,963	1.7%
Population (millions)	1	1	1	1	0.9%
Gross Regional Product (GRP)	47,103	52,953	58,286	64,021	2.4%

Generation Capacity (MW)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	1,383	1,459	1,459	1,459	0.4%
Coal Steam	180	180	180	180	0.0%
Hydro	14	14	14	14	0.0%
Biomass	60	195	195	195	9.5%
Wind	-	54	54	54	N/A
Other Renewable	-	110	220	221	N/A
Total	**1,637**	**2,012**	**2,122**	**2,122**	**2.0%**

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	6,342	5,468	5,278	5,457	-1.1%
Coal Steam	1,510	1,510	1,510	1,510	0.0%
Hydro	70	70	70	70	0.0%
Biomass	291	473	474	474	3.8%
Wind	-	148	148	148	N/A
Other Renewable	-	627	1,255	1,255	N/A
Purchases from industry	12	2	-	-	-100.0%
Total	**8,226**	**8,298**	**8,734**	**8,914**	**0.6%**

Work Plan 3

Total Secondary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential	8.0	7.2	6.5	6.0	-2.2%	(2.5)	-30%
Commercial	16.7	15.8	14.0	12.3	-2.3%	(4.6)	-27%
Industrial	4.6	4.6	5.0	4.9	0.4%	(0.2)	-5%
Passenger - Residents	25.7	25.5	22.0	19.2	-2.2%	(0.9)	-4%
Passenger - Visitors	1.8	1.6	1.1	0.9	-5.2%	(0.0)	-5%
Marine	20.9	20.7	21.1	20.6	-0.1%	0.1	0%
Aviation	81.1	82.7	87.1	87.0	0.5%	0.4	0%
Freight	11.1	11.5	11.5	11.8	0.5%	0.2	1%
Forestry & Agriculture	0.1	0.1	0.1	0.1	-4.0%	(0.0)	-7%
Total	**170.0**	**169.8**	**168.4**	**162.7**	**-0.3%**	(7.7)	-4%

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Personal Income	31,302	32,001	35,929	38,963	1.7%	-	0%
Population (millions)	1	1	1	1	0.9%	-	0%
Gross Regional Product (GRP)	47,103	52,953	58,286	64,021	2.4%	-	0%

Generation Capacity (MW)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Gas/Oil	1,383	1,459	1,364	1,364	-0.1%	(94.9)	-7%
Coal Steam	180	180	180	180	0.0%	-	0%
Hydro	14	14	14	14	0.0%	-	0%
Biomass	60	195	212	212	10.2%	17.2	9%
Wind	-	156	156	156	N/A	102.1	190%
Other Renewable	-	118	289	299	N/A	78.3	35%
Total	**1,637**	**2,122**	**2,215**	**2,225**	**2.4%**	102.7	5%

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Gas/Oil	6,342	4,665	1,799	945	-13.6%	(4,511.9)	-83%
Coal Steam	1,510	1,510	1,510	1,510	0.0%	-	0%
Hydro	70	70	70	70	0.0%	-	0%
Biomass	291	473	572	572	5.3%	98.3	21%
Wind	-	413	413	413	N/A	264.9	179%
Other Renewable	-	675	1,519	1,594	N/A	339.0	27%
Purchases from industry	12	11	13	15	1.8%	15.0	n/a
Total	**8,226**	**7,817**	**5,896**	**5,119**	**-3.6%**	(3,794.6)	-43%

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Proposed GHG Reduction Work Plans for Hawaii

Reference Projection vs. Work Plan 3: Oahu

Reference Case

Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	2,132	2,112	2,210	2,294	0.6%
Commercial	3,910	3,902	4,030	4,024	0.2%
Industrial	560	556	591	594	0.5%
Transportation	-	-	107	152	N/A
Military	1,221	1,320	1,367	1,414	1.1%
Total	**7,823**	**7,891**	**8,306**	**8,477**	**0.6%**

Distance Travelled (millions of vehicle miles travelled)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Passenger - Residents	7,031	7,143	7,418	7,577	0.6%
Passenger - Visitors	454	464	447	422	-0.6%

Vehicle Energy Consumption (TBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Resident Light	15.6	15.7	14.6	14.1	-0.8%
Resident Medium	8.3	8.6	8.4	8.5	0.1%
Resident Heavy	1.9	2.1	2.2	2.6	2.3%
Visitor Light	1.1	1.0	0.8	0.7	-3.8%
Visitor Medium	0.6	0.5	0.4	0.4	-2.9%
Visitor Heavy	0.1	0.1	0.1	0.1	-0.8%
Freight Light	-	-	-	-	N/A
Freight Medium	-	-	-	-	N/A
Freight Heavy	-	-	-	-	N/A
Total	**27.6**	**28.0**	**26.5**	**26.3**	**-0.4%**

Average Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	23.5	24.2	26.4	29.5	1.7%
Medium Gasoline	21.6	22.4	24.7	27.8	2.0%
Heavy Gasoline	16.9	17.3	18.7	20.6	1.5%
Heavy Diesel	16.9	17.2	18.5	20.3	1.4%
Fleet	22.1	22.8	25.2	28.6	2.0%

Work Plan 3

Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential	2,132	1,915	1,715	1,586	-2.3%	(708.0)	-31%
Commercial	3,910	3,673	3,180	2,785	-2.6%	(1,239.0)	-31%
Industrial	560	528	525	493	-1.0%	(101.2)	-17%
Transportation	-	-	132	197	N/A	45.7	30%
Military	1,221	1,320	1,367	1,414	1.1%	-	0%
Total	**7,823**	**7,436**	**6,919**	**6,475**	**-1.4%**	(2,002.4)	-24%

Distance Travelled (millions of vehicle miles travelled)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Passenger - Residents	7,031	7,147	7,475	7,666	0.7%	88.8	1%
Passenger - Visitors	454	465	445	415	-0.7%	(7.4)	-2%

Vehicle Energy Consumption (TBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Resident Light	15.6	15.7	14.4	13.5	-1.1%	(0.6)	-4%
Resident Medium	8.3	8.6	8.2	8.1	-0.2%	(0.4)	-4%
Resident Heavy	1.9	2.1	2.2	2.4	2.0%	(0.1)	-4%
Visitor Light	1.1	1.0	0.7	0.6	-4.1%	(0.0)	-5%
Visitor Medium	0.6	0.5	0.4	0.4	-3.2%	(0.0)	-5%
Visitor Heavy	0.1	0.1	0.1	0.1	-1.1%	(0.0)	-5%
Freight Light	-	-	-	-	N/A	-	n/a
Freight Medium	-	-	-	-	N/A	-	n/a
Freight Heavy	-	-	-	-	N/A	-	n/a
Total	**27.6**	**28.0**	**26.1**	**25.1**	**-0.7%**	(1.1)	-4%

Average Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	23.5	24.2	26.7	30.6	2.0%	1.1	4%
Medium Gasoline	21.6	22.4	25.0	28.8	2.2%	1.0	4%
Heavy Gasoline	16.9	17.3	19.0	21.6	1.9%	1.0	5%
Heavy Diesel	16.9	17.3	18.8	21.3	1.8%	1.0	5%
Fleet	22.1	22.8	26.0	31.2	2.7%	2.6	9%

Reference Projection vs. Work Plan 3: Oahu

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Marginal Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	24.4	28.1	34.0	37.7	3.4%
Medium Gasoline	23.4	26.9	32.6	36.0	3.4%
Heavy Gasoline	17.4	19.4	22.3	24.6	2.7%
Heavy Diesel	17.2	19.2	21.8	24.0	2.6%
Fleet	23.1	26.9	32.2	35.8	3.4%

Average Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	57.3	56.4	55.1	53.3	-0.5%
Medium Gasoline	33.3	33.5	33.6	33.7	0.1%
Heavy Gasoline	9.4	10.1	11.3	12.9	2.5%

Marginal Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	55.7	52.5	49.9	49.9	-0.8%
Medium Gasoline	34.9	33.9	33.8	33.8	-0.3%
Heavy Gasoline	9.3	13.6	16.4	16.3	4.4%

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020
Renewables as % of Electric Sales	5%	17%	23%	23%	18.3%
Ethanol/Gasoline	0%	1%	6%	11%	10.6%
Biodiesel/Diesel	0%	0%	2%	3%	3.1%

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Marginal Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	24.4	28.5	36.9	43.1	4.5%	5.4	14%
Medium Gasoline	23.4	27.3	35.3	41.2	4.4%	5.2	14%
Heavy Gasoline	17.4	19.8	24.0	27.9	3.7%	3.3	13%
Heavy Diesel	17.2	19.5	23.4	27.1	3.5%	3.1	13%
Fleet	23.1	27.3	36.4	43.4	5.0%	7.6	21%

Average Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	57.3	56.4	54.5	51.6	-0.8%	(1.7)	-3%
Medium Gasoline	33.3	33.5	33.6	33.7	0.1%	(0.0)	0%
Heavy Gasoline	9.4	10.1	11.9	14.7	3.5%	1.8	14%

Marginal Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	55.7	52.5	46.0	46.2	-1.4%	(3.8)	-8%
Medium Gasoline	34.9	33.9	33.7	33.7	-0.3%	(0.1)	0%
Heavy Gasoline	9.3	13.6	20.3	20.2	6.1%	3.9	24%

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020	Difference from Ref @ 2020	Difference from Ref @ 2020
Renewables as % of Electric Sales	5%	22%	37%	41%	36.3%	0.2	78%
Ethanol/Gasoline	0%	10%	15%	20%	19.6%	0.1	82%
Biodiesel/Diesel	0%	10%	15%	20%	20.0%	0.2	545%

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Reference Projection vs. Work Plan 3: Oahu

Reference Case

Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential					
Electricity	66.3	71.4	90.2	90.2	2.4%
Utility Gas	43.1	42.8	43.1	43.6	0.1%
Bottled Gas	60.0	62.6	68.5	69.2	1.1%
Commercial					
Electricity	55.0	59.2	79.5	79.5	2.9%
Utility Gas	28.1	27.8	28.0	28.6	0.1%
Oil	22.4	25.0	30.9	31.5	2.7%
Bottled Gas	25.0	27.6	33.5	34.1	2.4%
Industrial					
Electricity	51.7	55.6	76.5	76.5	3.1%
Utility Gas	28.1	27.8	28.0	28.6	0.1%
#6 Fuel	9.9	12.5	18.3	19.0	5.2%
Bottled Gas	-	-	-	-	N/A
#2 Fuel	22.4	25.0	30.9	31.5	2.7%
Transportation					
Gasoline	28.2	30.8	36.7	37.4	2.2%
LS Diesel	25.3	27.9	33.7	34.4	2.4%
Ethanol	28.1	25.7	27.9	27.8	-0.1%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%

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Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential						-	n/a
Electricity	66.3	71.4	98.3	102.3	3.4%	12.2	14%
Utility Gas	43.1	42.8	57.4	58.4	2.4%	14.8	34%
Bottled Gas	60.0	62.6	70.2	71.4	1.3%	2.3	3%
						-	n/a
Commercial						-	n/a
Electricity	55.0	59.2	87.1	91.7	4.0%	12.2	15%
Utility Gas	28.1	27.8	42.3	43.4	3.4%	14.8	52%
Oil	22.4	25.0	32.7	33.9	3.2%	2.4	8%
Bottled Gas	25.0	27.6	35.2	36.4	2.9%	2.3	7%
Industrial						-	n/a
Electricity	51.7	55.6	84.1	88.7	4.2%	12.2	16%
Utility Gas	28.1	27.8	42.3	43.4	3.4%	14.8	52%
#6 Fuel	9.9	12.5	22.2	24.1	7.1%	5.1	27%
Bottled Gas	-	-	-	-	N/A	-	n/a
#2 Fuel	22.4	25.0	32.7	33.9	3.2%	2.4	8%
Transportation						-	n/a
Gasoline	28.2	30.8	38.5	39.7	2.6%	2.3	6%
LS Diesel	25.3	27.9	35.6	36.8	2.9%	2.4	7%
Ethanol	28.1	25.7	27.9	27.8	-0.1%	-	0%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%	-	0%

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Proposed GHG Reduction Work Plans for Hawaii

Reference Projection vs. Work Plan 3: Maui

Reference Case

GHG Emissions (kt)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	6.3	6.1	6.2	6.3	0.0%
Commercial	54.1	51.5	50.1	47.0	-1.1%
Industrial	436.4	433.3	415.9	394.7	-0.8%
Passenger - Residents	373.4	311.0	230.4	181.9	-5.4%
Passenger - Visitors	120.7	97.3	69.1	52.8	-6.2%
Marine	-	-	-	-	N/A
Aviation	-	-	-	-	N/A
Freight	196.5	182.2	150.3	138.2	-2.7%
Power Sector	858.1	800.0	808.3	721.2	-1.3%
Waste	124.5	149.3	190.7	232.2	4.9%
Agriculture & Forestry	(307.0)	(306.5)	(305.7)	(304.9)	-0.1%
Total	**1,863.2**	**1,724.2**	**1,615.3**	**1,469.4**	**-1.8%**

Total Primary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Biodiesel	-	0.0	0.0	0.0	N/A
Biomass	4.1	4.2	4.1	6.9	4.0%
Coal	1.8	2.0	1.9	1.8	0.1%
Electricity	4.3	3.9	4.1	4.2	-0.2%
Ethanol	0.1	0.1	0.3	0.5	14.3%
Gasoline	8.1	6.7	5.0	4.0	-5.3%
Geothermal	-	0.0	0.0	0.0	N/A
HS Diesel	-	-	-	-	N/A
HS Fuel Oil	0.6	-	-	-	-100.0%
Hydrogen	-	-	-	-	N/A
Jet Fuel	-	-	-	-	N/A
LPG	0.7	0.7	0.7	0.6	-0.4%
LS Diesel	1.3	1.2	1.1	1.0	-1.7%
LS Fuel Oil	11.1	10.9	11.0	9.5	-1.2%
Oil, Unspecified	1.0	1.0	0.9	0.9	-1.4%
Utility Gas	0.1	0.1	0.1	0.1	1.1%
Still Gas	-	-	-	-	N/A
Waste	-	-	-	-	N/A
Total	**33.0**	**30.8**	**29.2**	**29.5**	**-0.9%**

Work Plan 3

GHG Emissions (kt)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Abs. Change from Ref @ 2020	% Change from Ref @ 2020
Residential	6.3	6.1	6.1	6.9	0.7%	0.6	9%
Commercial	54.1	51.8	48.3	45.8	-1.3%	(1.2)	-3%
Industrial	436.4	433.5	416.0	394.8	-0.8%	0.0	0%
Passenger - Residents	373.4	286.4	208.9	158.3	-6.4%	(23.6)	-13%
Passenger - Visitors	120.7	89.4	60.5	43.3	-7.6%	(9.5)	-18%
Marine	-	-	-	-	N/A	-	n/a
Aviation	-	-	-	-	N/A	-	n/a
Freight	196.5	174.1	140.3	126.3	-3.3%	(11.9)	-9%
Power Sector	858.1	646.9	753.5	711.5	-1.4%	(9.7)	-1%
Waste	124.5	161.9	196.5	236.7	5.1%	4.5	2%
Agriculture & Forestry	(307.0)	(306.2)	(305.7)	(304.9)	-0.1%	-	0%
Total	**1,863.2**	**1,543.8**	**1,524.3**	**1,418.6**	**-2.1%**	(50.8)	-3%

Total Primary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Biodiesel	-	0.1	0.2	0.2	N/A	0.2	483%
Biomass	4.1	4.2	4.0	7.2	4.4%	0.3	5%
Coal	1.8	2.0	1.9	1.8	-0.1%	(0.0)	-3%
Electricity	4.3	3.7	3.2	2.8	-3.3%	(1.4)	-34%
Ethanol	0.1	0.7	0.8	0.8	19.1%	0.4	71%
Gasoline	8.1	6.2	4.4	3.4	-6.5%	(0.6)	-15%
Geothermal	-	0.0	0.0	0.0	N/A	0.0	625%
HS Diesel	-	-	-	-	N/A	-	n/a
HS Fuel Oil	0.6	-	-	-	-100.0%	-	n/a
Hydrogen	-	-	-	-	N/A	-	n/a
Jet Fuel	-	-	-	-	N/A	-	n/a
LPG	0.7	0.7	0.6	0.6	-0.4%	(0.0)	0%
LS Diesel	1.3	1.2	1.0	0.9	-2.8%	(0.1)	-15%
LS Fuel Oil	11.1	8.8	10.3	9.4	-1.3%	(0.1)	-1%
Oil, Unspecified	1.0	1.0	0.9	0.8	-1.6%	(0.0)	-3%
Utility Gas	0.1	0.1	0.1	0.1	-1.0%	(0.0)	-24%
Still Gas	-	-	-	-	N/A	-	n/a
Waste	-	-	-	-	N/A	-	n/a
Total	**33.0**	**28.6**	**27.3**	**28.0**	**-1.3%**	(1.5)	-5%

Reference Projection vs. Work Plan 3: Maui

Reference Case

Total Secondary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	1.6	1.7	1.8	1.9	1.3%
Commercial	3.3	3.1	3.1	3.1	-0.4%
Industrial	7.1	7.1	6.9	6.6	-0.6%
Passenger - Residents	5.1	4.3	3.3	2.8	-4.6%
Passenger - Visitors	1.6	1.3	1.0	0.8	-5.4%
Marine	-	-	-	-	N/A
Aviation	-	-	-	-	N/A
Freight	2.7	2.5	2.1	2.0	-2.3%
Forestry & Agriculture	0.0	0.0	0.0	0.0	-6.1%
Total	**21.4**	**19.9**	**18.2**	**17.1**	**-1.7%**

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Personal Income	4,119	4,348	5,069	5,746	2.6%
Population (millions)	0	0	0	0	1.3%
Gross Regional Product (GRP)	6,723	7,289	7,719	8,420	1.7%

Generation Capacity (MW)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	264	266	312	315	1.4%
Coal Steam	-	-	-	-	N/A
Hydro	-	-	-	-	N/A
Biomass	-	-	0	25	N/A
Wind	30	33	44	44	2.9%
Other Renewable	-	0	0	1	N/A
Total	**294**	**299**	**356**	**384**	**2.1%**

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	1,199	1,141	1,157	1,012	-1.3%
Coal Steam	-	-	-	-	N/A
Hydro	-	-	-	-	N/A
Biomass	-	-	0	182	N/A
Wind	57	65	94	94	4.0%
Other Renewable	-	1	1	1	N/A
Purchases from industry	94	123	136	138	3.0%
Total	**1,350**	**1,329**	**1,388**	**1,428**	**0.4%**

Work Plan 3

Total Secondary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential	1.6	1.5	1.3	1.2	-2.4%	(0.7)	-39%
Commercial	3.3	3.1	2.7	2.4	-2.4%	(0.7)	-23%
Industrial	7.1	7.0	6.7	6.3	-0.9%	(0.3)	-4%
Passenger - Residents	5.1	4.3	3.3	2.6	-5.0%	(0.2)	-6%
Passenger - Visitors	1.6	1.3	0.9	0.7	-6.2%	(0.1)	-11%
Marine	-	-	-	-	N/A	-	n/a
Aviation	-	-	-	-	N/A	-	n/a
Freight	2.7	2.6	2.1	2.0	-2.2%	0.0	2%
Forestry & Agriculture	0.0	0.0	0.0	0.0	-6.0%	0.0	1%
Total	**21.4**	**19.8**	**17.0**	**15.2**	**-2.6%**	(1.9)	-11%

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Personal Income	4,119	4,348	5,069	5,746	2.6%	-	0%
Population (millions)	0	0	0	0	1.3%	-	0%
Gross Regional Product (GRP)	6,723	7,289	7,719	8,420	1.7%	-	0%

Generation Capacity (MW)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Gas/Oil	264	266	310	312	1.3%	(2.5)	-1%
Coal Steam	-	-	-	-	N/A	-	n/a
Hydro	-	-	-	-	N/A	-	n/a
Biomass	-	-	0	31	N/A	6.2	25%
Wind	30	72	483	483	23.8%	438.9	1006%
Other Renewable	-	2	2	12	N/A	11.5	1759%
Total	**294**	**340**	**795**	**838**	**8.4%**	454.2	118%

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Gas/Oil	1,199	940	1,101	1,011	-1.3%	(1.3)	0%
Coal Steam	-	-	-	-	N/A	-	n/a
Hydro	-	-	-	-	N/A	-	n/a
Biomass	-	-	2	218	N/A	35.6	20%
Wind	57	192	1,272	1,272	27.0%	1,178.0	1252%
Other Renewable	-	8	8	83	N/A	81.6	7758%
Purchases from industry	94	120	121	117	1.7%	(21.6)	-16%
Total	**1,350**	**1,260**	**2,504**	**2,701**	**5.5%**	1,272.4	89%

Reference Projection vs. Work Plan 3: Maui

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Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	449	465	500	541	1.4%
Commercial	716	685	697	695	-0.2%
Industrial	132	125	136	138	0.3%
Transportation	-	-	-	-	N/A
Military	1	1	1	1	0.9%
Total	**1,298**	**1,276**	**1,334**	**1,375**	**0.4%**

Distance Travelled (millions of vehicle miles travelled)					
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Passenger - Residents	1,240	1,121	1,007	945	-2.1%
Passenger - Visitors	426	375	337	304	-2.6%

Vehicle Energy Consumption (TBtu)					
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Resident Light	3.1	2.6	2.2	1.9	-3.5%
Resident Medium	1.6	1.4	1.2	1.2	-2.6%
Resident Heavy	0.4	0.3	0.3	0.4	-0.5%
Visitor Light	1.0	0.8	0.7	0.6	-4.3%
Visitor Medium	0.5	0.5	0.4	0.3	-3.4%
Visitor Heavy	0.1	0.1	0.1	0.1	-1.3%
Freight Light	-	-	-	-	N/A
Freight Medium	-	-	-	-	N/A
Freight Heavy	-	-	-	-	N/A
Total	**6.7**	**5.8**	**4.9**	**4.4**	**-3.2%**

Average Vehicle Efficiency (miles/gallon)					
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	23.3	23.9	26.1	28.9	1.7%
Medium Gasoline	21.1	21.9	24.2	27.1	1.9%
Heavy Gasoline	16.8	17.2	18.7	20.5	1.5%
Heavy Diesel	16.9	17.2	18.5	20.3	1.4%
Fleet	21.8	22.4	25.0	28.4	2.1%

Work Plan 3

Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential	449	425	361	321	-2.5%	(219.3)	-41%
Commercial	716	666	571	497	-2.8%	(198.2)	-28%
Industrial	132	120	121	117	-1.0%	(21.6)	-16%
Transportation	-	-	3	6	N/A	5.9	n/a
Military	1	1	1	1	0.9%	-	0%
Total	**1,298**	**1,211**	**1,057**	**942**	**-2.4%**	(433.2)	-32%

Distance Travelled (millions of vehicle miles travelled)							
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Passenger - Residents	1,240	1,124	1,013	949	-2.0%	3.7	0%
Passenger - Visitors	426	375	336	301	-2.6%	(2.7)	-1%

Vehicle Energy Consumption (TBtu)							
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Resident Light	3.1	2.6	2.1	1.8	-4.0%	(0.1)	-6%
Resident Medium	1.6	1.4	1.2	1.1	-3.1%	(0.1)	-6%
Resident Heavy	0.4	0.3	0.3	0.3	-1.0%	(0.0)	-6%
Visitor Light	1.0	0.8	0.6	0.5	-5.2%	(0.1)	-11%
Visitor Medium	0.5	0.5	0.4	0.3	-4.3%	(0.0)	-11%
Visitor Heavy	0.1	0.1	0.1	0.1	-2.2%	(0.0)	-11%
Freight Light	-	-	-	-	N/A	-	n/a
Freight Medium	-	-	-	-	N/A	-	n/a
Freight Heavy	-	-	-	-	N/A	-	n/a
Total	**6.7**	**5.8**	**4.7**	**4.1**	**-3.7%**	(0.3)	-7%

Average Vehicle Efficiency (miles/gallon)							
	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	23.3	23.9	26.5	30.1	2.0%	1.2	4%
Medium Gasoline	21.1	21.9	24.5	28.2	2.2%	1.1	4%
Heavy Gasoline	16.8	17.2	19.0	21.6	1.9%	1.1	5%
Heavy Diesel	16.9	17.2	18.9	21.3	1.8%	1.1	5%
Fleet	21.8	22.4	25.8	30.7	2.7%	2.3	8%

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Marginal Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	24.4	28.1	34.0	37.7	3.4%
Medium Gasoline	23.4	26.9	32.6	36.0	3.4%
Heavy Gasoline	17.4	19.4	22.3	24.6	2.7%
Heavy Diesel	17.2	19.2	21.8	24.0	2.6%
Fleet	23.0	26.6	32.2	35.8	3.5%

Average Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	56.8	55.9	53.4	50.8	-0.9%
Medium Gasoline	32.9	33.0	33.1	33.1	0.1%
Heavy Gasoline	10.3	11.1	13.5	16.1	3.5%

Marginal Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	56.5	52.1	46.3	46.5	-1.5%
Medium Gasoline	34.4	33.2	33.2	33.2	-0.3%
Heavy Gasoline	9.1	14.8	20.5	20.4	6.4%

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020
Renewables as % of Electric Sales	4%	5%	7%	20%	15.8%
Ethanol/Gasoline	1%	1%	6%	11%	9.9%
Biodiesel/Diesel	0%	1%	2%	4%	3.5%

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Marginal Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	24.4	28.5	36.9	43.1	4.5%	5.4	14%
Medium Gasoline	23.4	27.3	35.3	41.2	4.4%	5.2	14%
Heavy Gasoline	17.4	19.8	24.0	27.9	3.7%	3.3	13%
Heavy Diesel	17.2	19.5	23.4	27.1	3.5%	3.1	13%
Fleet	23.0	26.9	36.4	42.9	4.9%	7.2	20%

Average Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	56.8	55.9	53.0	50.2	-0.9%	(0.6)	-1%
Medium Gasoline	32.9	33.0	33.1	33.1	0.1%	(0.0)	0%
Heavy Gasoline	10.3	11.1	13.9	16.7	3.8%	0.6	4%

Marginal Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	56.5	52.1	45.4	45.6	-1.6%	(0.9)	-2%
Medium Gasoline	34.4	33.1	33.2	33.2	-0.3%	(0.0)	0%
Heavy Gasoline	9.1	14.8	21.4	21.2	6.8%	0.9	4%

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020	Difference from Ref @ 2020	Difference from Ref @ 2020
Renewables as % of Electric Sales	4%	16%	121%	167%	162.6%	1.5	728%
Ethanol/Gasoline	1%	10%	15%	20%	18.9%	0.1	82%
Biodiesel/Diesel	0%	10%	15%	20%	20.0%	0.2	467%

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Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential					
Electricity	102.4	110.3	122.2	121.4	1.3%
Utility Gas	41.3	41.0	41.3	41.9	0.1%
Bottled Gas	60.0	62.6	68.5	69.2	1.1%
Commercial					
Electricity	99.8	107.5	119.9	119.1	1.4%
Utility Gas	24.8	24.5	24.8	25.4	0.2%
Oil	22.4	25.0	30.9	31.5	2.7%
Bottled Gas	25.0	27.6	33.5	34.1	2.4%
Industrial					
Electricity	82.2	88.5	103.4	102.6	1.7%
Utility Gas	24.8	24.5	24.8	25.4	0.2%
#6 Fuel	9.9	12.5	18.3	19.0	5.2%
Bottled Gas	-	-	-	-	N/A
#2 Fuel	22.4	25.0	30.9	31.5	2.7%
Transportation					
Gasoline	28.2	30.8	36.7	37.4	2.2%
LS Diesel	25.3	27.9	33.7	34.4	2.4%
Ethanol	28.1	25.7	27.9	27.8	-0.1%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%

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Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential					
Electricity	102.4	110.3	197.8	209.3	5.7%
Utility Gas	41.3	41.0	55.6	56.7	2.5%
Bottled Gas	60.0	62.6	70.2	71.4	1.3%
Commercial					
Electricity	99.8	107.5	195.3	207.1	5.8%
Utility Gas	24.8	24.5	39.1	40.2	3.8%
Oil	22.4	25.0	32.7	33.9	3.2%
Bottled Gas	25.0	27.6	35.2	36.4	2.9%
Industrial					
Electricity	82.2	88.5	178.4	190.5	6.7%
Utility Gas	24.8	24.5	39.1	40.2	3.8%
#6 Fuel	9.9	12.5	20.2	21.5	6.2%
Bottled Gas	-	-	-	-	N/A
#2 Fuel	22.4	25.0	32.7	33.9	3.2%
Transportation					
Gasoline	28.2	30.8	38.5	39.7	2.6%
LS Diesel	25.3	27.9	35.6	36.8	2.9%
Ethanol	28.1	25.7	27.9	27.8	-0.1%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%

Change from Ref @ 2020	Change from Ref @ 2020
-	n/a
87.9	72%
14.8	35%
2.3	3%
-	n/a
-	n/a
87.9	74%
14.8	58%
2.4	8%
2.3	7%
-	n/a
87.9	86%
14.8	58%
2.5	13%
-	n/a
2.4	8%
-	n/a
2.3	6%
2.4	7%
-	0%
-	0%

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GHG Emissions (kt)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	12.4	11.1	12.3	13.6	0.7%
Commercial	51.0	48.7	49.0	48.9	-0.3%
Industrial	30.0	32.9	39.8	44.2	3.0%
Passenger - Residents	435.4	375.1	291.4	240.5	-4.5%
Passenger - Visitors	132.4	108.0	79.7	64.3	-5.4%
Marine	-	-	-	-	N/A
Aviation	-	-	-	-	N/A
Freight	300.2	267.2	226.3	221.3	-2.3%
Power Sector	669.9	532.1	574.1	612.6	-0.7%
Waste	130.1	149.0	180.5	211.9	3.8%
Agriculture & Forestry	(1,406.3)	(1,405.6)	(1,404.3)	(1,403.0)	0.0%
Total	**355.2**	**118.5**	**48.9**	**54.3**	**-13.4%**

Total Primary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Biodiesel	-	0.0	0.0	0.1	N/A
Biomass	-	-	-	-	N/A
Coal	-	-	-	-	N/A
Electricity	4.0	3.9	4.1	4.4	0.8%
Ethanol	-	0.1	0.4	0.7	N/A
Gasoline	9.9	8.4	6.5	5.6	-4.3%
Geothermal	2.2	2.2	2.2	2.2	0.0%
HS Diesel	-	-	-	-	N/A
HS Fuel Oil	4.1	0.9	1.0	1.2	-9.3%
Hydrogen	-	-	-	-	N/A
Jet Fuel	-	-	-	-	N/A
LPG	0.7	0.6	0.7	0.7	0.3%
LS Diesel	1.8	1.8	1.6	1.5	-1.5%
LS Fuel Oil	4.7	6.3	6.7	7.1	3.3%
Oil, Unspecified	1.1	1.0	1.1	1.1	0.4%
Utility Gas	0.2	0.2	0.2	0.2	1.1%
Still Gas	-	-	-	-	N/A
Waste	-	-	-	-	N/A
Total	**28.6**	**25.4**	**24.5**	**24.8**	**-1.1%**

Work Plan 3

GHG Emissions (kt)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Abs. Change from Ref @ 2020	% Change from Ref @ 2020
Residential	12.4	10.8	11.6	12.0	-0.2%	(1.6)	-12%
Commercial	51.0	48.4	47.9	46.7	-0.7%	(2.2)	-4%
Industrial	30.0	33.2	46.8	51.3	4.2%	7.1	16%
Passenger - Residents	435.4	344.4	262.5	207.7	-5.5%	(32.8)	-14%
Passenger - Visitors	132.4	99.0	70.1	53.5	-6.7%	(10.7)	-17%
Marine	-	-	-	-	N/A	-	n/a
Aviation	-	-	-	-	N/A	-	n/a
Freight	300.2	244.0	208.7	198.9	-3.1%	(22.4)	-10%
Power Sector	669.9	388.6	220.3	136.1	-11.5%	(476.6)	-78%
Waste	130.1	149.6	183.1	211.7	3.8%	(0.2)	0%
Agriculture & Forestry	(1,406.3)	(1,405.6)	(1,402.2)	(1,401.1)	0.0%	2.0	0%
Total	**355.2**	**(87.5)**	**(351.1)**	**(483.1)**	**-202.4%**	(537.4)	-989%

Total Primary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Biodiesel	-	0.2	0.2	0.3	N/A	0.3	428%
Biomass	-	-	2.2	2.2	N/A	2.2	n/a
Coal	-	-	-	-	N/A	-	n/a
Electricity	4.0	3.6	3.1	2.8	-2.7%	(1.6)	-37%
Ethanol	-	0.8	1.0	1.2	N/A	0.5	72%
Gasoline	9.9	7.6	5.7	4.8	-5.5%	(0.8)	-15%
Geothermal	2.2	2.8	2.8	2.8	1.8%	0.6	27%
HS Diesel	-	-	-	-	N/A	-	n/a
HS Fuel Oil	4.1	0.1	-	-	-100.0%	(1.2)	-100%
Hydrogen	-	-	-	-	N/A	-	n/a
Jet Fuel	-	-	-	-	N/A	-	n/a
LPG	0.7	0.6	0.6	0.7	0.0%	(0.0)	-3%
LS Diesel	1.8	1.6	1.4	1.2	-2.9%	(0.3)	-17%
LS Fuel Oil	4.7	5.1	3.0	1.9	-6.9%	(5.2)	-74%
Oil, Unspecified	1.1	1.0	1.2	1.2	1.1%	0.1	9%
Utility Gas	0.2	0.2	0.2	0.2	-0.9%	(0.1)	-22%
Still Gas	-	-	-	-	N/A	-	n/a
Waste	-	-	-	-	N/A	-	n/a
Total	**28.6**	**23.8**	**21.6**	**19.2**	**-3.0%**	(5.5)	-22%

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Total Secondary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	1.7	1.7	1.9	2.0	1.3%
Commercial	2.8	2.7	2.8	2.9	0.3%
Industrial	1.4	1.4	1.4	1.5	0.6%
Passenger - Residents	5.9	5.2	4.2	3.6	-3.7%
Passenger - Visitors	1.8	1.5	1.2	1.0	-4.6%
Marine	-	-	-	-	N/A
Aviation	-	-	-	-	N/A
Freight	4.0	3.6	3.2	3.2	-1.7%
Forestry & Agriculture	0.0	0.0	0.0	0.0	-5.0%
Total	**17.6**	**16.0**	**14.6**	**14.3**	**-1.6%**

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Personal Income	5,570	5,996	6,560	7,625	2.4%
Population (millions)	0	0	0	0	2.0%
Gross Regional Product (GRP)	4,215	4,406	5,167	5,946	2.7%

Generation Capacity (MW)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	236	297	297	297	1.8%
Coal Steam	-	-	-	-	N/A
Hydro	4	4	4	4	0.0%
Biomass	-	-	0	0	N/A
Wind	34	37	41	55	3.9%
Other Renewable	31	31	31	31	0.0%
Total	**305**	**368**	**373**	**387**	**1.8%**

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	892	855	914	965	0.6%
Coal Steam	-	-	-	-	N/A
Hydro	21	21	21	21	0.0%
Biomass	-	-	0	0	N/A
Wind	80	88	100	139	4.3%
Other Renewable	212	213	213	213	0.0%
Purchases from industry	-	-	-	-	N/A
Total	**1,205**	**1,178**	**1,249**	**1,339**	**0.8%**

Work Plan 3

Total Secondary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential	1.7	1.5	1.4	1.3	-2.0%	(0.7)	-35%
Commercial	2.8	2.5	2.2	2.0	-2.6%	(0.9)	-32%
Industrial	1.4	1.3	1.5	1.5	0.7%	0.0	1%
Passenger - Residents	5.9	5.2	4.1	3.4	-4.1%	(0.2)	-6%
Passenger - Visitors	1.8	1.5	1.1	0.9	-5.3%	(0.1)	-9%
Marine	-	-	-	-	N/A	-	n/a
Aviation	-	-	-	-	N/A	-	n/a
Freight	4.0	3.6	3.2	3.2	-1.7%	(0.0)	0%
Forestry & Agriculture	0.0	0.0	0.0	0.0	-5.0%	-	0%
Total	**17.6**	**15.7**	**13.6**	**12.3**	**-2.7%**	(1.9)	-14%

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Personal Income	5,570	5,996	6,560	7,625	2.4%	-	0%
Population (millions)	0	0	0	0	2.0%	-	0%
Gross Regional Product (GRP)	4,215	4,406	5,167	5,946	2.7%	-	0%

Generation Capacity (MW)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Gas/Oil	236	297	282	282	1.4%	(14.1)	-5%
Coal Steam	-	-	-	-	N/A	-	n/a
Hydro	4	4	4	4	0.0%	-	0%
Biomass	-	-	25	25	N/A	25.2	75661%
Wind	34	54	54	68	5.6%	13.0	24%
Other Renewable	31	40	40	40	1.9%	8.8	28%
Total	**305**	**395**	**406**	**420**	**2.5%**	32.9	9%

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Gas/Oil	892	649	371	229	-9.9%	(736.1)	-76%
Coal Steam	-	-	-	-	N/A	-	n/a
Hydro	21	21	21	21	0.0%	-	0%
Biomass	-	-	144	144	N/A	143.9	54700%
Wind	80	145	145	182	6.5%	42.7	31%
Other Renewable	212	272	272	272	1.9%	59.1	28%
Purchases from industry	-	-	-	-	N/A	-	n/a
Total	**1,205**	**1,087**	**953**	**848**	**-2.7%**	(490.3)	-37%

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Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	450	455	490	539	1.4%
Commercial	557	535	568	610	0.7%
Industrial	162	152	151	151	-0.6%
Transportation	-	-	-	-	N/A
Military	4	4	4	5	1.2%
Total	**1,173**	**1,146**	**1,213**	**1,304**	**0.8%**

Distance Travelled (millions of vehicle miles travelled)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Passenger - Residents	1,468	1,360	1,259	1,228	-1.4%
Passenger - Visitors	470	411	374	352	-2.2%

Vehicle Energy Consumption (TBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Resident Light	3.6	3.2	2.7	2.6	-2.6%
Resident Medium	1.9	1.7	1.6	1.5	-1.7%
Resident Heavy	0.4	0.4	0.4	0.5	0.5%
Visitor Light	1.1	0.9	0.8	0.7	-3.5%
Visitor Medium	0.6	0.5	0.4	0.4	-2.6%
Visitor Heavy	0.1	0.1	0.1	0.1	-0.5%
Freight Light	-	-	-	-	N/A
Freight Medium	-	-	-	-	N/A
Freight Heavy	-	-	-	-	N/A
Total	**7.7**	**6.9**	**6.0**	**5.8**	**-2.2%**

Average Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	23.3	23.9	26.3	29.3	1.8%
Medium Gasoline	21.2	22.0	24.5	27.5	2.0%
Heavy Gasoline	16.9	17.2	18.8	20.7	1.6%
Heavy Diesel	16.8	17.2	18.6	20.3	1.5%
Fleet	21.8	22.5	25.1	28.4	2.1%

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Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential	450	402	363	334	-2.3%	(205.5)	-38%
Commercial	557	504	422	354	-3.4%	(255.7)	-42%
Industrial	162	144	135	127	-1.8%	(23.4)	-16%
Transportation	-	-	4	8	N/A	7.9	n/a
Military	4	4	4	5	1.2%	-	0%
Total	**1,173**	**1,054**	**929**	**828**	**-2.7%**	(476.7)	-37%

Distance Travelled (millions of vehicle miles travelled)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Passenger - Residents	1,468	1,361	1,263	1,231	-1.3%	3.1	0%
Passenger - Visitors	470	411	375	354	-2.2%	2.2	1%

Vehicle Energy Consumption (TBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Resident Light	3.6	3.2	2.7	2.4	-3.0%	(0.2)	-6%
Resident Medium	1.9	1.7	1.5	1.4	-2.1%	(0.1)	-6%
Resident Heavy	0.4	0.4	0.4	0.4	0.0%	(0.0)	-6%
Visitor Light	1.1	0.9	0.7	0.6	-4.2%	(0.1)	-9%
Visitor Medium	0.6	0.5	0.4	0.4	-3.3%	(0.0)	-9%
Visitor Heavy	0.1	0.1	0.1	0.1	-1.2%	(0.0)	-9%
Freight Light	-	-	-	-	N/A	-	n/a
Freight Medium	-	-	-	-	N/A	-	n/a
Freight Heavy	-	-	-	-	N/A	-	n/a
Total	**7.7**	**6.9**	**5.9**	**5.4**	**-2.7%**	(0.4)	-7%

Average Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	23.3	24.0	26.7	30.5	2.1%	1.3	4%
Medium Gasoline	21.2	22.1	24.9	28.7	2.3%	1.2	4%
Heavy Gasoline	16.9	17.3	19.2	21.8	2.0%	1.1	5%
Heavy Diesel	16.8	17.2	18.9	21.4	1.9%	1.1	5%
Fleet	21.8	22.5	25.9	30.8	2.7%	2.4	8%

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Marginal Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	24.4	28.1	34.0	37.7	3.4%
Medium Gasoline	23.4	26.9	32.6	36.0	3.4%
Heavy Gasoline	17.4	19.4	22.3	24.6	2.7%
Heavy Diesel	17.2	19.2	21.8	24.0	2.6%
Fleet	23.1	26.3	32.1	35.6	3.4%

Average Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	56.6	56.1	54.0	51.7	-0.7%
Medium Gasoline	33.2	33.3	33.5	33.6	0.1%
Heavy Gasoline	10.2	10.6	12.5	14.7	2.8%

Marginal Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	56.0	54.2	47.8	47.9	-1.2%
Medium Gasoline	34.6	33.8	33.7	33.6	-0.2%
Heavy Gasoline	9.3	12.0	18.6	18.5	5.4%

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020
Renewables as % of Electric Sales	27%	28%	28%	29%	1.9%
Ethanol/Gasoline	0%	1%	6%	11%	11.0%
Biodiesel/Diesel	0%	1%	2%	4%	3.8%

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Marginal Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	24.4	28.5	36.9	43.1	4.5%	5.4	14%
Medium Gasoline	23.4	27.3	35.3	41.2	4.4%	5.2	14%
Heavy Gasoline	17.4	19.8	24.0	27.9	3.7%	3.3	13%
Heavy Diesel	17.2	19.5	23.4	27.1	3.5%	3.1	13%
Fleet	23.1	26.7	36.2	42.6	4.8%	7.0	20%

Average Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	56.6	56.1	53.5	50.9	-0.8%	(0.8)	-2%
Medium Gasoline	33.2	33.3	33.5	33.6	0.1%	(0.0)	0%
Heavy Gasoline	10.2	10.6	13.0	15.5	3.3%	0.9	6%

Marginal Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	56.0	54.2	46.5	46.6	-1.4%	(1.2)	-3%
Medium Gasoline	34.6	33.8	33.6	33.6	-0.2%	(0.0)	0%
Heavy Gasoline	9.3	12.0	19.9	19.8	5.9%	1.3	7%

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020	Difference from Ref @ 2020	Difference from Ref @ 2020
Renewables as % of Electric Sales	27%	42%	63%	75%	48.1%	0.5	161%
Ethanol/Gasoline	0%	10%	15%	20%	20.0%	0.1	82%
Biodiesel/Diesel	0%	10%	15%	20%	20.0%	0.2	429%

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Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential					
Electricity	106.0	114.1	118.2	116.0	0.7%
Utility Gas	48.1	47.8	48.1	48.7	0.1%
Bottled Gas	60.0	62.6	68.5	69.2	1.1%
Commercial					
Electricity	96.7	104.1	109.9	107.6	0.8%
Utility Gas	24.8	24.5	24.8	25.4	0.2%
Oil	22.4	25.0	30.9	31.5	2.7%
Bottled Gas	25.0	27.6	33.5	34.1	2.4%
Industrial					
Electricity	84.7	91.2	98.5	96.2	1.0%
Utility Gas	24.8	24.5	24.8	25.4	0.2%
#6 Fuel	9.9	12.5	18.3	19.0	5.2%
Bottled Gas	-	27.6	33.5	34.1	N/A
#2 Fuel	22.4	25.0	30.9	31.5	2.7%
Transportation					
Gasoline	28.2	30.8	36.7	37.4	2.2%
LS Diesel	25.3	27.9	33.7	34.4	2.4%
Ethanol	28.1	25.7	27.9	27.8	-0.1%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%

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Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential						-	n/a
Electricity	106.0	114.1	131.3	130.9	1.6%	14.9	13%
Utility Gas	48.1	47.8	62.4	63.5	2.1%	14.8	30%
Bottled Gas	60.0	62.6	70.2	71.4	1.3%	2.3	3%
						-	n/a
Commercial						-	n/a
Electricity	96.7	104.1	122.5	123.8	1.9%	16.2	15%
Utility Gas	24.8	24.5	39.1	40.2	3.8%	14.8	58%
Oil	22.4	25.0	32.7	33.9	3.2%	2.4	8%
Bottled Gas	25.0	27.6	35.2	36.4	2.9%	2.3	7%
Industrial						-	n/a
Electricity	84.7	91.2	111.1	111.2	2.1%	14.9	16%
Utility Gas	24.8	24.5	39.1	40.2	3.8%	14.8	58%
#6 Fuel	9.9	12.5	20.2	21.5	6.2%	2.5	13%
Bottled Gas	-	27.6	35.2	36.4	N/A	2.3	7%
#2 Fuel	22.4	25.0	32.7	33.9	3.2%	2.4	8%
Transportation						-	n/a
Gasoline	28.2	30.8	38.5	39.7	2.6%	2.3	6%
LS Diesel	25.3	27.9	35.6	36.8	2.9%	2.4	7%
Ethanol	28.1	25.7	27.9	27.8	-0.1%	-	0%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%	-	0%

Proposed GHG Reduction Work Plans for Hawaii

Reference Projection vs. Work Plan 3: Kauai

Reference Case

GHG Emissions (kt)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	5.0	4.6	4.3	4.0	-1.6%
Commercial	19.4	18.8	18.5	18.2	-0.5%
Industrial	54.7	55.6	56.6	57.3	0.4%
Passenger - Residents	218.5	186.8	140.1	109.0	-5.2%
Passenger - Visitors	66.3	55.3	39.6	29.9	-5.9%
Marine	-	-	-	-	N/A
Aviation	-	-	-	-	N/A
Freight	88.6	78.4	64.1	59.1	-3.1%
Power Sector	264.1	255.8	94.8	131.8	-5.2%
Waste	63.0	70.0	81.7	93.4	3.1%
Agriculture & Forestry	(236.9)	(235.2)	(232.4)	(229.6)	-0.2%
Total	**542.7**	**490.1**	**267.4**	**273.2**	**-5.1%**

Total Primary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Biodiesel	-	0.0	0.0	0.0	N/A
Biomass	0.7	0.8	3.0	3.1	11.7%
Coal	-	-	-	-	N/A
Electricity	1.4	1.3	1.4	1.5	0.1%
Ethanol	-	0.1	0.2	0.3	N/A
Gasoline	4.4	3.8	2.8	2.3	-4.9%
Geothermal	-	0.0	0.0	0.0	N/A
HS Diesel	-	-	-	-	N/A
HS Fuel Oil	-	-	-	-	N/A
Hydrogen	-	-	-	-	N/A
Jet Fuel	-	-	-	-	N/A
LPG	0.4	0.4	0.3	0.3	-0.6%
LS Diesel	0.7	0.6	0.5	0.4	-4.0%
LS Fuel Oil	3.6	3.5	0.9	0.7	-12.2%
Oil, Unspecified	0.2	0.2	0.1	0.1	-3.7%
Utility Gas	0.0	0.0	0.0	0.0	-0.2%
Still Gas	-	-	-	-	N/A
Waste	-	-	0.1	1.1	N/A
Total	**11.4**	**10.5**	**9.5**	**9.7**	**-1.2%**

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GHG Emissions (kt)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Abs. Change from Ref @ 2020	% Change from Ref @ 2020
Residential	5.0	4.5	4.2	3.7	-2.2%	(0.3)	-7%
Commercial	19.4	18.7	18.1	17.5	-0.8%	(0.7)	-4%
Industrial	54.7	55.6	56.6	57.3	0.4%	(0.0)	0%
Passenger - Residents	218.5	170.6	125.1	93.1	-6.4%	(15.9)	-15%
Passenger - Visitors	66.3	50.5	34.4	24.4	-7.4%	(5.4)	-18%
Marine	-	-	-	-	N/A	-	n/a
Aviation	-	-	-	-	N/A	-	n/a
Freight	88.6	71.3	58.9	53.6	-3.8%	(5.6)	-9%
Power Sector	264.1	192.2	37.8	75.4	-9.2%	(56.4)	-43%
Waste	63.0	69.9	82.4	94.0	3.1%	0.5	1%
Agriculture & Forestry	(236.9)	(235.2)	(232.4)	(229.6)	-0.2%	-	0%
Total	**542.7**	**398.2**	**185.1**	**189.5**	**-7.8%**	(83.7)	-31%

Total Primary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Biodiesel	-	0.1	0.1	0.1	N/A	0.1	386%
Biomass	0.7	0.8	2.5	1.9	7.6%	(1.2)	-38%
Coal	-	-	-	-	N/A	-	n/a
Electricity	1.4	1.2	1.1	1.1	-2.1%	(0.4)	-26%
Ethanol	-	0.4	0.4	0.5	N/A	0.2	71%
Gasoline	4.4	3.4	2.5	1.9	-6.1%	(0.3)	-15%
Geothermal	-	0.0	0.0	0.0	N/A	0.0	625%
HS Diesel	-	-	-	-	N/A	-	n/a
HS Fuel Oil	-	-	-	-	N/A	-	n/a
Hydrogen	-	-	-	-	N/A	-	n/a
Jet Fuel	-	-	-	-	N/A	-	n/a
LPG	0.4	0.4	0.3	0.3	-0.9%	(0.0)	-4%
LS Diesel	0.7	0.5	0.4	0.3	-5.4%	(0.1)	-17%
LS Fuel Oil	3.6	2.6	0.2	0.0	-31.7%	(0.6)	-96%
Oil, Unspecified	0.2	0.2	0.1	0.1	-3.7%	(0.0)	0%
Utility Gas	0.0	0.0	0.0	0.0	-1.6%	(0.0)	-17%
Still Gas	-	-	-	-	N/A	-	n/a
Waste	-	-	0.1	1.1	N/A	-	0%
Total	**11.4**	**9.6**	**7.9**	**7.4**	**-3.2%**	(2.3)	-24%

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Reference Projection vs. Work Plan 3: Kauai

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Total Secondary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	0.5	0.5	0.5	0.6	1.5%
Commercial	1.4	1.3	1.3	1.3	-0.4%
Industrial	0.9	0.8	0.9	0.9	0.0%
Passenger - Residents	3.0	2.6	2.0	1.7	-4.4%
Passenger - Visitors	0.9	0.8	0.6	0.5	-5.1%
Marine	-	-	-	-	N/A
Aviation	-	-	-	-	N/A
Freight	1.2	1.1	0.9	0.9	-2.4%
Forestry & Agriculture	0.0	0.0	0.0	0.0	-5.8%
Total	**7.8**	**7.0**	**6.2**	**5.7**	**-2.3%**

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Personal Income	1,529	1,716	1,898	2,196	2.8%
Population (millions)	0	0	0	0	1.0%
Gross Regional Product (GRP)	2,618	2,692	2,949	3,222	1.6%

Generation Capacity (MW)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	122	122	139	139	1.0%
Coal Steam	-	-	-	-	N/A
Hydro	5	5	26	26	13.1%
Biomass	-	-	22	29	N/A
Wind	-	4	14	14	N/A
Other Renewable	-	0	0	0	N/A
Total	**127**	**131**	**201**	**208**	**3.9%**

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Gas/Oil	404	392	110	78	-11.9%
Coal Steam	-	-	-	-	N/A
Hydro	39	39	148	148	10.8%
Biomass	-	-	158	211	N/A
Wind	-	10	39	39	N/A
Other Renewable	-	0	0	0	N/A
Purchases from industry	4	-	3	5	1.7%
Total	**447**	**442**	**458**	**481**	**0.6%**

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Total Secondary Energy Use (TBtu/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential	0.5	0.5	0.4	0.5	-0.4%	(0.1)	-21%
Commercial	1.4	1.2	1.1	1.0	-2.3%	(0.3)	-21%
Industrial	0.9	0.8	0.9	0.9	-0.1%	(0.0)	0%
Passenger - Residents	3.0	2.6	2.0	1.6	-4.8%	(0.1)	-6%
Passenger - Visitors	0.9	0.8	0.5	0.4	-5.9%	(0.0)	-10%
Marine	-	-	-	-	N/A	-	n/a
Aviation	-	-	-	-	N/A	-	n/a
Freight	1.2	1.1	0.9	0.9	-2.3%	0.0	1%
Forestry & Agriculture	0.0	0.0	0.0	0.0	-5.8%	-	0%
Total	**7.8**	**6.9**	**5.8**	**5.2**	**-3.1%**	(0.5)	-9%

Economic Drivers (2008 M$/Year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Personal Income	1,529	1,716	1,898	2,196	2.8%	-	0%
Population (millions)	0	0	0	0	1.0%	-	0%
Gross Regional Product (GRP)	2,618	2,692	2,949	3,222	1.6%	-	0%

Generation Capacity (MW)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Gas/Oil	122	122	139	139	1.0%	-	0%
Coal Steam	-	-	-	-	N/A	-	n/a
Hydro	5	5	26	26	13.1%	-	0%
Biomass	-	-	22	29	N/A	0.2	1%
Wind	-	26	26	26	N/A	11.6	81%
Other Renewable	-	0	0	0	N/A	0.3	586%
Total	**127**	**153**	**213**	**221**	**4.3%**	12.1	6%

Generation Output (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Gas/Oil	404	299	26	3	-31.5%	(74.8)	-96%
Coal Steam	-	-	-	-	N/A	-	n/a
Hydro	39	39	148	148	10.8%	-	0%
Biomass	-	-	125	136	N/A	(74.6)	-35%
Wind	-	71	71	71	N/A	32.1	82%
Other Renewable	-	2	2	2	N/A	1.8	700%
Purchases from industry	4	0	4	6	3.4%	1.2	24%
Total	**447**	**412**	**377**	**367**	**-1.5%**	(114.2)	-24%

Reference Projection vs. Work Plan 3: Kauai

Reference Case

Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential	120	125	139	155	2.0%
Commercial	283	269	274	275	-0.2%
Industrial	1	2	3	5	14.6%
Transportation	-	-	-	-	N/A
Military	16	17	18	18	1.0%
Total	**420**	**414**	**433**	**453**	**0.6%**

Distance Travelled (millions of vehicle miles travelled)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Passenger - Residents	545	490	433	402	-2.3%
Passenger - Visitors	170	152	138	127	-2.2%

Vehicle Energy Consumption (TBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Resident Light	1.8	1.6	1.3	1.2	-3.3%
Resident Medium	1.0	0.9	0.8	0.7	-2.4%
Resident Heavy	0.2	0.2	0.2	0.2	-0.3%
Visitor Light	0.5	0.5	0.4	0.3	-4.0%
Visitor Medium	0.3	0.3	0.2	0.2	-3.1%
Visitor Heavy	0.1	0.1	0.1	0.1	-1.0%
Freight Light	-	-	-	-	N/A
Freight Medium	-	-	-	-	N/A
Freight Heavy	-	-	-	-	N/A
Total	**3.9**	**3.4**	**2.9**	**2.6**	**-2.9%**

Average Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	23.3	23.9	26.1	28.9	1.7%
Medium Gasoline	21.3	22.0	24.3	27.1	1.9%
Heavy Gasoline	16.9	17.2	18.7	20.5	1.5%
Heavy Diesel	16.9	17.2	18.8	20.6	1.5%
Fleet	21.9	22.5	24.9	28.1	1.9%

Work Plan 3

Sales (GWh/year)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential	120	112	110	119	-0.1%	(36.0)	-23%
Commercial	283	253	221	198	-2.7%	(76.7)	-28%
Industrial	1	2	4	6	16.6%	1.2	24%
Transportation	-	-	1	3	N/A	2.6	n/a
Military	16	17	18	18	1.0%	-	0%
Total	**420**	**385**	**354**	**344**	**-1.5%**	(108.9)	-24%

Distance Travelled (millions of vehicle miles travelled)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Passenger - Residents	545	490	433	402	-2.3%	0.0	0%
Passenger - Visitors	170	152	138	128	-2.2%	0.8	1%

Vehicle Energy Consumption (TBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Resident Light	1.8	1.6	1.3	1.1	-3.8%	(0.1)	-6%
Resident Medium	1.0	0.9	0.7	0.7	-2.9%	(0.0)	-6%
Resident Heavy	0.2	0.2	0.2	0.2	-0.8%	(0.0)	-6%
Visitor Light	0.5	0.5	0.4	0.3	-4.8%	(0.0)	-10%
Visitor Medium	0.3	0.3	0.2	0.2	-3.9%	(0.0)	-10%
Visitor Heavy	0.1	0.1	0.1	0.1	-1.8%	(0.0)	-10%
Freight Light	-	-	-	-	N/A	-	n/a
Freight Medium	-	-	-	-	N/A	-	n/a
Freight Heavy	-	-	-	-	N/A	-	n/a
Total	**3.9**	**3.4**	**2.8**	**2.5**	**-3.5%**	(0.2)	-7%

Average Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	23.3	23.9	26.5	30.1	2.0%	1.2	4%
Medium Gasoline	21.3	22.0	24.6	28.2	2.2%	1.1	4%
Heavy Gasoline	16.9	17.2	19.0	21.5	1.9%	1.0	5%
Heavy Diesel	16.9	17.3	19.2	21.7	2.0%	1.2	6%
Fleet	21.9	22.5	25.6	30.0	2.5%	1.9	7%

Reference Projection vs. Work Plan 3: Kauai

Reference Case

Marginal Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	24.4	28.1	34.0	37.7	3.4%
Medium Gasoline	23.4	26.9	32.6	36.0	3.4%
Heavy Gasoline	17.4	19.4	22.3	24.6	2.7%
Heavy Diesel	17.2	19.2	21.8	24.0	2.6%
Fleet	23.0	26.6	32.1	35.6	3.4%

Average Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	56.6	55.8	54.0	52.0	-0.6%
Medium Gasoline	33.2	33.4	33.6	33.7	0.1%
Heavy Gasoline	10.2	10.8	12.5	14.3	2.7%

Marginal Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Light Gasoline	55.3	52.3	48.3	48.4	-1.0%
Medium Gasoline	34.9	33.9	33.7	33.7	-0.3%
Heavy Gasoline	9.8	13.8	18.0	17.9	4.7%

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020
Renewables as % of Electric Sales	9%	12%	80%	88%	78.7%
Ethanol/Gasoline	0%	1%	6%	11%	11.0%
Biodiesel/Diesel	0%	1%	2%	4%	4.1%

Work Plan 3

Marginal Vehicle Efficiency (miles/gallon)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	24.4	28.5	36.9	43.1	4.5%	5.4	14%
Medium Gasoline	23.4	27.3	35.3	41.2	4.4%	5.2	14%
Heavy Gasoline	17.4	19.8	24.0	27.9	3.7%	3.3	13%
Heavy Diesel	17.2	19.5	23.4	27.1	3.5%	3.1	13%
Fleet	23.0	27.0	35.7	41.9	4.7%	6.3	18%

Average Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	56.6	55.7	53.6	51.5	-0.7%	(0.6)	-1%
Medium Gasoline	33.2	33.4	33.5	33.6	0.1%	(0.0)	0%
Heavy Gasoline	10.2	10.9	12.9	14.9	3.0%	0.6	4%

Marginal Vehicle Market Share (Percent)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Light Gasoline	55.3	51.9	47.3	47.5	-1.2%	(0.9)	-2%
Medium Gasoline	34.9	33.8	33.7	33.7	-0.3%	(0.0)	0%
Heavy Gasoline	9.8	14.3	19.0	18.9	5.1%	0.9	5%

Renewable Shares	2007	2010	2015	2020	Difference 2007-2020	Difference from Ref @ 2020	Difference from Ref @ 2020
Renewables as % of Electric Sales	9%	29%	98%	104%	94.7%	0.2	18%
Ethanol/Gasoline	0%	10%	15%	20%	20.0%	0.1	82%
Biodiesel/Diesel	0%	10%	15%	20%	20.0%	0.2	389%

Proposed GHG Reduction Work Plans for Hawaii

Reference Projection vs. Work Plan 3: Kauai

Reference Case

Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020
Residential					
Electricity	115.1	124.0	127.7	151.1	2.1%
Utility Gas	46.8	46.5	46.8	47.3	0.1%
Bottled Gas	60.0	62.6	68.5	69.2	1.1%
Commercial					
Electricity	111.5	120.1	124.4	147.9	2.2%
Utility Gas	-	-	-	-	N/A
Oil	22.4	25.0	30.9	31.5	2.7%
Bottled Gas	25.0	27.6	33.5	34.1	2.4%
Industrial					
Electricity	104.9	112.9	144.2	150.6	2.8%
Utility Gas	-	-	-	-	N/A
#6 Fuel	-	12.5	18.3	19.0	N/A
Bottled Gas	-	27.6	33.5	34.1	N/A
#2 Fuel	22.4	25.0	30.9	31.5	2.7%
Transportation					
Gasoline	28.2	30.8	36.7	37.4	2.2%
LS Diesel	25.3	27.9	33.7	34.4	2.4%
Ethanol	28.1	25.7	27.9	27.8	-0.1%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%

Work Plan 3

Prices (Including Permits) (2008 $/mmBtu)	2007	2010	2015	2020	Avg. Annual Growth Rate 2007-2020	Change from Ref @ 2020	Change from Ref @ 2020
Residential						-	n/a
Electricity	115.1	124.0	137.1	137.1	1.4%	(14.0)	-9%
Utility Gas	46.8	46.5	61.1	62.1	2.2%	14.8	31%
Bottled Gas	60.0	62.6	70.2	71.4	1.3%	2.3	3%
						-	n/a
Commercial						-	n/a
Electricity	111.5	120.1	133.8	133.8	1.4%	(14.1)	-10%
Utility Gas	-	-	-	-	N/A	-	n/a
Oil	22.4	25.0	32.7	33.9	3.2%	2.4	8%
Bottled Gas	25.0	27.6	35.2	36.4	2.9%	2.3	7%
Industrial						-	n/a
Electricity	104.9	112.9	147.4	135.6	2.0%	(15.1)	-10%
Utility Gas	-	-	16.3	17.4	N/A	17.4	n/a
#6 Fuel	-	12.5	22.2	24.1	N/A	5.1	27%
Bottled Gas	-	27.6	35.2	36.4	N/A	2.3	7%
#2 Fuel	22.4	25.0	32.7	33.9	3.2%	2.4	8%
Transportation						-	n/a
Gasoline	28.2	30.8	38.5	39.7	2.6%	2.3	6%
LS Diesel	25.3	27.9	35.6	36.8	2.9%	2.4	7%
Ethanol	28.1	25.7	27.9	27.8	-0.1%	-	0%
Biodiesel	26.9	26.3	25.3	24.3	-0.8%	-	0%

Appendix E: Policy Case Modeling Outputs – REMI Macro-economic Modeling

REMI Macro-economic Model Outputs:

Reference Case:

State	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Employment *Thousands (Jobs)*														
Commercial	619.0	636.1	650.2	654.1	663.5	672.5	681.7	690.3	698.7	706.3	712.0	718.3	724.5	730.1
Industrial	18.5	19.0	18.9	18.8	18.9	18.9	19.0	19.0	19.0	18.9	18.8	18.8	18.8	18.7
Forestry & Agriculture	3.8	4.0	4.1	4.2	4.2	4.3	4.3	4.4	4.4	4.4	4.4	4.4	4.4	4.4
Utilities	2.9	2.9	3.0	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	3.0	3.0
Total -	***644.2***	***662.1***	***676.1***	***680.0***	***689.6***	***698.7***	***707.9***	***716.6***	***725.0***	***732.5***	***738.2***	***744.5***	***750.6***	***756.1***
GDP ***Billions of Fixed (2000) Dollars***														
Commercial	62.3	63.5	64.4	64.4	66.0	67.4	68.7	69.8	70.7	71.6	72.1	72.7	73.1	73.4
Industrial	4.6	4.6	4.7	4.6	4.7	4.8	4.8	4.9	4.9	4.9	5.0	5.0	5.0	5.0
Forestry & Agriculture	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Utilities	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Private households	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total GDP	49.5	50.3	55.7	55.1	55.9	56.9	58.0	59.2	60.3	61.7	62.7	64.0	65.3	66.6
Total Government (Chained)	19.3	20.3	21.0	20.9	21.0	21.2	21.3	21.5	21.6	21.7	21.8	22.0	22.2	22.3
Population	1,291.3	1,303.2	1,319.2	1,335.3	1,353.4	1,371.1	1,388.2	1,404.8	1,420.9	1,435.1	1,448.9	1,462.0	1,474.5	1,486.4
Personal Income	48.7	51.4	54.3	55.1	58.5	62.2	66.2	70.3	74.7	79.4	84.0	89.0	94.2	99.5
Real Disposable Personal Income	35.3	36.1	37.8	37.2	38.2	39.1	40.0	40.9	41.8	42.6	43.2	43.9	44.6	45.1
PCE-Price Index (Fixed 2000$)	506.0	532.1	541.8	560.7	581.4	603.5	627.3	652.2	678.6	706.1	736.0	766.8	799.4	834.4
PCE-Price Index with Housing Price	540.5	565.9	575.3	593.7	614.4	636.4	660.1	684.7	710.6	737.6	766.6	796.4	827.8	861.2

Proposed GHG Reduction Work Plans for Hawaii

Work Plan 1:

State

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Employment *Thousands (Jobs)*														
Commercial	619.0	636.1	651.2	657.5	665.6	676.0	682.7	693.0	701.9	708.0	713.8	720.1	726.1	731.7
Industrial	18.5	19.0	18.9	18.9	18.9	19.6	19.7	20.0	20.3	20.2	20.1	20.1	20.1	20.0
Forestry & Agriculture	3.8	4.0	4.1	4.2	4.2	4.4	4.5	4.5	4.5	4.5	4.6	4.5	4.5	4.4
Utilities	2.9	2.9	3.3	3.9	3.8	3.9	2.6	2.7	3.0	2.9	2.7	2.6	2.5	2.5
Total -	***644.2***	***662.1***	***677.6***	***684.5***	***692.6***	***703.9***	***709.5***	***720.2***	***729.5***	***735.5***	***741.2***	***747.3***	***753.2***	***758.6***
GDP *Billions of Fixed (2000) Dollars*														
Commercial	62.3	63.5	64.5	64.8	66.3	67.8	68.9	70.2	71.1	71.9	72.5	73.0	73.5	73.8
Industrial	4.6	4.6	4.7	4.7	4.7	5.0	5.0	5.1	5.3	5.3	5.3	5.4	5.4	5.4
Forestry & Agriculture	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Utilities	1.7	1.7	1.9	2.1	2.1	2.2	1.5	1.5	1.6	1.6	1.5	1.5	1.4	1.3
Private households	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total GDP	49.5	50.3	55.9	55.7	56.4	57.5	58.1	59.5	60.8	62.0	63.0	64.3	65.6	66.8
Total Government (Chained)	19.3	20.3	21.0	20.9	21.1	21.2	21.3	21.5	21.6	21.7	21.8	22.0	22.2	22.3
Population	1291.3	1303.2	1319.6	1336.7	1355.2	1373.3	1390.2	1407.1	1423.4	1437.5	1451.1	1464.1	1476.4	1488.2
Personal Income	48.7	51.4	54.4	55.3	58.8	62.6	66.3	70.6	75.1	79.8	84.3	89.4	94.5	99.9
Real Disposable Personal Income	35.3	36.1	37.8	37.4	38.3	39.3	40.2	41.1	42.0	42.8	43.4	44.1	44.8	45.3
PCE-Price Index (Fixed 2000$)	506.0	532.1	541.7	560.5	581.6	603.7	627.1	652.0	679.1	706.4	736.1	766.8	799.1	833.9
PCE-Price Index with Housing Price	540.5	565.9	575.2	593.7	614.9	636.8	660.3	684.7	711.2	738.0	766.8	796.5	827.7	860.9

Work Plan 2:

State

		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Employment *Thousands (Jobs)*															
Commercial		619.0	636.1	651.2	657.5	665.6	675.9	682.7	693.0	701.9	708.1	714.0	720.3	726.4	732.0
Industrial		18.5	19.0	18.9	18.9	18.9	19.6	19.7	19.9	20.2	20.1	20.1	20.1	20.0	20.0
Forestry & Agriculture		3.8	4.0	4.1	4.2	4.2	4.4	4.4	4.5	4.5	4.5	4.6	4.5	4.5	4.4
Utilities		2.9	2.9	3.3	3.9	3.9	4.0	2.7	2.9	3.1	2.9	2.8	2.7	2.6	2.6
	Total -	644.2	662.1	677.6	684.5	692.6	704.0	709.6	720.3	729.7	735.7	741.4	747.6	753.5	758.9
GDP ***Billions of Fixed (2000) Dollars***															
Commercial		62.3	63.5	64.5	64.7	66.2	67.7	68.8	70.1	71.0	71.8	72.3	72.9	73.4	73.6
Industrial		4.6	4.6	4.7	4.6	4.7	4.9	5.0	5.1	5.3	5.3	5.3	5.4	5.4	5.4
Forestry & Agriculture		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Utilities		1.7	1.7	1.9	2.1	2.1	2.2	1.5	1.6	1.7	1.6	1.6	1.5	1.5	1.4
Private households		0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total GDP		49.5	50.3	55.9	55.7	56.4	57.5	58.1	59.4	60.8	62.0	63.0	64.2	65.5	66.8
Total Government (Chained)		19.3	20.3	21.0	20.9	21.1	21.2	21.3	21.5	21.6	21.7	21.8	22.0	22.2	22.3
Population		1,291.3	1,303.2	1,319.6	1,336.7	1,355.1	1,373.2	1,390.1	1,406.9	1,423.2	1,437.3	1,450.9	1,463.9	1,476.3	1,488.1
Personal Income		48.7	51.4	54.4	55.3	58.8	62.6	66.3	70.6	75.1	79.8	84.4	89.4	94.5	99.9
Real Disposable Personal Income		35.3	36.1	37.8	37.4	38.3	39.3	40.1	41.1	42.0	42.8	43.4	44.1	44.7	45.3
PCE-Price Index (Fixed 2000$)		506.0	532.1	541.7	560.5	581.7	603.8	627.3	652.2	679.3	706.5	736.3	767.0	799.3	834.2
PCE-Price Index with Housing Price		540.5	565.9	575.2	593.7	615.0	637.0	660.5	684.9	711.4	738.2	767.0	796.7	827.9	861.1

Work Plan 3:

State

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Employment *Thousands (Jobs)*														
Commercial	619.0	636.1	651.2	657.5	665.6	678.3	685.4	695.8	705.0	711.5	717.5	724.0	730.3	735.9
Industrial	18.5	19.0	18.9	18.9	18.9	19.7	19.8	20.0	20.3	20.2	20.1	20.2	20.1	20.0
Forestry & Agriculture	3.8	4.0	4.1	4.2	4.2	4.4	4.5	4.5	4.5	4.5	4.6	4.5	4.5	4.5
Utilities	2.9	2.9	3.3	3.9	3.8	3.9	2.8	2.8	3.0	2.9	2.7	2.7	2.6	2.5
Total -	***644.2***	***662.1***	***677.6***	***684.5***	***692.6***	***706.3***	***712.4***	***723.2***	***732.8***	***739.1***	***745.0***	***751.3***	***757.5***	***762.9***
GDP ***Billions of Fixed (2000) Dollars***														
Commercial	62.3	63.5	64.5	64.8	66.3	67.9	69.1	70.3	71.3	72.2	72.7	73.3	73.8	74.0
Industrial	4.6	4.6	4.7	4.7	4.7	5.0	5.0	5.2	5.3	5.3	5.3	5.4	5.4	5.4
Forestry & Agriculture	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Utilities	1.7	1.7	1.9	2.1	2.1	2.2	1.6	1.6	1.7	1.6	1.5	1.5	1.4	1.4
Private households	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total GDP	49.5	50.3	55.9	55.7	56.4	57.7	58.4	59.7	61.1	62.3	63.4	64.7	66.0	67.2
Total Government (Chained)	19.3	20.3	21.0	20.9	21.1	21.3	21.4	21.6	21.7	21.8	21.9	22.1	22.3	22.4
Population	1,291.3	1,303.2	1,319.6	1,336.7	1,355.2	1,374.2	1,391.9	1,409.5	1,426.6	1,441.5	1,455.9	1,469.6	1,482.6	1,494.9
Personal Income	48.7	51.4	54.4	55.3	58.8	62.8	66.6	71.0	75.6	80.3	84.9	90.0	95.2	100.6
Real Disposable Personal Income	35.3	36.1	37.8	37.4	38.3	39.5	40.3	41.3	42.2	43.1	43.7	44.4	45.1	45.6
PCE-Price Index (Fixed 2000$)	506.0	532.1	541.7	560.5	581.6	603.7	627.4	652.0	679.2	706.4	736.1	766.9	799.3	834.2
PCE-Price Index with Housing Price	540.5	565.9	575.2	593.7	614.9	636.9	660.6	684.9	711.4	738.2	767.1	796.9	828.1	861.4

County Level Results

REMI Macro-economic Modeling

Reference Case:

Oahu

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Employment *Thousands (Jobs)*														
Commercial	430.9	440.1	450.4	452.7	459.1	465.1	471.0	476.5	481.8	486.2	489.2	492.6	495.9	498.6
Industrial	13.6	13.9	13.8	13.7	13.8	13.8	13.8	13.8	13.8	13.7	13.6	13.6	13.5	13.4
Forestry & Agriculture	1.7	1.8	1.8	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.8
Utilities	1.8	1.8	1.8	1.8	1.8	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
GDP ***Billions of Fixed (2000) Dollars***														
Commercial	46.0	47.3	48.3	48.4	49.7	50.8	51.9	52.8	53.5	54.2	54.6	55.0	55.3	55.4
Industrial	3.7	3.8	3.8	3.8	3.9	3.9	4.0	4.0	4.0	4.1	4.1	4.1	4.1	4.1
Forestry & Agriculture	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Utilities	1.1	1.1	1.1	1.0	1.1	1.1	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0
Private households	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total GDP	37.6	38.5	42.6	42.2	43.0	43.7	44.7	45.6	46.5	47.5	48.3	49.2	50.2	51.1
Total Government (Chained)	17.6	18.6	19.1	19.0	19.2	19.3	19.4	19.6	19.7	19.8	19.9	20.1	20.2	20.3
Population	912.8	918.0	926.4	935.0	945.7	956.2	966.4	976.4	986.0	994.2	1,002.1	1,009.5	1,016.4	1,022.8
Personal Income	36.9	38.8	40.9	41.4	44.0	46.6	49.5	52.5	55.7	59.0	62.2	65.8	69.4	73.2
Real Disposable Personal Income	27.3	28.0	29.2	28.8	29.5	30.2	30.8	31.5	32.0	32.6	32.9	33.4	33.8	34.1
PCE-Price Index (Fixed 2000$)	118.3	122.4	123.9	128.3	132.7	137.6	143.0	148.7	154.8	161.2	168.2	175.3	182.9	191.2
PCE-Price Index with Housing Price	131.5	136.2	137.9	142.4	147.1	152.3	157.9	163.8	170.0	176.5	183.6	190.8	198.4	206.6

Reference Case:

Maui

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Employment *Thousands (Jobs)*														
Commercial	81.3	85.2	86.8	87.4	88.5	89.7	90.8	91.9	93.1	94.1	95.0	95.9	96.9	97.7
Industrial	2.0	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Forestry & Agriculture	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0
Utilities	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
GDP ***Billions of Fixed (2000) Dollars***														
Commercial	7.6	7.5	7.5	7.5	7.6	7.7	7.8	7.9	7.9	8.0	8.0	8.0	8.0	8.0
Industrial	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Forestry & Agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Utilities	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Private households	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total GDP	5.4	5.3	5.9	5.8	5.8	5.9	6.0	6.1	6.2	6.3	6.4	6.5	6.6	6.7
Total Government (Chained)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8
Population	142.8	144.9	147.2	149.5	151.9	154.3	156.5	158.6	160.5	162.3	164.0	165.5	167.0	168.4
Personal Income	4.9	5.2	5.5	5.6	6.0	6.4	6.9	7.3	7.9	8.4	8.9	9.5	10.2	10.8
Real Disposable Personal Income	3.3	3.3	3.5	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.3	4.4
PCE-Price Index (Fixed 2000$)	128.9	136.7	139.6	144.5	150.0	155.9	162.3	169.0	176.1	183.6	191.8	200.2	209.2	218.9
PCE-Price Index with Housing Price	139.4	146.9	149.6	154.4	160.0	165.9	172.2	178.8	185.8	193.1	201.0	209.1	217.6	226.8

Reference Case:

Hawaii

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Employment *Thousands (Jobs)*														
Commercial	72.6	75.1	76.8	77.6	79.0	80.4	81.9	83.4	85.0	86.6	88.0	89.5	91.0	92.5
Industrial	2.0	2.0	2.0	2.0	2.0	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.2	2.2
Forestry & Agriculture	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Utilities	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
GDP ***Billions of Fixed (2000) Dollars***														
Commercial	5.8	5.7	5.7	5.7	5.8	5.9	6.0	6.1	6.2	6.4	6.5	6.6	6.7	6.8
Industrial	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Forestry & Agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Utilities	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Private households	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total GDP	4.4	4.4	4.9	4.8	4.8	4.9	5.0	5.1	5.2	5.4	5.5	5.7	5.9	6.1
Total Government (Chained)	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9
Population	172.7	176.8	181.2	185.7	189.8	193.8	197.7	201.6	205.4	208.9	212.5	216.1	219.6	223.1
Personal Income	5.0	5.3	5.6	5.7	6.1	6.5	7.0	7.5	8.0	8.6	9.2	9.8	10.5	11.2
Real Disposable Personal Income	3.4	3.4	3.6	3.5	3.6	3.8	3.9	4.0	4.1	4.3	4.4	4.5	4.6	4.8
PCE-Price Index (Fixed 2000$)	129.4	136.2	139.0	143.8	149.2	154.8	160.7	166.8	173.2	179.8	186.9	194.2	201.9	210.0
PCE-Price Index with Housing Price	132.1	138.3	140.9	145.4	150.6	155.9	161.6	167.5	173.6	180.0	186.7	193.7	200.9	208.5

Reference Case:

Kauai

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Employment *Thousands (Jobs)*														
Commercial	34.2	35.7	36.3	36.4	36.9	37.4	37.9	38.4	38.9	39.4	39.8	40.3	40.7	41.2
Industrial	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Forestry & Agriculture	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Utilities	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3
GDP ***Billions of Fixed (2000) Dollars***														
Commercial	2.9	2.9	2.9	2.9	2.9	3.0	3.0	3.1	3.1	3.1	3.1	3.2	3.2	3.2
Industrial	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Forestry & Agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Utilities	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Private households	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total GDP	2.1	2.1	2.4	2.3	2.3	2.4	2.4	2.4	2.5	2.5	2.6	2.6	2.7	2.7
Total Government (Chained)	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Population	62.9	63.6	64.4	65.2	66.1	66.9	67.6	68.3	69.0	69.7	70.3	70.9	71.5	72.0
Personal Income	2.0	2.2	2.3	2.3	2.5	2.6	2.8	3.0	3.2	3.4	3.7	3.9	4.2	4.4
Real Disposable Personal Income	1.4	1.4	1.4	1.4	1.5	1.5	1.6	1.6	1.6	1.7	1.7	1.8	1.8	1.8
PCE-Price Index (Fixed 2000$)	129.3	136.8	139.4	144.1	149.5	155.2	161.3	167.6	174.4	181.4	189.1	197.0	205.4	214.3
PCE-Price Index with Housing Price	137.5	144.5	146.9	151.5	156.8	162.4	168.4	174.6	181.1	188.0	195.3	202.9	210.9	219.3

Work Plan 1:

Oahu

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Employment *Thousands (Jobs)*														
Commercial	430.9	440.1	450.6	453.6	459.9	466.0	472.0	478.0	484.0	487.9	490.9	494.3	497.5	500.3
Industrial	13.6	13.9	13.8	13.8	13.8	14.2	14.3	14.5	14.8	14.7	14.6	14.6	14.5	14.4
Forestry & Agriculture	1.7	1.8	1.8	1.9	1.9	1.9	1.9	2.0	2.0	2.0	1.9	1.9	1.9	1.8
Utilities	1.8	1.8	1.8	1.6	1.6	1.7	1.5	1.5	1.4	1.4	1.3	1.3	1.2	1.2
GDP ***Billions of Fixed (2000) Dollars***														
Commercial	46.0	47.3	48.3	48.5	49.8	51.0	52.1	53.0	53.8	54.5	54.9	55.3	55.6	55.8
Industrial	3.7	3.8	3.8	3.8	3.9	4.1	4.1	4.2	4.4	4.4	4.4	4.4	4.4	4.4
Forestry & Agriculture	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Utilities	1.1	1.1	1.1	1.0	1.0	1.0	0.9	0.9	0.9	0.8	0.8	0.8	0.7	0.7
Private households	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total GDP	37.6	38.5	42.7	42.3	43.0	43.9	44.8	45.7	46.7	47.7	48.4	49.4	50.3	51.2
Total Government (Chained)	17.6	18.6	19.1	19.0	19.2	19.3	19.4	19.6	19.7	19.8	19.9	20.1	20.2	20.3
Population	912.8	918.0	926.5	935.3	946.2	956.7	967.1	977.3	987.2	995.5	1,003.4	1,010.9	1,017.9	1,024.4
Personal Income	36.9	38.8	40.9	41.5	44.0	46.7	49.6	52.7	55.9	59.2	62.5	66.0	69.6	73.4
Real Disposable Personal Income	27.3	28.0	29.3	28.8	29.5	30.2	30.9	31.6	32.2	32.7	33.1	33.5	33.9	34.2
PCE-Price Index (Fixed 2000$)	118.3	122.4	123.9	128.2	132.6	137.6	142.9	148.5	154.7	161.1	168.0	175.1	182.7	190.9
PCE-Price Index with Housing Price	131.5	136.2	137.9	142.3	147.1	152.3	157.8	163.6	169.9	176.5	183.5	190.7	198.3	206.4

Work Plan 1:

Maui

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Employment *Thousands (Jobs)*														
Commercial	81.3	85.3	86.8	89.8	89.7	91.9	90.8	92.4	93.0	94.1	94.9	95.9	96.7	97.6
Industrial	2.0	2.1	2.1	2.2	2.1	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Forestry & Agriculture	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.1	1.1	1.1	1.1
Utilities	0.4	0.5	0.5	1.5	1.5	1.5	0.4	0.6	0.9	0.8	0.8	0.8	0.8	0.7
GDP ***Billions of Fixed (2000) Dollars***														
Commercial	7.6	7.5	7.5	7.7	7.7	7.9	7.8	7.9	7.9	7.9	8.0	8.0	8.0	8.0
Industrial	0.4	0.4	0.4	0.4	0.4	0.5	0.4	0.5	0.4	0.4	0.4	0.5	0.5	0.5
Forestry & Agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Utilities	0.2	0.2	0.2	0.8	0.8	0.8	0.2	0.3	0.4	0.4	0.4	0.4	0.4	0.4
Private households	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total GDP	5.4	5.3	5.9	6.3	6.3	6.4	6.0	6.1	6.3	6.4	6.5	6.6	6.7	6.8
Total Government (Chained)	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8
Population	142.8	144.9	147.2	150.1	152.9	155.6	157.6	159.6	161.4	163.0	164.5	166.0	167.3	168.6
Personal Income	4.9	5.2	5.5	5.8	6.2	6.7	6.9	7.4	7.9	8.5	9.0	9.6	10.2	10.9
Real Disposable Personal Income	3.3	3.3	3.5	3.6	3.7	3.8	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.4
PCE-Price Index (Fixed 2000$)	128.9	136.7	139.5	144.5	150.4	156.2	162.5	169.0	177.1	184.5	192.6	201.0	210.0	219.7
PCE-Price Index with Housing Price	139.4	146.9	149.5	154.4	160.6	166.3	172.7	179.0	186.7	193.9	201.7	209.8	218.3	227.5

Proposed GHG Reduction Work Plans for Hawaii

Work Plan 1:

Hawaii

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Employment *Thousands (Jobs)*														
Commercial	72.6	75.1	77.3	77.7	79.0	80.5	81.9	84.6	86.1	86.6	88.0	89.5	91.0	92.4
Industrial	2.0	2.0	2.0	2.0	2.0	2.2	2.2	2.2	2.2	2.2	2.2	2.3	2.3	2.3
Forestry & Agriculture	1.0	1.0	1.0	1.0	1.0	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Utilities	0.5	0.5	0.7	0.5	0.5	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.3
GDP ***Billions of Fixed (2000) Dollars***														
Commercial	5.8	5.7	5.8	5.7	5.8	5.9	6.0	6.2	6.3	6.4	6.5	6.6	6.7	6.8
Industrial	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Forestry & Agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Utilities	0.3	0.3	0.4	0.3	0.3	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2
Private households	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total GDP	4.4	4.4	5.0	4.8	4.8	4.9	5.0	5.2	5.3	5.4	5.5	5.7	5.9	6.1
Total Government (Chained)	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Population	172.7	176.8	181.4	185.9	190.0	194.0	197.9	202.0	205.9	209.5	213.0	216.5	219.9	223.4
Personal Income	5.0	5.3	5.6	5.7	6.1	6.5	7.0	7.5	8.1	8.6	9.2	9.8	10.5	11.1
Real Disposable Personal Income	3.4	3.4	3.6	3.5	3.7	3.8	3.9	4.0	4.2	4.3	4.4	4.5	4.6	4.8
PCE-Price Index (Fixed 2000$)	129.4	136.2	138.9	143.8	149.1	154.7	160.5	166.8	173.1	179.6	186.6	193.9	201.4	209.5
PCE-Price Index with Housing Price	132.1	138.3	140.8	145.4	150.5	155.9	161.5	167.5	173.6	179.9	186.5	193.4	200.6	208.2

Proposed GHG Reduction Work Plans for Hawaii

Work Plan 1:

Kauai

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Employment *Thousands (Jobs)*														
Commercial	34.2	35.7	36.5	36.4	36.9	37.5	38.0	38.0	38.8	39.4	39.9	40.4	40.9	41.3
Industrial	0.9	0.9	0.9	0.9	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.2
Forestry & Agriculture	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3
Utilities	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2
GDP ***Billions of Fixed (2000) Dollars***														
Commercial	2.9	2.9	2.9	2.9	2.9	3.0	3.0	3.0	3.1	3.1	3.2	3.2	3.2	3.2
Industrial	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Forestry & Agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Utilities	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Private households	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total GDP	2.1	2.1	2.4	2.3	2.3	2.4	2.4	2.4	2.5	2.5	2.6	2.6	2.7	2.7
Total Government (Chained)	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Population	62.9	63.6	64.5	65.3	66.1	66.9	67.6	68.2	68.9	69.5	70.1	70.7	71.3	71.8
Personal Income	2.0	2.2	2.3	2.3	2.5	2.6	2.8	3.0	3.2	3.4	3.7	3.9	4.2	4.5
Real Disposable Personal Income	1.4	1.4	1.5	1.4	1.5	1.5	1.6	1.6	1.7	1.7	1.7	1.8	1.8	1.9
PCE-Price Index (Fixed 2000$)	129.3	136.8	139.4	144.0	149.4	155.1	161.2	167.6	174.3	181.1	188.9	196.7	205.0	213.9
PCE-Price Index with Housing Price	137.5	144.5	146.9	151.5	156.7	162.4	168.4	174.6	181.0	187.8	195.1	202.7	210.5	219.0

Work Plan 2:

Oahu

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Employment *Thousands (Jobs)*														
Commercial	430.9	440.1	450.6	453.6	459.9	466.0	472.0	478.0	484.0	487.9	491.0	494.4	497.7	500.5
Industrial	13.6	13.9	13.8	13.8	13.8	14.2	14.3	14.5	14.7	14.6	14.6	14.5	14.4	14.3
Forestry & Agriculture	1.7	1.8	1.8	1.9	1.9	1.9	1.9	2.0	2.0	2.0	1.9	1.9	1.9	1.8
Utilities	1.8	1.8	1.8	1.6	1.7	1.8	1.6	1.5	1.5	1.5	1.4	1.4	1.3	1.3
GDP ***Billions of Fixed (2000) Dollars***														
Commercial	46.0	47.3	48.3	48.4	49.8	50.9	52.0	52.9	53.7	54.4	54.7	55.2	55.5	55.7
Industrial	3.7	3.8	3.8	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.4	4.4	4.4	4.4
Forestry & Agriculture	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Utilities	1.1	1.1	1.1	1.0	1.0	1.1	1.0	0.9	0.9	0.9	0.8	0.8	0.8	0.8
Private households	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total GDP	37.6	38.5	42.7	42.2	43.0	43.9	44.7	45.7	46.7	47.6	48.4	49.3	50.3	51.2
Total Government (Chained)	17.6	18.6	19.1	19.0	19.2	19.3	19.4	19.6	19.7	19.8	19.9	20.1	20.2	20.3
Population	912.8	918.0	926.5	935.3	946.1	956.6	967.0	977.1	987.0	995.3	1,003.3	1,010.7	1,017.7	1,024.2
Personal Income	36.9	38.8	40.9	41.5	44.0	46.7	49.6	52.7	55.9	59.2	62.5	66.0	69.6	73.4
Real Disposable Personal Income	27.3	28.0	29.3	28.8	29.5	30.2	30.9	31.6	32.2	32.7	33.1	33.5	33.9	34.2
PCE-Price Index (Fixed 2000$)	118.3	122.4	123.9	128.2	132.7	137.7	142.9	148.6	154.7	161.1	168.1	175.2	182.8	191.0
PCE-Price Index with Housing Price	131.5	136.2	137.9	142.3	147.1	152.3	157.8	163.7	170.0	176.6	183.6	190.7	198.3	206.4

Work Plan 2:

Maui

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Employment *Thousands (Jobs)*														
Commercial	81.3	85.3	86.8	89.8	89.7	91.8	90.8	92.4	93.0	94.1	94.9	95.9	96.8	97.6
Industrial	2.0	2.1	2.1	2.2	2.1	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Forestry & Agriculture	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.1	1.1	1.1	1.1
Utilities	0.4	0.5	0.5	1.5	1.5	1.5	0.4	0.6	0.9	0.9	0.8	0.8	0.8	0.7
GDP ***Billions of Fixed (2000) Dollars***														
Commercial	7.6	7.5	7.5	7.7	7.7	7.9	7.8	7.9	7.9	7.9	7.9	8.0	8.0	7.9
Industrial	0.4	0.4	0.4	0.4	0.4	0.5	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4
Forestry & Agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Utilities	0.2	0.2	0.2	0.8	0.8	0.8	0.2	0.3	0.5	0.4	0.4	0.4	0.4	0.4
Private households	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total GDP	5.4	5.3	5.9	6.3	6.3	6.4	6.0	6.1	6.3	6.4	6.5	6.6	6.7	6.8
Total Government (Chained)	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8
Population	142.8	144.9	147.2	150.1	152.9	155.6	157.6	159.6	161.4	163.0	164.5	166.0	167.3	168.6
Personal Income	4.9	5.2	5.5	5.8	6.2	6.7	6.9	7.4	7.9	8.5	9.0	9.6	10.2	10.9
Real Disposable Personal Income	3.3	3.3	3.5	3.6	3.7	3.8	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.4
PCE-Price Index (Fixed 2000$)	128.9	136.7	139.5	144.5	150.5	156.3	162.6	169.1	177.1	184.5	192.7	201.1	210.1	219.8
PCE-Price Index with Housing Price	139.4	146.9	149.5	154.4	160.6	166.4	172.7	179.0	186.7	193.9	201.7	209.8	218.4	227.5

Work Plan 2:

Hawaii

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Employment *Thousands (Jobs)*														
Commercial	72.6	75.1	77.3	77.7	79.0	80.6	81.9	84.6	86.1	86.7	88.1	89.5	91.0	92.5
Industrial	2.0	2.0	2.0	2.0	2.0	2.2	2.2	2.2	2.2	2.2	2.2	2.3	2.3	2.3
Forestry & Agriculture	1.0	1.0	1.0	1.0	1.0	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Utilities	0.5	0.5	0.7	0.5	0.5	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4
GDP ***Billions of Fixed (2000) Dollars***														
Commercial	5.8	5.7	5.8	5.7	5.8	5.9	6.0	6.2	6.3	6.4	6.5	6.6	6.7	6.8
Industrial	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Forestry & Agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Utilities	0.3	0.3	0.4	0.3	0.3	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2
Private households	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total GDP	4.4	4.4	5.0	4.8	4.8	4.9	5.0	5.2	5.3	5.4	5.5	5.7	5.9	6.1
Total Government (Chained)	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Population	172.7	176.8	181.4	185.9	190.0	194.0	197.9	202.0	205.9	209.5	213.0	216.5	220.0	223.4
Personal Income	5.0	5.3	5.6	5.7	6.1	6.5	7.0	7.5	8.1	8.6	9.2	9.8	10.5	11.2
Real Disposable Personal Income	3.4	3.4	3.6	3.5	3.7	3.8	3.9	4.0	4.2	4.3	4.4	4.5	4.6	4.8
PCE-Price Index (Fixed 2000$)	129.4	136.2	138.9	143.8	149.1	154.7	160.6	166.8	173.2	179.7	186.7	193.9	201.5	209.5
PCE-Price Index with Housing Price	132.1	138.3	140.8	145.4	150.5	155.9	161.6	167.5	173.6	179.9	186.5	193.4	200.6	208.2

Work Plan 2:

Kauai

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Employment *Thousands (Jobs)*														
Commercial	34.2	35.7	36.5	36.4	36.9	37.5	38.0	38.0	38.9	39.4	39.9	40.5	40.9	41.4
Industrial	0.9	0.9	0.9	0.9	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.2
Forestry & Agriculture	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3
Utilities	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.2	0.2
GDP ***Billions of Fixed (2000) Dollars***														
Commercial	2.9	2.9	2.9	2.9	2.9	3.0	3.0	3.0	3.1	3.1	3.1	3.2	3.2	3.2
Industrial	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Forestry & Agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Utilities	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Private households	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total GDP	2.1	2.1	2.4	2.3	2.3	2.4	2.4	2.4	2.5	2.5	2.6	2.6	2.7	2.7
Total Government (Chained)	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Population	62.9	63.6	64.5	65.3	66.1	66.9	67.7	68.2	68.9	69.5	70.1	70.7	71.3	71.9
Personal Income	2.0	2.2	2.3	2.3	2.5	2.6	2.8	3.0	3.2	3.5	3.7	3.9	4.2	4.5
Real Disposable Personal Income	1.4	1.4	1.5	1.4	1.5	1.5	1.6	1.6	1.7	1.7	1.7	1.8	1.8	1.9
PCE-Price Index (Fixed 2000$)	129.3	136.8	139.4	144.0	149.4	155.2	161.2	167.7	174.3	181.2	188.9	196.8	205.0	213.9
PCE-Price Index with Housing Price	137.5	144.5	146.9	151.5	156.7	162.4	168.4	174.7	181.1	187.8	195.2	202.7	210.6	219.0

Work Plan 3:

Oahu

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Employment *Thousands (Jobs)*														
Commercial	430.9	440.1	450.6	453.6	459.9	467.8	474.0	480.2	486.3	490.5	493.8	497.3	500.7	503.5
Industrial	13.6	13.9	13.8	13.8	13.8	14.2	14.4	14.5	14.8	14.7	14.6	14.6	14.5	14.4
Forestry & Agriculture	1.7	1.8	1.8	1.9	1.9	1.9	2.0	2.0	2.0	2.0	1.9	1.9	1.9	1.8
Utilities	1.8	1.8	1.8	1.6	1.6	1.7	1.7	1.5	1.4	1.4	1.3	1.3	1.2	1.2
GDP ***Billions of Fixed (2000) Dollars***														
Commercial	46.0	47.3	48.3	48.5	49.8	51.1	52.2	53.1	54.0	54.6	55.0	55.5	55.8	56.0
Industrial	3.7	3.8	3.8	3.8	3.9	4.1	4.1	4.2	4.4	4.4	4.4	4.4	4.5	4.5
Forestry & Agriculture	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Utilities	1.1	1.1	1.1	1.0	1.0	1.0	1.0	0.9	0.9	0.8	0.8	0.8	0.7	0.7
Private households	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total GDP	37.6	38.5	42.7	42.3	43.0	44.0	45.0	45.9	47.0	48.0	48.7	49.7	50.6	51.5
Total Government (Chained)	17.6	18.6	19.1	19.0	19.2	19.4	19.5	19.6	19.8	19.9	20.0	20.1	20.3	20.4
Population	912.8	918.0	926.5	935.3	946.2	957.4	968.4	979.1	989.7	998.6	1,007.2	1,015.2	1,022.7	1,029.6
Personal Income	36.9	38.8	40.9	41.5	44.0	46.9	49.9	53.0	56.2	59.6	62.9	66.5	70.2	74.0
Real Disposable Personal Income	27.3	28.0	29.3	28.8	29.5	30.3	31.0	31.7	32.4	32.9	33.3	33.8	34.2	34.5
PCE-Price Index (Fixed 2000$)	118.3	122.4	123.9	128.2	132.7	137.7	143.0	148.6	154.7	161.1	168.0	175.2	182.7	190.9
PCE-Price Index with Housing Price	131.5	136.2	137.9	142.3	147.1	152.4	158.0	163.8	170.0	176.6	183.6	190.8	198.4	206.5

Work Plan 3:

Maui

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Employment *Thousands (Jobs)*														
Commercial	81.3	85.3	86.8	89.8	89.7	92.1	91.1	92.7	93.3	94.5	95.4	96.3	97.2	98.1
Industrial	2.0	2.1	2.1	2.2	2.1	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Forestry & Agriculture	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.1	1.1	1.1	1.1
Utilities	0.4	0.5	0.5	1.5	1.5	1.5	0.4	0.6	0.9	0.9	0.8	0.8	0.8	0.7
GDP ***Billions of Fixed (2000) Dollars***														
Commercial	7.6	7.5	7.5	7.7	7.7	7.9	7.8	7.9	7.9	8.0	8.0	8.0	8.0	8.0
Industrial	0.4	0.4	0.4	0.4	0.4	0.5	0.4	0.5	0.4	0.4	0.4	0.5	0.5	0.5
Forestry & Agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Utilities	0.2	0.2	0.2	0.8	0.8	0.8	0.2	0.3	0.5	0.4	0.4	0.4	0.4	0.4
Private households	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total GDP	5.4	5.3	5.9	6.3	6.3	6.4	6.0	6.2	6.3	6.4	6.5	6.6	6.7	6.8
Total Government (Chained)	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8
Population	142.8	144.9	147.2	150.1	152.9	155.7	157.8	159.9	161.7	163.4	165.0	166.5	167.9	169.2
Personal Income	4.9	5.2	5.5	5.8	6.2	6.7	6.9	7.5	8.0	8.5	9.1	9.7	10.3	10.9
Real Disposable Personal Income	3.3	3.3	3.5	3.6	3.7	3.8	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.4
PCE-Price Index (Fixed 2000$)	128.9	136.7	139.5	144.5	150.4	156.2	162.5	169.0	177.2	184.6	192.7	201.2	210.2	219.9
PCE-Price Index with Housing Price	139.4	146.9	149.5	154.4	160.6	166.3	172.7	178.9	186.8	194.0	201.9	210.0	218.6	227.7

Work Plan 3:

Hawaii

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Employment *Thousands (Jobs)*														
Commercial	72.6	75.1	77.3	77.7	79.0	80.7	82.1	84.8	86.3	86.9	88.3	89.8	91.3	92.7
Industrial	2.0	2.0	2.0	2.0	2.0	2.2	2.2	2.2	2.2	2.2	2.2	2.3	2.3	2.3
Forestry & Agriculture	1.0	1.0	1.0	1.0	1.0	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Utilities	0.5	0.5	0.7	0.5	0.5	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4
GDP ***Billions of Fixed (2000) Dollars***														
Commercial	5.8	5.7	5.8	5.7	5.8	5.9	6.0	6.2	6.3	6.4	6.5	6.6	6.7	6.8
Industrial	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Forestry & Agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Utilities	0.3	0.3	0.4	0.3	0.3	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2
Private households	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total GDP	4.4	4.4	5.0	4.8	4.8	4.9	5.0	5.2	5.3	5.4	5.5	5.7	5.9	6.1
Total Government (Chained)	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9
Population	172.7	176.8	181.4	185.9	190.0	194.1	198.0	202.1	206.2	209.8	213.3	216.9	220.4	223.9
Personal Income	5.0	5.3	5.6	5.7	6.1	6.5	7.0	7.6	8.1	8.6	9.2	9.8	10.5	11.2
Real Disposable Personal Income	3.4	3.4	3.6	3.5	3.7	3.8	3.9	4.1	4.2	4.3	4.4	4.5	4.7	4.8
PCE-Price Index (Fixed 2000$)	129.4	136.2	138.9	143.8	149.1	154.6	160.5	166.7	173.1	179.6	186.5	193.8	201.4	209.4
PCE-Price Index with Housing Price	132.1	138.3	140.8	145.4	150.5	155.8	161.5	167.4	173.6	179.8	186.5	193.4	200.6	208.1

Work Plan 3:

Kauai

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Employment *Thousands (Jobs)*														
Commercial	34.2	35.7	36.5	36.4	36.9	37.7	38.2	38.2	39.0	39.6	40.1	40.6	41.1	41.6
Industrial	0.9	0.9	0.9	0.9	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.2
Forestry & Agriculture	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.4	0.3	0.3	0.3	0.3
Utilities	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.2	0.2
GDP *Billions of Fixed (2000) Dollars*														
Commercial	2.9	2.9	2.9	2.9	2.9	3.0	3.0	3.0	3.1	3.1	3.2	3.2	3.2	3.2
Industrial	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Forestry & Agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Utilities	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Private households	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total GDP	2.1	2.1	2.4	2.3	2.3	2.4	2.4	2.4	2.5	2.5	2.6	2.6	2.7	2.8
Total Government (Chained)	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Population	62.9	63.6	64.5	65.3	66.1	66.9	67.7	68.3	69.0	69.7	70.3	70.9	71.5	72.1
Personal Income	2.0	2.2	2.3	2.3	2.5	2.7	2.8	3.0	3.2	3.5	3.7	4.0	4.2	4.5
Real Disposable Personal Income	1.4	1.4	1.5	1.4	1.5	1.5	1.6	1.6	1.7	1.7	1.7	1.8	1.8	1.9
PCE-Price Index (Fixed 2000$)	129.3	136.8	139.4	144.0	149.4	155.1	161.3	167.7	174.2	181.1	188.8	196.7	205.0	213.9
PCE-Price Index with Housing Price	137.5	144.5	146.9	151.5	156.7	162.4	168.4	174.7	181.0	187.7	195.1	202.7	210.6	219.0

Hawaii Greenhouse Gas Emission Reductions Modeling

ENERGY 2020 Model Inputs and Assumptions

31 August 2009

Prepared for:
Hawaii Department of Business, Economic Development & Tourism

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PLEASE NOTE:

This report outlines the assumptions and data inputs used in developing a Reference Case for the Hawaii Department of Business, Economic Development and Tourism, in support of the Greenhouse Gas Emission Reduction Task Force.

Table of Contents:

Acronyms & Definitions

AEO	Annual Energy Outlook (published by EIA)
AFUDC	Accumulated Funds Used During Construction
Bunker Fuel	Fuel supplied to ships and aircraft, both domestic and foreign.
Btu	British Thermal Units
CAC	Criteria Air Contaminants (SO_x, NO_x, PM, etc.)
CECS	Commercial Energy Consumption Survey
CFL	Compact Fluorescent Light bulb
CHP	Combined Heat and Power
CO_2e	Carbon Dioxide equivalent
GDP	Gross Domestic Product
GO	Gross Output
GWP	Global Warming Potential
DBEDT	Department of Business, Economic Development and Tourism
DG	Distributed Generation
DOE	United States Department of Energy
DSM	Demand Side Management
EIA	Energy Information Administration
EPA	Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
GHG	Greenhouse Gas
IECC	International Energy Conservation Code
IGCC	Integrated Gasification Combined Cycle
IPCC	Intergovernmental Panel on Climate Change
IRP	Integrated Resource Plan
kW	Kilowatt
kWh	Kilowatt-hour
MECS	Manufacturer’s Energy Consumption Survey
Mt	Megatonne
MW	Megawatt
MWe	Megawatt electric
Mt CO_2e	Megatonne Carbon Dioxide Equivalent
MTCE	Megatonne Carbon Equivalent (as distinct from Carbon Dioxide Equivalent)
NAICS	North American Industry Classification System
NERC	North American Electric Reliability Corporation
NHTSA	National Highway Traffic Safety Administration
NOx	Nitrogen Oxides
OGCC	Oil/Gas Combined Cycle Turbine
OGCT	Oil/Gas Combustion Turbine
OGST	Oil/Gas Steam Turbine
PC	Pulverized Coal
REMI	Regional Economic Models, Inc.
RECS	Renewable Energy Certificates
Rest of US	Balance of systems in US
SEDS	State Energy Data System
SLH	Session Laws of Hawaii
SO_x	Sulfur Oxides (including sulfur dioxide)
SSI	Systematic Solutions, Inc.

USEPA	United States Environmental Protection Agency
W	Watt

1 Background and Project Scope

The State of Hawaii has committed to reducing its greenhouse gas (GHG) emissions to 1990 levels or below by 2020. The State's Greenhouse Gas Emissions Reduction law (Act 234, SLH 2007) established a Greenhouse Gas Emissions Reduction Task Force (the 'Task Force') to develop a plan to achieve this state goal.

ICF International ('ICF') was selected to assist the state and the Task Force in updating the State's inventory of GHG emissions and to develop and model alternative plans to achieve the State's GHG reduction target.[1] ICF selected ENERGY 2020, a multi-fuel, multi-sector energy and emissions model, owned by Systematic Solutions Inc. ('SSI') as the most appropriate tool to model different emission reduction plans. ENERGY 2020 realistically represents the impacts of potential policies, including the interactions of those policies as part of a broader action plan.

This report outlines the assumptions and data inputs used in developing the Reference Case that will be used as the basis for evaluating proposed policy changes. The report describes the data and assumptions used, the sources of this data, and the processes used in developing the Reference Case.

2 Organization of the Report

The report is organized into four main sections. Section 1 provides background information regarding the purpose and scope of the project. Section 2 describes how the report is organized. Section 3 describes the analytic approach used by ENERGY 2020 and the characteristics of the model. The final section (4) describes the model inputs. A more detailed explanation of the ENERGY 2020 model is included as Appendix A.

3 Analytic Approach

ICF developed an updated inventory of GHG emissions for Hawaii in December 2008. The inventory covered sources and sinks of GHG emissions by island for 1990 and 2007. Building on the information collected as part of this inventory, ENERGY 2020 was then used to model a business-as-usual outlook for Hawaii to 2020 – the Reference projection – at a county level. While this projection represents only one possible trajectory for future emissions, it provides a realistic structure on which to test the implications of various proposed GHG reduction policies. The model will be used to develop alternative combinations of policies (i.e., work plans) to meet the State's GHG emissions reduction target.

ENERGY 2020 is an integrated multi-region energy model that provides complete and detailed, all-fuel demand and supply sector simulations. These simulations can additionally include

[1] The target levels do not include emissions resulting from aviation. Act 234 specifies that emissions from aviation cannot be regulated as part of the emissions reduction effort. International bunker fuels (fuel supplied to ships and aircraft for international transportation) are also excluded from totals per IPCC convention.

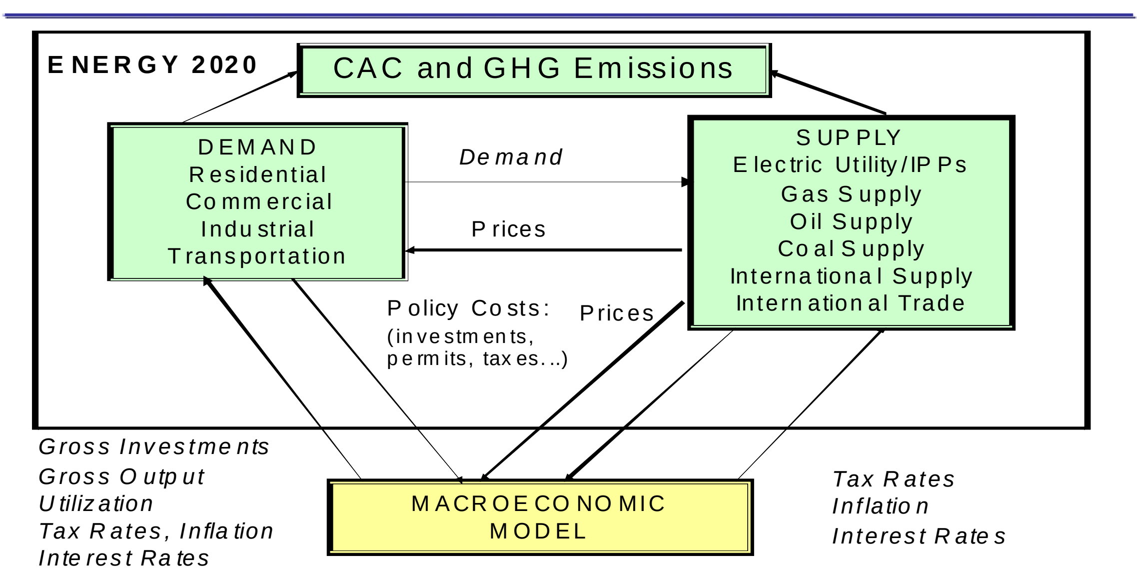
macroeconomic interactions to determine the benefits or costs to the local economy of new facilities or changing energy prices.

The basic implementation of ENERGY 2020 for North America now contains a user-defined level of aggregation down to the 10 provincial and 50 state (and sub-state) level. ENERGY 2020 contains historical information on all generating units in the US and Canada. Data for Mexico can be incorporated as needed. ENERGY 2020 is parameterized with local data for each region/state/province as well as all the associated energy suppliers it simulates. Thus, it captures the unique characteristics (physical, institutional and cultural) that affect how people make choices and use energy. The specific data sources used for Hawaii are described in Section 4.5 below.

ENERGY 2020 can be linked to a detailed macroeconomic model to determine the economic impacts of energy/environmental policy and the energy and environmental impacts of proposed policies. For US regional and state level analyses, the Regional Economic Models Incorporated[2] (REMI) macroeconomic model is regularly linked to ENERGY 2020. The REMI macroeconomic model includes inter-state/provincial, US and world trade flows, price and investment dynamics, and simulates the real-time impact of energy and environmental concerns on the economy and vice versa.

The macro-economic model, in this case REMI, is used to provide a forecast of the economy to ENERGY 2020. The projected level of economic activity is then used in the model to drive requirements for new investments, processes and equipment (as described in Appendix A).

Model Structure & Relationships



ENERGY2020 simulates energy choices relating to these investments regarding the types of fuel and energy efficiency associated with those investments based on prices, policies and other

[2] Regional Economic Models, Inc. www.remi.com

factors. Once ENERGY 2020 has completed its simulation, outputs from ENERGY 2020, including the level of investments, energy prices, policy costs, etc., can be fed back to REMI. These outputs are then used to determine the extent of economic impacts resulting from changes in energy policy.

The structure of the ENERGY 2020 model is well tested and has been used to simulate not only US and Canadian energy and environmental dynamics, but also those of several countries in South America, Western, Central, and Eastern Europe. These efforts include strategic and tactical analyses for both planning and energy industry restructuring/deregulation. In the 1990s, the US EPA made ENERGY 2020 available to interested states to analyze emissions, energy, and economic impacts of state-level climate change initiatives. Further, the model has been used successfully for deregulation analyses in all the US states and Canadian provinces. Many US and Canadian energy suppliers use the model for the analysis of combined electricity and gas deregulation dynamics.[3]

The default version of ENERGY 2020 simulates demand by three residential categories (single family, multi-family, and agriculture/rural), over 40 North American Industry Classification System (NAICS) commercial and industrial categories[4], and three transportation services (passenger, freight, and off-road). There are approximately six end-uses per category and six technology/mode families per end-use.[5] Currently, the technology families correspond to six fuels groups (oil, gas, coal, electric, solar and biomass) and 30 detailed fuel products. The transportation sector contains 45 modes of transportation, including various type of automobile, truck, off-road, bus, train, plane, marine and alternative-fuel vehicles. More end-uses, technologies, and modes can be added as data allow. For all end-uses and fuels, the model is parameterized based on historical, locale-specific data. The load duration curves are dynamically constructed from the individual end-uses to capture changing conditions under consumer choice and combined gas/electric programs. ***The specific data sets used to model Hawaii are described in Appendix B.***

Each energy demand sector includes cogeneration, self-generation, and distributed generation simulation, including mobile-generation, micro-turbines, and fuel-cells. Fuel-switching responses are rigorously determined. The technology families (which can be split, as an option, to portray specific technology dynamics) are aggregates that, within the model, change building shell, economic-process and device efficiency and capital costs as price or other information that the decision makers see, change. Historical and forecast energy use developed for each technology family is disaggregated by economic sector, end-use and technology to parameterize the model.

The supply portion of the model includes endogenous detailed electric supply simulation of capacity expansion/construction, rates/prices, load shape variation due to weather, and changes in regulation.[6] The model dispatches plants according to the specified rules whether

[3] ENERGY 2020 is the only model known to have simulated and predicted the dynamics that occurred in the UK electric deregulation. These include gaming, market consolidation and re-regulation dynamics.
[4] NAICS is the North America Industrial Classification System which was developed jointly by the U.S., Canada, and Mexico to provide new comparability in statistics about business activity across North America.
[5] End-uses include Process Heat, Space Heating, Water Heating, Other Substitutable, Refrigeration, Lighting, Air Conditioning, Motors, and Other Non-Substitutable (Miscellaneous). Detailed modes include: small auto, large auto, light truck, medium-weight truck, heavy-weight truck, bus, freight train, commuter train, airplane, and marine. Each mode type can be characterized by gasoline, diesel, electric, ethanol, NG, propane, fuel-cell, or hybrid vehicles.
[6] ENERGY 2020 does include a complete, but aggregate representation of the electric transmission system. Electric transmission data is provided by FERC, the Department of Energy, and the National Electric Reliability Council. The dispatch technologies in the basic model include: Oil/Gas Combustion turbine, Oil/Gas Combined Cycle, Oil/Gas Combined Cycle with CCS, Oil/Gas Steam

they are optimal or heuristic and simulates transmission constraints when determining dispatch.[7] A sophisticated dispatch routine selects critical hours along seasonal load duration curves as a way to provide a quick but accurate determination of system generation. Peak and base hydro usage is explicitly modeled to capture hydro-plant impacts on the electric system.

ENERGY 2020 supply sectors include electricity, oil, natural gas, refined petroleum products, ethanol, land-fill gas, and coal supply. For Hawaii, coal and natural gas supply are not modeled. Energy used in primary production and emissions associated with primary production and its distribution is included in the model. The supply sectors included in a particular implementation of ENERGY 2020 will depend on the characteristics of the area being simulated and the problem being addressed.

The ENERGY 2020 model includes pollution accounting for both combustion (by fuel, end-use, and sector) and non-combustion, and non-energy (by economic activity) for SO_2, NO_2, N_2O, CO, CO_2, CH_4, PMT, $PM_{2.5}$, PM_5, PM_{10}, VOC, CF_4, C_2F_6, SF_6, and HFC at the state and provincial level by economic sector. Other (gaseous, liquid, and solid) pollutants can be added as desired. Pollution does not need to be determined directly by coefficients but can recognize the accumulation of capital investments that result in pollution emission with usage. National and international allowance trading is also included. Plant dispatch can consider emission restrictions. For Hawaii, only GHG emissions are simulated.

The model captures the feedback among energy consumers, energy suppliers, and the economy using Qualitative Choice Theory and co-integration.[8] For example, a change in price affects demand that then affects future supply and price. Increased economic activity increases demand; increased demand increases the investment in new supplies. The new investment affects the economy and energy prices. The energy prices also affect the economy.

In order to assess the potential impacts of proposed policy options, a *business-as-usual* scenario (the Reference Case) is developed as a point of reference. This *Reference Case* represents a scenario that is viewed as a reasonable expectation of how the economy, energy use and emissions might develop over time.

Part of the nature of developing a Reference Case is the need to address inherently uncertain issues that can have significant impacts on future energy use and emissions. No forecast is going to be *right* or *accurate* in that no one can tell today how some of the key underlying issues may develop. Given the level of uncertainty involved in any projection of a possible future, caution should be used in applying a high level of precision to the modeling results. Understanding the Reference Case, however, can be extremely useful in providing an underlying structure against which to model proposed policies, and in determining directionality and cause and effect.

Numerous assumptions are required to perform an analysis of this type across a range of topic areas, including economic developments, fuel and electric markets, and regulatory structures. Projected outcomes are only as good as the input assumptions upon which they are based, with

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Turbine, Coal Steam Turbine, Advanced Coal, Coal with CCS, Nuclear, Baseload Hydro, Peaking Hydro, Small Hydro, Wind, Solar, Wave, Geothermal, Fuel-cells, Flow-Battery Storage, Pumped Hydro, Biomass, Landfill Gas, Trash, and Biogas.

[7] A 110 node transmission system is used in the default model, but a full AC load-flow bus representation model has also been interfaced with ENERGY 2020.

[8] The model has used the work of Daniel McFadden and Clive Granger since its inception in the late 1970s. A description of theory, its development and application, can be found in McFadden's Nobel Prize Lecture from December 2000, available at: http://nobelprize.org/nobel_prizes/economics/laureates/2000/mcfadden-lecture.html.

more rigorous assumptions leading to a more rigorous analysis. The inputs and assumptions described in this document were developed to provide as accurate a representation as possible of the activities and structures underlying energy use and GHG emissions in Hawaii.

4 Reference Case Inputs

ENERGY 2020 derives energy demands, such as the demand for electricity based on economic activity and device efficiency. The following sections provide a brief overview of the data inputs and assumptions as well as the sources of data used in the Reference Case. Actual data inputs for specific elements such as generating units, emission factors, etc., will be provided to the client separately in Excel spreadsheets.

As a multi-sector analytical tool, ENERGY 2020 requires data and assumptions covering a broad range of economic sectors and their interactions. In most cases, the necessary data – both historical and projected – is available from the federal government (EIA, EPA, FERC, etc.), the private sector (REMI) and the state government (DBEDT, State of Hawaii Data Book, IRP). In developing the model, a considerable amount of state-specific information was available and has been used wherever possible as described in the sections which follow.

The following sections provide an overview of the data and assumptions that will be required to perform the multi-sector analysis, and list the data sources that have been used to populate ENERGY 2020.

Data[9] inputs for ENERGY 2020 are required in five areas:

1. Population and economic
2. Fuel prices
3. Energy use and consumption
4. Emissions and air regulations
5. Electricity generation capacity and operation

The sections below list the key data elements required in each of these areas and the specific data and assumptions used in modeling Hawaii's energy use and emissions.

ENERGY 2020 requires both historical data and projections to calibrate and generate forward-looking projections. Various historical data will be used up to and including 2007, which is the most recent year for which detailed data is available.[10] Projections for the period to be modeled (e.g., through 2020) will be gathered where possible to provide points of comparison and check the reasonableness of the projection.

4.1 *Population and Economic Data*

Population and economic data are required to generate demands for services. The following data sources were used to establish the Reference Case for the State of Hawaii. For each

[9] "Data" here refers to both historical data and assumptions and projections of future inputs.
[10] ICF International completed the 2007 GHG Inventory for the state in December 2008. Hawaii Greenhouse Gas Inventory: 1990 and 2007, Prepared by ICF International for the Hawaii Department of Business, Economic Development & Tourism, December 2008

area, the tables below show the source of default data for the US as well as state and county-specific sources used.

For both the population and economic data, the base information provided by REMI was adjusted to conform to the DBEDT 2035 projections of population[11] and economic activity.

Description of Data/Input	**Sources**	**Detailed Reference**
Total population, historical and projected	REMI	REMI projection modified to align with the DBEDT 2035 Series.
	DBEDT	DBEDT 2035 Series. Population and Economic Projections for the State of Hawaii to 2035. Research and Economic Analysis Division; Department of Business, Economic Development and Tourism. January 2008
Housing Units	U.S. Census Bureau	Population Estimates Program, Population Division
Households by housing type (single-family, multi-family, etc.)	US Census Bureau	Household splits (data available through 2001, then held constant): *Source: U.S. Census Bureau, Housing and Household Economic Statistics Division* Last Revised: *December 16, 2005* http://www.census.gov/hhes/www/housing/census/historic/units.html **Household size** US Census Bureau, Census 2000 - assumes household size is same for all housing types in state. **Number of households** Calculated based on population, household fraction, and household size.
Personal income	REMI	REMI projection.
	DBEDT	DBEDT 2035 Series
	Future	DBEDT 2035 Series
Gross Domestic Product	DBEDT/REMI	REMI projection DBEDT 2035 Series.
Employment	DBEDT/REMI	DBEDT 2035 Series
Tourism	DBEDT	DBEDT 2035 Series

[11] Resident population estimates (as opposed to de facto population estimates, which include visitors) were used in calibrating the baseline in REMI, per correspondence between Bansari Saha, ICF, and Fred Treyz, REMI, in May 2009.

4.2 *Energy Price Data*

Energy prices can play a significant role in end user decisions on equipment, capital and operating decisions. Fuel costs can be critical in determining the costs of electric dispatch, as well as input costs of some industrial processes and home heating. ENERGY 2020 calculates future electric prices based in part on these fuel cost, combined with the costs of dispatched generation.

Energy prices are largely determined by international markets, although domestic demand, such as electric sector demand for natural gas can influence prices. As a result, fuel prices are treated by the model as an exogenous input.

Historic energy price data are taken from US DOE State Energy Data and the DBEDT Data Book. For this project, DBEDT agreed to use a projection of energy prices based on the Energy Information Administration's 2009 Annual Energy Outlook Reference Case Price scenario for 2009 to 2030.[12]

Power prices are calculated endogenously by the model based on generation costs and dispatch. While the model estimates retail electricity prices, actual consumer prices may differ as a result of political, regulatory or market influences. The model has been calibrated to actual electricity prices by county, within reasonable parameters, for the historic period[13].

4.3 *Historic Energy Consumption Data*

ENERGY 2020 models energy use at the end-use level within each economic sector based on the existing physical stock and the efficiency of that stock. The database of device efficiencies reflects both the average efficiency of energy use for current stocks and the efficiency/energy alternatives available to consumers at the margin. Technology and efficiency choices are modeled based on past experience with consumer choice rather than on a purely economic evaluation.

Historic energy use and consumption data used in modeling US jurisdictions is generally derived from the federal Energy Information Administration (EIA) State Energy Data System (SEDS) database. For Hawaii, considerable volume of state-specific data was available, and this data was used to replace national data sources wherever possible.

Default sectoral and end-use data as well as energy intensities are based on the Residential Energy Consumption Survey (RECS), Commercial Energy Consumption Survey (CECS) and Manufacturers Energy Consumption Survey (MECS).

Description of Data/Input	Sources Used/Available
Residential Data - Household income by housing type - No. of people per household - End-use consumption data, including	2001 EIA Residential Energy Consumption Survey (RECS), by Census Region and Division (2005 RECS in process) http://www.eia.doe.gov/emeu/recs/contents.html

[12] Energy Information Administration, Annual Energy Outlook 2009, Report #DOE/EIA-0383(2009), March 2009, http://www.eia.doe.gov/oiaf/aeo/
[13] Based on data from DBEDT, Hawaii Data Books.

Description of Data/Input	Sources Used/Available
fuels used for space and water heating, air conditioning, etc.	Hawaii: HELCO IRP 3, Appendix O - Demand-Side Management Report Phase II study, Global Energy Partners, February 2006. Maui: MECO IRP 3, Appendix L - Assessment of Demand-Side Management Resource Options, Global Energy Partners, December 2006; Oahu: HECO IRP 4, Appendix N – Assessment of Energy Efficiency and Demand Response Potential, Volume II, Appendix D, Global Energy Partners, 2006. Kauai: KIUC IRP, Energy Efficiency Potential Study, April 26, 2005, prepared by KEMA Inc. Data on Military electricity use provided by DBEDT, April 2009
Commercial Data - Floor area by sub-sector - End-use consumption data, including fuels used for space and water heating and energy intensities	2003 EIA Commercial Buildings Energy Consumption Survey (CBECS), by Census Region and Division (2007 CBECS underway) http://www.eia.doe.gov/emeu/cbecs/contents.html Hawaii- sources as above for Residential.
Industrial/Manufacturing Data - Energy use by fuel for each sub-sector and end-use	2002 EIA Manufacturing Energy Consumption Survey (MECS), by Census Region (2006 MECS underway) http://www.eia.doe.gov/emeu/mecs/contents.html Hawaii – as above.
State Energy Data: - Energy consumption and expenditures by sector and energy source	2004 EIA State Energy Data System (SEDS) http://www.eia.doe.gov/emeu/states/_seds.html State of Hawaii Data Book (2000 to 2007) http://hawaii.gov/dbedt/info/economic/databook/

4.4 *Historic Emission Data*

4.4.1 Emissions and Air Regulations

Historic GHG emissions are based on the GHG emissions inventory as prepared by ICF.[14] ENERGY 2020 is calibrated using historic information on all of the major GHG emissions including:

[14] Hawaii Greenhouse Gas Inventory: 1990 and 2007, Prepared by ICF International for the Hawaii Department of Business, Economic Development & Tourism, December 2008

- Carbon dioxide (CO_2),
- Nitrous oxide (N_2O),
- Methane (CH_4),
- Sulfur hexafluoride (SF_6),
- Hydrofluorocarbons (HFCs) and
- Perfluorocarbons (PFCs).

GHG emissions are presented in CO_2 equivalent (CO_2e) terms. The global warming potentials used to convert the different GHG emissions into CO_2e terms are provided in Appendix D.

Input	Sources Used/Available
Emissions by sector, end-use, fuel & GHG	US EPA http://www.epa.gov/climatechange/emissions/usinventoryreport.html ICF International, Hawaii Greenhouse Gas Inventory, 1990 & 2007.

4.4.2 Emission Factors

Emission factors for most fuels are based on values used by ICF in developing national and state inventories. For the transportation sector, the emission factors for CH_4 and N_2O pollutants were adapted from the Canadian National Inventory Report.[15] ENERGY 2020 calculates GHG emissions at the point of combustion for most fuels. Upstream emissions from extraction and processing are captured as part of those respective economic sectors.

Emissions associated with the use of biomass as a fuel are deemed to be biogenic and therefore not contribute to global warming. As a result, the model assumes no GHG emissions are created from the use of biomass.

Emissions from ethanol and other biofuels represent an exception from a modeling perspective. In order to capture the emissions associated with their production and distribution, the model applies full cycle emission factors for these fuels. While the combustion of ethanol and biodiesel are not deemed to result in any anthropogenic emissions, the model uses an emission factor to recognize upstream emissions for biofuels produced within the state. Biofuels produced outside of the state but used within Hawaii will be treated as biogenic emissions.

The full-cycle emission factors used in the model for each biofuels type are shown in the table below:

Sugar Ethanol	26.6 g CO_2e / MJ[16]
Cellulosic Ethanol	14 gCO_2e / MJ[17]
Biodiesel	26.1 gCO_2e / MJ[18]

[15] Environment Canada. National Inventory Report 1990-2005, Greenhouse Gas Sources and Sinks in Canada, April 2007. (Annex 12- Emission Factors)
[16] PEW Centre on Global Climate Change, Ethanol Factsheet, http://www.pewclimate.org/technology/factsheet/Ethanol
[17] Alexander Farrell, UC Berkeley and Daniel Sperling, UC Davis, A Low-Carbon Fuel Standard for California Part 1: Technical Analysis May 29, 2007 Table 2-3 http://www.energy.ca.gov/low_carbon_fuel_standard/UC-1000-2007-002-PT1.PDF
[18] California Air Resources Board, Detailed California-Modified GREET Pathway for Biodiesel (Esterified Soyoil)from Midwest Soybeans, February 2009.

When these fuels are used in combination with other fuels, for example in a mix of gasoline and ethanol, the emissions associated with gasoline combustion are reported as part of total gasoline-related emissions.

4.5 *Electricity Sector Data*

4.5.1 Generation Data

ENERGY 2020 contains information on every generating unit in the county/state. The model tracks and uses the following information for each generating unit:

- Historic Peak Capacity (MW);
- Historic generation levels (GWh);
- Type of fuel used;
- Heat rate;
- Historic annual fuel use (PJ);
- Emissions by pollutant type;
  O&M costs;
- Capacity factors;
- Emission rates;
- Outage rates;
- Location (county);
- Ownership information;
- Plant type (Hydraulic, Coal, Combined Cycle Turbine, etc.)

The data on existing and committed generating units for Hawaii were derived from EIA data (Form 860) supplemented by utility-specific information from the Hawaii Public Utilities Commission (PUC) Integrated Resource Planning (IRP) process.

4.5.2 Electricity Generation Capacity and Operation Data

ENERGY 2020 is populated with data describing the type, operation and performance of every generating unit in the US and Canada. In order to improve model performance, some smaller units with common characteristics have been combined (i.e., wind units at the same site, or small hydraulic units). In addition to plant-level data, the table below includes other inputs necessary to describe the electric system, including transmission capability.

Input	Sources Used/Available
Plant type	Annual Electric Generator Report: EIA Form 860 (2007) IRP 3 documents
Plant capacity	Annual Electric Generator Report: EIA Form 860 (2007) IRP 3 documents
Plant historical generation	EIA Form 906/920 (2001-2007) IRP 3 documents
Plant fuel type	Annual Electric Generator Report: EIA Form 860 (2007)

Input	Sources Used/Available
	IRP 3 documents
Plant heat rate	EIA Form 906/920 (2001-2007)
Plant fuel consumption	EIA Form 906/920 (2001-2007)
Plant emissions by pollutant	EPA CAMD (2001-2007)
Plant costs (operation and maintenance, variable and fixed)	IRP 3 documents
Plant historical capacity factor	EIA Form 906/920 (2001-2007)
Plant availability (outages)	Calculated using generation data
Plant owner and location	Annual Electric Generator Report: EIA Form 860 (2007)
Planned capacity additions and retirements	Annual Electric Generator Report: EIA Form 860 IRP 3 documents
Sales by Rate Class (historic)	FERC Form 1 and Annual Reports to PUC. HELCO: Schedule C Statistical Information from p. 36 of Annual Report to PUC, Data through 2007 obtained from DBEDT; KIUC: Schedule C Statistical Information from p. 36 of Annual Report to PUC, MECO: Sales of Electricity by Rate Schedules from p. 304 of FERC Form No. 1 Annual Report HECO: Sales of Electricity by Rate Schedules from p. 304 of FERC Form No. 1 Annual Report State of Hawaii Data Book (2000 to 2007) http://hawaii.gov/dbedt/info/economic/databook/

The resulting list of generating units was matched to emission data from the EPA in order to calculate emission rates. The resulting emission rates for the targeted GHG emissions were then reviewed for reasonableness based on plant type and capacity factors, etc.

Historic generation by plant type will be calibrated with historic generation data available from the EIA.

4.5.3 Transmission Structure and Dispatch

Power flows are modeled within ENERGY 2020 based on existing transmission capabilities and interconnections as obtained from NERC and IRP reports. In Hawaii, each county has been treated as one node. In the Reference Case it is assumed that there are no interconnections between counties.

Generation is dispatched at the node level for a set of sample hours in each season. Each node is economically dispatched, selecting lowest cost generation first with the resulting clearing price determining the generation price for that node as described in Appendix A. As part of the calculation the model can utilize resources from a neighboring node within the constraints of the transfer capacity between nodes. The transfer of energy between nodes is subject to a 1% loss to represent additional transmission losses.

4.5.4 Planned Capacity Changes

As part of the modeling process, ENERGY 2020 builds new capacity endogenously as needed to meet capacity and reserve requirements or to minimize the total cost of generation (e.g., in response to allowance prices). At any given time, however, plans may already be in place to build, re-furbish, upgrade or retire generation facilities. These plans must be incorporated into the model in order to reflect decisions and commitments that have already been made.

For this project, we reviewed information on generation projects proposed in Hawaii PUC's IRP 3 process. While it is not possible to determine which specific projects will proceed, it was agreed that this modeling effort would assume that units proposed in the IRP 3 process would be completed.

ENERGY 2020 can determine the need for new generation based on a pre-determined reserve requirement. Normally, this determination is based on the highest level of demand for power and the available capacity at the time of that peak. Some types of generation, such as wind or some types of hydro-electric generation however, may not be available at the time of the peak. For modeling purposes, we have assumed that only 15% of installed wind capacity is available at the time of the peak.

4.5.5 New Generation Characteristics

The costs and characteristics of new generation are based on information provided in the IRP 3 reports for each of the utilities in Hawaii.

Carbon capture and storage (CCS) is not assumed to be available during the time frame modeled.

4.5.6 Industrial Generation and Co-generation

ENERGY 2020 models both utility generation, which supplies the power grid, and what the model defines as "industrial generation," which supplies a particular end user.

Industrial generation is defined as power generation that is within an end user's facility that is primarily designed to supply the end user's load. This type of generation may supply some power to the grid through net metering or other arrangements but is primarily run to supply a specific end user. The term is used because this type of generation is most commonly found in industrial operations but may also occur in the commercial, institutional or residential sectors.

In Hawaii, there are a several such generators which serve industrial, residential, resort and medical facilities. Industrial generation, as defined in ENERGY 2020, could also be referred to as “self-generation” or “load displacement generation”. Industrial generation may be supplied by any of the fuels listed below:

- Biomass
- Coal
- LPG
- Oil
- Solar
- Steam

Co-generation, or combined heat and power facilities, simultaneously generate electricity and supply a heat load. ENERGY 2020 recognizes that co-generation may occur either as industrial generation or as utility generation and may use any of a number of fuels.

- Within the power sector, these plants are normally treated as ‘must run’ units, meaning that they will always operate when available. Power from these units contributes to overall electricity supply. Heat from these units may be captured as part of a separate steam supply system; however, limited data is available regarding overall US steam demand.
- Within the industrial sector, co-generation capacity will run based on heating requirements. Heat produced from co-generation is used to meet industrial heat requirements based on a co-generation heat rate. Co-generated electricity is used to meet industrial power requirements, reducing net demand from the grid.

Where the heat contribution of co-generation is significant, the preferred modeling approach is to include these units in the industrial sector as has been done in this project.

The databases used to represent electricity generation often include all significant generators, including both utility and industrial boilers and generators. By contrast, reported electricity consumption information tends to be based on metered electricity sales, and as such are net of self generation. Total electricity consumption and generation will generally be slightly higher than reported electricity sales. It is therefore important in calibrating the model with historic electricity consumption that existing generation used as industrial or self-generation be appropriately identified. This is particularly true in Hawaii where the level of industrial or self generation is relatively high.

Hawaii has historically had significant levels of industrial and self-generation, primarily associated with the petroleum and sugar refining industries but also serving a variety of commercial and even residential facilities. Historic levels of industrial generation for Hawaii are based on information from EIA reports (Form EIA-860 Database and EIA-923 Survey), and supplemented by information from the IRP3 process, the Combined Heat and Power Installation Database (supported by US DOE), the Hawaii Data Books and DBEDT. Appendix F contains a list of industrial or self-generation facilities included in the model. Note that the listing includes generators which have been retired. These units have been included to allow the model to be run and calibrated with the historic period.

4.6 *Transportation*

ENERGY 2020 models passenger, freight and off road transportation separately, based on different underlying drivers. Transportation is assumed to be a derived demand based on levels of economic output (for freight) or population growth (for passenger). As the economic drivers (industrial gross output and population) grow, transportation demand increases. The amount of transportation required per unit of economic output changes over time based on historic trends. Off road transportation energy use in ENERGY 2020 is driven by activity in the Agriculture, Forestry and Construction sectors.

Transportation requirements are developed for each geographic area in the model based on historic demands for transportation, consumer preferences, business requirements, and the cost for each mode of transportation. Consumers of transportation select among available modes within the model based on preferences and relative costs. Mode choices include bus, train, and various types of personal and freight vehicles. Consumers choose among modes based on consumer preferences and cost. The model uses average vehicle lifetimes to vintage the vehicle stock.

Personal vehicle choices are made in a similar manner. Consumers consider capital cost, fuel cost and efficiency as well as non-price factors in their purchase decision and seek to maximize perceived utility. Historically, non-price factors such as vehicle size, performance and appearance have dominated the choice decision with efficiency playing a relatively minor role. Costs are presented in the model in terms of the capital cost per mile traveled for different vehicle classes. Larger vehicles therefore have a higher associated capital cost as well as lower energy efficiency for the level of delivered service (miles traveled).

The transportation categories represented in the model are shown below.

ENERGY 2020 Classifications				
Economic Categories	**Modes**	**Vehicle Classes** *(Personal Vehicles)*	**Fuel Types** *(Personal Vehicles)*	**Technology Types**
Residential	Ground	Light	Gasoline	Internal Combustion Engine
Local Tourism	• Highway	Medium	Diesel	Hybrids
Aviation	• Bus	Heavy	Propane	Fuel Cell
Marine	• Train		CNG	Plug-In Hybrid
Commercial/Institutional	Passenger Freight		Electric	
Agriculture	Air/Water		Ethanol	
	• Aviation • Marine		Biodiesel Hydrogen	

Vehicle and modal efficiencies used in the model are based on the *Transportation Energy Data Book* (Edition 28, 2009)[19] published by the US Department of Energy's Oak Ridge National Laboratory. Specific data references are provided in the table below. This information has

[19] http://cta.ornl.gov/data/download28.shtml

been supplemented by information on vehicle registration and fuel use from the State of Hawaii Data Books and information supplied by DBEDT.

Information regarding state-specific travel patterns has been obtained from the Research and Innovative Technology Administration Bureau of Transportation Statistics.[20] The model also reflects the changes to new passenger vehicle CAFE standards recently announced by the Obama administration (please see section 4.8). Within the model, we have separated the transportation category into the visitor and resident populations, due to the unique level of tourism in Hawaii.

Input	**Sources Used/Available**
All tables below are from ***Transportation Energy Data Book*** *(Edition 28, 2009)*[21] *published by the US Department of Energy's Oak Ridge National Laboratory.*	
Average fuel economy	Tables 4.1, 4.2 and 4.3
New Vehicle Efficiency	Tables 4.7 and 4.9
Scrap/Survival Rates	Tables 3.7, 3.8 and 3.9
Freight Truck Fuel Economy	Tables 5.1 and 5.2
Bus Efficiency	Table 2.13
Rail Efficiency – Passenger	Table 9.10 and 9.11
Rail Efficiency - Freight	Table 9.8
Marine – Freight	Table 9.5
Air Travel	Table 9.2

The Reference Case assumes that the High Capacity Transit system will be completed to serve the Honolulu area. Estimates from the draft Environmental Assessment[22] projections indicate that the transit system will result in about a 3.6% reduction in vehicle miles traveled (VMT) and fuel use for passenger transportation in Honolulu by 2030. For modeling purposes, we have assumed that Oahu VMT will be reduced by 2.8% by 2020, with the reduction starting in 2012. Power consumption for the system has been based on information from the HECO IRP[23].

4.7 *Built Environment*

ENERGY 2020 models multiple residential, commercial and industrial sectors and multiple end uses within each sector as described in Appendices A and B. When a new model is built for a particular project, actual historic energy use is input to the model (generally from the EIA SEDS database) and allocated by sector based on census region data from the most recent energy surveys available from the EIA (e.g., Residential Energy Consumption Survey, Commercial Building Energy Consumption Survey) or jurisdiction-specific sources. The model does not represent the spatial distribution of buildings or how compact the urban form is, however, the pattern and level of transportation and building energy demands is represented based on historic levels of energy use. For this project, the distribution of electricity use has been based

[20] RITA, Bureau of Transportation Statistics, State Transportation Statistics 2007. http://www.bts.gov/publications/state_transportation_statistics/state_transportation_statistics_2007

[21] http://cta.ornl.gov/data/download26.shtml

[22] Honolulu High-Capacity Transit Corridor Project, Draft Environmental Impact Statement, U.S. Department of Transportation, Federal Transit Administration, November 2008.

[23] Hawaiian Electric Company Inc., Integrated Resource Plan 2009-2028, Docket No. 2007-0084, September 30, 2008. Appendix L, Exhibit 7, August 2007 and March 2008 sales and Peak Forecast.

on county-specific analyses prepared as part of the IRP process. Average and maximum device efficiencies are adjusted within the model over time in calibrating to this actual energy use data. Over the past two years, ICF and SSI have subjected this data to an internal review and updated the values based on expert opinion and data from a variety of sources.

Each end use within the model has a minimum and maximum level of efficiency associated with it. The minimum efficiency level is established by standards, such as building codes, lighting, appliance and equipment standards. The maximum is set by technical limitations. As regulations are introduced to raise efficiency standards for a particular end use, new equipment decisions for that end use are restricted from choosing a level of efficiency below the new standard. This same logic applies in transportation choices.

4.8 *Waste, Agriculture, Forestry and Other Land Uses (AFOLU)*

Non-energy emission sources and sinks such as those from waste and AFOLU sectors are modeled within ENERGY 2020. However, the model does not include the same level of detail with regards to the underlying drivers of these emissions as that included for energy-related emissions. For Hawaii, historic emission levels and other assumptions required as inputs to the model are based upon the Hawaii Greenhouse Gas Inventory.[24]

The waste sector cover emissions from municipal solid waste landfills, incineration facilities and wastewater, while AFOLU includes emissions and sinks resulting from enteric fermentation, manure management, agricultural soil management, field burning of agricultural residues, urea application, landfilled yard trimmings and food scraps, urban trees, and forests, and forest fires.

A description of the methodologies used to project future emissions from these sources and sinks is provided in Appendix G. For modeling purposes, it is assumed that waste emissions will increase at a rate projected in Appendix G. Given the uncertainties surrounding some elements of AFOLU emissions they have been held constant at 2007 levels over the period.

4.9 *Programs/Policies Incorporated in Reference Case*

The following policies are assumed to be implemented in the Reference Case.

- o The US Energy Independence and Security Act (EISA or Energy Act 2007) – includes changes to CAFE standard, biofuels mandate and lighting, equipment and appliance standards. The CAFÉ standard is modeled by incrementally increasing the efficiency of new vehicles to meet the required fleet average by 2020. Lighting and equipment standards are introduced as changes to the specified end use to meet the standards set out in the Act. The renewable fuel standard is discussed further below.
- o US Emergency Economic Stabilization Act of 2008 changes to Energy Tax Incentives.

[24] Hawaii Greenhouse Gas Inventory: 1990 and 2007, Prepared by ICF International for the Hawaii Department of Business, Economic Development & Tourism, December 2008. See pages 39 to 55.

- o Hawaii Renewable Portfolio Standards (RPS) law provided in Chapter 269, Part V, Hawaii Revised Statutes (HRS).[i] The assumptions used in modeling this policy are discussed below.
- o Hawaii Net Energy Metering (NEM) provided in Chapter 269, Part VI, HRS. This policy is modeled by including the opportunity to sell power to the grid at grid prices in the economic evaluation of potential distributed renewable projects.
- o Hawaii Public Benefits Fund (PBF) provided in Chapter 269, Part VII, HRS. This policy was not specifically modeled.
- o Hawaii ethanol content requirement provided in §486J-10, HRS (modeling of renewable fuel requirements is discussed below).
- o Hawaii Lead by Example Initiatives for State Facilities provided in Chapter 196, Part III, HRS. (not specifically modeled in reference projection).
- o Hawaii Solar water heater system requirements provided in Chapter 196, HRS.. Modeling of this policy assumes that 90% of new homes will install solar water heating.

The Hawaii State legislature passed several relevant pieces of legislation in the 2009 session. This legislation could affect RPS requirements, net metering, tax credits for ethanol, establish an Energy Efficiency Portfolio Standard and incent or encourage more efficient transportation. The Governor signed into law Act 155 (HB 1464)[25] and Act 156 (SB 1202)[26] on June 25, 2009. The changes that will be associated with this new legislation have not been included in the reference case, however, per discussion and agreement by Task Force members at the June 16, 2009, meeting.

The U.S. *Energy Independence and Security Act of 2007* was passed into law in early January 2008. The following assumptions have been used to model the Act in the Reference Case:

- Renewable Fuels: The Act specifies a minimum volume of biofuels to be produced each year. The EIA in its Energy Outlook 2009 projects that the level of biofuels produced and consumed by 2020 will fall somewhat below the levels proposed in the Act. For modeling purposes, we have assumed a level of biofuel production that is consistent with the AEO projection. Renewable Fuel Standards are included in the model by modifying the percentage of vehicles which use renewable fuels in order to meet the Standard.
- Residential Boilers and Furnace Fans: Savings estimates developed by the American Council for an Energy-Efficient Economy (ACEEE) for the state has been used to model this portion of the Act, using only the benefits realized by upgrades to the residential energy boilers, leaving out any energy benefits associated with reduced electricity consumption by furnace fans.
- Walk-In Coolers and Walk-In Freezers: Savings estimates developed by the ACEEE for the state has been used to model this portion of the Act.
- Electric Motor Efficiency Standards: The model will utilize the ACEEE savings projections, pro-rated to the state's relative industrial electricity sales.
- External Power Supply Efficiency Standard: savings estimates developed by the ACEEE for each state have been used to model this portion of the Act.

[25] The final text of House Bill 1464 is available online at: http://www.capitol.hawaii.gov/session2009/Bills/HB1464_CD1_.HTM
[26] The final text of Senate Bill 1202 is available online at: http://www.capitol.hawaii.gov/session2009/Bills/SB1202_CD1_.HTM

- Energy Efficient Light Bulbs: The base assumptions are that general service lighting accounts for about 90% of residential lighting, 10% of commercial lighting and 5% of industrial lighting.
- Metal Halide Lamp Fixtures: The model assumes that 15% of commercial lighting and 60% of industrial lighting now use metal halide fixtures. For new installations, the model assumes that 80% of this market would use pulse start ballasts.

On May 19, 2009, the Obama administration announced its intention to establish standards for vehicle GHG emissions and CAFE standards which would align with the GHG emission standards previously proposed by California. If this proposal proceeds, it would establish a national standard which would require the fuel efficiency of new passenger cars and light trucks to reach an average fleet efficiency of 35.5 mpg by 2016. Based on discussions with the Task Force, it was determined that this proposal would not be included in the Reference Case but may be modeled as part of later policy scenarios.

The reference case includes a Renewable Portfolio Standard (RPS) for the state as described in Appendix E. As stated above, the amendments to the RPS requirements signed into law on June 25, 2009,have not been included in the Reference Case. The RPS is introduced into the model as a constraint which must be met as the model selects among available generation technologies.

Appendix A: The ENERGY 2020 Model

The Model – ENERGY 2020

ENERGY 2020 is an integrated multi-region, multi-sector energy analysis system that simulates the supply, price and demand for all fuels. It is a causal and descriptive model, which dynamically describes the behavior of both energy suppliers and consumers for all fuels and for all end-uses. It simulates the physical and economic flows of energy users and suppliers. It simulates how they make decisions and how those decisions causally translate to energy-use and emissions.

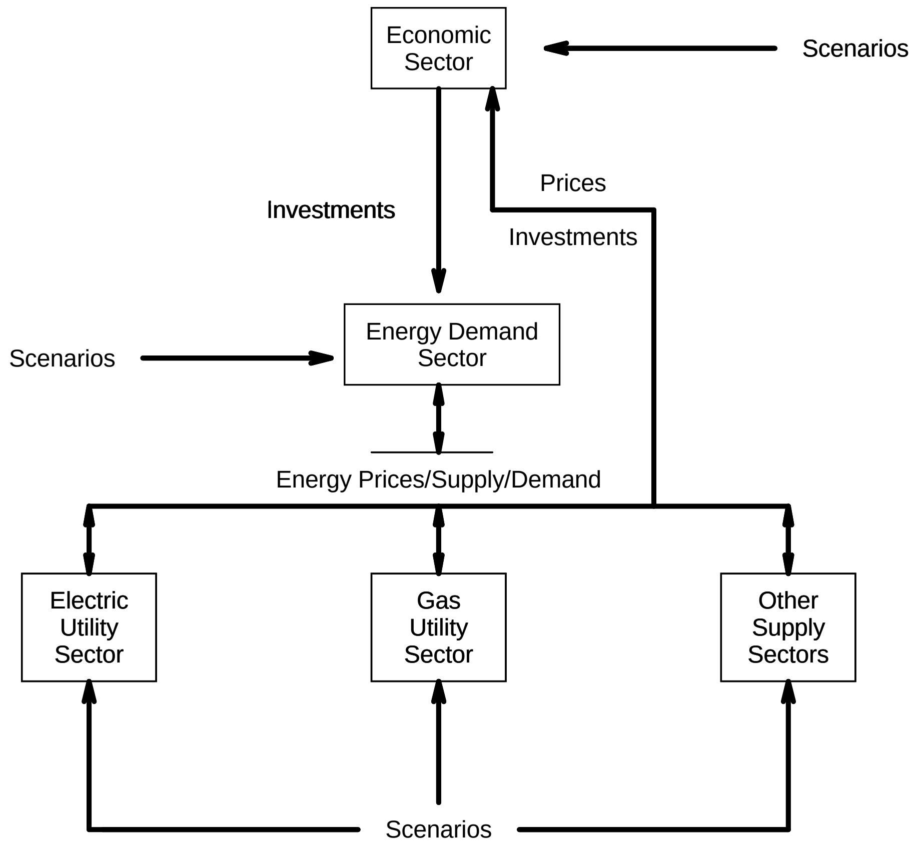
ENERGY 2020 is an outgrowth of the FOSSIL2/IDEAS model developed for the US Department of Energy (DOE) and used for all national energy policy since the Carter administration.[27] This early version of ENERGY 2020 was developed in 1978 at Dartmouth College for the DOE's Office of Policy Planning and Analysis.

Model Overview:

The basic structure of ENERGY 2020 is provided in Figure 1.1. Energy Demand sector interacts with the Energy Supply sector to determine equilibrium levels of demand and energy prices. Energy Demand is driven by the Economy sector, which in turn provides inputs to the Economy sector in terms of investments in energy using equipment and processes and energy prices. The model has a simplified Economy sector to capture the linkages between the energy system and the macro-economy. However, the model is best run with full integration with a macroeconomic model such as REMI. Given the modular nature of ENERGY 2020, additional sectors or modules from other, non-ENERGY 2020 related, models (macroeconomic, supply such as oil, gas, renewables etc.) can be incorporated directly into the ENERGY 2020 framework.

[27] *FOSSIL2 was the original version but was renamed to IDEAS a few years ago to reflect its evolutionary development since its original construction.*

Figure 1.1: ENERGY 2020 Overview



Energy Demand:

The demand sector of the model represents the geographic area by disaggregating the four economic sectors into sub-sectors based on energy services. As many sub-sectors as required can be incorporated into the model. Multiple technologies, multiple end-uses and multiple fuels are detailed. The level of detail that can be incorporated is of course subject to the data availability. The four economic sectors are:

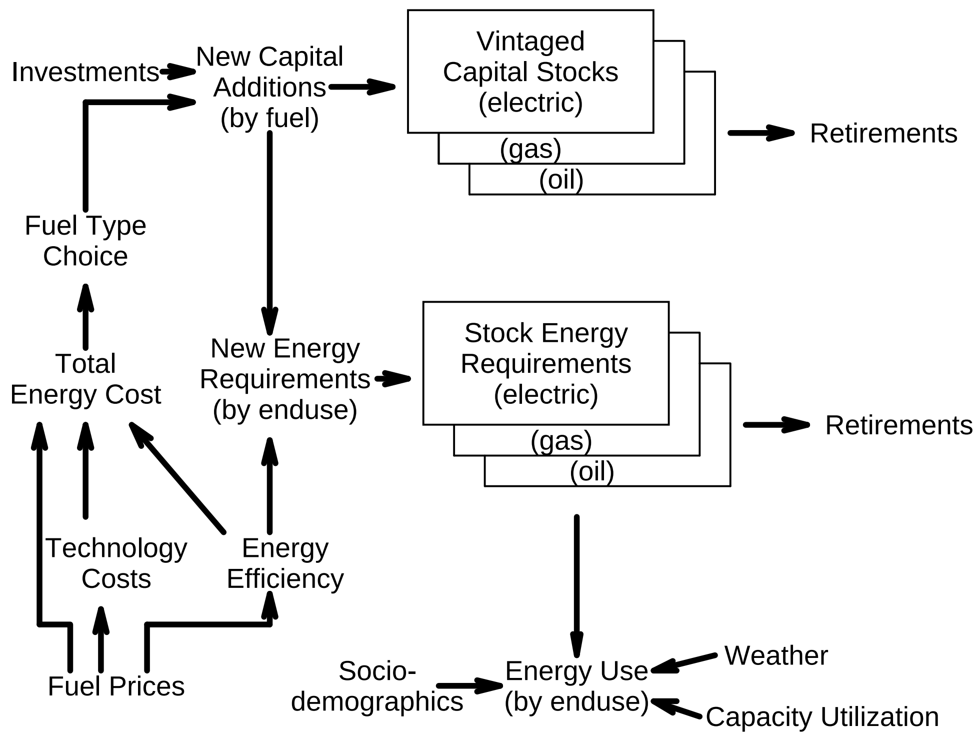
- Residential sector which includes three classes, single family, multi family and other, with 7 end-uses including refrigeration, lighting, water heating, cooking, drying, air conditioning and miscellaneous.
- Commercial sector which is divided into 11 classes: hotel, small office, large office, retail, grocery, warehouse, school, college, health, restaurant and miscellaneous. End-uses include refrigeration, lighting, water heating, cooking, drying, ventilation, air conditioning and miscellaneous.
- Industrial sector which includes 6 categories including sugar, other food/agriculture, oil refineries, steel plants, other industrial and water pumping & sewage. This sector is further broken down into motors, process heat, lighting, cooling and miscellaneous.
- Transportation sector which includes eight categories: residential passengers, tourist passenger, aviation, international aviation, marine, international marine, freight, and

agriculture. These categories are broken down into residential, local tourism, aviation, marine, commercial/institutional and agriculture.

For each of the end-uses, up to six fuels are modeled, for example, the residential space heating has the choice of a gas, oil, coal, electric, solar and biomass space heating technologies. Added end-uses, technologies and modes can be added as data allow. For all end-uses and fuels, the model is parameterized based on historical locale-specific data. The load duration curves are dynamically built up from the individual end-uses to capture changing condition under consumer choice and combined gas/electric programs.

A few basic concepts are crucial to an understanding of how the model simulates the energy system. These concepts including, the capital stock driver, the modeling of energy efficiency through trade-off curves, the fuel market share calculation, utilization multipliers and the cogeneration module are discussed below in abbreviated form. Figure 1.2 (Demand Overview) illustrates the demand sector interactions.

Figure 1.2: Demand Overview



Energy Demand as a Function of Capital Stock:

The model assumes that energy demand is a consequence of using capital stock in the production of output. For example, the industrial sector produces goods in factories, which require energy for production; the commercial sector requires buildings to provide services; and the residential sector needs housing to provide sustained labor services. The occupants of these buildings require energy for heating, cooling, and electromechanical (appliance) uses.

The amount of energy used in any end-use is based on the concept of energy efficiencies. For example, the energy efficiency of a house along with the conversion efficiency of the furnace determines how much energy the house uses to provide the desired warmth. The energy efficiency of the house is called the capital stock energy or process efficiency. This efficiency is primarily technological (e.g. insulation levels) but can also be associated with control or life-style changes (e.g. less household energy use because both spouses work outside the home.) The furnace efficiency is called the device or thermal efficiency. Thermal efficiency is associated with air conditioning, electromotive devices, furnaces and appliances.

The model simulates investment in energy using capital (buildings and equipment) from installation to retirement through three age classes or vintages. This capital represents embodied energy requirements that will result in a specified energy demand as the capital is utilized, until it is retired or modified.

The size and efficiency of the capital stock, and hence energy demands, change over time as consumers make new investments and retire old equipment. Consumers determine which fuel and technology to use for new investments based on perceptions of cost and utility. Marginal trade-offs between changing fuel costs and efficiency determine the capital cost of the chosen technology. These trade-offs are dependent on perceived energy prices, capital costs, operating costs, risk, access to capital, regulations and other imperfect information.

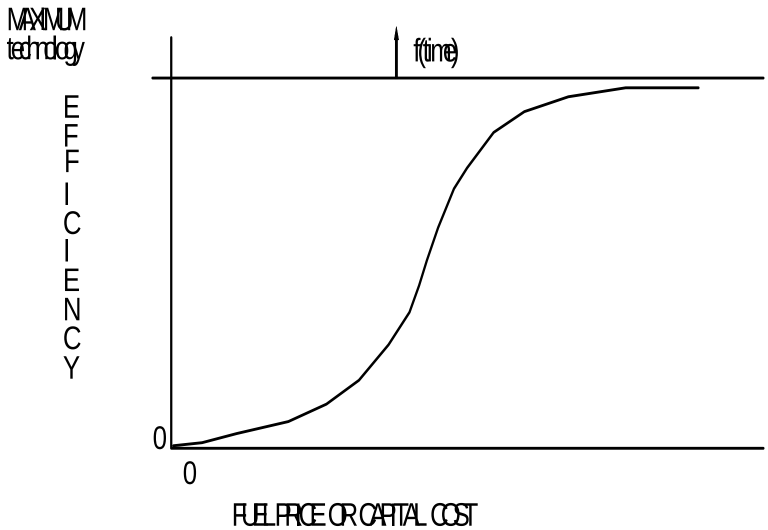
The model formulates the energy demand equation causally. Rather than using price elasticities to determine how demand reacts to changes in price, the model explicitly identifies the multiple ways price changes influence the relative economics of alternative technologies and behaviors, which in turn determine consumers' demand. In this sense, price elasticities are outputs, not inputs, of the model. The model accurately recognizes that price responses vary over time, and depend upon factors such as the rate of investment, age and efficiency of the capital stock, and the relative prices of alternative technologies.

Device and Process Energy Efficiency:

The energy requirement embodied in the capital stock can be changed only by new investments, retirements, or by retrofitting. The efficiency with which the capital uses energy has a limit determined by technological or physical constraints. The trade-off between efficiency and other factors (such as capital costs) is depicted in Figure 1.3 (Efficiency/Capital Cost Trade-Off). The efficiency of the new capital purchased depends on the consumer's perception of this trade-off. For example, as fuel prices increase, the efficiency consumers choose for a new furnace is increased despite higher capital costs. The amount of the increase in efficiency depends on the perceived price increase and its relevance to the consumer's cash flow.

Figure 1.3: Efficiency/Capital Cost Trade-Off

The



standard the model efficiency trade-off curves are called consumer-preference curves because they are estimated using cross-sectional (historical) data showing the decisions consumers made based on their perception of a choice's value. Many planners are now interested in measure-by-measure or least-cost curves which use engineering calculations and discount rates to show how consumers should respond to changing energy prices. Another analysis focuses on the technical/price differences in alternative technologies and the incentives needed to increase the market-share or market penetration of a specific technology. This perspective on the choice process uses market share curves. The model allows the user to select any of these three types of curves to represent the way consumers make their choices. Shared savings, rebate, subsidy programs, etc. can be tested using any of the curves.

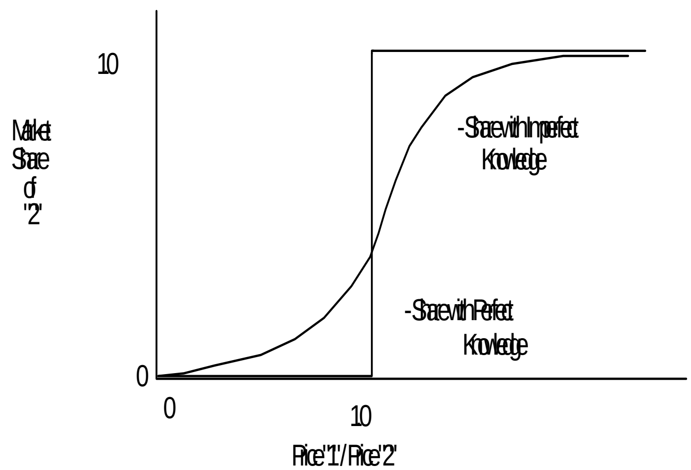
Cumulative investments determine the average embodied efficiency. The efficiency of new investments versus the average efficiency of existing equipment is one measure of the gap between realized and potential conservation savings.

The model uses saturation rates for devices to represent the amount of energy services necessary to produce a given level of output. Saturation rates may change over time to reflect changes in standard of living or technological improvements. For example, air conditioning has historically increased with rising disposable incomes. These rates can be specified exogenously or can be defined in relation to other variables within the model (such as disposable income).

The Market Share Calculation:

Not all investment funds are allocated to the least expensive energy option. Uncertainty, regional variations, and limited knowledge make the perceived price a distribution. The investments allocated to any technology are then proportional to the fraction of times one technology is perceived as less expensive (has a higher perceived value) than all others. This process is shown graphically in Figure 1.4 (Market Share Dynamics).

Figure 1.4: Market Share Dynamics



Short Term Budget Responses:

A short-term, temporary response to budget constraints is included in the model. Customers reduce usage of energy if they notice a significant increase in their energy bills. The customers' budgets are limited and energy use must be reduced to keep expenditures within those limits. These cutbacks are temporary behavioral reactions to changes in price, and will phase out as budgets adjust and efficiency improvements (true conservation) are implemented. This causes the initial response to changing prices to be more exaggerated than the long-term response, a phenomenon called "take-back" in studies of consumer behavior.

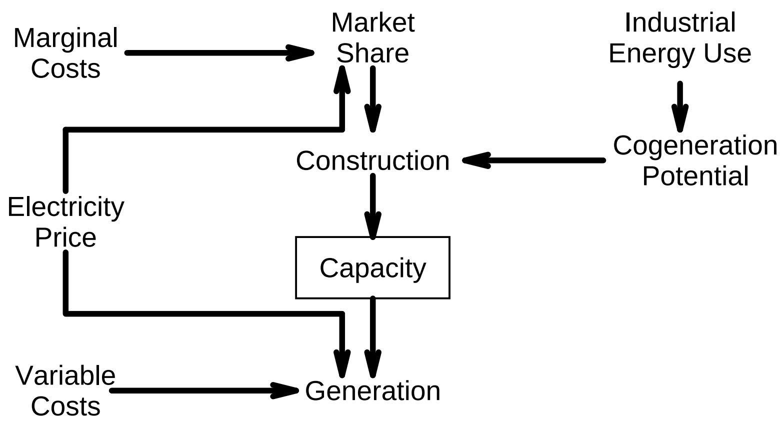
Accounting for Fungible Demand:

Some furnaces and processes can use multiple fuels. That is, they can switch almost instantaneously between, for example, gas and oil or coal and biomass as prices or the market dictates. Energy demand that is affected by this short-term fuel switching phenomena is called fungible demand. The model explicitly simulates this market share behavior.

Modeling Cogeneration:

Most energy users meet their electricity requirements through purchases from a utility. Some users (industrial and commercial) can, however, convert some of their own waste heat into usable electricity when economics warrant such action. Other users (residential and commercial) can purchase self-generation energy sources such as gas turbines, diesel-generators or fuel cells. Figure 1.5 shows a simplified overview of the cogeneration structure.

Figure 1.5: Cogeneration Concepts



In the model all energy used for heating is a candidate for cogeneration. The cost of cogeneration is the fixed capital cost of the investment plus the variable fuel costs (net of efficiency gains). This cogeneration cost is estimated for all technologies and compared to the price of electricity. The marginal market share for each cogeneration technology is based on this comparison.

Cogeneration is restricted to consumers who directly produce part of their own electricity requirement. Companies which generate power primarily for resale to the electric utility are considered independent power producers and are included in the electric supply model.

Energy Supply:

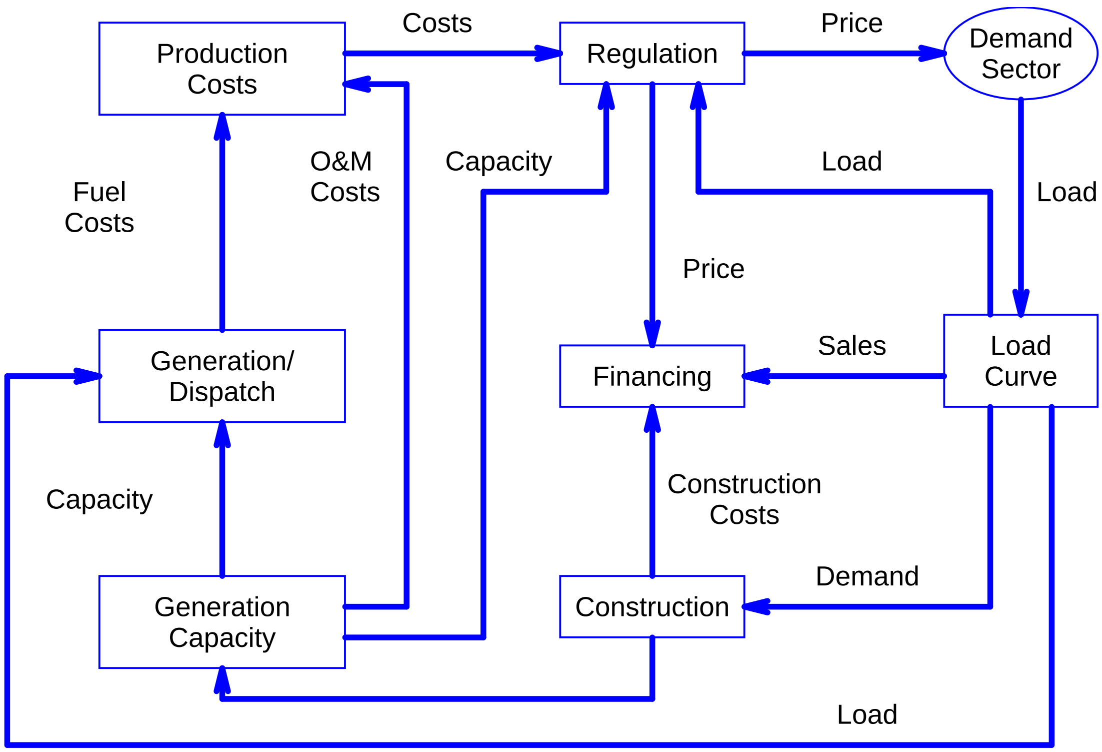
For electric and gas utilities (separate or combined), ENERGY 2020 internally and self-consistently simulates sales, load (by end-use, time-of-use, and class), production (across thirty-six dispatch types), demand-side management (by technology), forecasting, capacity expansion (new generation, independent power producers, purchases, and DSM), all important financial variables, and rates (by class, end-use, and time-of-use.)

The version currently used in this analysis only has the electricity utility sector.

With the inclusion of the electric utility sector, the generic supply model turns over the calculation of electricity prices to that sector. The model is capable of endogenously simulating the forecasting of capacity needs, as well as the planning, construction, operation and retirement of generating plants and transmission facilities. Each step is financed in the model by revenues, debt, and the sale of stock. The simulated utility, like its real world counterpart, pays taxes and generates a complete set of accounting books. In ENERGY 2020, the regulatory function is modeled as a part of the utility sector. The regulator sets the allowed rate of return, divides revenue responsibility among customer classes, approves rate base, revenues and expenses, and sets fuel adjustment charges.

The interactions in the electric utility sector are summarized in Figure 1.6

Figure 1.6: Electric Utility Structure Overview



Expansion Planning:

The utility sector endogenously forecasts future demand for electricity. From the forecast it projects the future capacity required meeting future demand by taking into account retirements and plants already under construction. Construction of additional capacity is initiated if future electricity requirements, including reserves, are forecast to exceed available capacity (using seasonal ratings).

If additional capacity is needed to meet forecasted needs, the basic capacity expansion module in ENERGY 2020 determines whether base or peaking capacity is required. The model determines the maximum number of hours that new peaking capacity can be economically operated, before it would be less expensive to construct and operate base load capacity instead. If the forecasted peaking capacity would operate more than that economic maximum, base loads units are initiated, otherwise peaking units are initiated. Any plant type including geothermal, wind, biomass and storage can be considered.

New plants, of a pre-specified minimum size, are initiated when the reserve margin would be violated if the plants were not built or if base load capacity is inadequate to serve base load energy needs at the end of the forecast period. The model does allow the minimum reserve margin to be temporarily violated at the peak if new base load capacity is scheduled to be available within the year. Peaking units are allowed to serve more than the maximum economical number of hours until base load capacity comes on-line.

Minimum plant size is exogenous. The mix of new base load plants (i.e. alternative coal technologies, hydro, or nuclear) is user-specified in the standard ENERGY 2020 configuration. The model also evaluates the financial implications of new construction, including total construction costs, cost schedules, and AFUDC/CWIP. The gross rate on AFUDC equals the weighted average cost of capital. The actual construction progress and financial impacts are simulated on a year by year basis.

ENERGY 2020 can also be configured to consider intermediate load units, firm purchases contracts, external sales, independent power producers, and demand-side options. These options can be optionally selected based on endogenous least-cost analysis or can be chosen by user-specified criteria to meet. A detailed automatic Integrated Resource Planning module that would endogenously choose (with user control) from DSM measures utility and non-utility generation and purchase alternatives using linear programming techniques is now being offered as an enhancement.

Financing:

The ENERGY 2020 utility finance sub-sector simulates the activities of a utility's finance department. It forecasts funding requirements and follows corporate policies for obtaining new funds. The model simulates borrowing and issuing of stock, and can repurchase stock or make investments if it has excess cash. Cash flows are explicitly modeled, as are any decision that affects them. Coverage ratios, intermediate- and long-term debt limits, capitalization, rates of return, new stock issues, bond financing, and short-term investments are endogenously calculated. The model keeps track of gross, net, and tax assets. It also calculates the depreciation values used for the income statement and tax obligations.

Regulation:

The utility sector sets electricity prices according to regulatory requirements. The regulatory procedures use allowed rate-of-return and test year cost and demands to determine allowed revenues. Electricity prices are calculated from peak-demand fractions by allocation of costs. Any other allocation scheme can also be considered. The regulatory sub-sector of ENERGY 2020 automatically factors in a wide variety of regulatory policies and options. More importantly, the model can be readily modified to consider a wide spectrum of scenarios.

The regulatory process revolves around a test year, usually one year forward, when proposed rates will go into effect. The utility sector forecasts test year sales and peak demands by season and customer class, just as it does to determine capacity needs. These test year demand estimates are used to allocate responsibility for system peak, and therefore, generation capacity costs.

Fuel costs for the test year are estimated by dispatching the plants that will be available in the test year, using the dispatching routine explained below. Fuel costs and operating and maintenance costs are adjusted for expected inflation, and these costs are factored into the electricity rates using forecasted sales.

ENERGY 2020 calculates the utility rate-base according to a detailed conventional rate making formula. The model allows the user to adjust allowable costs, and has been used extensively to evaluate alternative rate-base scenarios for individual plants, including allowing return of, but no return on investment, and partial disallowment of construction and interest costs.

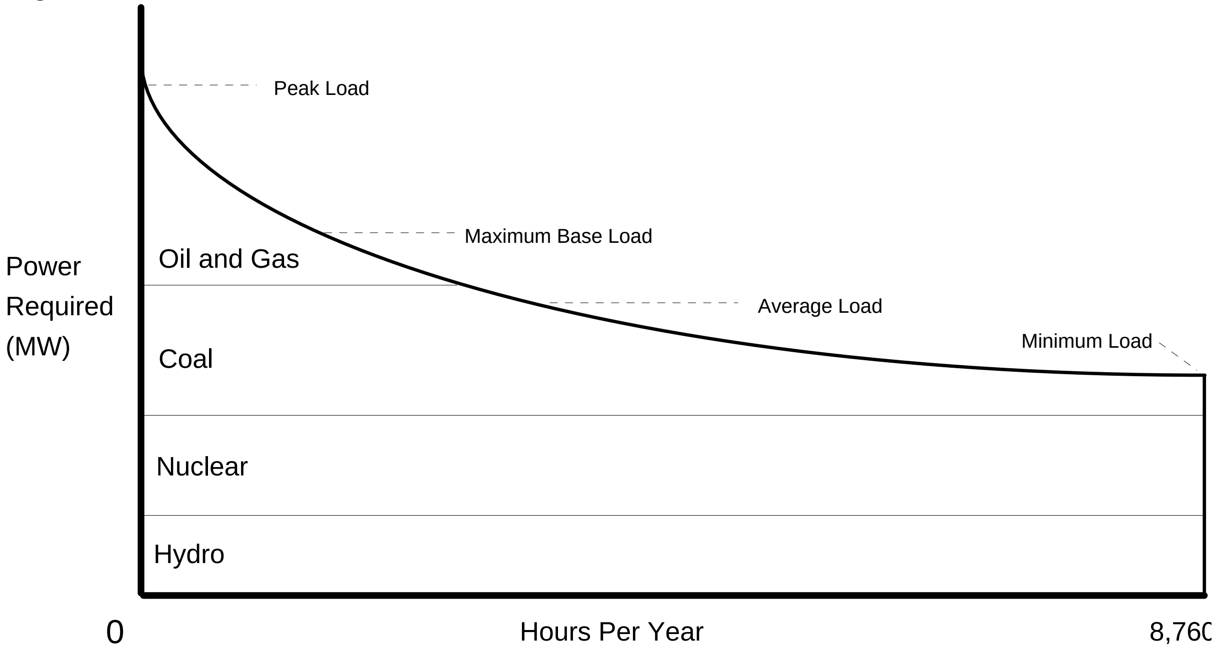
The ENERGY 2020 system also includes estimation of avoided costs, which determines when the utility may be required to purchase third party power. Environmental constraints, such as air pollution restrictions, can also be included in the model. If ENERGY 2020 is configured as a regional or state-wide system, municipal utilities, with their unique tax and rate structures, are incorporated. Similarly, regional or power pool interchange is also recognized by ENERGY 2020. As with the other sectors of ENERGY 2020, the regulatory sub-sector is flexible enough to accommodate any existing or hypothetical circumstance. Hawaii is modeled as a fully regulated market and modeled as four separate utilities with boundaries corresponding to the four counties.

Operations:

Each end-use in ENERGY 2020 has a related set of load shape factors. Typically, these factors define the relationship between peak, minimum and average load for each season. These factors when combined with the weather-adjusted energy demand by end-use and corrected for cogeneration, resale, and load management programs, form the basis of the approximated system load duration curve. Alternatively, unit hourly loads for each end-use for three days per month (average weekday, weekend and peak weekday) are used.

The standard ENERGY 2020 production sub-sector uses an advanced de-rating or chronological method to estimate the seasonal or hourly dispatch of plants. It purchases power externally when economic or necessary. Plant availability and generation for coal, nuclear, hydroelectric, oil and gas are currently considered, as well as pumped storage, firm purchases, interruptible load, and fuel switching and qualified facilities. Figure 1.7 also shows a typical plant dispatch schedule.

Figure 1.7: Generation from the Load Curve



The ENERGY 2020 system estimates conventional fuel costs based on the unit dispatch, heat rates, and fuel prices (from the supply sector.) Nuclear fuel costs are capitalized and depreciated throughout the re-fuelling cycle. Nuclear fuel expenses also include fuel disposal costs.

ENERGY 2020 explicitly models the costs of maintaining the transmission and distribution (T&D) system. New facility investments are scheduled and incurred endogenously. In addition, the user can specify the decision rules that dictate T&D expenditures. ENERGY 2020 also explicitly models both fixed and variable operation and maintenance costs, power pool interchanges, nuclear decommissioning costs, plant capital additions, plant cancellations, and general administration costs.

Model Applications:

The structure of the model is well tested and has been used to simulate not only US and the Canada energy and environmental dynamics but also those of several countries in Western, Central and Eastern Europe. Current efforts include strategic and tactical analyses for South America deregulation. Further, the model has been used successfully for deregulation analyses in over 50 energy suppliers and in all the US states and Canadian provinces. Several US and Canadian energy suppliers currently use the model for the analysis of combined electricity and gas deregulation dynamics.[28] The model contains confidence and validity packages that allow it to determine how to take maximal advantage of RTO rules. The ISO NE used the model to find gaps in its rules and to develop more efficient market conditions. The model was used for the CAPX/ISO to model to show, before the fact, many of the “games” played in the California market.

[28] ENERGY 2020 is the only model known to have simulated and predicted the dynamics that occurred in the UK electric deregulation. These include gaming, market consolidation and re-regulation dynamics.

Policy Modeling:

Building and Equipment Standards

The processes by which energy demand is derived are described in the earlier sections on "*Energy Demand*", "*Energy Demand as a Function of Capital Stock*" and "*Device and Process Energy Efficiency*".

Choices can be made between different levels of energy efficiency when making device and process investments for each sector, end use and fuel combination (i.e. residential electric water heating). The level of efficiency available is bounded on the upper end by the maximum technical level of efficiency (close to 100% in the case of electric water heating). The lower boundary is set by the minimum allowable level of efficiency allowed by regulation (ie. an appliance standard or building code). As regulations are changed through new policies, these standards are adjusted in the model; limiting the range of efficiency choices available for new investments. Using new passenger vehicles as an example, if a policy is introduced to raise the average efficiency of new vehicles (ie. a CAFÉ standard), then car buyers will only be able to select vehicles with efficiency levels above the new standard. They may select a more efficient vehicle up to the maximum technical efficiency based on their perceptions of utility and costs.

Performance Standards

Some policies, such as an EEPS, RPS or Alternative Fuel Standard, require utilities or other actors to attain a certain target; for example, that 25% of electricity sales must come from renewable sources by 2020. These policies are applied in the model by establishing a target or constraint that the defined sector must meet. Using the RPS as an example, the model will build new capacity using a defined class of 'renewable' resources in order to meet the established target, adjusting the level of generation output required as electricity sales vary. The model will solve for a solution which meets the established target to meet the imposed constraint using the processes described in the sections relating to "Energy Supply" above.

Appendix B: Data Sets Used in ENERGY 2020

This Appendix describes the initial set definitions for ENERGY 2020 used for this project. The sets are the dimensions of the variables (sometimes called indexes) which delineate the scope and detail of the model. For example, the time frame set could be defined as a base year 1990 and every 5 years.

Time Frame

The initial historical year for calibration is 2000. The last historic year of data is 2007.

Current end year of the analysis is 2020, but analysis can be extended to 2030 or beyond.

All data sets include annual data for each year of history and the forecast.

For some data sets, the period covered by actual data will depend on available data (e.g., emissions).

Geographical Areas

The model provides separate results for each county, identified for convenience as Oahu (City and County of Honolulu), Maui, Kauai, and Hawaii, as well as a total for the state.

Generating Units

The list of units is based on the FERC database for the US supplemented by Hawaii-specific information. Some of the smaller plants may be aggregated by plant type in order to expedite model operation.

Electric Companies

Although ENERGY 2020 can model individual utilities or groups of utilities, for this project the model assumes that each county has a single aggregate utility.

Sectors and Classes

The energy demand portion of the model simulates residential, commercial, industrial, and transportation demands. Electric sales are simulated for each sector.

Emission Only Sectors

Several sectors generate emissions, but do not have full energy demand simulations in the model. These include solid waste, waste water, incineration, and land use.

Pollutants

The model currently has the capability to cover 15 pollutants, although the final set used in each project depends on client requirements and available data. The GHG pollutants modeled in this project include Carbon Dioxide, Methane, Nitrous Oxide, Sulfur-Hexafluoride, Perfluorocarbon, and Hydrofluorocarbon.

Fuels

- Biodiesel
- Biomass
- Coal
- Electric
- Ethanol
- Gasoline
- Geothermal
- High Sulphur Diesel
- High Sulphur Fuel Oil
- Hydro
- Hydrogen
- Kerosene
- Liquefied Petroleum Gas (LPG)
- Low Sulphur Diesel
- Low Sulphur Fuel Oil
- Naphtha
- Oil
- Utility Gas
- Solar
- Still Gas
- Waste
- Wave
- Wind
- Other
- Unknown

Electric Generation Plants Types

The electric generation plant types are used to hold the data for future generic plants which the model will construct endogenously. The list currently includes:

- Internal Combustion Diesel
- Combustion Turbine 6
- Combustion Turbine 2
- Combustion Turbine Naphtha
- Combustion Turbine Refinery Gas
- Combustion Turbine Other
- Combined Cycle 6
- Combined Cycle 2
- Hydro
- Pumped Hydro
- Coal
- Biomass
- Refuse
- Wind
- Geothermal
- Solar Thermal
- Battery
- Sugar
- Firm Wind
- Solar PV
- Fuel Cells
- Wave

Residential Sectors

The residential sector is split into housing types:

- Single Family
- Multi-Family
- Other

Commercial Sectors

- Hotel
- Small Office
- Large Office
- Retail
- Grocery
- Warehouse
- School
- College
- Health
- Restaurant
- Miscellaneous Buildings

Industrial Sectors

- Sugar
- Other Food
- Oil Refineries
- Steel
- Other Industrial
- Water

Transportation Sectors

- Residential Passengers
- Tourist Passengers
- Aviation
- International Aviation
- Marine
- International Marine
- Freight
- Agriculture

Miscellaneous Sectors

- Forestry
- Street Lighting
- Military
- Utility Electric Generation
- Industrial Generation
- Solid Waste
- Waste Water
- Incineration

- Land Use

Residential End-Uses

- Refrigeration
- Lighting
- Water Heating
- Cooking
- Drying
- Air Conditioning
- Miscellaneous

Commercial End-Uses

- Refrigeration
- Lighting
- Water Heating
- Cooking
- Drying
- Ventilation
- Air Conditioning
- Miscellaneous

Industrial End-uses

- Motors
- Process Heat
- Lighting
- Cooling
- Miscellaneous

Residential, Commercial, and Industrial Technology Types

Each technology type has its own trade-off curve which determines the efficiency and the capital cost of the technology type. These curves allow the model to contain many different technologies within these broad types.

- Electric
- Utility Gas
- Coal
- Oil
- Bottled Gas
- Solar
- #2 Fuel
- #6 Fuel
- Biomass

Transportation Technology Types

Several technology types are provided for transportation, and each of these contains a trade-off curve which allows the model to simulate even more individual technologies.

- Light Gasoline
- Light Diesel
- Light Propane
- Light Hybrid Gasoline
- Light Hybrid Diesel
- Light Plug-In Hybrids
- Medium Gasoline
- Medium Diesel
- Medium Propane
- Medium Hybrid Gasoline
- Medium Hybrid Diesel
- Medium Plug-In Hybrids
- Heavy Gasoline
- Heavy Diesel
- Heavy Propane
- Heavy Hybrid Gasoline
- Heavy Hybrid Diesel
- Heavy Plug-In Hybrids
- Bus Diesel
- Bus Propane

- Bus Electric
- Train Diesel
- Train Electric
- Plane
- Marine Diesel
- Marine HFO

Prices

Delivered energy prices are presented for the following fuels:

- Residential Electricity
- Residential Utility Gas
- Residential Bottled Gas
- Commercial & Institutional Electricity
- Commercial & Institutional Utility Gas
- Commercial & Institutional Bottled Gas
- Commercial Oil
- Low Sulphur Fuel Oil
- High Sulphur Diesel
- Industrial Coal
- Industrial Biomass
- Industrial Electric
- Gasoline
- Low Sulphur Diesel
- Ethanol
- Biodiesel
- Blended Gasoline
- Blended Diesel
- Blended Ethanol
- Blended Biodiesel
- Jet Fuel
- High Sulphur Fuel Oil
- Naptha
- GU LPG
- Electric Utility SNG
- Electric Utility Ethanol
- Electric Utility Biodiesel
- Electric Utility Coal
- Electric Utility Biomass

Electric Load Segments

The model dispatches for 6 different hour types (high peak, low peak, high intermediate, low intermediate, high base load, low base load) for each of the four seasons.

Appendix C: Planned or Committed Plants Post-2007

County	Planned/option	Plant Name	Plant Type	Generating Capacity - Net (MW)	Fuel	Planned in-service date
Kauai	Planned	1x1 Titan 130	Combined Cycle CT	17.37	Diesel	2012
Kauai	Planned	Direct Fired Biomass	Biomass	20.00	Biomass	2013
Kauai	Planned	Kekaha	Landfill Gas	1.60	Refuse	2011
Kauai	Planned	Mass Burn	Waste-to-Energy	7.30	Refuse	2016
Kauai	Planned	Wainiha	Hydro-electric	4.00	Hydro	2015
Kauai	Planned	Upper Waiahi	Hydro-electric	0.30	Hydro	2015
Kauai	Planned	Wailua	Hydro-electric	6.6	Hydro	2015
Kauai	Planned	Wind Project	Wind	10.5	Wind	2013
Oahu	Planned	CT1 - GE PG7121 (EA)	Simple Cycle combustion turbine	110	Biofuel (ethanol or biodiesel)	2009
Oahu	Planned	Atmospheric FBC (180 MW)	Thermal Plant Resources	180	Coal	2022
Oahu	Planned	Biomass Combustion (25 MW)	Thermal Plant Resources	25	Banagrass (Biomass)	2009
Maui	Planned	Waena 1	Simple Cycle Resources	21.18	No. 2 FO	2011
Maui	Planned	Waena 2	Simple Cycle Resources	21.2	No. 2 FO	2013
Maui	Planned	Waena 3	Simple Cycle Resources	18.2	No. 2 FO	2024

County	Planned/option	Plant Name	Plant Type	Generating Capacity - Net (MW)	Fuel	Planned in-service date
Maui	Planned	Palaau 10	Simple Cycle Resources	2.2	No. 2 FO	2010
Maui	Planned	CHP system	CHP system			2005
Maui	Planned	WTE	Thermal Plant Resources	25	Banagrass	2018
Maui	Planned		Refuse	7.1	Waste	2023
Maui	Planned		Wind Energy Resources	3.6	Wind	2011
Hawaii	Planned	2-on-1 GE LM2500	Combined Cycle Resources	60.3	No. 2 FO	2009
Hawaii	Planned	Wind: 7 x 1.5MW	Wind Energy Resources	10	Wind	2020
Hawaii	Firm	Residential Application: 2kW Fixed Tilt	Photovoltaic Resources	0.002	Solar	2010
Hawaii	Firm	Residential Application: 2kW Hybrid Fixed Tilt and Battery System with Back-up Battery Charging System	Photovoltaic Resources	0.002	Solar, Propane,	2015
Hawaii	Planned	25MW Geothermal	Geothermal Resources	25.5	Geothermal	2022
Oahu	Planned	Wind Project	Wind	50	Wind	2009

County	Planned/option	Plant Name	Plant Type	Generating Capacity - Net (MW)	Fuel	Planned in-service date
Oahu	Planned	Diesel Project	Diesel	76	IC Diesel	2009
Oahu	Planned	Solar PV Distributed	Solar PV	0.30	Solar	2015
Oahu	Planned	Solar PV Distributed	Solar PV	0.30	Solar	2020
Oahu	Planned	Solar PV Distributed	Solar PV	0.30	Solar	2025
Maui	Planned	Diesel Projects	IC Diesel	4	LS Fuel Oil	2012
Maui	Planned	Solar PV Distributed	Solar PV	0.1	Solar	2008
Maui	Planned	Solar PV Distributed	Solar PV	0.1	Solar	2009
Maui	Planned	Solar PV Distributed	Solar PV	0.1	Solar	2010
Maui	Planned	Solar PV Distributed	Solar PV	0.1	Solar	2015
Maui	Planned	Solar PV Distributed	Solar PV	0.1	Solar	2017
Maui	Planned	Solar PV Distributed	Solar PV	0.1	Solar	2019
Maui	Planned	Solar PV Distributed	Solar PV	0.1	Solar	2021
Maui	Planned	Solar PV Distributed	Solar PV	0.1	Solar	2023

County	Planned/option	Plant Name	Plant Type	Generating Capacity - Net (MW)	Fuel	Planned in-service date
Maui	Planned	Solar PV Distributed	Solar PV	0.1	Solar	2025

Appendix D: Global Warming Potential

ENERGY 2020 models emissions of each of the six greenhouse gases reported under the Kyoto protocol. These emissions are then translated into equivalent quantities of CO_2 emissions (CO_2e) based on the global warming potential of each of the gases.

The Global Warming Potential (GWP) values used in ENERGY 2020 are shown in the table below.

Greenhouse Gas	**Global Warming Potential**
Carbon Dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous Oxide (N_2O)	310
Sulfur Hexafluoride (SF_6)	23,900
Perfluorocarbons (PFC)	7,000
Hydrofluorocarbons (HFC)	1,300

The values currently used in the model (as shown in the Assumptions Book) are consistent with the Global Warming Potential values used in the 1996 Intergovernmental Panel on Climate Change (IPCC) Second Assessment Report based on 100-year warming potential for the individual gases. In the case of HFC's and PFC's, the GWP values used in the model are based on an estimated average GWP for these gases.

The GWP associated with some of these gases has been re-stated based on subsequent scientific assessments. The 1996 values continue to be used internationally to maintain consistency and comparability in reporting. They have, therefore, been used for this modeling exercise.

Comparison of 100-Year GWP Estimates from the IPCC's Second (1996), Third (2001) and Fourth (2007) Assessment Reports			
Gas	*1996 IPCC GWP[a]*	*2001 IPCC GWP[b]*	*2007 IPCC GWP[c]*
Carbon Dioxide	*1*	*1*	*1*
Methane	*21*	*23*	*25*
Nitrous Oxide	*310*	*296*	*298*
HFC-23	*11,700*	*12,000*	*14,800*
HFC-125	*2,800*	*3,400*	*3,500*
HFC-134a	*1,300*	*1,300*	*1,430*
HFC-143a	*3,800*	*4,300*	*4,470*
HFC-152a	*140*	*120*	*124*
HFC-227ea	*2,900*	*3,500*	*3,220*

Comparison of 100-Year GWP Estimates from the IPCC's Second (1996), Third (2001) and Fourth (2007) Assessment Reports			
Gas	*1996 IPCC GWP*[a]	*2001 IPCC GWP*[b]	*2007 IPCC GWP*[c]
HFC-236fa	*6,300*	*9,400*	*9,810*
Perfluoromethane (CF_4)	*6,500*	*5,700*	*7,390*
Perfluoroethane (C_2F_6)	*9,200*	*11,900*	*12,200*
Sulfur Hexafluoride (SF_6)	*23,900*	*22,200*	*22,800*

a Intergovernmental Panel on Climate Change, Climate Change 1995: The Science of Climate Change (Cambridge, UK: Cambridge University Press, 1996).
b Intergovernmental Panel on Climate Change, Climate Change 2001: The Scientific Basis (Cambridge, UK: Cambridge University Press, 2001).
c Intergovernmental Panel on Climate Change Fourth Assessment Report, 2007, chapter 2 of IPCC Working Group 1 portion (table 2.14): http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-chapter2.pdf

Source: Comparison of Global Warming Potentials from the Second and Third Assessment Reports of the Intergovernmental Panel on Climate Change (IPCC) http://www.eia.doe.gov/oiaf/1605/gwp.html, modified to add values from the Fourth Assessment Report, 2007.

Appendix E: Existing Policies Included in Reference Case

1. Renewable Portfolio Standards (RPS)

Source: Hawaii Revised Statutes, Chapter 269 Part V
http://www.capitol.hawaii.gov/hrscurrent/Vol05_Ch0261-0319/HRS0269/HRS_0269-0091.htm

"Renewable portfolio standard" means the percentage of electrical energy sales that is represented by renewable electrical energy.

Each electric utility company shall establish a RPS of
- 10% by 31 Dec 2010
- 15% by 31 Dec 2015
- 20% by 31 Dec 2020

An electric utility company and its electric utility affiliates may aggregate their renewable portfolios in order to achieve the renewable portfolio standard.

Renewable electrical energy	Including	Excluding	% of RPS
Renewable energy as the source	(1) Wind (2) Sun (3) Falling water (4) Biogas, including landfill and sewage-based digester gas (5) Geothermal (6) Ocean water, currents and waves (7) Biomass, including biomass crops, agricultural and animal residues and wastes, and municipal solid waste; (8) Biofuels (9) Hydrogen produced from renewable energy sources	(*)	at least 50%
Offsets or Displacement	(1) Solar water heating (2) Sea-water air-conditioning (3) District cooling systems (4) Solar air-conditioning (5) Customer-sited grid-connected renewable energy systems	(**)	

Renewable electrical energy	Including	Excluding	% of RPS
Energy efficiency	(1) Heat pump water heating (2) Ice storage (3) Ratepayer- funded energy efficiency programs (4) Use of rejected heat from co-generation (5) Combined heat and power systems (exclusions noted to right).	(1) Fossil-fuelled qualifying facilities that sell electricity to electric utility companies (2) Central station power projects	

(*) Where fossil and renewable fuels are co-fired in the same generating unit, the unit shall be considered to generate renewable electrical energy (electricity) in direct proportion to the percentage of the total heat value represented by the heat value of the renewable fuels.

(**) Where electrical energy is generated or displaced by a combination of renewable and non-renewable means the proportion attributable to the renewable means shall be credited as renewable energy.

July 2009 Update:

The Governor signed into law Act 155 (HB 1464)[29] and Act 156 (SB 1202)[30] on June 25, 2009. These Acts amend the RPS to raise the level of renewable electricity required. The proposed revisions would require that the following targets be met. These targets are expressed in terms of the percentage of net utility sales that must be met from defined renewable sources.

- 2010 – 10%
- 2015 – 15%
- 2020 - 25%
- 2030 – 40%

The proposed amendments also revise the definition of 'renewables' that can contribute to meeting the targets after 2015. These amendments would restrict the definition of 'renewable' sources under the Act to eliminate contributions from displacement sources or energy efficiency as of January 1, 2015. The revised Act would also prevent electricity-generating public utilities from owning or operating any new generating sources of over 2 MW fired by fossil-fuels. Co-operative associations are exempted from this provision.

The changes associated with this new legislation have not been included in the reference case, however, per discussion and agreement by Task Force members at the June 16, 2009, meeting.

[29] The final text of House Bill 1464 is available online at: http://www.capitol.hawaii.gov/session2009/Bills/HB1464_CD1_.HTM
[30] The final text of Senate Bill 1202 is available online at: http://www.capitol.hawaii.gov/session2009/Bills/SB1202_CD1_.HTM

2. Solar Water Heater System

Source: Hawaii Revised Statutes, Chapter 196 [196-6.5]
http://www.capitol.hawaii.gov/hrscurrent/Vol03_Ch0121-0200D/HRS0196/HRS_0196-0006_0005.htm

On or after January 1, 2010, no building permit shall be issued for a single-family dwelling that does not include a solar water heater system that meets the Standards that will be established in July 2009 by the Public Utilities Commission (PUC) (including but not limited to, specifications for the performance, materials, components, durability, longevity, proper sizing, installation, and quality).

A variance shall only be approved if an architect or engineer licensed attests that:

- Installation is impracticable due to poor solar resource
- Installation is cost-prohibitive based upon a life cycle cost-benefit analysis that incorporates the average residential utility bill and the cost of the new solar water heater system with a life cycle that does not exceed fifteen years;
- A substitute renewable energy technology system is used as the primary energy source for heating water
- A demand water heater device approved by Underwriters Laboratories, Inc., is installed; provided that at least one other gas appliance is installed in the dwelling. For the purposes of this paragraph, "demand water heater" means a gas-tankless instantaneous water heater that provides hot water only as it is needed.

Nothing in this section shall preclude participation in any utility demand-side management program or public benefits fund under part VII of chapter 269. (See the description in point 4)

3. Net Energy Metering (NEM)

Source: Hawaii Revised Statutes, Chapter 269, Part VI
http://www.capitol.hawaii.gov/hrscurrent/Vol05_Ch0261-0319/HRS0269/HRS_0269-0101.htm

Regulation legislated in 2001 amended in 2005

"Eligible customer-generator" means a metered residential or commercial customer, including a government entity, of an electric utility who owns and operates a solar, wind turbine, biomass, or hydroelectric energy generating facility, or a hybrid system consisting of two or more of these facilities, that is
(1) Located on the customer's premises
(2) Operated in parallel with the utility's transmission and distribution facilities
(3) In conformance with the utility's interconnection requirements
(4) Intended primarily to offset part or all of the customer's own electrical requirements.

"Net energy metering" means measuring the difference between the electricity supplied through the electric grid and the electricity generated by an eligible customer-generator and fed back to the electric grid over a monthly billing period.

Eligible customer generator
residential
commercial
government entity
Eligible renewable energy
solar
wind
biomass
hydroelectric
hybrid system consisting of 2 or more of the above
Maximum capacity of eligible customer-generator (except by order)
50 kW
Minimum capacity from eligible customer-generator each electric utility has to accept
combined customer-generators peak capacity = 0.5 % of peak demand (*)

(*) "Every electric utility shall develop a standard contract or tariff providing for net energy metering and shall make this contract available to eligible customer-generators, upon request, on a first-come-first-served basis until the time that the total rated generating capacity produced by eligible customer-generators equals 0.5 per cent of the electric utility's system peak demand;

- provided that the public utilities commission may modify, by rule or order, the total rated generating capacity produced by eligible customer-generators
- provided further that the public utilities commission shall ensure that a percentage of the total rated generating capacity produced by eligible customer-generators shall be reserved for electricity produced by eligible residential or small commercial customer-generators
- The public utilities commission may define, by rule or order, the maximum capacity for eligible residential or small commercial customer-generators.
- Notwithstanding the generating capacity requirements of this subsection, the public utilities commission may evaluate, on an island-by-island basis, the applicability of the generating capacity requirements of this subsection and, in its discretion, may exempt an island or a utility grid system from the generating capacity requirements."

<u>Tariff:</u>

Each net energy metering contract is identical with respect to rate structure to the contract to which the same customer would be assigned if the customer was not an eligible customer-generator.

The charges for all retail rate components for eligible customer-generators are based exclusively on the eligible customer-generator's net kilowatt-hour consumption over a monthly billing period.

The excess electricity generated by a customer-generator in each monthly billing period shall be carried over to the next month as credit, which may be accumulated used to offset the compensation owed the electric utility for the eligible customer-generator's net kilowatt-hour consumption for succeeding months within each twelve-month period; The eligible customer-generator shall not be owed any compensation for excess kilowatt-hours unless the electric utility enters into a purchase agreement with the eligible customer-generator for those excess kilowatt-hours.

Standards
A solar, wind turbine, biomass, or hydroelectric energy generating system, or a hybrid system consisting of two or more of these facilities, used by an eligible customer-generator shall meet all applicable safety and performance standards established by the *National Electrical Code*, the *Institute of Electrical and Electronics Engineers*, and accredited testing laboratories such as the *Underwriters Laboratories* and, where applicable, rules of the public utilities commission regarding safety and reliability.

4. Public Benefits Fee (PBF)

Source: Hawaii Revised Statutes, Chapter 269, Part VII
http://www.capitol.hawaii.gov/hrscurrent/Vol05_Ch0261-0319/HRS0269/HRS_0269-0121.htm

Regulation legislated in 2006 amended in 2008

The PUC, by order or rule, may require that all or a portion of the moneys collected by Hawaii's electric utilities from its ratepayers through a demand-side management surcharge be transferred to a third-party administrator contracted by the public utilities commission. The moneys transferred shall be known as the public benefits fee (PBF).

The PBF shall be used to support energy-efficiency and demand-side management programs and services, subject to the review and approval of the public utilities commission. This money shall not be available to meet any current or past general obligations of the State; provided that the State may participate in any energy-efficiency or demand-side management programs and services on the same basis as any other electric consumer.

The PBF can be used to identify, develop, administer, and implement demand-side management and energy-efficiency programs. Especially, the PBF administrator shall encourage programs, measures, and delivery mechanisms that reasonably reflect current and projected utility integrated resource planning (IRP), market conditions, technological options, and environmental benefits.

5. Ethanol Content Requirement

Source: Hawaii Revised Statutes, Chapter 486 J -10
http://www.capitol.hawaii.gov/hrscurrent/Vol11_Ch0476-0490/HRS0486J/HRS_0486J-0010.htm

Regulation legislated in 1997 amended in 2002 and in 2006

It is required that gasoline sold in the State for use in motor vehicle contains 10% ethanol by volume.

- Gasoline blended with an ethanol-based product, such as ethyl tertiary butyl ether, shall be considered to be in conformance with this section if the quantity of ethanol used in the manufacture of the ethanol-based product represents ten per cent, by volume, of the finished motor fuel.
- Ethanol used in the manufacture of ethanol-based gasoline additives, such as ethyl tertiary butyl ether, may be considered to contribute to the distributor's conformance with this section; provided that the total quantity of ethanol used by the distributor is an amount equal to or greater than the amount of ethanol required under this section

The sale of gasoline that does not meet the Ethanol percentage required may be authorized by the Director of Business, Economic Development, and Tourism only to the extent that sufficient quantities of competitively-priced ethanol are not available to meet the minimum requirements of this section or In the event of any other circumstances for which the director determines compliance with this section would cause undue hardship.

6. Lead by Example Initiatives for State Facilities or Energy efficiency & Environmental Standards for state facilities, motor vehicles, and transportation fuel

Source: Hawaii Revised Statutes, Chapter 196-9
http://www.capitol.hawaii.gov/hrscurrent/Vol03_Ch0121-0200D/HRS0196/HRS_0196-0009.htm

"Agency" means any executive department, independent commission, board, bureau, office, or other establishment of the State, or any quasi-public institution that is supported in whole or in part by state funds.

Each agency is directed to implement, to the extent possible, the following goals during planning and budget preparation and program implementation.

<u>For buildings and facilities</u>

"Facility" means a building or buildings or similar structure owned or leased by, or otherwise under the jurisdiction of, an agency.

- Design and construct buildings meeting the Leadership in Energy and Environmental Design silver or two green globes rating system or another comparable state approved, nationally recognized, and consensus based guideline, standard, or system, except when the guideline, standard, or system interferes or conflicts with the use of the building or facility as an emergency shelter.

The Leadership in Energy and Environmental Design (LEED) Green Building Rating System™ encourages and accelerates global adoption of sustainable green building and development practices through the creation and implementation of universally understood and accepted tools and performance criteria.

http://www.usgbc.org/ShowFile.aspx?DocumentID=5546

LEED includes a minimum energy performance level as a component but does not necessarily require buildings to optimize energy performance.
http://www.epa.gov/solar/energy-programs/state-and-local/states/hi.html

- Incorporate energy efficiency measures to prevent heat gain in residential facilities up to three stories in height to provide R-19 or equivalent on roofs, R-11 or equivalent in walls, and high-performance windows to minimize heat gain and, if air conditioned, minimize cool air loss.

  R-value is the constant time rate resistance to heat flow through a unit area of a body induced by a unit temperature difference between the surfaces. R-values measure the thermal resistance of building envelope components such as roof and walls. The higher the R-value, the greater the resistance to heat flow. Where possible, buildings shall be oriented to maximize natural ventilation and day-lighting without heat gain and to optimize solar for water heating.

  This provision shall apply to new residential facilities built using any portion of state funds or located on state lands;

- Install solar water heating systems where it is cost-effective, based on a comparative analysis to determine the cost-benefit of using a conventional water heating system or a solar water heating system.
  The analysis shall be based on the projected life cycle costs to purchase and operate the water heating system. If the life cycle analysis is positive, the facility shall incorporate solar water heating.
  If water heating entirely by solar is not cost-effective, the analysis shall evaluate the life cycle, cost-benefit of solar water heating for preheating water.
  If a multi-story building is centrally air conditioned, heat recovery shall be employed as the primary water heating system.

  Single family residential clients of the department of Hawaiian home lands and any agency or program that can take advantage of utility rebates shall be exempted from the requirements of this paragraph so they may continue to qualify for utility rebates for solar water heating;

- Use life cycle cost-benefit analysis to purchase energy efficient equipment such as ENERGY STAR products and use utility rebates where available to reduce purchase and installation costs;

Motor vehicles and transportation fuel:

- Comply with Title 10, Code of Federal Regulations, Part 490, Subpart C, "Mandatory State Fleet Program", if applicable;

Mandatory State Fleet Program

Except as otherwise provided in this part, of the new light duty motor vehicles acquired annually for State government fleets, including agencies thereof but excluding municipal fleets, the following percentages shall be alternative fuelled vehicles for the following model years;

(1) 10 percent for model year 1997;
(2) 15 percent for model year 1998;
(3) 25 percent for model year 1999;
(4) 50 percent for model year 2000; and
(5) 75 percent for model year 2001 and thereafter.

http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr;sid=7e6135ee120c509494ff0dbe8d8675a5;rgn=div6;view=text;node=10%3A3.0.1.4.30.3;idno=10;cc=ecfr

- Once federal and state vehicle purchase mandates have been satisfied, purchase the most fuel-efficient vehicles that meet the needs of their programs; provided that life cycle cost-benefit analysis of vehicle purchases shall include projected fuel costs

Appendix F: Self Generation (non-utility) Generation Included in Reference Case

County	Owner	Facility Name	Capacity (MW)	Fuel Type	Source
Hawaii	Mauna Loa Macadamia Nut Corporation	Mauna Loa Macadamia Nut Corporation	1	Biomass	EEA
Honolulu	United Airlines	Honolulu International Airport	0.12	Propane	EEA
Honolulu	Dobbs House Cogeneration Project	Dobbs House Cogeneration Project	0.06	Propane	EEA
Honolulu	Pri Energy Systems, Inc.	Pauahi Block - A Non-Profit Housing Corp	0.06	Propane	EEA
Honolulu	Alpac Corporation	Pepsi Cola/Seven Up Bottling Company	0.18	Propane	EEA
Honolulu	U.S. Army	Fort Shafter	0.2	Propane	EEA
Honolulu	Pohai Nani Retirement Community	Pohai Nani Retirement Community	0.12	Propane	EEA
Honolulu	Hale Pauahi Condominiums	Multi-Family Building	0.09	Propane	EEA
Honolulu	City and County of Honolulu	Honolulu Hale	0.22	Propane	EEA
Maui	Grand Wailea Resort, Hotel, & Spa	Grand Wailea Resort, Hotel, & Spa	0.15	Propane	EEA
Kauai	Kauai Marriott	Kauai Marriott	0.81	Propane	EEA
Hawaii	Kona Community Hospital	Kona Community Hospital	0.455	#2 Fuel Oil	EEA
Hawaii	Hilo Medical Center	Hilo Medical Center	0.73	#2 Fuel Oil	EEA
Kauai	Kauai Veterans Memorial Hospital	Kauai Veterans Memorial Hospital	0.275	#2 Fuel Oil	EEA
Hawaii	Gulf Gas Cogen, Inc	Hawaii Preparatory Academy	0.12	#2 Fuel Oil	EEA
Honolulu	Earle M. Jorgensen Co.	Campbell Industrial Park	0.075	#2 Fuel Oil	EEA
Hawaii	Alaska Power Systems, Inc	Cyanotech Utility Master System	0.705	#2 Fuel Oil	EEA
Hawaii	Amerada Hess Company	Kailua-Kona Facility	0.105	Propane	EEA
Maui	Kaanapali Ocean Resort Villas	Kaanapali Ocean Resort Villas	0.9	Propane	EEA
Kauai	Lihue Plantation Co Ltd	Lihue Plantation Ltd	21.7	Biomass	EIA
Kauai	Lihue Plantation Co Ltd	Lihue Plantation Ltd	0.5	Hydro	EIA
Kauai	Lihue Plantation Co Ltd	Lihue Plantation Ltd	0.8	Hydro	EIA
Oahu	Tesoro Hawaii Corp	Tesoro Hawaii	20	JetFuel	EIA
Oahu	Chevron Refinery-Hawaii	Hawaii Cogen	3	Other Gas	EIA
Oahu	Chevron Refinery-Hawaii	Hawaii Cogen	3	Other Gas	EIA
Oahu	Chevron Refinery-Hawaii	Hawaii Cogen	3	Other Gas	EIA
Maui	Hawaiian Com & Sugar Co Ltd	Hawaiian Comm & Sugar Puunene Mill	4	Biomass	EIA
Maui	Hawaiian Com & Sugar Co Ltd	Hawaiian Comm & Sugar Puunene Mill	12	Biomass	EIA
Maui	Hawaiian Com & Sugar Co Ltd	Hawaiian Comm & Sugar Puunene Mill	10	Biomass	EIA
Maui	Hawaiian Com & Sugar Co Ltd	Hawaiian Comm & Sugar Puunene Mill	20	Biomass	EIA
Maui	Hawaiian Com & Sugar Co Ltd	Hawaiian Comm & Sugar Puunene Mill	16.1	Biomass	EIA
Kauai	Gay & Robinson Inc	Gay Robinson	0.4	#2 Fuel Oil	EIA
Kauai	Gay & Robinson Inc	Gay Robinson	0.4	#2 Fuel Oil	EIA
Kauai	Gay & Robinson Inc	Gay Robinson	1.2	Hydro	EIA
Kauai	Gay & Robinson Inc	Gay Robinson	4	Biomass	EIA

Sources:
EEA = Energy & Environmental Analysis (now part of ICF International), Combined Heat and Power Installation Database; supported by the U.S. Department of Energy and Oak Ridge National Laboratory. Last updated 1/21/2009. http://www.eea-inc.com/chpdata/States/HI.html

Appendix G: Methodology for Projecting Non-Energy Emissions

Projections of GHG emissions in 2020 for all non-energy sectors and sources included in the updated inventory for 1990 and 2007 were developed using a wide range of growth rates for variables that would affect emissions for each source, such as population, economic indicators (e.g., agricultural jobs), and source-specific information (e.g., planned expansion of MSW combustion capacity). Methodological decisions were based on knowledge of the source categories and review of similar projections such as the California Air Resources Board's (CARB) Draft 2020 Forecast (http://www.arb.ca.gov/cc/inventory/data/forecast.htm).

Waste

Sources and Gases Covered:

- CH_4 from Municipal Solid Waste Landfills
- CO_2 and N_2O from Municipal Solid Waste Combustion
- CH_4 and N_2O from Municipal Wastewater

Municipal Solid Waste Landfills

Emissions from landfills were based on projections of waste disposal and de facto population[31] by island. Waste disposal projections were obtained from county-level reports provided by the Solid and Hazardous Waste Branch (SHWB) at the Department of Health (DOH) (Otsu 2008). These waste disposal projections varied in terms of years of projected data, with some counties projecting in 5-year increments out to 2020 and others only to 2013. Missing year information was estimated using de facto population projections calculated using the following methodology.

Projections of island-specific *resident* population in 5-year increments are available (DBEDT 2008). Projections of island-specific *de facto* population were calculated by applying the percent difference between each island's calculated 2007 resident and de facto population statistics to the projected resident population. It was, thus, assumed that the de facto population will grow at the same rate as the resident population for each island. These population estimates were used to calculate the amount of waste landfilled on each island and, in turn, estimate total emissions from landfills in 2020.

The emissions projections have taken into account the additional waste that will be diverted to the new H-POWER facility slated to open in 2013. Thus, the projected waste disposal values for the island of Oahu are lowered by the amount of waste that will be diverted to the new H-POWER facility starting in 2013. It was assumed that in the business-as-usual projection case, the same percentage of landfill gas recovery that occurred in 2007 will occur in 2020.

[31] The de facto population is defined as the number of persons physically present in an area, regardless of military status or usual place of residence. It includes visitors present but excludes residents temporarily absent, both calculated as an average daily census.

Municipal Solid Waste (MSW) Combustion

It was assumed that the average emissions for 2005-2007 from the existing H-POWER facility (as it is at or near capacity) were representative of the emissions for H-POWER in 2020 (Hahn 2008). Projections of emissions for the new H-POWER plant slated to come online in 2013 were developed based on activity data from Covanta Energy.

Specifications for the new H-POWER facility, as well as data on MSW and RDF combustion for its existing H-POWER facility, provided from Covanta energy, were used to estimate emissions for the planned H-POWER plant. This new facility will combust an additional 300,000 tons of MSW per year and thus emissions from the waste combustion sector is projected to significantly increase by 2020. Accordingly, the amount of waste projected to be landfilled in Oahu was decreased by the amount of waste expected to be handled by the new plant (as described in Municipal Solid Waste Landfills).

Municipal Wastewater

Emissions from wastewater were projected based on island-specific de facto population projections described in the Municipal Solid Waste Landfills section above. Per capita BOD 1990 value was used to project emissions to 2020. Projected emissions from the wastewater source increase to the extent that de facto population is projected to increase.

Agriculture, Forestry, and Other Land Uses (AFOLU)

Sources and Gases Covered:

- Enteric fermentation (CH_4)
  - *Dairy and beef cattle, sheep, goats, swine, horses*
- Manure management (CH_4, N_2O)
  - *Dairy and beef cattle, sheep, goats, swine, horses, chickens*
- Agricultural soil management (N_2O)
  - *Synthetic fertilizer, organic fertilizer, manure N, and crop residue inputs*
- Field burning of agricultural residues (CH_4, N_2O)
  - *Sugarcane*
- Urea application (CO_2)
- Agricultural soil management (CO_2)
- Landfilled yard trimmings and food scraps (CO_2)
- Carbon flux in urban trees (CO_2)
- Carbon flux in forests (CO_2)
- Forest fires (CO_2, CH_4, N_2O)

Enteric Fermentation (CH_4)

Specific projections were not available. The projected increase in the number of jobs in the agricultural sector by county from 2007 to 2020 from DBEDT's Population and Economic Projections for the State of Hawaii to 2035 (DBEDT 2008) were reviewed as one possible indicator of future emissions. Agricultural jobs for each county were projected to increase, with an average increase of 8.8 percent from 2007 and 2020. To the extent that changes in crop production areas and livestock populations do not track with agricultural job changes, GHG emissions projections would change at a different rate. Given the uncertainty and lack of specific projections, emissions were held constant at 2007 levels.

Manure Management (CH_4, N_2O)

Projections were based on projected job increases in the agricultural sector. For further details, see the Enteric Fermentation section above.

Agricultural Soil Management (N_2O)

Projections were based on projected job increases in the agricultural sector. For further details, see the Enteric Fermentation section above.

Field Burning of Agricultural Residues (CH_4, N_2O)

Projections were based on projected job increases in the agricultural sector. For further details, see the Enteric Fermentation section above.

Urea Application (CO_2)

Reported urea sales in Hawaii have not changed since 2000. Accordingly, this amount was extended to 2020.

Agricultural Soil Management (CO_2)

The National Resources Inventory has not reported changes in land-use data since 1997 (Ogle 2008), and the estimates in C flux for 2007 were developed based on the land-use changes through 1997. It was, thus, assumed that the best approach would be to hold 2007 values constant out to 2020.

Landfilled Yard Trimmings and Food Scraps (CO_2)

Combustion and landfilling trends between 2007 and 2020 were projected with an exponential growth model using a Microsoft Excel™ regression based on 1990 to 2007 data. For yard trimmings, the volume of generation has been slowing in growth, while the amount of composting has been steadily increasing. Accordingly, we used linear models based on 1997 to 2007 data instead of exponential models for yard trimmings projections. Food scraps were modeled using exponential functions based on the most recent data (1998 to 2007).

Population for future years was obtained from U.S. Census projections for the US and Hawaii (U.S. Census Bureau 2006). Island population projections, for apportioning estimates by island, were based on the 2007 Hawaii Databook.

Urban Trees (CO_2)

We obtained data from DBEDT's "Report on Urban Lands in the State of Hawaii" (DBEDT 2006) to estimate future sequestration by urban trees. This report provided an estimate of 2007 urban areas on Oahu and projections of urban land needs in 2010 and 2020. This estimate was developed by DBEDT accounting for factors such as changing lot sizes, the land needs for new schools, growth in industry, etc. This data was used to calculate the percentage growth from 2007 to 2010 and to 2020. We then applied the 2020 percentage growth to the 2007 sequestration estimate.

Forest Carbon (CO_2)

Forest land area has not substantially changed from 1990 to 2007. However, forests have been categorized in different ways over the different years of data compilation in the *Hawaii Databook*. These reporting changes made it difficult to compare data by island and by category, or to establish trends in the data spanning multiple years. Therefore, a linear regression was developed for each island based on the average forest acreage in the years 2005 and 2007. This regression was then used to develop estimates for forest acreage in 2020. The island estimates were summed in order to calculate the state total.

Forest Fires (CO_2, CH_4, N_2O)

For data on acres burned, the average for a 12-year increment (1994 to 2007) was used to develop 2020 projections. Trends are not a reliable predictor of future fires, due to the randomness with which they occur from year to year. It was assumed that the area of land under wildland protection will remain the same out to 2020, since the two available data points do not provide a robust trend estimate.

References

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SUBCHAPTER 11

GREENHOUSE GAS EMISSIONS

§11-60.1-201 Purpose. The purpose of this subchapter is to further implement the goals of Act 234, 2007 Hawaii Session Laws. A statewide greenhouse gas emission (GHG) limit, to be achieved by 2020, is set to equal or below the 1990 statewide greenhouse gas emission levels. Greenhouse gas emissions from airplanes shall not be included. [Eff and comp] (Auth: HRS §§342B-3, 342B-12, 342B-71, 342B-72, 342B-73; 42 U.S.C. §§7407, 7416)(Imp: HRS §§ 342B-3, 342B-12, 342B-71, 342B-72, 342B73; 42 U.S.C. §§7407, 7416)

§11-60.1-202 Definitions. As used in this subchapter:

"Carbon sink or carbon dioxide sink" means a carbon reservoir that removes a greenhouse gas or a precursor of a greenhouse gas or aerosol from the atmosphere, and is the opposite of a carbon source.

The main sinks are the oceans and growing vegetation that absorb CO_2.

"Facility-wide GHG emissions cap" means a permit emissions limitation, applicable to a covered source, limiting the entire source's annual non-biogenic greenhouse gas, and biogenic nitrous oxide and methane emissions. A facility-wide GHG emissions cap may also be defined in multiple covered source permits to identify partnering facilities with an approved combined GHG emissions cap as described in subparagraph 11-60.1-204(d)(6)(A).

"Municipal waste combustion operations" means a permitted covered source that combusts solid, liquid, or gasified household, commercial/retail, and/or institutional waste.

"On-the-Book" means control measures or operational practices affecting GHG emissions that the owner or operator of a facility plans, or is undertaking to implement because of regulatory or legal obligations; or as demonstrated through financial and resource commitments. Examples include required controls or practices mandated by a state or federal law; or budgeted and contracted/funded projects or resources.

"Permitted covered source" means a stationary source or facility issued or required to hold a covered source permit pursuant to this chapter, and has begun construction or operation by the effective date of this subchapter.

"Affected source" or "affected facility" means an existing stationary source or facility with 2010 reported GHG emissions at or above 100,000 tons of CO_2e according to the US EPA's GHG Reporting Program ("GHGRP"), and that has not been provided an exemption by the director in this rule. Facilities that emit 25,000 metric tons of CO_2e or over are required under 40 CFR Part 98 to report emissions to the US EPA based on standardized methodologies through the e-Greenhouse Gas Reporting Tool or e-GGRT on an annual basis. This information is made available for use by the general public and state and local decision-makers through interactive, web-based tools as well as downloadable datasets.

[Eff and comp] (Auth: HRS §§ 342B-3, 342B-12,342B-71, 342B-72, 342B-73; 42 U.S.C. §§7407, 7416) (Imp: HRS §§ 342B-3, 342B-12, 342B-71, 342B-72, 342B73; 42 U.S.C. §§7407, 7416)

§11-60.1-203 Greenhouse gas emission limit.

The statewide GHG emission cap to be achieved by 2020, is equal to or below 13.66 million metric tons (or 15.06 million tons) per year of CO2e, based on Hawaii's 1990 GHG emission estimates prepared under Act 234, 2007 Hawaii Session Laws. The GHG cap excludes aviation and international bunker fuel emissions, and includes carbon sinks. The director may determinethe numerical GHG emission limit using improved methodologies and data should it become available for estimating emissions. Based on the director's estimates in response to public comments, the aggregate system-wide emissions limit for affected facilities to comply with Act 234 is 8,930,000 metric tons of CO2e. The limit serves as an indicator to measure progress of the state's GHG reduction measures and to determine the achievement and maintenance of the state's GHG limit by 2020.

[Eff and comp] (Auth: HRS §§ 342B-3,342B-12, 342B-71, 342B-72, 342B-73; 42 U.S.C. §§7407,7416) (Imp: HRS §§ 342B-3, 342B-12, 342B-71, 342B72,342B-73; 42 U.S.C. §§7407, 7416)

§11-60.1-204. System-wide GHG emissions monitoring and reporting program. Using verified GHG emissions data provided through the US EPA's GHG Reporting Program (GHGRP), as codified in 40 CFR Part 98, the director shall be responsible for tracking reported GHG emissions on a yearly basis and communicating the state's progress to affected facilities and the general public through public notice and other methods. The director shall be responsible for validating all emissions data provided by EPA through the GHGRP or other sources. If data for an affected facility is not included in the GHGRP database, then the director shall require that facility to report its generation and emissions data using the approved methodologies employed for the GHGRP under 40 CFR Part 98.

§11-60.1-205. System-level compliance check. If the system-wide reported GHG emissions from affected facilities plus the department's 2012 estimate of GHG emissions from non-covered sources are equal to or lower than 8,930,000 metric tons of CO2e for calendar year 2017, the director shall rule the system in compliance with the intent and objectives of Act 234. The director will continue to monitor, verify and report ongoing GHG emissions on a yearly basis with compliance milestones every five years thereafter.

§11-60.1-206. Facility-level compliance check. If any affected facility's 2017 reported GHG emissions according to the GHGRP are greater than its latest five year average GHG emissions that affected facility will be subject to the rules contained in Sections 11-60.1-208 through 209 herein.

§11-60.1-207Greenhouse gas emission reduction plan. If the system-level compliance check reveals that aggregate reported GHG emissions from affected facilities plus the department's 2012 estimate of GHG emissions from non-covered sources are greater than 8,930,000 metric tons of CO2e then all affected facilities will be required to develop a GHG emissions reduction plan as described in this Section and Section 11-60.1-209 herein. (a) This section applies to an owner or operator of a permitted covered source, affected facility, or affected source, except for municipal waste combustion operations, with the potential to emit GHG emissions (biogenic plus nonbiogenic) equal to or above 100,000 tons per year CO2e. Each owner or operator of an affected source shall submit a GHG emission reduction plan for the director's approval within twelve (12) months of the effective date of this section. An owner or operator may submit a written request for an extension 30 days prior to the deadline.

(b) The GHG emission reduction plan will be used to evaluate and establish an annual facility-wide GHG emissions cap for the affected source in support of achieving and maintaining the statewide GHG limit. The approved facility-wide GHG emissions cap and the associated provisions will be made a part of the covered source permit, and may be revised through the permit process to respond to new rules, updated technology, GHG reduction initiatives, and any other circumstances deemed necessary by the director to facilitate the state's GHG limit.

(c) Unless substantiated by the owner or operator of an affected source and approved by the director to be unattainable pursuant to the GHG control assessment described in subsection 11-60.1-204(d), each GHG emission reduction plan shall establish a minimum facility-wide GHG emissions cap in tons per year CO_2e, to be achieved by 2020 and maintained thereafter. The minimum facility-wide GHG emissions cap shall be sixteen percent (16%) below the facility's total baseline GHG emission levels less

biogenic CO_2 emissions, as follows:

Facility- Facility Facility

wide cap = (1 – 0.25)) (1-0.16) X Total - Baseline

(tpy CO_2e) Baseline Biogenic

Emissions CO_2 Emissions

(tpy CO_2e)

Where:

Facility Total Baseline Emissions (tpy CO_2e) =

Baseline[Biogenic CO_2 + Non-Biogenic GHG

Emissions]

Calendar year 2010 shall be used as the baseline year, unless the owner or operator can provide records for the director's approval demonstrating another year or an average of other years to be more representative of normal operations. Newly permitted sources without an operating history, shall estimate normal operations for the director's approval in establishing the facility-wide GHG emissions cap.

(d) The GHG emission reduction plan required of affected sources shall at a minimum include:

(1) The facility-wide baseline annual emission rate (tpy CO_2e). Calendar year 2010 annual emissions shall be used as the baseline emissions to calculate the required facility-wide GHG emissions cap, unless another baseline year or period is approved by the director. Baseline emissions shall be determined in accordance with section 11-60.1-115, separated between biogenic and non-biogenic emissions, and exclude all emissions of noncompliance with an applicable requirement or permit limit. The owner or operator shall include the data and calculations used to determine the baseline emissions. If calendar year 2010 is deemed unrepresentative of normal operations, then the owner or operator may propose an alternate baseline annual emission rate for the director's approval, as follows:

(A) The owner or operator shall clearly document why calendar year 2010 is not representative of normal operations and why the proposed alternate year or period is more suitable based on trends, existing equipment and controls, scheduled maintenance, operational practices, and any

other relevant information. Acceptable methods for determining alternate facility-wide baseline annual emissions include:
(i) the facility-wide GHG emissions (less biogenic CO2) based on the most recent representative year during the five-year period ending 2010;
(ii) average facility-wide GHG emissions(less biogenic CO2) over any consecutive two-year period during the five-year period ending in 2010;
(iii) average facility-wide GHG emissions (less biogenic CO2) for the five-year period ending in 2010; or
(iv) comparable methods as approved by the director. The director will not consider the use of periods greater than five years from 2010, except for extreme cases such as where an affected source may not have been fully operational for an extended period of time.
(B) For newly permitted covered sources without a 2010 operating history, the owner or operator shall make the best estimate of normal operations based on contract agreements, available operational records, required scheduled maintenance, market forecast, or any other information for projecting the affected source emissions. Potential emissions shall not be used, unless the owner or operator can clearly demonstrate that the facility will be continually operating at the maximum capacity for each and every year. The owner or operator shall provide all supporting documentation for the proposed alternate baseline emission rate. The director, based on available information, may reject and modify the baseline emission rate in establishing the final facility-wide GHG emissions cap.
(2) The 2020 facility-wide GHG emissions cap. Determine the facility-wide GHG emissions cap in accordance with subsection(c), using calendar year 2010 or the proposed GHG baseline emission rate determined by paragraph (1) above. If the required emissions cap requiring a sixteen percent (16%) emission reduction from baseline year emissions is deemed unattainable, the owner or operator shall provide, as part of the reduction plan:
(A) The justification and supporting documentation of why the required emissions cap cannot be met; and
(B) A proposal, for the director's approval, of an alternate emissions cap resulting in the maximum achievable GHG reductions. In determining whether or not the required GHG emissions cap is attainable, the owner or operator of an affected source shall first conduct the GHG control assessment described in paragraphs (3) to (5).
Available EPA guidelines for GHG Best Available Control Technology analysis, and GHG control measures by source type shall be used as applicable for this assessment.
(3) Available Control Measures. Identify all available control measures with potential application for each source type, and all on-the-book control measures the facility is committed or will be required to implement affecting GHG emissions. At a minimum, the following shall be considered as applicable:
(A) Available technologies for direct GHG capture and control;
(B) Fuel switching or co-fired fuels;
(C) Energy efficiency upgrades;
(D) Combustion or operational improvements;
(E) Restrictive operations;
(F) Planned upgrades, overhaul, or retirement of equipment;
(G) Outstanding regulatory mandates, emission standards, and binding agreements; and
(H) Other GHG reduction initiatives that may affect the facility's GHG emissions. Unless the owner or operator of the source has direct ownership or legal control over a GHG reduction

initiative, that initiative cannot be relied upon as a proposed control strategy. Identification of GHG reduction initiatives, whether or not the owner or operator has ownership or legal control, will serve to highlight their potential importance for reducing GHG emissions in the state. The owner or operator of an affected source will only benefit from a GHG initiative, if the initiative reduces or helps to reduce and maintain the source's GHG emissions below its permitted facility-wide GHG emissions cap.

(4) The Technically Feasible Measures. For any new control measure identified for the facility, eliminate all technically infeasible options based on physical, chemical, or engineering principles that would preclude the successful operation of the control with the applicable emission unit or source. Document the basis of elimination, and generate the list of technically feasible control options for further evaluation. All committed and required on-the-book measures shall remain on the list.

(5) Control Effectiveness and Cost Evaluation. List the technically feasible control options and identify the following for each control measure as applicable. All cost data shall be provided in present dollars.

(A) Control effectiveness (percent pollutant removed);

(B) Expected emission rate (tons per year CO_2e, pounds CO_2e/kilowatt-hour);

(C) Expected emission reduction (tons per year CO_2e);

(D) Energy impacts (BTU, kilowatt-hour);

(E) Environmental impacts (other media and the emissions of other regulated air pollutants);

(F) Any secondary emissions or impacts resulting from the production or acquisition of the control measure; and

(G) Economic impact (cost effectiveness:
annualized control cost, dollar/megawatt-hr, dollar/ton CO_2e removed, and incremental cost effectiveness between the control and status quo). For committed or required on-the-books control measures and any other GHG control initiatives, identify at a minimum, items (A) through (C) above. Considering the energy, environmental, and economic impact,
determine the GHG control or suite of controls found to be feasible in achieving the maximum degree of GHG reductions for the facility. Determine whether the required GHG emissions cap, pursuant to subsection
(c) will be met. If an alternate cap must be proposed for approval, declare the proposed percentage GHG reduction and the alternate GHG reduction cap. Provide the justification and associated support information (e.g., references, assumptions, vendor quotes, sample calculations, etc.) to substantiate the control analysis and alternate GHG emissions cap.

(6) The proposed Control Strategy. Present the listing of control measures to be used for implementation in meeting the required or proposed alternate 2020 facility-wide GHG emissions cap. Include discussion of the control effectiveness, control implementation schedule, and the overall expected GHG CO_2e emission reductions (tpy) for the entire facility. Owners or operators shall also consider the following:

(A) Affected sources may propose to combine their facility-wide GHG emissions caps to leverage emission reductions among partnering facilities in meeting the combined GHG emissions caps. If approved by the director, each partnering facility will be responsible for complying with its own adjusted GHG facility-wide emissions cap.

(B) Except for fee assessments and determining applicability to this section, biogenic CO_2 emissions will not be included when determining compliance with the facility-wide emissions cap until further guidance can be provided by EPA, or the director, through rulemaking.

(C) The approved facility-wide GHG emissions cap and the associated monitoring, recordkeeping, and reporting provisions will be made a part of the covered source permit, enforceable by the director.

(e) Failure to submit an adequate GHG emission reduction plan, or failure to submit relevant facts or correct information upon becoming aware of such failure, constitutes a violation of this chapter. The owner or operator of an affected source has the same duty to certify the GHG emission reduction plan in accordance with section 11-60.1-4, and supplement or correct the GHG emission reduction plan, similar to the provisions in section 11-60.1-84 for covered source permit applications. During the processing of a GHG emission reduction plan, if the director determines that a re-submittal of the plan is required, or submittal of additional information is necessary to evaluate or take final action on the plan, the director may make the request in writing and set a reasonable deadline for the response.

(f) If the owner or operator of an affected source fails to submit an adequate GHG emission reduction plan, or if a facility-wide GHG emissions cap cannot be mutually agreed upon, the director reserves the right to establish, and incorporate into the applicable covered source permit, a facility-wide GHG emissions cap as required or the lowest cap deemed achievable by the affected source based on the intent of this subchapter.

(g) Once a facility-wide GHG emissions cap is established and placed into the covered source permit, the GHG emission reduction plan shall become a part of the covered source permit application process for renewals and any required modifications pursuant to subchapter 5. With each subsequent GHG emission reduction plan submittal, the owner or operator of the affected source shall report:

(1) The GHG emission reduction status;

(2) Factors contributing to the emission changes;

(3) Any control measure updates; and

(4) Any new developments or changes that would affect the basis of the facility-wide GHG emissions cap.

(h) The facility-wide GHG emissions cap may be re-evaluated and revised by the director if any of the following events or circumstances exists:

(1) Consideration for new rules, updated technology, implementation of GHG reduction initiatives, significant changes with renewable energy cost and supply, and any other measures deemed necessary by the director to facilitate the state’s GHG limit;

(2) The basis for establishing the facility-wide GHG emissions cap is found to be incorrect;

(3) The methodology for calculating GHG emissions is updated or modified;

(4) Renewable energy producers cease operations or fail to meet contractual obligations with the affected source, and there are no other reasonable alternatives; or

(5) Reasonably unforeseen events beyond the control of the owner or operator of an affected source, resulting in long-term or temporary emission changes, whereby the maintenance of the GHG emissions cap would be detrimental to the health and welfare of the public.

Any revision to a facility-wide GHG emissions cap is considered a significant modification subject to the application and review requirements of section 11-60.1-104. The owner or operator of an affected source seeking a GHG emissions cap change has the burden of proof to substantiate any requested change for the director’s approval. Upon approving any GHG

emissions cap revision, the director may impose additional emission limits or requirements on the affected source, or limit the time-frame allowed for the revised GHG emissions cap.
(i) Municipal solid waste landfills required by 40 CFR Part 60, Subpart Cc or 40 CFR Part 60, Subpart WWW to use gas collection and control systems are conditionally exempt from the GHG emission reduction requirements of Subsection 11-60.1-204(c).
(j) Should the permitted facility-wide GHG emissions cap not be met by January 1, 2020 and annually maintained thereafter, the owner or operator of the covered source shall be subject to enforcement action for each year after 2019 that the facility-wide cap is not met. Compliance with the facility-wide cap shall be determined at the end of each calendar year, or January 1 of the following year, starting with the end of 2019 or January 1, 2020. Each CO2e ton over the cap shall constitute a separate offense and violation.

[Eff and comp] (Auth: HRS §§ 342B-3, 342B-12, 342B-71, 342B-72, 342B-73; 42 U.S.C. §§7407, 7416) (Imp: HRS §§ 342B-3, 342B-12, 342B-71, 342B-72, 342B-73; 42 U.S.C. §§7407, 7416)

§11-60.1-208 Public participation. (a) The director shall provide for public notice, including the method by which a public hearing can be requested, and an opportunity for public comment on all draft GHG emission reduction plans from §11-60.1-204. Any person requesting a public hearing shall do so during the public comment period. Any request from a person for a public hearing shall indicate the interest of the person filing the request and the reasons why a public hearing is warranted. (b) Procedures for public notice, public comment periods, and public hearings shall be as follows:

(1) The director shall make available for public inspection in at least one location in the county affected by the proposed action, or in which the source is or would be located:

(A) Information on the subject matter;

(B) Information submitted by the proposing party, except for that determined to be confidential pursuant to section 11-60.1-14;

(C) The department's analysis and proposed action; and

(D) Other information and documents determined to be appropriate by the department;

(2) Notification of a public hearing shall be given at least thirty days in advance of the hearing date;

(3) A public comment period shall be no less than thirty days following the date of the public notice, during which time interested persons may submit to the department written comments on:

(A) The subject matter;

(B) The greenhouse gas emission reduction plan;

(C) The department's analysis;

(D) The proposed actions; and

(E) Other considerations as determined to be appropriate by the department;

(4) Notification of a public comment period or a public hearing shall be made:

(A) By publication in a newspaper which is printed and issued at least twice weekly in the county affected by the proposed action, or in which the source is or would be located;

(B) To persons on a mailing list developed by the director, including those who request in writing to be on the list; and

(C) If necessary by other means to assure adequate notice to the affected public;

(5) Notice of public comment and public hearing shall identify:

(A) The affected facility;

(B) The name and address of the proposing party;

(C) The name and address of the agency of the department reviewing the plan;

(D) The activity or activities involved in the plan, including, but not limited to, whether the proposing party proposes:

(i) an alternate baseline year;

(ii) an alternate facility-wide GHG emissions cap;

(iii) a control strategy involving partnering with one or more facilities.

(E) The emissions change involved in the plan;

(F) The name, address, and telephone number of a person from whom interested persons may obtain additional information, including copies of the draft plan, all relevant supporting materials, and all other materials available to the department that are relevant to the decision, except for information that is determined to be confidential, including information determined to be confidential pursuant to section 11-60.1-14;

(G) A brief description of the comment procedures;

(H) The time and place of any hearing that may be held, including a statement of procedures to request a hearing if one has not already been scheduled; and

(I) The availability of the information listed in paragraph (1), and the location and times the information will be available for inspection; and

(6) The director shall maintain a record of the commenters and the issues raised during the public participation process and shall provide this information to the Administrator upon request." [Eff and comp] Auth: HRS §§ 342B-3, 342B-12, 342B-71, 342B-72, 342B-73; 42 U.S.C. §§7407, 7416) (Imp: HRS §§ 342B-3, 342B-12, 342B-71, 342B-72, 342B-73; 42 U.S.C. §§7407, 7416)

§11-60.1-209Public petitions.

(a) The applicant and any person who participated in the public comment or hearing process and objects to the grant or denial of a draft GHG emission reduction plan, may petition the department for a contested case hearing by submitting a written request to the director.

(b) The petition shall be based solely upon objections to the draft GHG emission reduction plan, that were raised with reasonable specificity during the public participation process, unless the petitioner demonstrates that it was impracticable to raise such objections; for example, the grounds for such objections arose after the public participation process.

(c) Any petitioner shall file a petition for a contested case hearing within ninety days of the date of the department's approval or disapproval of the proposed draft GHG emission reduction plan.

(d) Notwithstanding the provisions of subsection (b), if based solely on objections which were impracticable to raise during the public participation process, a petition for a contested case hearing may be filed up to ninety days after the objections could be reasonably raised.

(e) Except as provided in subsection (f), any draft GHG emission reduction plan that has been issued shall not be invalidated by a petition for a contested case hearing. If a draft GHG emission reduction plan is issued by the director, the owner or operator of the source shall not be in violation of the requirement to have submitted a timely and complete application.

(f) The effective date of draft GHG emission reduction plan shall be as specified for permits in 40 CFR Part 124.15.

(g) Any person may petition for a contested case hearing for the director's failure to take final action on an application for draft GHG emission reduction plan, within the time required for permits by this chapter. Such petition shall be submitted in writing and may be filed any time before the director issues a proposed draft GHG emission reduction.

(h) Any person aggrieved by a final administrative decision and order, including the denial of any contested case hearing, may petition for judicial review pursuant to section 91-14, HRS. A petition for judicial review shall be filed no later than thirty days after service of the certified copy of the final administrative decision and order." [Eff and comp] Auth: HRS §§ 342B-3, 342B-12, 342B-71, 342B-72, 342B-73; 42 U.S.C. §§7407, 7416) (Imp: HRS §§ 342B-3, 342B-12, 342B-71, 342B72, 342B-73; 42 U.S.C. §§7407, 7416)

Amendments to and compilation of chapter 60.1, title 11, Hawaii Administrative Rules, on the Summary Page dated were adopted on following public hearings held on November 20, 28, 29 and 30, 2012, after public notice was given in the
Honolulu Star Advertiser, The Garden Island, The Maui News, West Hawaii Today, and *Hawaii Tribune Herald*, on
October 19, 2012. The rules shall take effect ten days after filing with the Office of the Lieutenant Governor.

Hawaii Energy Facts & Figures

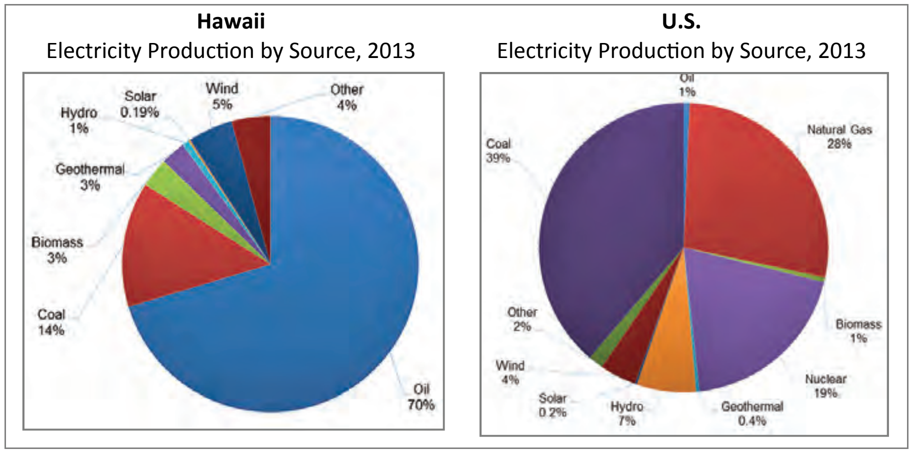
May 2015

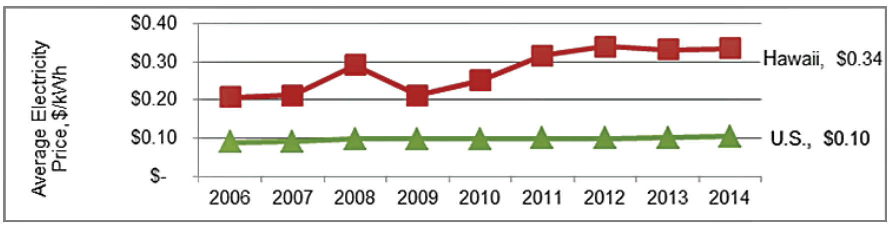
HAWAII STATE
Energy Office

State of Hawaii Department of Business, Economic Development, and Tourism
Hawaii State Energy Office · energy.hawaii.gov

Hawaii Energy Overview

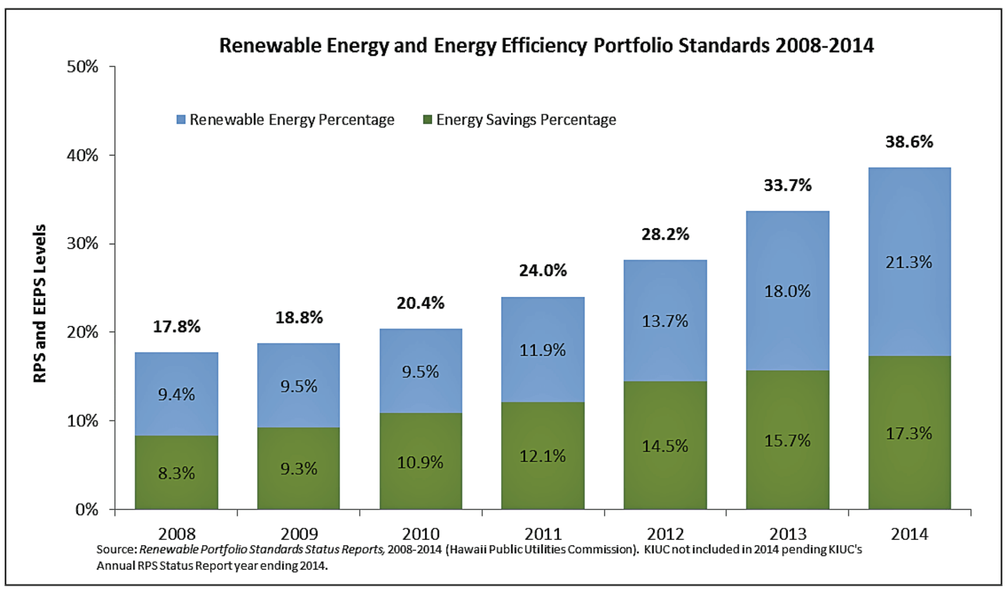
Hawaii is the only state that depends so heavily on petroleum for its energy needs. Whereas less than 1% of electricity in the nation is generated using oil, in 2013 Hawaii relied on oil for 70% and on coal for 14% of its electricity generation.[1]



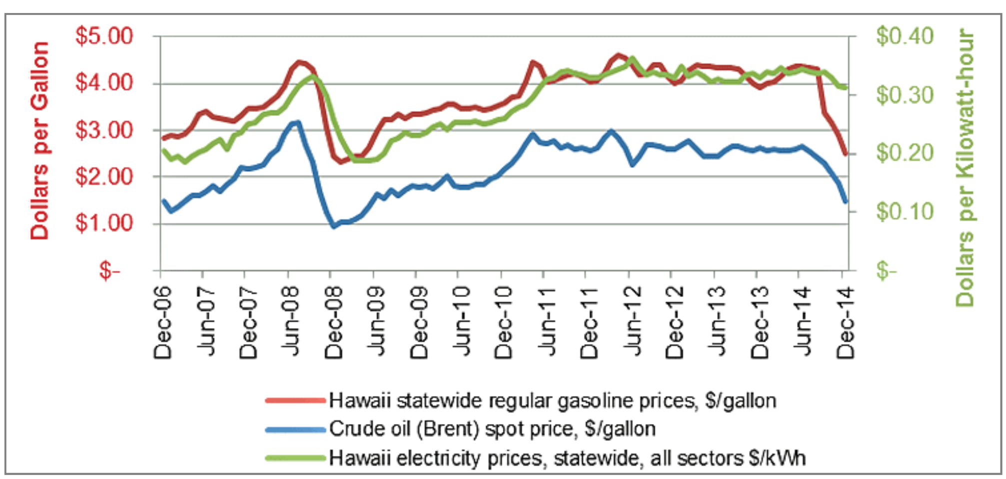


Hawaii's **electricity prices are three times higher** than the U.S. average.[2,3]

Although Hawaii's electricity production and costs are still heavily reliant on oil, energy efficiency and renewable energy have been increasing[4] in all counties.

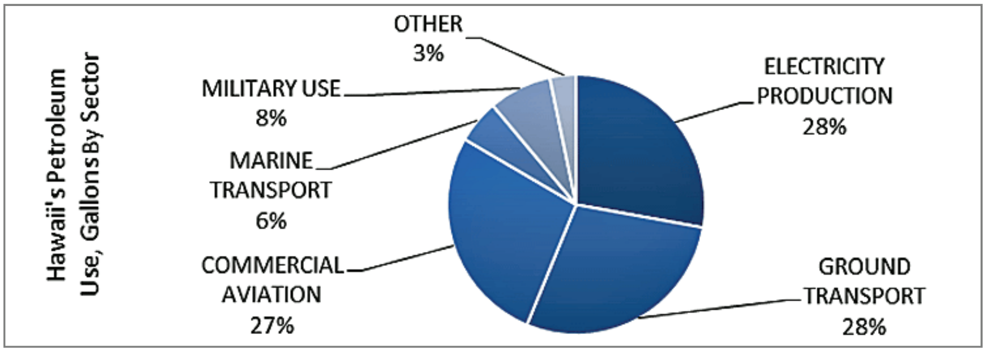


In Hawaii, both electricity and gasoline prices follow the price of petroleum. The graph below shows the prices of Brent crude oil, gasoline, and electricity.[5]



Hawaii Energy Overview

Electricity and gasoline are just part of Hawaii's energy picture. Large quantities of jet fuel are also used (this is different from the mainland, where most petroleum is used for ground transportation). In Hawaii, roughly equal amounts of petroleum are used for electricity production, ground transportation, and commercial aviation, with the rest used for marine transport, military, and other uses.[6]



Total petroleum use 2014 (million barrels per year)[7]	**34.3**	Fuel for electricity production (million gallons per year)[8]	**394**
Total petroleum use 2014 (million gallons per year)[9]	**1442**	Fuel for air transportation (i.e. jet fuel) (million gallons per year)[10]	**411**
Hawaii's rank among 50 states for energy prices[11]	**1**	Fuel for ground transportation (million gallons per year)[12]	**448**

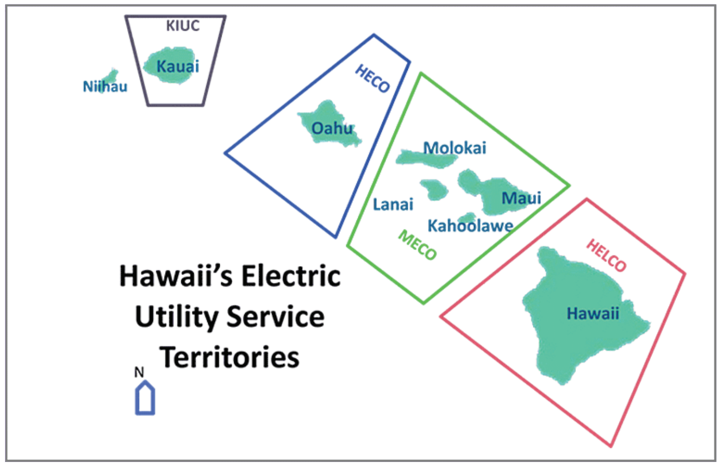
Electric Utilities

Each of Hawaii's six main islands has its own electrical grid, not connected to any other island. Hawaiian Electric Company (HECO) and its subsidiaries, Maui Electric (MECO) and Hawaii Electric Light Company (HELCO), serve about 95% of the State's population.[13] The island of Kauai is served by Kauai Island Utility Cooperative (KIUC).[14 15]

2013	HECO Oahu	MECO Maui	MECO Lanai	MECO Molokai	HELCO Hawaii	HECO Companies Total	KIUC Kauai	State Total
2013 Electricity Production	7,561	1,200	27	34	1,195	**10,017**	452	**10,469**
Firm capacity (MW)	1,778	262	10	12	292	**2,354**	431	**2,785**
Intermittent capacity (MW)	568	391	0	0	447	**1,406**	44	**1,450**
System Peak (MW)	1,141	195	5	6	189	Not Applicable[14]	78[15]	Not Applicable[14]
Residential Customer	265,772	55,301	1,469	2,649	69,719	**394,910**	28,371	**423,281**
Commercial Customers	33,756	9,356	240	562	12,918	**56,832**	8,343	**65,175**
% of KWh used by Residential	24%	34%	30%	36%	37%	**27%**	37%	**27%**
% of KWh used by Commercial	76%	66%	70%	64%	63%	**73%**	63%	**73%**

Electric Utilities

COMPETITIVE BIDDING



Hawaii's electric utilities deliver electricity generated with their own units as well as power generated by Independent Power Producers (IPPs). If new or replacement generation is required, HECO, MECO, and HELCO are required to follow the "Competitive Bidding Framework" for new generation with capacities greater than 5 MW (Oahu) or 2.72 MW (MECO, HELCO), or receive a waiver of the competitive bidding requirements from the Hawaii Public Utilities Commission (PUC).[16] Current procurement activities include:[17]

HECO: A Request for Proposals (RFP) for 600-800 gigawatt-hours (or 200 MW) of as-available renewable electricity for use on Oahu is being redrafted per a July 2013 Order from the PUC. The redrafted RFP will remove references to the Lanai Wind Project and eliminate solicitations for an undersea transmission cable. Also in July 2013, the PUC opened a new docket to examine whether the cable may be in the public interest.

MECO: On July 11, 2013, the PUC closed the competitive bidding proceedings to acquire up to 50MW of new, renewable firm dispatchable capacity generation resources on the island of Maui. The commission will consider future requests from MECO to open another proceeding to conduct a RFP for firm generation upon a demonstration of need and a plan focused on customer needs.

HELCO: In February 2015, HELCO announced the selection of Ormat[18] for a new 25 MW geothermal power plant on the Island of Hawaii. HELCO and Ormat will be commencing negotiation to contract for the sale of new power to be generated from this new geothermal power plant and submit such agreement to the PUC for review and approval.

CONVERTING MW OF CAPACITY INTO MWh OF ELECTRICITY PRODUCTION

Generators do not always produce at full capacity, due to resource limits (sun not shining, wind not blowing), maintenance requirements, or power not needed.

The "capacity factor" is the percent of time a facility is expected to operate at full capacity (or its equivalent, in terms of energy production) over a one year period. For example, if a facility has a capacity of 1 MW and a capacity factor of 100%, it will generate (1MW)* (24 hours/day)* (365 days/year) = 8,760 MWh per year.

CAPACITY FACTOR ASSUMPTIONS FOR RENEWABLE RESOURCES	Capacity Factors (assumed)*	MWh produced per MW capacity[19]
Biomass-Direct Firing	80%	7,000
Wind (Oahu, Hawaii, Kauai)**	35%	3,100
Wind (Lanai, Molokai)	40%	3,500
Wind (Maui)	45%	3,900
Geothermal	96%	8,400
Hydro	44%	3,900
Solar (rooftop)	23%	2,000
Solar (utility)	24%	2,100
Ocean	35%	3,100

Capacity factors presented in this table are assumptions used by Booz Allen, under contract to the National Renewable Energy Laboratory, in the *Hawaii Clean Energy Initiative Scenario Analysis*, Appendix C, Slide 26. March 2012.

*Actual capacity factors may vary from the assumptions presented here. **The Pakini Nui wind farm (on Hawaii island) generally has an annual capacity factor of over 60%.

Electric Utilities: Customers & Rates

Residential electricity use, rates, and average bills are shown below for 2013 and 2012. In general, rates were fairly stable and electricity use declined, so bills also declined.[20]

Residential Electricity Use, Rates, and Average Bill, 2013							
	Oahu	Hawaii	Kauai	Maui	Molokai	Lanai	State
Average use (kWh/month)	523	473	464	557	329	430	514
Average cost per kWh	$ 0.35	$ 0.42	$ 0.44	$ 0.38	$ 0.46	$ 0.46	$ 0.37
Average monthly bill	$ 181	$ 199	$ 205	$ 211	$ 153	$ 199	$ 189

Residential Electricity Use, Rates, and Average Bill, 2012							
	Oahu	Hawaii	Kauai	Maui	Molokai	Lanai	State
Average use (kWh/month)	561	494	465	574	345	413	543
Average cost per kWh	$ 0.35	$ 0.42	$ 0.45	$ 0.39	$ 0.46	$ 0.47	$ 0.37
Average monthly bill	$ 197	$ 210	$ 209	$ 222	$ 159	$ 192	$ 203

FEED - IN TARIFF (FIT)

The FIT queue is now closed.[21] Prior to this, renewable electricity suppliers with generators smaller than 5 MW would be eligible to participate in the HECO Companies' Feed in Tariff,[22] supplying as-available power to the utility at constant, contracted rates over 20 years.

Feed-in Tariff (FIT) Rates, Hawaiian Electric Companies' Service Areas										
Tier	**Island**	**Photovoltaics (PV)**		**Concentrating Solar Power (CSP)**		**On-Shore Wind**		**In-line Hydro**		
		rate (¢/kWh)	size limit	rate (¢/kWh)	size limit	rate (¢/kWh)	size limit	rate (¢/kWh)	size limit	
1	All Islands	21.8* / 27.4**	20 kW	26.9* / 33.1**	20 kW	16.1	20 kW	21.3	20 kW	
2	Oahu	18.9* / 23.8**	500 kW	25.4* / 27.5**	500 kW	13.8	100 kW	18.9	100 kW	
	Maui & Hawaii	18.9* / 23.8**	250 kW	25.4* / 27.5**	500 kW	13.8	100 kW	18.9	100 kW	
	Lanai & Molokai	18.9* / 23.8**	100 kW	25.4* / 27.5**	100 kW	13.8	100 kW	18.9	100 kW	
3	Oahu	19.7* / 23.6**	5 MW	31.5* / 33.5**	5 MW	12.0	5 MW	--	--	
	Maui & Hawaii	19.7* / 23.6**	2.72 MW	31.5* / 33.5**	2.72 MW	--	--	--	--	

* With tax credit of 35%. ** With tax rebate of 24.5%.

HECO and the Independent Observer submitted a joint plan to the PUC for administering the FIT queues in September 2013. The joint plan was accepted by the PUC on 12/5/14.[23] Future revisions or modifications to the FIT program will be addressed in Docket No. 2014-0192 or 2014-0183.

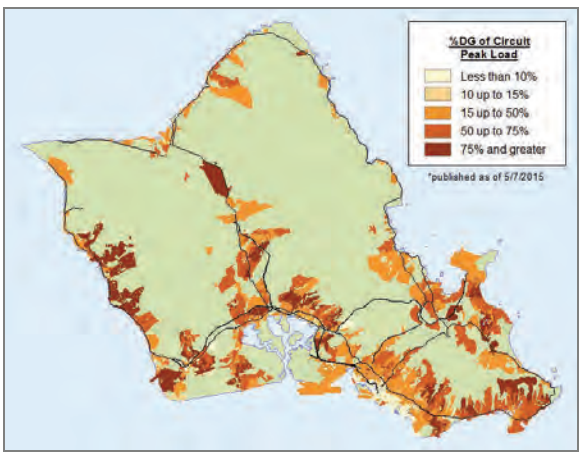
FIT aggregate limits: Oahu: 60 MW; Big Island: 10 MW; Maui, Lanai, Molokai (combined): 10 MW

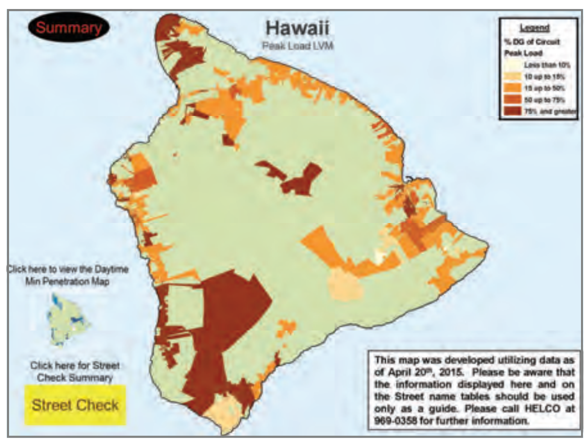
Electric Utilities: Customers & Rates

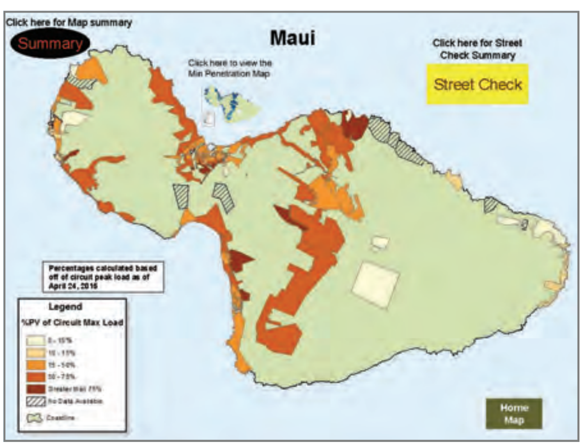
NET ENERGY METERING[24]

Customers who generate renewable solar, wind, hydro, or biomass energy on their own property may be eligible for "net energy metering" (NEM) to offset their own use.

- If the customer uses more electricity than is produced, the customer pays for that net amount.
- If the customer produces more electricity than used, the customer pays a minimum bill (e.g. $17 for Oahu residential customers) or customer charge, and excess credits are carried forward to the next month, for up to 12 months.
- About 12% of Hawaiian Electric Companies residential electric utility customers had rooftop PV systems as of December 2014.[25]
- On August 26, 2014, under PUC Docket 2001-0206, the HECO companies delivered to the PUC the Reliability Standards Working Group distributed generation interconnection plan (DGIP). The DGIP has been merged into the Distributed Energy Resource (DER[26]) Docket (PUC Docket No. 2014-0192) along with other relevant proceedings, and is presently under review. Among other things, the DER should "include actionable strategies and implementation plans for distribution system upgrades and utilization of advanced inverter technical functionality to enable distribution circuit solar PV penetrations to be increased over time in a safe and reliable manner."
- KIUC: New interconnections use Schedule Q[27] (100 kW or less) and "NEM Pilot"[28] (200 kW or less; 20¢/kWh for excess).





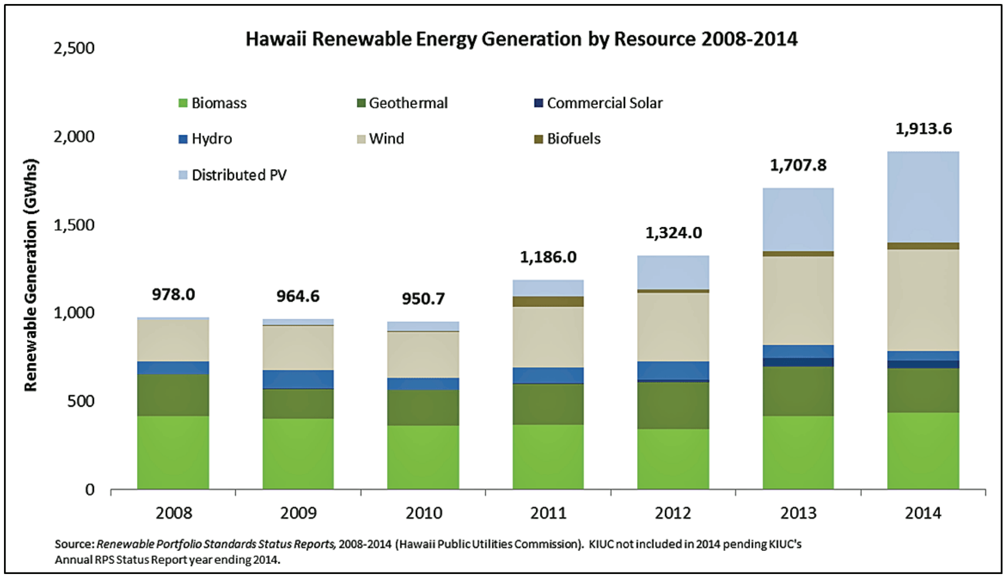


Sample Locational Value Maps for HECO, HELCO, and MECO Service Territories (http://www.hawaiianelectric.com/portal/site/heco/menuitem.508576f78baa14340b4c0610c510b1ca/?vgnetoid=47a22314e39e8310VgnVCM10000005041aacRCRD&vgnextchannel=f1230488c7d00410VgnVCM10000005041aacRCRD&vgnextfmt=default)

Renewable Energy

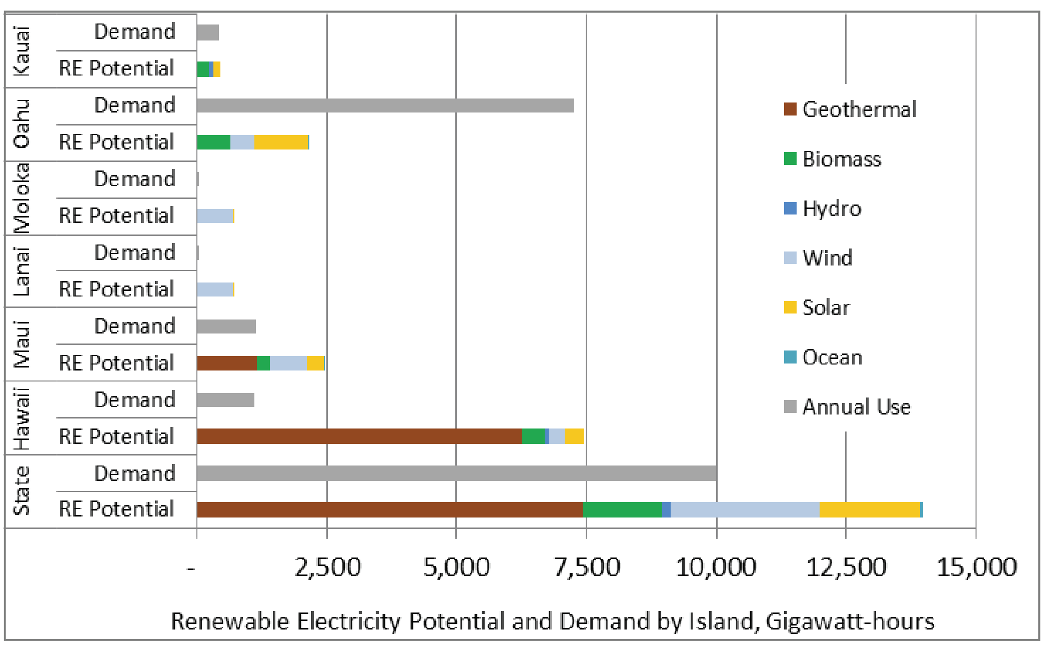
"Renewable Energy"[29] is energy from:

- Sun (i.e. solar)
- Wind
- Falling water (i.e. hydropower)
- Bioenergy, including biomass (e.g. crops, agricultural and animal residues, municipal and other solid waste); biofuels, and biogas
- Geothermal
- Ocean water, including ocean thermal energy conversion (OTEC) and wave energy
- Hydrogen produced from renewable energy sources



In 2014, approximately 21.3% of Hawaii's electricity was generated from renewable sources. Renewable electricity production is primarily from bioenergy, wind, and geothermal, with solar, especially distributed photovoltaics, increasing rapidly.[30]

Renewable resource potential, statewide, is greater than current electricity demand.[31]

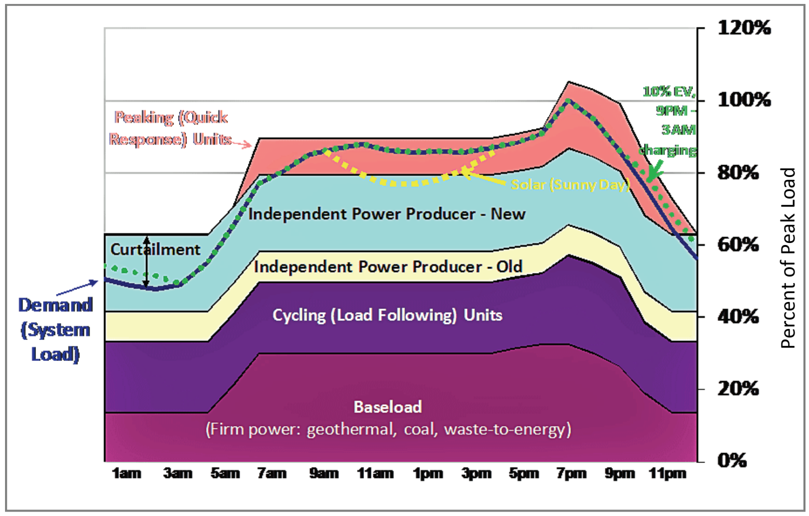


Renewable Energy

Electricity must be used, transmitted, or stored at the instant it is produced. If renewable energy is not used when it's produced, it is usually curtailed (i.e., not used).

Baseload generation facilities produce energy at a constant rate. They generally do not react (ramp up or ramp down) quickly.

Dispatchable (cycling and peaking) units produce power when called upon by the utility, to fill gaps between production and load; they can ramp up and down quickly.



Independent power producer contracts may govern which units are brought on-line (dispatched) first when load is increasing, and which are taken off-line first, when load is decreasing. A new facility generally will not displace an older facility's place in the dispatch order, unless there is a technical reason for the utility to do so.

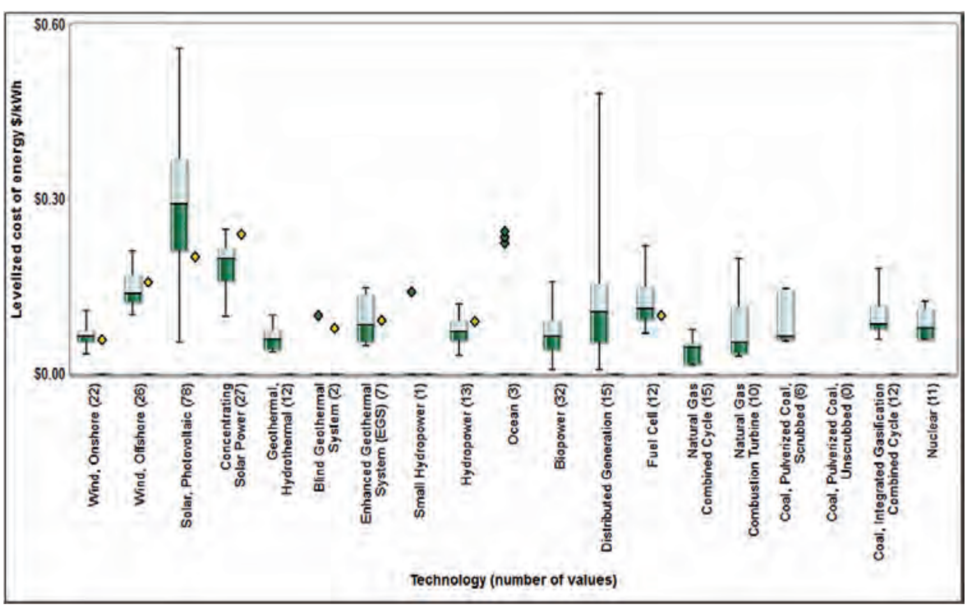
Intermittent (as-available) energy, such as from photovoltaic and wind independent power producers, may be curtailed at times of low load. The yellow line in the graph shows solar systems, on a sunny day, reducing mid-day demand for electricity from other sources.

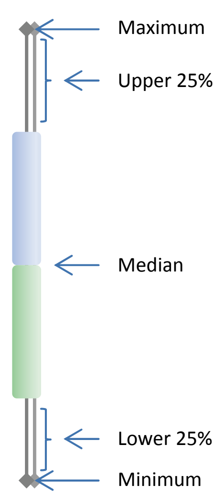
Electric vehicle charging, if managed so that it occurs at times of low load, can use energy that otherwise may have been curtailed.

Percent of Hawaii's electricity from renewable sources (2014)	**21.3%**	Renewable generation required (i.e. Renewable Portfolio Standard, "RPS") by 12/31/2015[32]	**15%**
Renewable generation required (RPS) by 12/31/2020	**25%**	Renewable generation required (RPS) by 12/31/2030	**40%**

"Levelized Cost of Energy" is the price per kilowatt-hour required for an energy project to break even; it does not include risk or return on investment. Costs (land, construction, labor) are different for every project.

The Transparent Cost Database[33] compiles cost information from studies and projects across the United States. The box & whisker chart below shows the data distribution using five numbers: The minimum (bottom of the whisker), lowest 25% (below green box), median, highest 25% (above blue box), and maximum point (top of the whisker). Where fewer than three data points are available, the individual data points (green diamonds) are shown. Yellow diamonds are US Department of Energy estimates.

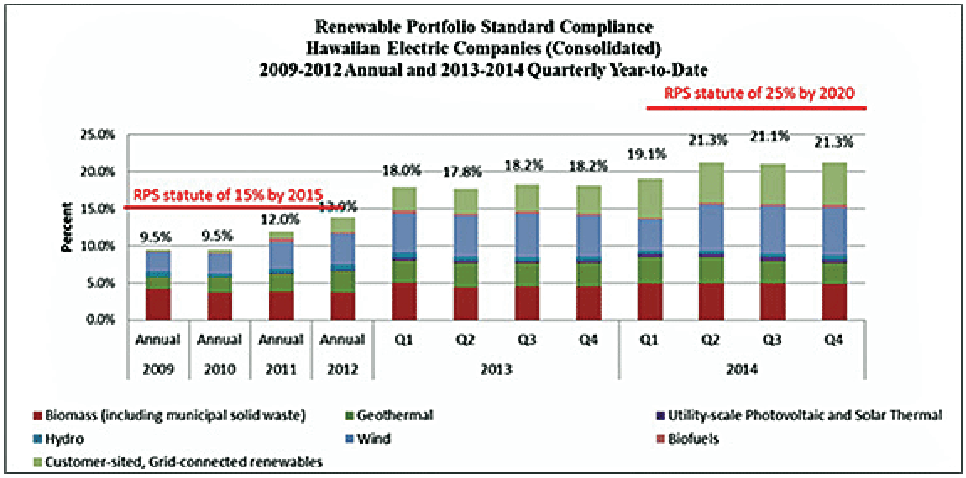




Renewable Energy: RPS

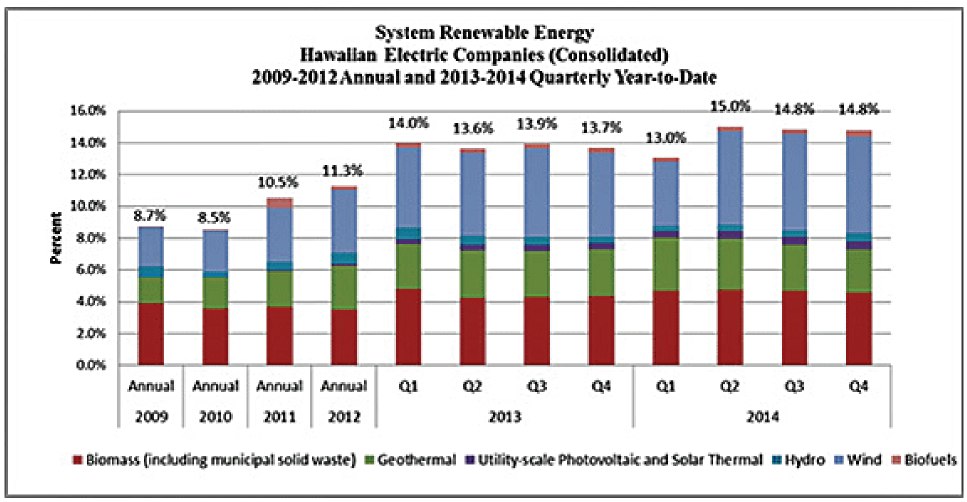
Renewable Portfolio Standard ("RPS") Compliance[34]

"The Hawaiian Electric Companies' RPS Status Report is filed annually and calculates the RPS percentage based on total sales for the previous calendar year in accordance with the RPS law. This RPS Compliance metric estimates the percent of sales that is represented by renewable energy. This metric approximates how the RPS will be calculated from 2015 forward when electrical savings from energy efficiency and solar water heating will not be counted towards achievement of RPS compliance."



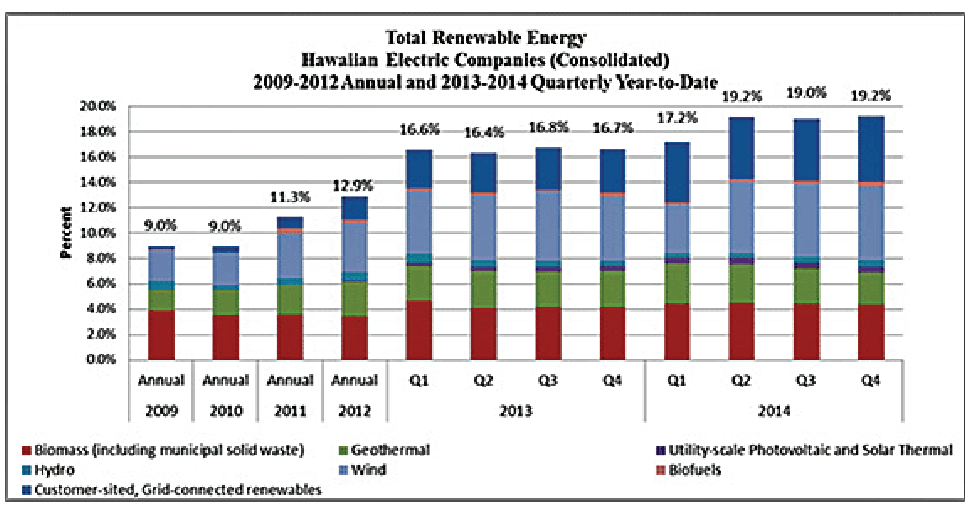
System Renewable Energy ("System RE")[35]

"The System Renewable Energy metric differs from the Renewable Portfolio Standard because it estimates the percent of total net generation that is represented by renewable energy rather than being based on sales. Net generation is the amount of electricity generated and transmitted to the utility grid from the source (i.e., power plant). Generation from independent power producers ("IPPs") and utility power plants is recorded at the net generation level. Sales are lower than the net generation due to losses in transmitting the electricity from the source to the customers. Therefore, the System Renewable Energy will result in values lower than the RPS."



Total Renewable Energy ("Total RE")[36]

"The Total Renewable Energy metric differs from the RPS because it is based on total energy and not sales. Similar to the RPS, the contribution from customer -sited renewable generation is included as part of the renewable energy generated and must also be added to the total net generation of the system."



Bioenergy

"Bioenergy" includes both electricity generation and fuel production from biomass.

Biomass is plant and animal matter, including energy crops, wood, grasses, algae, vegetable oils, and agricultural and municipal wastes. Bioenergy production potential in Hawaii depends on the availability of land and feedstock; CO_2 sources (for algae); markets and values for primary products (electricity, fuels) and by-products (animal feed); and overall revenues compared to costs.

Fuel ethanol could be blended with petroleum-based fuels. Hawaii's energy consumption estimates for major energy sources in 2012 are shown below:

Hawaii's Energy Consumption Estimates[37]

Coal (Thousand Short Tons)	803
Natural Gas (Billion cubic feet)	3
Petroleum (Thousand Barrels)	42,359
Hydroelectric Power (Million Kilowatt-Hours)	115
Fuel Ethanol (Thousand Barrels)	1,250

Bioenergy facilities:[38]

- Kauai:
  - Green Energy is planning to build a facility that will produce 6.7 MW from woodchips.
  - Pacific Light & Power is planning to develop a High Solids Anaerobic Digestion project that will produce 4.5 MW from organic material.
- Oahu:
  - H-POWER[39] produces 10%[40] of Oahu's electricity from more than 600,000 tons of waste.
  - Hawaii Gas' Campbell Industrial Park Synthetic Natural Gas Facility produces 0.1 MGY and aims to increase the renewable components of its gas supply.
  - HECO's Campbell Industrial Park Generating Station simple-cycle unit produces 110 MW from sustainable biodiesel.
  - HECO is planning to own and operate a biofuel capable power plant at Schofield Barracks that will produce 50 MW.
  - Honolulu International Airport is planning to build 4 generators for their Emergency Power Facility that will produce 10 MW from renewable fuel.
- Maui:
  - Hawaiian Commercial and Sugar's (HC&S) 2 steam plants and 3 hydroelectric plants produces 16 MW from renewable crop sources.
  - Maui County has contracted for an Integrated Waste Conversion and Energy Project that will produce at least 1.5 MW.[41]
  - Maui Electric Co. is planning to develop a Mahinahina Energy Park that will produce 4.5-6 MW energy from sorghum or other energy crops.
- Hawaii Island: Hu Honua is planning to develop biomass generators that will produce 21.5MW from eucalyptus biomass.

Bioenergy

Waste materials (such as used cooking oil) and by-products from food, feed, or fiber production, although limited in quantity, are often the first bioenergy feedstocks due to their relatively low cost and the need for reduced waste management costs.

Since biodiesel fuel imports for electricity production began in 2010, the relative cost of the imported biodiesel fuel has been significantly higher than for the fossil-based fuels used for electricity generation in Hawaii.[42] In December 2014, fuel oil averaged $108.22/bbl, diesel fuel averaged $122.02/bbl, and biodiesel averaged $210.11/bbl.[43]

Crops may also be cultivated to produce biomass materials (oils, fiber, sugar) usable for electricity or fuel production.

Studies conducted in 2010 indicate that 136,000 suitable acres could be available without displacing current farming in Hawaii; with biomass production of 10 - 20 tons of fiber per acre per year, potential would be about 1.4 - 2.7 million tons of biomass per year.[44] As a reference, two million tons of biomass, if burned in conventional biomass combustion processes, would generate energy equivalent[45] to two million barrels (84 million gallons) of oil.

Algae has also been receiving attention, due to high yields per acre and potential use of CO_2. The 8.3 million tons[46] of CO_2 produced by large energy facilities (power plants and refineries) in Hawaii could theoretically support the production of over 0.56 million gallons of oil per year.

Hawaii Biofuel Projects[47]

Facility	Input (feedstocks)	Output (products)	Production Capacity
Aina Koa Pono	1. Remove invasive species. 2. Plant crops.	Renewable diesel, gasoline, biochar	16-24 million gallons per year (mgy) (planned)
Big Island Biodiesel	Used cooking oil, grease trap waste, crop oils	Biodiesel, glycerin, animal feed	5 mgy (built)
Cellana	Algae	Algae oil, animal feed	2500+ gallons per year per acre by 2018 (built)
Hawaii BioEnergy, LLC Renewable Fuels Project	Eucalyptus, energy grasses, other	Renewable fuel oil, jet fuel, gasoline; feeds, fertilizers, electricity possible	Fuel oil replacement: 10-20 mgy (planned)
Hawaii Gas Renewable Natural Gas (RNG) Plant	Animal and plant fats and oils	Renewable methane, hydro-gen, propane	1 mgy (built)
Kauai Algae Farm	Algae	Algae oil	TBD (built)
Pacific Biodiesel Honolulu Plant	Local feedstock and cooking oil	Biodiesel	1 mgy (built)

Biofuel, a renewable energy source that can be stored and transported in a manner similar to fossil fuels, can often be used in existing equipment and be blended with petroleum fuels. One ton of biomass replaces approximately one barrel of oil.

Hawaii's current use of petroleum-based fuels (million gallons/yr)	**1,800**	Algae oil yields demonstrated on Kauai[48]	**2000** gal/acre
Hawaii's current cost per gallon of biofuels[49]	**$5**	Hawaii's potential liquid biofuel waste production (mil gal/yr)[50]	**97**
Hawaii's current cost per kWh for biofuel generated[51]	**60¢/kWh**	Hawaii's potential ethanol production from energy crops[52]	**1202**

Electric Vehicles

An electric vehicle (EV) uses electricity in place of gasoline, reducing the need for petroleum-based fuel. Since EVs can use electricity produced from renewable resources available in Hawaii (i.e. sun, wind, hydropower, ocean energy, geothermal energy), the transition from gasoline fueled vehicles to EVs supports Hawaii's energy independence goals.

Based on statewide averages, the amount of fossil fuel used to power an electric vehicle in Hawaii is 31% less than the fossil fuel required to power a similar gasoline-fueled vehicle.[53] This is expected to get even better as renewable energy increases in Hawaii.

Registered EVs and Public Charging Stations in Hawaii, May 2015[54]

County	Electric Vehicles	Level 2[55] Charging Station Ports	Level 3[56] Charging Station Ports	Total Ports
Oahu	2,571	244	5	249
Maui	629	68	35	103
Hawaii	160	51	2	53
Kauai	118	32	1	33
Total statewide	**3,479**	**395**	**43**	**438**

Fuel Cost Comparison

Vehicle	2014 Nissan Versa	2014 Honda Civic	2014 Nissan LEAF[59]
Fuel Type	Gasoline	Gasoline	Electricity
Miles Per Gallon (MPG)	30 mpg Combined 324 miles total range	35mpg Combined 462 miles total range	114 Combined MPG 84 miles total range
Fuel Costs	$ 4.25/gallon	$ 4.25/gallon	Electricity: $ 0.38/kWh
Cost to Drive 25 Miles	$ 3.54	$ 3.04	$ 2.85
Fuel Cost per Year[60]	$ 1,700	$ 1,450	$ 1,400

Fuel cost comparisons show approximate savings between internal combustion engine and electric vehicles.
The example above shows that fuel costs are lower for the Nissan LEAF than for a comparable gasoline fueled vehicle.

Hawaii EV Dealers by County

County	Nissan LEAF	GM/ Chevy Volt	Mitsubishi iMiEV	Toyota plug-in Prius	Ford Focus, C-MAX, Fusion	BMW i3	Cadillac ELR	Porsche Panamera S E-hybrid	Tesla	Kia (estimated summer 2015)
Oahu	3	3	1	3	4	1	1	1	1	3
Maui	1	1	0	1	1	0	0	0	0	1
Hawaii	1	1	0	2	0	0	0	0	0	2
Kauai	1	1	0	1	1	0	0	0	0	1
State of Hawaii	**6**	**6**	**1**	**7**	**6**	**1**	**1**	**1**	**1**	**7**

Electric Vehicles

Hawaii's electric vehicle policies and incentives include:

- Free parking is provided in state and county government lots, facilities, and at parking meters. (Act 168 of 2012, Hawaii Revised Statutes, 291-71, Note)
- Vehicles with EV license plates are exempt from High Occupancy Vehicle lane restrictions. (Act 168 of 2012, Hawaii Revised Statutes, 291-71, Note)
- Parking lots with at least one hundred public parking spaces are required to have at least one parking space, equipped with an EV charging system, reserved exclusively for EVs. (Hawaii Revised Statutes 291-71)
- Non-EVs parked in a space designated and marked as reserved for EVs shall be fined not less than $50 nor more than $100. (Hawaii Revised Statutes 291-72)
- Hawaiian Electric Co. offer EV Time of Use Rates designed to incentivize customers, through lower rates, to charge their EVs during off-peak times of day.
- Multi-family residential dwellings or townhomes cannot prohibit the placement or use of EV charging systems altogether. (Hawaii Revised Statutes, 196-7.5)

EV Quick Facts

The first car to arrive in Hawaii was Electric.[61]	Year 1899
Amount of energy a fully charged Nissan LEAF has potential to tap	24kWh
Best temperature range to operate lithium ion batteries (most common EV batteries today).	68°- 95° Fahrenheit
Hawaii ranks second in the nation behind California in the number of EVs registered in the state registered light cars and trucks in Hawaii are Electric.[62]	4.2 out of every 1,000 registered light cars and trucks in Hawaii are EV
Cost for a government or commercial property owner to install a Level 2 charging station is	Approximately $6,000-$8,000 per station. A relatively simple project in Hawaii can range from $4,000 to $25,000; however, prices vary considerably.[63]

EV Stations Hawaii

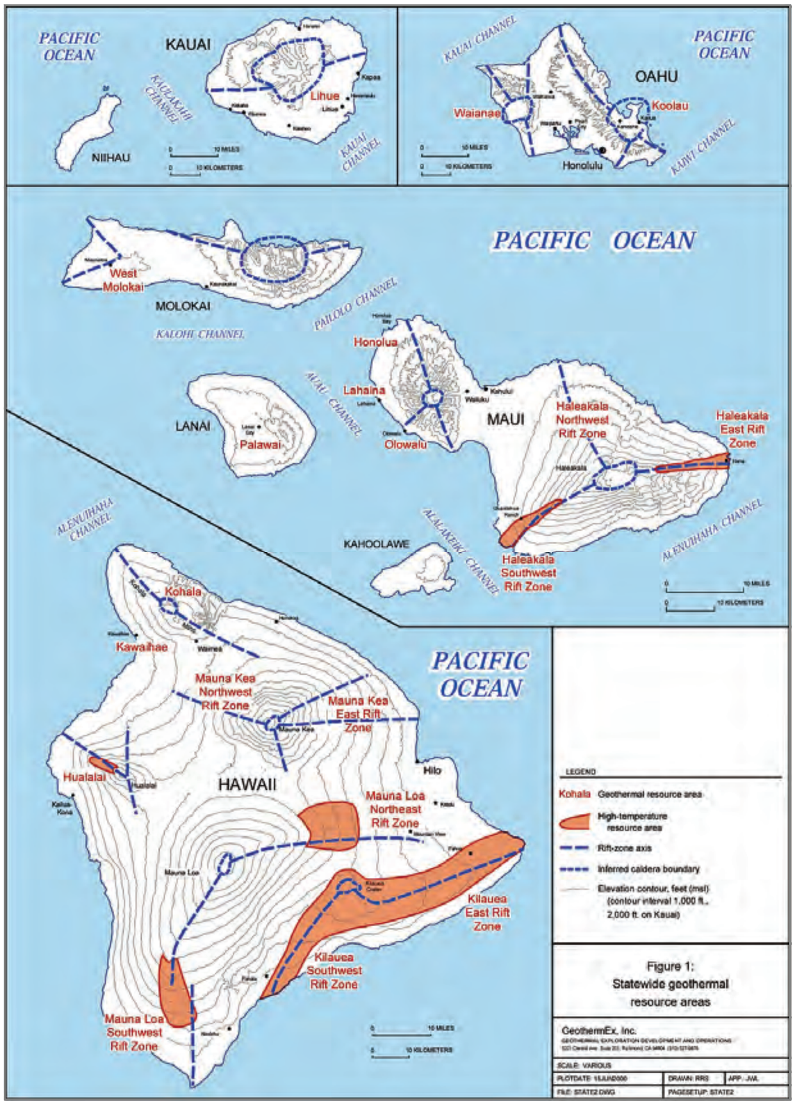
The Hawaii State Energy Office developed a mobile app designed to help drivers locate publicly available EV charging stations statewide. *EV Stations Hawaii* helps drivers pinpoint charging stations as well as provide detailed information of the station giving them the confidence that they can recharge while on the road. The free app is available for Apple and Android smartphones and mobile devices.

http://energy.hawaii.gov/testbeds-initiatives/ev-ready-program/ev-stations-hawaii-mobile-app

EVs on the Move

EVs have a greater initial purchase price[58] than comparable gasoline-fueled vehicles. Most experts, including Hawaii's auto dealers, believe that widespread acceptance of EVs will grow as a full battery charge provides greater driving range and the cost of EVs more closely matches the cost of conventional internal combustion engine (ICE) vehicles.

Geothermal



Map of Geothermal Resource Areas (Source: GeothermEx, 2005)

Hawaii's single geothermal power plant, Ormat's Puna Geothermal Venture (PGV) facility located on the Island of Hawaii, produced 255 gigawatt-hours (GWh) in 2014 which was approximately 24% of the total electricity distributed on Hawaii Island in 2014[64]. The PGV facility, which began operating in 1993, produces both baseload and dispatched electricity.

In August 2014, the Hawaii Electric Light Company (HELCO) filed an updated Power Supply Improvement Plan with the Hawaii Public Utilities Commission (PUC) which specifies additional geothermal generation on the west side of the island by 2025 and no additional geothermal capacity on the east side of the island. Resulting from a request for proposals issued by HELCO in November 2012; in February 2015, HELCO announced it had selected Ormat to provide HELCO with 25 megawatts (MW) of new geothermal power on Hawaii Island. The next step in this process is for HELCO and Ormat to negotiate a contract for the sale of the new power to be generated. If an agreement is reached, it will be submitted to the PUC for review and approval. All other applicable facility permits and approvals would be required. The location of the proposed new facility is not yet publically available.

Current geothermal production Capacity in Hawaii	**38** MW	Contracted price for first 25 MW of electricity from PGV[66]	**18.8¢** on peak **15.9¢** off peak per kilowatt-hour (kWh)
Estimated probable reserves, Maui & Hawaii	**1,000** MW	Contracted price for next 5 MW	**11.8¢ / kWh**
Median levelized cost of geothermal energy, U.S.[67]	**6¢** per kWh	Contracted price for next 8 MW	**9¢ / kWh**

Continued geothermal exploration will contribute to better understanding of Hawaii's geothermal resources. Ormat is exploring on Maui, focusing on the southwest rift zone of Haleakala, with partial funding from the U.S. Department of Energy (USDOE). The University of Hawaii (UH) is also exploring rift zones on Hawaii Island using a non-invasive technique called magnetotellurics designed to detect subsurface electrical conductivity. The Hawaii Play Fairway Project, managed by UH and supported by USDOE, will compile and integrate all geothermal-relevant data across the state into a map showing the probability of encountering a resource in the subsurface. In essence, this will provide the first statewide geothermal resource assessment conducted since the late 1970s.

Geothermal resources are difficult to characterize without exploration and drilling since Hawaii's high-temperature resources are usually more than a mile beneath the surface. However, estimates from exploration efforts in the 1970s and '80s indicate that there may be more than 1,000 MW of geothermal reserves[65] (recoverable heat at drillable depths) on Maui and Hawaii islands, which would be sufficient to collectively power Maui, Hawaii Island, and about one quarter of Oahu or, alternatively, about 60% of Oahu's energy needs. Reaching that level of production would require interconnection of the islands' grids. Geothermal electricity is cheaper than that produced from petroleum fuels in Hawaii, and also generally cheaper than other forms of renewable electricity.

Hydropower

Hydroelectricity was the first renewable energy technology used to generate electricity in Hawaii; plants date back to 1888.[68] Early hydroelectric facilities were located in Honolulu and Hilo, and on the island of Kauai. During the sugar era, additional hydroelectric plants were installed to help power sugar operations.

The technology is fully commercial and reliable but is limited by fluctuating water levels in Hawaii's streams and irrigation ditches. Due to our geology, run-of-the-river and run-of-the-ditch systems, which have no dams, are used (also see pumped hydro storage in right column). Both small, home-scale plants and utility-scale facilities are in operation.

1.1-MW Waiau Hydro Power Plant on the Wailuku River, Hilo

Hawaii currently has about 31 megawatts (MW) of hydroelectricity capacity statewide, or about 1% of the state's total power capacity.[69] In 2014, hydropower accounted for approximately 3.7% of the renewable energy generated by the three Hawaiian Electric Industries utilities: HECO, MECO, and HELCO.[70]

Hydro is an important part of the energy portfolios on Kauai, where it represents 8% of the electricity sold in 2013, and on the island of Hawaii, where it generated 3% of the island's electrical sales in 2013.[71] Kauai Island Utility Cooperative (KUIC) continues to investigate new hydroelectric projects which, if successful, could provide more than 20% of the island's annual electricity requirements.[72]

Hawaii Hydropower Assessments

As part of the Oak Ridge National Laboratory's National New Stream Development project, approximately 145 MW of undeveloped hydroelectric potential have been identified in Hawaii. That potential comes from 47 hydro sites identified in reconnaissance and feasibility reports. Most of the potential sites are small run-of-the-river projects.[73] The U.S. Army Corps of Engineers (USACOE) also conducted a Hydroelectric Power Assessment for the State of Hawaii in 2011.[74] This feasibility study identifies, evaluates, and recommends solutions to address the potential hydroelectric power needs in the State of Hawaii. USACOE studied more than 160 hydro sites and ocean energy areas across Hawaii as part of this assessment.

Pumped storage hydro is a related technology. A non-hydro source of electricity (e.g., wind, solar, conventional generation) is used to pump water from one reservoir to a second, higher reservoir. The water stored in the upper reservoir can be released as needed, running through a turbine on the way back down and generating power. KIUC is investigating the possibility of financing and owning a 25 MW pumped storage hydro facility on Kauai using the Puu Lua Reservoir,[75] which was one of the four project sites of focus in the 2011 USACOE Hydropower Assessment.

Grand River Dam Authority (GRDA) Salina Pumped-Storage Project, Oklahoma

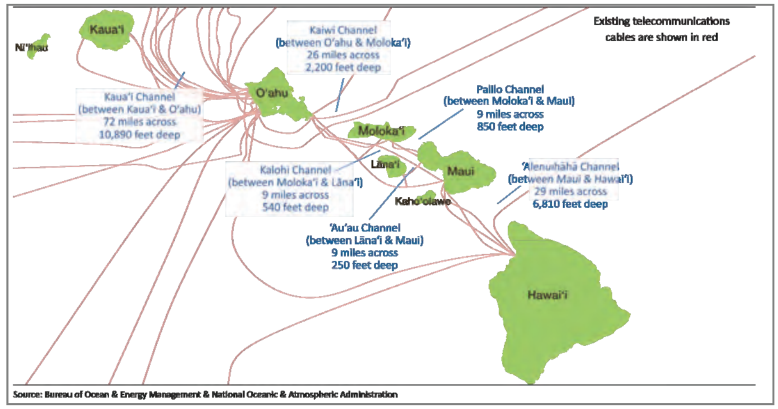
Another related technology is in-line hydro, which harvests energy within water pipelines. For instance, the Hawaii County Department of Water Supply (DWS) has three small in-line hydro power plants which each have capacities of 40 kW. These facilities capture the energy in pipes carrying water to DWS customers in West Hawaii.

Hawaii County Dept. of Water Supply's 45-kW in-line hydro plan in Kona

MW of hydroelectric capacity installed statewide	**31**[76]	Capacity of Wailuku River hydroelectric plant, the state's largest	**12.1**[77] MW
Year that Puueo hydro power plant, still in operation, began generating	**1910**[78]	Combined power Wailuku River, Waiau, and Puueo Hydro in 2013[79]	**16.45** MW

Oahu-Maui Grid Tie

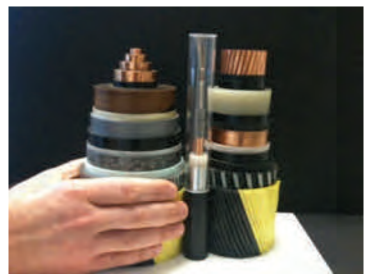
The Interisland Cable Grid-Tie Project (a.k.a., the Oahu-Maui Interisland Transmission System) is an investigation by the Hawaii Public Utilities Commission (PUC) into the viability of connecting the electricity grids of Maui and Oahu with a 200 MW High Voltage Direct Current (HVDC) cable. DBEDT is strongly in favor of the project due to the significant economic, environmental and community benefits that it will bring to Hawaii ratepayers. The Cable is a key enabler of achieving the state's Renewable Portfolio Standards (RPS).



Hawaii's islands are already connected by several telecommunications cables.

The type of system being proposed is a two-way "grid-tie" (not the one-way "gen-tie" transmission cable that was proposed earlier). This adds significant value to Hawaii's public and ratepayers because it will allow Oahu and Maui to coordinate operation of their respective electric grids, and provide flexibility to add significantly more clean, renewable energy generation in the most economical and equitable manner.

Eventually, the goal is to connect Maui to Hawaii Island to create an integrated system and take advantage of the Big Island's abundant renewable resources.



The 200 MW HVDC cable bundle is no more than 10 inches in diameter. The bundle shown in the picture is for transmission of 500 MW.

DBEDT estimates the overall savings on both islands at up to $423 million (2020-2050) before taking into consideration the environmental benefits. Taking into account the reduction of greenhouse gases and other emissions, the net benefit would rise to $551 million. These figures include fuels savings of approximately $1 billion. Other significant benefits include: [80]

Economic

- Lower and more uniform electricity prices for Maui and Oahu;
- Lower fuel costs and less exposure to price volatility;
- Increased capacity factors for wind generation;
- Greater utilization of lower cost generation resources;
- Reduced curtailment of intermittent renewable energy;
- Reduced environmental compliance costs; and
- Lower operating reserve requirements.

Environmental

- Lower nitrogen oxides (NOx), sulfur oxides (SOx), particulate matter (PM), and carbon dioxide (CO2) emissions;
- Higher penetration of renewable energy generation; and
- Increased flexibility in siting new renewable generation.

Public Policy

- Helps the State meet RPS requirements and the objectives of the Hawaii Clean Energy Initiative (HCEI), i.e., 40% renewable energy by 2030;
- Reduced dependence on fossil fuels; and
- A model for potentially connecting with Hawaii Island in the future.

There have been at least 22 similar projects globally, including the following noteworthy ones:

- Trans Bay Cable (California), 53 miles: 660 MW installed in 2010.
- Cross Sound Cable (New York - Connecticut), 24 miles: 330 MW installed in 2002.
- Neptune (New York-New Jersey), 50 miles: 660 MW installed in 2007.
- NorNed (Netherlands – Norway) (longest HVDC submarine cable), 360 miles: 700 MW installed in 2008.
- SAPEI (Italy) (deepest HVDC submarine cable, at 5,380 feet), 261 miles: 1000 MW installed in 2011.

Longest undersea power cable	360 miles	Deepest undersea power cable	5,380 feet
Highest capacity undersea HVDC system	2,000 MW	Estimated installed cost of Oahu to Maui grid tie[81]	$526 million
Year of installation, first HVDC undersea power cable	1954	Estimated net benefit of Oahu-Maui grid tie, (including social costs of carbon)[82]	$551 million
Expected undersea transmission cable life in years	30-50	2012 legislation: regulatory structure for inter-island power cables	Act 165

Ocean

Surrounded by the Pacific Ocean, Hawaii is rich in ocean renewable energy resources. Ocean energy includes both hydrokinetic and thermal resources.

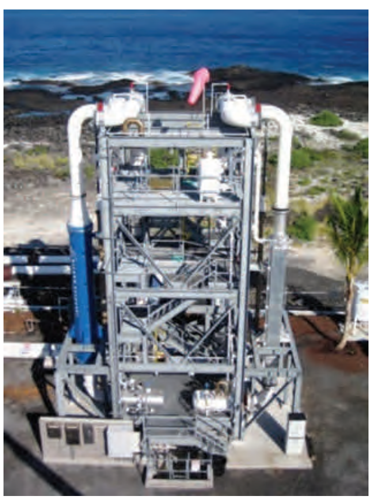
OPT's PB40 PowerBuoy in Kaneohe Bay, Oahu

Hydrokinetic technologies tap the movement in the ocean—waves, currents and tides—to generate electricity. Ocean Thermal Energy Conversion (OTEC) makes use of the temperature differences between warm surface waters and cold, deep ocean waters.

Hawaii has superior potential for wave energy and OTEC. However, ocean current and tidal resources are not as promising with presently-envisioned technologies in Hawaii. Ocean energy research, development and demonstration projects are taking place in Hawaii and elsewhere in the world.

The Hawaii National Marine Renewable Energy Center (HINMREC) at the University of Hawaii-Manoa is one of three federally-funded centers for marine energy research and development in the nation. HINMREC worked with the Department of Defense to establish a multiple-berth wave energy test center at Kaneohe Bay, Oahu. The first new tenant, NWEI, has been selected to occupy the existing 30-meter-deep berth. An Environmental Assessment, resulting in a Finding of No Significant Impact, was completed on two new berths, at 60 m and 80 m depths, in February 2014. Construction is anticipated to begin in 2014.

The first ocean wave-generated electricity ever transmitted to the grid in the USA was generated by an Ocean Power Technologies (OPT) PowerBuoy at Kaneohe Bay in 2010. In a cooperative program with the U.S. Navy, three OPT buoys were deployed from 2004 to 2011.



OTEC heat exchanger test facility at NELHA

The Natural Energy Laboratory of Hawaii Authority (NELHA) at Keahole Point, Kona, is among the world's premier OTEC research centers. Major milestones in OTEC were achieved at NELHA in the 1980s and '90s, including a 1-MW floating OTEC pilot plant, Mini-OTEC (the world's first demonstration of net power output from a closed-cycle plant) and other demonstrations in both open- and closed-cycle OTEC.

NELHA's cold seawater supply pipes are the deepest large-diameter pipelines in the world's oceans, extending to 2,000-foot depths. The laboratory's location, with access to both warm surface water and cold deep ocean water, makes it a prime site for OTEC R&D. Presently, Makai Ocean Engineering is operating a heat exchanger test facility at NELHA, testing components and materials. A 100-kW OTEC generator has been added to the test facility and is expected to be operational in 2015, after an interconnection study has been completed and permits obtained.

A one-megawatt OTEC demonstration facility at NELHA is in the planning stages and power plants up to 100 MW in capacity have been proposed for locations off Oahu.

Number of berths expected at Kaneohe wave test center	**3**	Projected Levelized Cost of Electricity (LCOE) for commercial ocean energy[83]	**23¢-25¢/kWh**
Energy potential of trade wind waves in Hawaiian waters[84]	**10-15** kW/meter	Temperature of cold, deep seawater at NELHA[85]	**6°C (43°F)**
Number of operating hours achieved by OPT PowerBuoy PB40 at Kaneohe Bay[86]	**>5,600** hours	Temperature range of warm surface seawater at NELHA[87]	**24° – 28.5°C (75° – 83°F)**

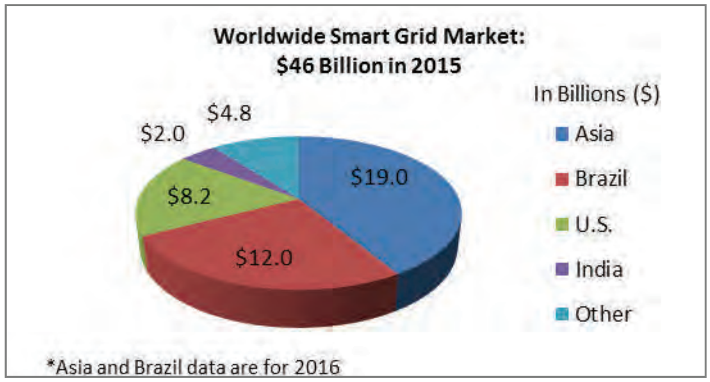
Smart Grid

What is Smart Grid?[88]

The electric "grid" is a network of transmission lines, substations, transformers and more that deliver electricity from power plants to homes and businesses. It's what electric lights and appliances are plugged into. A "smart grid" is one that has more automatic sensors, controls, energy storage, and intelligent systems to better manage the complexity of constantly fluctuating demand and production of electricity efficiently and cost-effectively. Some common "smart grid" components are:

- Smart ("Advanced") Meters
  - Provide timely and detailed energy use information for customers
  - Allow for time of use rates
- Sensors, controls, and forecasting
  - Monitor conditions in real time
  - Allow higher penetration of renewables
- Energy Storage (batteries, capacitors, flywheels, pumped hydro, hydrogen)
  - Allow for increased renewable energy penetration
  - Stabilize the grid by conditioning power and smoothing fluctuations
- Demand Response (managing electricity use in response to available supply)
- DOE gave $3.4 billion in grants for smart grid projects and grid upgrades in recent years[90]

Smart Grid Market is Large[89]



Potential Market in Hawaii

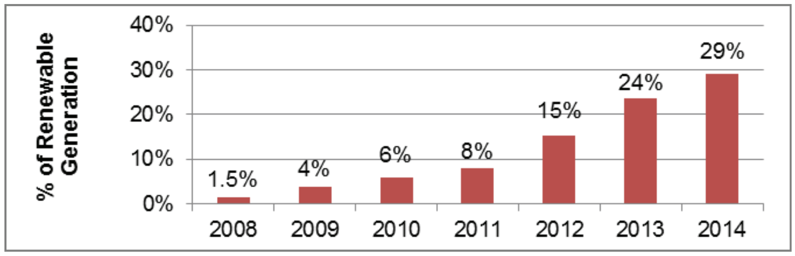
- Residential and commercial building energy management systems may become even more effective when connected to a utility-wide smart grid.
- Over 500,000 housing units and condos[91], and tens of thousands of commercial and government buildings statewide, can take advantage of smart grid technologies.
- Over $57 million has been invested in Smart Grid demonstration projects in Hawaii.[92]

Existing Smart Grid Projects in Hawaii

Name	Description	Key Companies	Location
HECO Smart Grid and Smart Meter Initial Phase	First phase for an island wide rollout of smart grid technology and smart meters, pending approval by the Public Utilities Commission. During the initial phase, about 5,200 smart meters will be installed in homes and businesses.[93]	HECO, Silver Spring Networks, Blue Planet Foundation, Hawaii Energy	Moanalua Valley, parts of Pearl City, Kaimuki, Kahala, Diamond Head and Waikiki, Oahu
DOE Renewable and Distributed Systems Integration (RDSI) Maui Smart Grid Demonstration Project	Develop a distribution management system that aggregates distributed generation, energy storage, and demand response technologies with $7 million in DOE funds and $8 million in industry funds.[94]	HNEI, HECO/MECO, General Electric, First Wind	Maui Meadows and Wailea, Maui
JUMPSmart Maui Project	Develop advanced technologies that automate EV charging and demand response to allow more renewable energy on the grid. NEDO will invest $37 million in the project.[95]	NEDO, Hitachi, Mizuho, Cyber-Defense, US DOE, NREL, HECO/MECO, HNEI, MEDB, Maui County & DBEDT	Kihei, Maui
KIUC Smart Grid Demonstration	Installation of advanced metering infrastructure (AMI) and other smart grid technologies for grid management and energy efficiency information. Total cost of around $11 million for 33,000 meters in five years.[96]	KIUC, USDOE	Kauai
Honeywell Fast Demand Response	Industrial and Commercial programs available for designating non-essential facilities that can be turned off during critical energy situations with ten minutes' notice or less.[97]	HECO, Honeywell	Oahu
Hawaiian Electric/ Stem 1 MW Distributed Storage	Stem will deploy behind-the-meter energy storage in a demonstration project with HECO to support grid response services. Stem's energy storage and data analytics predict and respond to spikes in customers' electricity demand. Installations are expected to be completed by March 2015.[98]	Stem, Hawaiian Electric, Hawaii Energy Excelerator	Oahu TBD. HECO and Stem will enlist commercial & industrial customers with rooftop PV.

Solar

Due to Hawaii's extremely high energy prices, superior solar resource and progressive energy policies, the state has experienced unprecedented growth in solar generation. Solar energy in 2014 provided 29 percent of Hawaii's renewable energy generation.

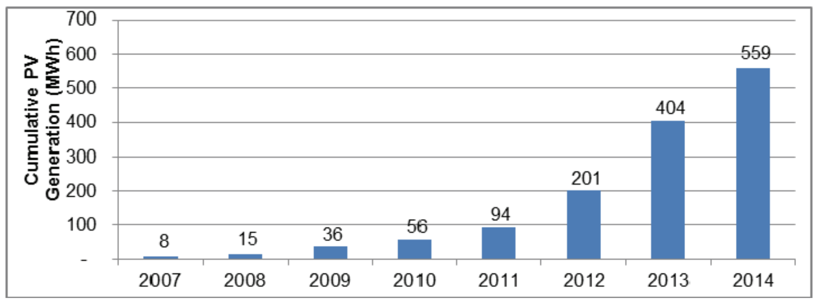


Solar Energy as a % of Total Renewable Generation in Hawaii 2014[99]

	Number of PV Systems	Capacity (MW)
HECO[100]	36,042	268.9
HELCO	7,745	54.7
MECO	7,387	56.9
KIUC[101]	1,875	12.3
TOTAL	**53,409**	**392.8**

Most photovoltaic systems are installed under the utilities' net metering program. Both residential and commercial entities participate in the program. There are approximately 51,534 photovoltaic systems currently installed, providing a capacity of 381 MW.

From 2007-2014, solar capacity nearly doubled annually. However since 2013, and due to new utility interconnection requirements, total solar generation growth has materially slowed down. The graph below shows growth Hawaii's total solar generation.



Total Photovoltaic (PV) Generation[102] *by Year (GWh)*

Hawaii's progressive energy polices supporting PV include:

- Net Energy Metering (NEM), which allows residential customers to receive full retail value for excess solar energy occasionally fed to the grid; and
- State tax incentives.

The integration of large amounts of solar generation has proven to be a challenge for the utility due to the rapid growth of the solar industry, the intermittent nature of solar power and the condition of Hawaii's islanded, centralized electric grid infrastructure. Potential solutions include advanced or "smart" inverter settings, battery storage and interconnecting the island grids. To this end, the Hawaii State Energy Office has provided input in various technical and regulatory investigative proceedings designed to clear the current backlog of PV systems awaiting interconnection by the HECO Companies as well as modernizing the electric utility system to allow for greater renewable penetration and transparency, network interoperability and distributed intelligence.[103]

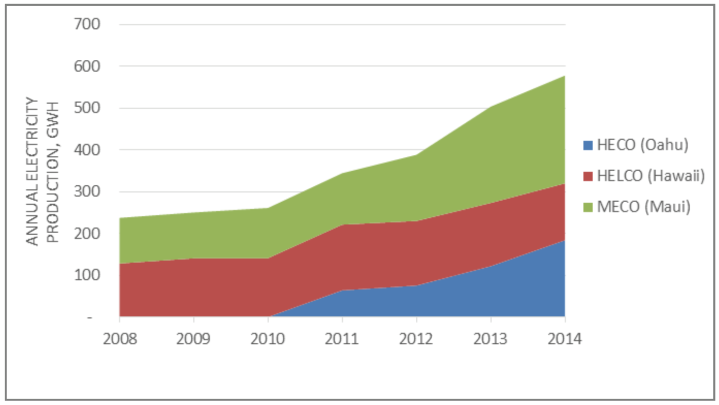
Existing Utility Scale Solar Projects

Project Name	Year Installed	Island	Developer	Capacity
La Ola Solar Farm	2006	Lanai	Castle & Cooke	1.1 MW
Kapolei Sustainable Energy Park	2011	Oahu	Forest City, Hoku	1.18 MW
Kapaa Solar Project	2011	Kauai	Kapaa Solar, KIUC	1.21 MW
Port Allen Solar Facility	2012	Kauai	A&B, McBryde, KIUC	6 MW
Kalaeloa Renewable Energy Park	2013	Oahu	Hanwha Solar Energy, Swinerton, Scatec, Hunt Dev	5 MW
Kalaeloa Solar Power II	2013	Oahu	SunPower, Dept. of Hawaiian Homelands	5 MW
MP2 Solar Project	2013	Kauai	REC Solar, KIUC	300 kW
Pearl Harbor Peninsula	2013	Oahu	Forest City, NAVFAC, HECO, HOKU	1.23 MW
Koloa Solar Farm	2014	Kauai	Solar City, KIUC	12 MW

Percentage of electricity generated by solar, 2014 statewide[104]	5.9%	Nationwide rank of cumulative installed PV capacity per capita, 2013[105]	3rd
Penetration of rooftop PV, residential[106]	~12%	Levelized cost of PV, Hawaii utility scale[107]	~13-15¢ / kWh
Power density of PV array[108]	11-19 watts per square foot	Watts per PV module (i.e. "panel")[109]	60 - 445 watts/panel
Installed cost, U.S., residential[110]	$3.29 / W	Installed cost, U.S., utility-scale[111]	$1.80 / W
Statewide 2014 construction expenditures attributed to solar[112]	7.4%	Acres per megawatt (Hawaii, utility-scale)[113]	3.3 – 7.2 acres/MW

Wind

- Wind energy is Hawaii's second most utilized renewable energy resource, accounting for about 30.2% of the state's total renewable energy generation in 2014.[114]
- Hawaii has one of the most robust and consistent wind regimes in the world, with capacity factors exceeding those commonly found elsewhere. In 2011, the capacity factor of the Pakini Nui wind farm on the Big Island was 65%; Kaheawa I on Maui was 47%; and the Hawi wind farm on the Big Island was 45%.[115]
- Existing projects in Hawaii are located on the islands of Oahu, Maui, and Hawaii.



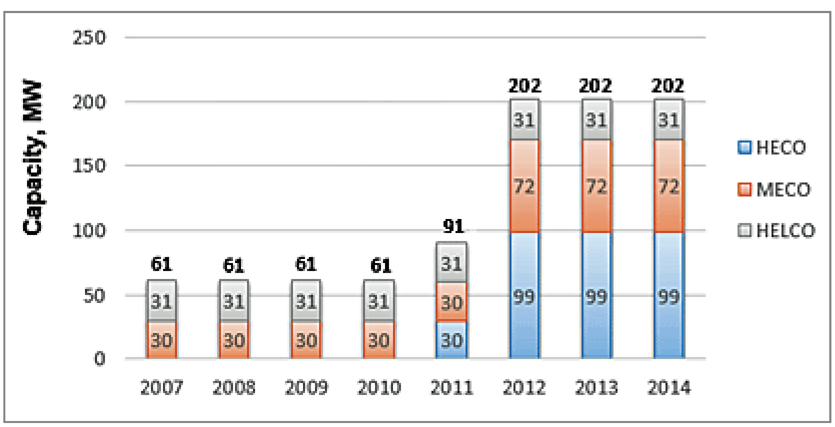
Electricity Produced from Wind Energy in Hawaii, by Island and Service Area[116]

Existing Utility Scale Projects

Project Name	Year Installed	Island	Developer	Capacity (MW)	Acres	Acres per MW
Hawi Renewable Development[117]	2006	Hawaii	Hawi Renewables	10.5	250	23.8
Kaheawa I Wind Farm[118]	2006	Maui	First Wind	30	200	6.7
Pakini Nui Wind Farm[119]	2007	Hawaii	Tawhiri Power	20.5	67	3.3
Kahuku Wind Farm[120]	2011	Oahu	First Wind	30	578	19.3
Kawailoa Wind Farm[121]	2012	Oahu	First Wind	69	650	9.4
Kaheawa II Wind Farm[122]	2012	Maui	First Wind	21	143	6.8
Auwahi Wind[123]	2012	Maui	Sempra Generation	21	68	3.2

Challenges Facing Wind Energy Development in Hawaii

- Endangered avian and plant species can complicate the siting and development of wind projects in Hawaii's unique environments. Proactive measures, such as the development of area-wide habitat conservation plans, could be helpful for species protection as well as easier project siting in the future.
- Given the height of wind turbines and limited sites suitable for wind development in Hawaii, visual impacts may be of concern; they should be identified early and addressed carefully, working with local communities.



Installed Wind Energy Production Capacity by Service Area[124]

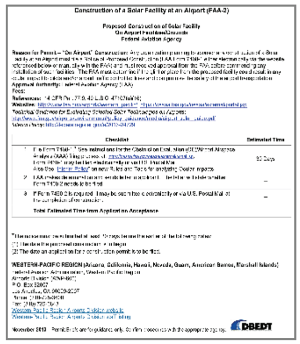
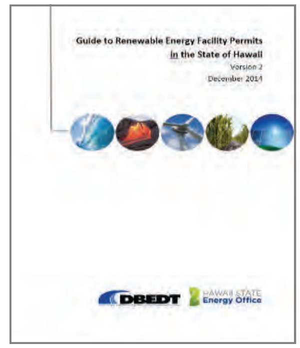
Current installed wind capacity in Hawaii[125]	**202** MW	Average land area used per MW of wind	**9.7** acres
Height of 2.3 MW wind turbine[126]	**456** ft.	Levelized cost of wind energy[127]	**7¢** per kWh

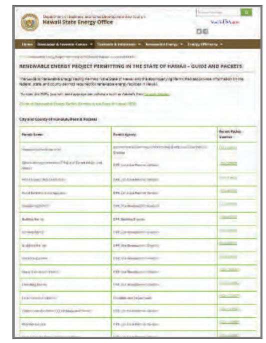
Permitting

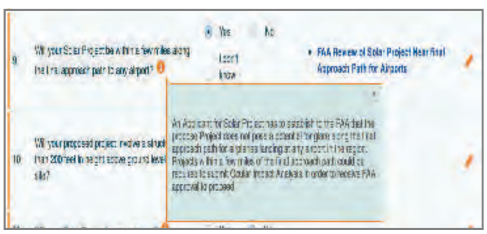
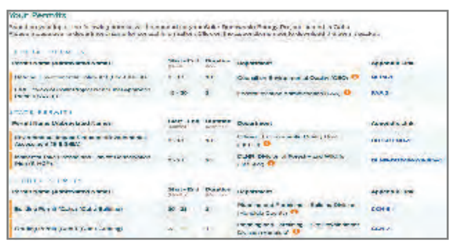
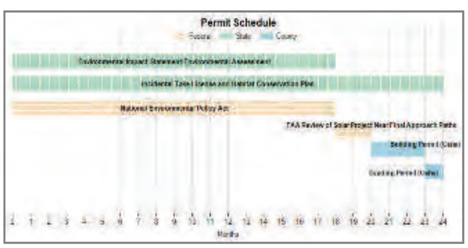
Permitting any large project in Hawaii, including a utility-scale renewable energy project, requires a thorough understanding of local processes, issues, and stakeholders. The tools described below provide information on these topics, as well as guidance to assist appropriate project siting and due diligence. These tools also seek to lower project "soft" costs by reducing the resources needed to undergo the permitting processes[128] without removing any of the environmental or community safeguard processes in place. Many local federal, state, and county agencies contributed to the development to these tools. Some of these tools were featured by the National Association of State Energy Officials (NASEO) as a best-practice other state energy offices could use to abate soft costs associated with renewable energy permitting processes.[129]

Developer & Investor Center, Self-Help Suite (Hawaii State Energy Office)

The Hawaii State Energy Office's interactive *Developer & Investor Center* and *Self-Help Suite* provide comprehensive information on the siting, permitting, and development of renewable energy facilities in Hawaii. Updates to these resources will be released in late 2015. (http://energy.hawaii.gov/developer-investor/project-permitting-assistance-and-resources)

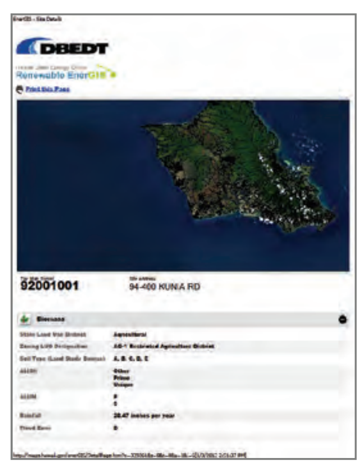





Renewable Energy Permitting Wizard (Hawaii State Energy Office)

The Wizard was developed to help those proposing renewable energy projects understand the county, state, and federal permits that may be required for their individual projects. Software upgrades and content updates to the Wizard were completed in October 2014, with additional content edits to be implemented by the Hawaii State Energy Office in 2015. (http://wizard.hawaiicleanenergyinitiative.org/)



Renewable EnerGIS Mapping Tool (Hawaii State Energy Office, Office of Planning)

Renewable EnerGIS provides renewable energy resource and site information for specific Hawaii locations selected by the user. EnerGIS helps stakeholders understand the renewable energy potential and permitting requirements for selected sites. Upgrades to EnerGIS are planned for release in 2016. (http://energy.hawaii.gov/resources/renewable-energis-map)

Permitting

Electronic permitting is another effective method of streamlining the permit review process without removing any of the environmental or community safeguards in place.[130] Some examples of state and county agencies utilizing electronic permitting include:

e-Permitting Portal (Hawaii Department of Health / DOH)

The DOH Environmental Health Administration (EHA) *e-Permitting Portal* provides access to environmental permit applications. *e-Permitting* allows for efficient and accurate electronic application compilation and submission, tracking, processing, management, and fee payment. (https://eha-cloud.doh.hawaii.gov/epermit/)

Online Building Permits (City and County of Honolulu/CCH)

CCH's Department of Planning and Permitting website provides for the electronic submission and processing of building permits required for residential solar heating, photovoltaic, and electric vehicle charger installations in the City and County of Honolulu. Building Permit status can also be monitored online. (http://dppweb.honolulu.gov/DPPWeb/Default.aspx?PossePresentation=OnlineBuildingPermit&PosseObjectDef=j_OnlineBP)

Electronic Plan Review and Building Permit Status (County of Kauai)

Kauai's Department of Public Works, Building Division, offers online tools to submit building permits electronically (Electronic Plan Review or "ePlan") and get information on Building Permit status, details, and other relevant information. (http://www.kauai.gov/Government/Departments/PublicWorks/BuildingDivision/ElectronicPlanReview/tabid/392/Default.aspx)

[UNDER DEVELOPMENT] Online Permitting (Department of Land and Natural Resources

DBEDT and DLNR are currently developing new online permitting tools for DLNR's Engineering Division and Division of Forestry and Wildlife. These tools are scheduled for public release in late 2015.

Facts about permitting renewable energy projects in Hawaii

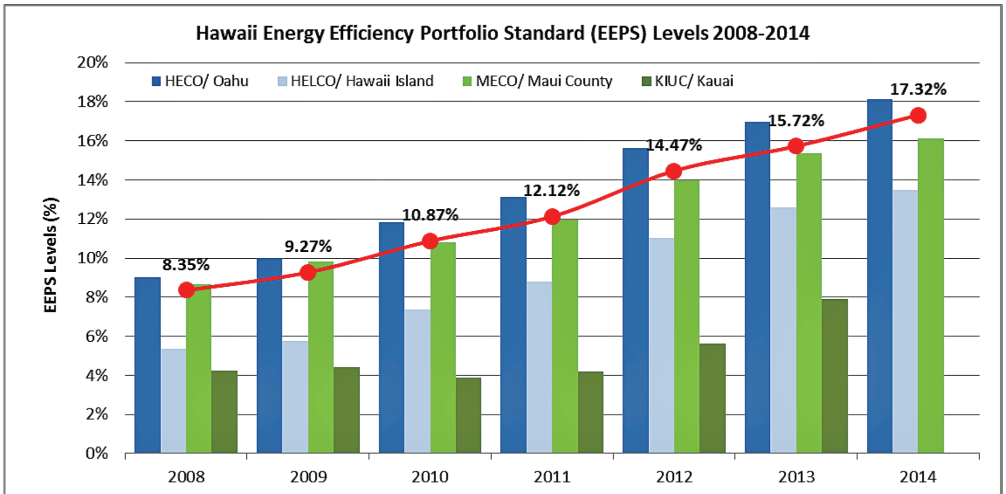
- Permitting costs in Hawaii can range from 1% to 20% of overall project construction costs.[131]
- Large energy projects in Hawaii average 15 federal, state, and county permits.
- It can take 1-5 years to permit a large renewable energy project in Hawaii.
- Hawaii's Energy Policy: Balance technical, economic, environmental, & cultural considerations.

Common solutions to renewable energy permitting issues in Hawaii

- Know the requirements and processes - retain professionals with experience in Hawaii.
- Meaningful community participation - engage public early in the project design process.
- Engage all stakeholders - identify and address all issues early in the process.
- Site projects appropriately - minimize environmental impacts, seek compatible areas.
- Be diligent - go slow in the beginning to go fast in the end.
- 1 submittal / 1 review - present agencies w/ well-planned projects, complete applications.
- Electronic permit processing - saves time, reduces back & forth, transparency, tracking.

Energy Efficiency Portfolio Standards

This graph shows Hawaii Energy Efficiency Portfolio Standard (EEPS) levels from 2008-2014. The EEPS requires that by 2030 annual energy savings amount to 30% of annual electricity sales statewide. Excluding KIUC, we are at 21.3% for the RPS (vs. 18% in 2013) and 17.3% for the EEPS (vs. 15.7% in 2013) for a total of 38.6% (vs. 33.7% in 2013). An Energy Efficiency Potential Study, initiated by the Public Utilities Commission, indicates that there is the potential of exceeding this goal by 50% by 2030.



Source: *Renewable Portfolio Standards Status Reports*, 2008-2014 (Hawaii Public Utilities Commission). KIUC not included in 2014 pending KIUC's Annual RPS Status Report year ending 2014.

A major contributor to EEPS is Hawaii Energy (HE), a ratepayer-funded energy conservation and efficiency program that serves all islands except Kauai, which is handled by Kauai Island Utility Cooperative. HE is administered by Leidos Engineering, LLC, under contract with the Hawaii Public Utilities Commission.

For HE's program year ending June 30, 2014, the program invested more than $32 million to deliver approximately 1.75 billion kilowatt hours (kWh) in lifetime system level energy savings at a cost of just 1.8 cents per kWh. The energy saved is enough to power 239,237 single-family homes for a year or half of all households in the state. It is also equivalent to eliminating 2.6 million barrels of oil from being imported to Hawaii and burned to generate electricity. HE delivered over $20.4 million in incentives driving customer energy bill savings of over $49.5 million for the first year and more than $517 million over the lifetime of the energy efficiency measures installed.

Energy Performance Contracting

Energy performance contracting (EPC) provides building owners with the opportunity to design, install, and maintain energy-efficient equipment without significant upfront cost. Costs are paid over time from the energy savings. DBEDT provides technical assistance on energy performance contracting to state and county agencies.

Twelve projects initiated since 1996:

- University of Hawaii at Hilo
- Hawaii Health Services Corporation
- Judiciary
- Department of Accounting and General Services Phase I
- Department of Accounting and General Services Phase II
- Department of Public Safety (4 prisons)
- Department of Transportation - Airports
- University of Hawaii Community Colleges
- Counties of Hawaii and Kauai; C&C of Honolulu

Preliminary data show:

- The projects include over 190 buildings and over 14 million square feet
- Annual cost savings for all projects is over $40 million, representing an average of nearly 45% savings
- Hawaii is ranked 1st in the nation per capita for energy performance contracting (Energy Services Coalition)

Over 20 years, the projects will:

- Save over $830 million in electricity costs
- Provided over $469 million of direct (total investment) and indirect (repair/maintenance/taxes) impacts to the economy
- Claim over $6 million in rebate incentives
- Created over 2,670 jobs due to contract investments

Energy Performance Contracting

Hawaii honored with national energy award for third consecutive year

For the third consecutive year, the State of Hawaii was nationally recognized and awarded the Energy Services Coalition's (ESC)* Race to the Top for leading the nation in per capita energy performance contracting for state and county buildings. Hawaii led the nation with $235.74 invested per capita; national average is $48.93 per capita. Hawaii was well ahead of second place Kentucky with EPC investment of $172.84 per capita and third place Delaware at $154.47 per capita.

The State Energy Office has been providing technical assistance for performance contracting to state agencies and counties since 1996. The EPC projects vary widely and include courthouses, community colleges, hospitals, prisons, and airports.

**ESC is a national nonprofit organization, composed of a network of experts from a wide range of organizations, working together at the state and local levels to increase energy efficiency and building upgrades through energy performance contracting.*

State and County Energy Performance Contracting Projects

Over $315 million in EPC contracts awarded in Hawaii since the program's inception has resulted in the creation of 2,670 jobs and an energy savings of over $830 million over the life of the contracts.

Energy savings for these projects over 20 years (over 1.9 billion kWh) is equivalent to powering an estimated total of 254,194 households for one year.

Agency	Year(s)	Contract Amount ($)	Estimated Savings Over Life of Contract ($)
UH-Hilo	1996	$6,402,695	$14,630,066
County of Hawaii	1997-2006	$2,215,546	$8,157,880
County of Kauai	1998-2006	$525,965	$1,205,990
C&C of Honolulu	2001-2005	$11,900,205	$36,066,761
HHSC	2001-2005	$22,542,969	$55,766,365
Judiciary	2003	$1,474,406	$9,785,036
DAGS Phase I	2009	$36,873,266	$72,580,767
PSD	2010	$25,511,264	$57,211,112
UHCC	2011	$32,802,838	$37,000,000
C&C Kailua WWTP	2013	$6,054,178	$13,693,910
DAGS Phase II	2013	$17,400,000	$28,000,000
DOT	2013	$151,366,855	$496,238,674
	Total	**$315,070,187**	**$830,336,561**

$150 Million Airports Energy Performance Contract
Largest Energy Performance Contract in the Nation

Hawaii is the first in the nation per capita investment for energy performance contracting.

As of December 2013, the Hawaii Department of Transportation Airports Division reports it has:

- Executed a $150 million agreement for energy performance contracting for 12 airports statewide
- Financed the project by selling $167.7 million of certificates in the municipal bond market
- Received an overwhelming response from market investors offering more than $1.1 billion in orders from local Hawaii and national investors

Using EPC, the state's 12 airports statewide will be updated with the latest in energy efficient and green technology. The project will result in the following:

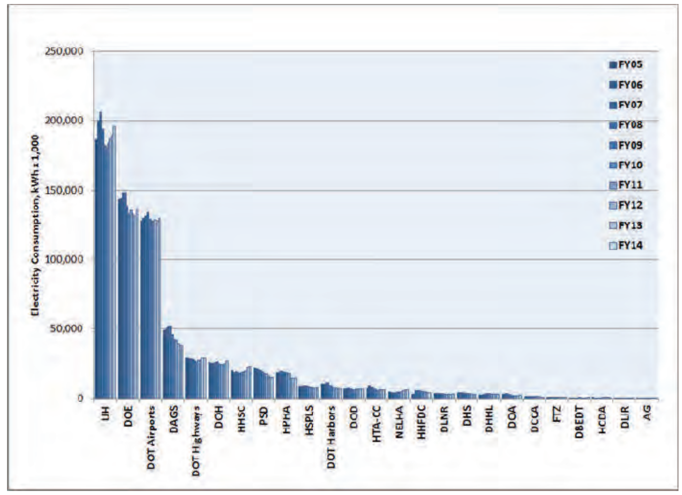
- Cut energy use by 49 percent
- Save at least $496 million in energy costs over the next 20 years

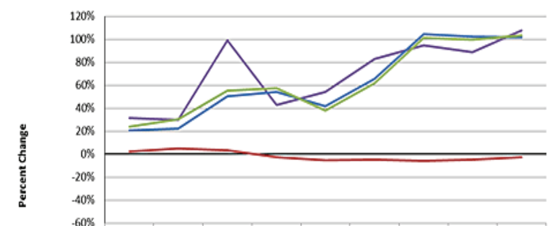
Improvements will include:

- Replacing 74,500 light fixtures and 372 transformers
- Installing 9,100 solar photovoltaic panels
- Upgrading and replacing chilled water and air conditioning systems
- Installing smart controls
- Addressing deferred maintenance such as roof repairs to accommodate the upgrades

State of Hawaii Agencies Lead By Example

During FY14 state agencies' energy consumption increased by 2.5% from FY13 levels and the state paid 2.0 % more than FY13. When comparing FY14 figures against the 2005 baseline year, energy consumption dropped 2.5%, but due to the increasing cost for electricity, costs rose 103.4%. Consumption (kWh) by agency by year is shown in the chart to the right.





	FY05-06	FY05-07	FY05-08	FY05-09	FY05-10	FY05-11	FY05-12	FY05-13	FY05-14
Price of Oil ($/bbl)	31.8%	30.0%	99.1%	43.0%	54.2%	83.1%	94.9%	89.1%	107.9%
Total State Avg Retail Price (All Sectors; $/KWH)	20.9%	22.1%	50.5%	54.5%	41.8%	65.5%	104.6%	102.5%	101.8%
Total SOH Building Electricity Cost ($)	23.7%	30.3%	55.4%	57.3%	38.2%	62.0%	101.3%	99.5%	103.4%
KWH	2.2%	4.9%	3.3%	-2.6%	-5.3%	-4.8%	-5.6%	-4.9%	-2.5%

Sources: NYMEX WTI Future Price; EIA-826 ; Utilty (HECO, MECO, HELCO, & KIUC) Billing data

The chart to the left shows the percentage of change from the baseline year (2005) each year since the Lead By Example program began. Shown are the price of oil, the average retail price of electricity (based on EIA-826 reporting, dividing utility total revenues by total kWh sold and including fuel adjustment cost), total State of Hawaii electricity costs and the State of Hawaii electricity consumption (kWh).

- State agencies have received more than $8.13 million in efficiency rebates since 1996 from the Hawaiian Electric Company (HECO) and its subsidiaries and from Hawaii Energy. These rebates combined have resulted in estimated cumulative dollar savings of over $150 million and electricity savings of 892 million kilowatt-hours. Over the life of the equipment, the savings will be equivalent to approximately 177,000 households' annual electricity use. In FY14 state agencies received $776,355 in rebates.
- Twenty-one (21) state buildings have received ENERGY STAR® awards, acknowledging that they rank in the top 25% of similar buildings nationwide. Agencies are reviewing buildings to recertify existing buildings and to identify new buildings for certification.

Power Purchase Agreements

- DOT-Airports signed a 20-year power purchase agreement in 2009 for a total of seven (7) photovoltaic systems totaling 901 kW of capacity.
- Through a second round of power purchase agreements in 2011, DOT-Airports awarded development of photovoltaic renewable energy generation systems at 15 sites. Seven (7) power purchase agreements have been signed for a total capacity of 606 kW. The remaining eight (8) are pending, but are planned for an additional 2.69 MW. In an earlier power purchase agreement, DOT-Airports installed nearly 1.4 MW of photovoltaic systems at seven airports and harbors facilities in the state. A total of nearly 5.2 MW of photovoltaics has been installed.

	Utility kWh	Hoku kWh	Total		Utility $	Hoku $	Total $
FY2008	25,593,580	0	25,593,580	FY2008	$7,757,716	$0	$7,757,716
FY2009	25,319,886	217,682	25,537,568	FY2009	$7,859,866	$74,722	$7,934,588
FY2010	25,183,956	1,345,475	26,529,431	FY2010	$6,656,506	$466,998	$7,123,504
FY2011	24,881,079	1,432,550	26,313,629	FY2011	$7,631,471	$504,653	$8,136,123
FY2012	24,520,683	1,397,630	25,918,313	FY2012	$8,836,160	$508,313	$9,344,473

- In January 2014, OpTerra Energy Solutions was awarded the Energy Efficiency and Sustainability Master Plan RFP. DOE is rebranding this program "Ka Hei." Under the Ka Hei Program, OpTerra will conduct whole school audits beginning 2015 to determine energy and water efficiencies for each DOE school. Based on these audits, DOE will determine the feasibility to fund these energy and water efficiency projects, either through the Ka Hei Program or using bond funds.
- State Building Code Update: The State Building Code Council voted on a proposed draft to update the International Energy Conservation Code of 2015; Administrative Rules must be prepared once the draft is approved.

Leadership in Energy and Environmental Design

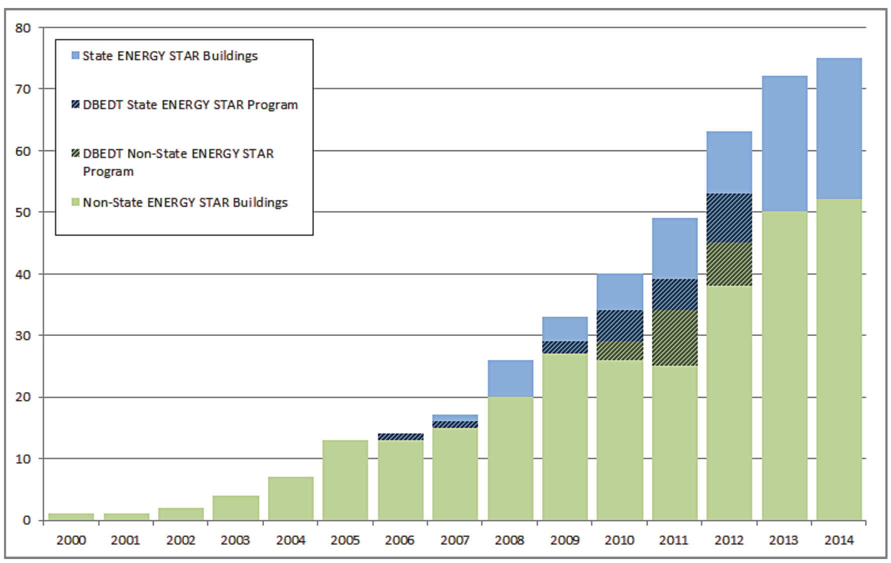
Leadership in Energy and Environmental Design (LEED)

The U.S. Green Building Council (USGBC) released its annual ranking of the Top 10 States for LEED, on which the State of Hawaii placed sixth. Last year, Hawaii placed ninth. The list highlights the regions around the country that are at the forefront of the movement for sustainable building design, construction and operation. Utilizing less energy and water, LEED-certified spaces save money for families, businesses and taxpayers; reduce carbon emissions; and contribute to a healthier environment for residents, workers and the larger community. The per-capita list is based on 2010 U.S. Census data and includes commercial and institutional green building projects that were certified throughout 2014. Hawaii certified 30 projects (public and private) in 2014 representing 2,657,808 square feet of real estate, or 1.95 square feet per resident. The certified buildings included numerous private developments, as well as some state and county buildings.

- Twenty-nine (29) State of Hawaii buildings are LEED certified or pending certification since 2006. An additional 43 LEED projects are in the process toward the goal of certification.
- Hawaii remains a member of the U.S. Green Buildings Council (USGBC), the non-profit entity which administers the LEED program. DAGS is developing LEED application guidelines to be used by state agencies.
- There are over 30 LEED Accredited Professionals on staff at six state agencies; DAGS, DBEDT, DOE, DOT, HPHA and UH. Currently additional state personnel are in training for this goal. The state requires all new construction and major renovation to meet LEED Silver standards, to the extent possible. DBEDT continues to offer LEED training opportunities for state agency staff. Six years ago, there was only one LEED Accredited Professional (AP) working for the state.

ENERGY STAR® Buildings

Agencies and private sector building owners and managers can benchmark buildings to compare energy usage with other buildings in their portfolio or similar buildings nationally to identify investment priorities. If a building's performance, as reflected in its ENERGY STAR score, ranks in the top 25% of all buildings of its type, it can be certified as an ENERGY STAR building. Since 2000, 75 Hawaii buildings have received the ENERGY STAR certification. They include 27 public and 48 private buildings. During this time, DBEDT has assisted with the benchmarking and certification of 36 public and private (buildings should be certified annually). The chart below shows the rapidly increasing number of ENERGY STAR certified buildings in the state.



Hawaii Green Business Program

The state's Hawaii Green Business Program assists and recognizes businesses that strive to operate in an environmentally, culturally and socially responsible manner. As a partnership between the state's Department of Health and the Department of Business, Economic Development and Tourism; the Board of Water Supply; and the Chamber of Commerce of Hawaii, the program recognizes businesses that are committed to going green by implementing energy and resource efficiency practices. Not only does energy efficiency keep utility costs down and create a more sustainable environment, the businesses are also collectively contributing to Hawaii's energy efficiency goal. From 2009-2013, the program has assisted and recognized over 80 business and government entities, from the hospitality, commercial office, retail, restaurant and food services sectors, resulting in the following savings:

- 12.7 million kWh of energy (equivalent to powering 1,720 homes for one year in Hawaii)
- 47.93 million gallons of water
- $3.313 million of energy cost

For more information on the Hawaii Green Business Program, visit energy.hawaii.gov/green-business-program

GreenSun Hawaii Loan Program

DBEDT is closing down the GreenSun Hawaii Loan Loss Reserve Program. Any future loan activity will be handled by the Green Energy Market Securitization (GEMS) Program. For more information on the GEMS Program, visit gems.hawaii.gov. Following is a summary of the GreenSun Hawaii Loan Loss Reserve Program and its accomplishments during its three years of operation.

Program Objectives

- A State of Hawaii credit enhancement program that was funded by a grant from the U.S. Department of Energy
- Provided local financial institutions with access to a loan loss reserve (LLR) which could cover up to 100% of actual losses
- Enabled participating lenders to:
  - Extend loan availability to a larger pool of borrowers
  - Offer more aggressive rates and terms than may otherwise be available without this credit enhancement
- Public-private partnership with the ability to leverage $4.25 million in federal funds into $85 million in energy efficiency and renewable energy equipment loans statewide

Program Purpose

Supported loans for all property owners

- Eligible Residential Loan Purposes:
  - ENERGY STAR refrigerators and air conditioners
  - Solar Thermal Hot Water System
  - Solar Electric (PV) System
  - Heat Pumps
  - Insulation installed with an ENERGY STAR air conditioner
- Eligible Non-Residential Loan Purposes:
  - Lighting Retrofits & Upgrades/Air Conditioning Retrofits & Upgrades
  - Solar Thermal Systems/Solar Electric (PV) Systems
  - Energy Efficiency Windows, Cool Roofs & all other installations eligible for Hawaii Energy/KIUC Rebates
  - Loan related fees
- Required energy efficiency improvements before renewable improvements were funded

GreenSun Hawaii Loan Program

Participants

- 12 participating Lenders statewide
- 42 authorized Contractors statewide

Impacts

GreenSun Hawaii was a public-private partnership that had the ability to leverage $4.25 million in federal funds into $85 million in energy efficiency and renewable energy equipment loans statewide

Impacts include:

- GreenSun Hawaii covered 194 low-interest loans amounting to over $4.7 million
- The estimated energy savings for these installations is 28.9 million kWh of electricity over the life of the installations which will save participants' in excess of $12.8 million over the life of the installations
- Annual CO_2 reduction of 2,171,627 lbs. (43.4 million lbs. over the life of the installations)

Energy savings over the life of the equipment is equivalent to powering 3,916 households

Endnotes/References and Links

[1] U.S. Energy Information Administration, http://www.eia.gov/electricity/data/state/annual_generation_state.xls. 2013 data will be available 11/14.

[2] DBEDT's Monthly Energy Trends, http://dbedt.hawaii.gov/economic/data_reports/energy-trends/

[3] http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_06_a. Table 5.6A Average Retail Price of Electricity to Ultimate Customers by End-use Sector—located at http://www.eia.gov/electricity/monthly/

[4] Source: 2008-2014 Annual RPS Reports to the Hawaii PUC. http://dms.puc.hawaii.gov/dms/. RPS Docket Number: 2007-0008. Due to the unavailability of information, the "Renewable Energy and Energy Efficiency Portfolio Standards chart excludes Kauai Island Utility Cooperative information.

[5] DBEDT's Monthly Energy Trends, http://dbedt.hawaii.gov/economic/data_reports/energy-trends/

[6] Volumes. Source: *Biofuels Study*; DBEDT; 2012. http://energy.hawaii.gov/wp-content/uploads/2011/10/BiofuelsStudy_Act203_Dec2012.pdf

[7] DBEDT's Monthly Energy Trends, http://dbedt.hawaii.gov/economic/data_reports/energy-trends-2/

[8] DBEDT's Monthly Energy Trends, http://dbedt.hawaii.gov/economic/data_reports/energy-trends-2/

[9] 1 barrel = 42 U.S. gallons.

[10] DBEDT's Monthly Energy Trends, http://dbedt.hawaii.gov/economic/data_reports/energy-trends-2/

[11] Electricity: http://www.eia.gov/state/rankings/#/series/31 (last accessed 4/14/15); natural gas: http://www.eia.gov/state/rankings/#/series/28 (last accessed 9/24/14)

[12] DBEDT's Monthly Energy Trends, http://dbedt.hawaii.gov/economic/data_reports/energy-trends-2/

[13] The State of Hawaii Data Book 2013 Tables 17.07 and 17.10 & Hawaiian Electric Industries 2013 Annual Report, "Generation Statistics".

[14] KUIK grid is separate from HECO's infrastructure.

[15] All-time system peak as reported 7/24/14 in Electric Light & Power/POWERGRID International, "Saft to supply energy storage system for Hawaii utility." http://www.elp.com/articles/2014/07/saft-to-supply-energy-storage-system-for-hawaii-utility.html.

[16] Hawaiian Electric Company, http:// www.heco.com/waiverprojects

[17] Hawaiian Electric Company, http://generationbidding.heco.com

[18] On 2/23/13, HELCO released an RFP for up to 50 MW of geothermal capacity on the Island of Hawaii. Concluding its analysis of the parties submitting application to this RFP, HELCO selected Ormat.

[19] The amount of electricity produced per year = facility capacity x 24 hours/day x 365 days/year x capacity factor.

[20] Residential electricity use, rates, and average bill obtained from DBEDT's *2012 and 2013 Data Book*, http://dbedt.hawaii.gov/economic/databook/db2013/ & http://dbedt.hawaii.gov/economic/databook/db2012/. (Table 17.10)

[21] The FIT queue was closed pursuant to Docket No. 2013-0194, Order No. 32499.

[22] HECO, http://www.heco.com/fit/

[23] The FIT queue joint plan was accepted by the PUC on December 5, 2014 under Docket No. 2013-0194, Order No. 32499.

[24] Database of State incentives for Renewable Energy, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=HI04R&re=0&ee=0

[25] Source: PUC Docket No: 2014-0192 filed by Hawaiian Electric Industries on 1/21/15, Page 1, first bullet point under "Summary of This Filing".

[26] The DER docket proceeding was formally initiated on March 31, 2015 in PUC Order No. 32737, and calls for the utilities and other docket interveners from government, industry and advocacy groups to develop joint recommendations to 1) revise interconnection rules to allow for new distributed functions and capabilities such as energy storage or other grid-supportive services, 2) transition the current net energy metering (NEM) program, if necessary, and 3) create new market choices for non-exporting and "smart" exporting distributed energy systems.

[27] Kauai Island Utility Cooperative (KIUC), http://kauai.coopwebbuilder.com/sites/kauai.coopwebbuilder.com/files/schedule_q_eff_092012.pdf

[28] http://kauai.coopwebbuilder.com/files/42_schedule_nem_effective_june_3_2011.pdf

[29] Hawaii Revised Statutes, Chapter 269-91.

[30] Source: 2007-2013 Annual RPS Reports to the Hawaii PUC. http://dms.puc.hawaii.gov/dms/. RPS Docket Number: 2007-0008. KIUC RSP data for 2014 was unavailable at the time of this publication.

[31] National Renewable Energy Laboratory, *Hawaii Clean Energy Initiative Scenario Analysis*, 2012; and DBEDT.

[32] Chapter 269-91 *et.seq*., Hawaii Revised Statutes. http://www.capitol.hawaii.gov/hrscurrent/Vol05_Ch0261-0319/HRS0269/HRS_0269-0091.htm

[33] National Renewable Energy Laboratory, http://en.openei.org/apps/TCDB/

[34] http://www.hawaiianelectric.com/heco/_hidden_Hidden/Community/Renewable-Energy?cpsextcurrchannel=1

[35] http://www.hawaiianelectric.com/heco/_hidden_Hidden/Community/Renewable-Energy?cpsextcurrchannel=1

[36] http://www.hawaiianelectric.com/heco/_hidden_Hidden/Community/Renewable-Energy?cpsextcurrchannel=1

[37] Naphtha data from facility-level data, USEPA (http://ghgdata.epa.gov/ghgp/main.do#/facility/) and USEIA (http://www.eia.gov/beta/api/qb.cfm?category=1017)

[38] Aside from the sited source for endnotes #37 and #38, the source for the remaining section under "Bioenergy facilities" section was obtained from https://energy.ehawaii.gov/epd/public/energy-projects-map.html.

[39] The Honolulu Program of Waste Energy Recovery (HPOWER) is the waste-to-energy facility of the City and County of Honolulu.

[40] http://www.opala.org/solid_waste/archive/How_our_City_manages_our_waste.html

[41] http://hightechmaui.com/maui-county-continues-to-lead-the-way-in-renewable-energy/

[42] DBEDT, *Biofuels Report to the Legislature in Response to Act 203*, 2012. http://energy.hawaii.gov/wp-content/uploads/2011/10/BiofuelsStudy_Act203_Dec2012.pdf

[43] DBEDT Research and Economic Analysis Division, *Monthly Energy Trend Highlights,* August 2014

[44] Hawaii Natural Energy Institute, Bioenergy Master Plan, 2010. http://energy.hawaii.gov/resources/hawaii-state-energy-office-publications

[45] Sugar industry rule of thumb, for combustion process without pre-drying of biomass (Hawaiian Commercial and Sugar, http://www.hcsugar.com/energy_and_the_environment.shtml).

[46] EPA Facility Level Information on Greenhouse Gases Tool, http://ghgdata.epa.gov/ghgp/main.do

[47] Hawaii Renewable Energy Projects Directory, Hawaii State Energy Office, https://energy.ehawaii.gov/epd/public/energy-projects-map.html

[48] With CO_2 from power plant. General Atomics, DARPA-funded Kauai algae facility, Congressional Briefings, Washington, D.C. (March 2012).

[49] Source: Monthly Energy Trend, READ, DBEDT: The Potential for biofuels production in Hawaii, DBEDT.

[50] Source: Monthly Energy Trend, READ, DBEDT: The Potential for biofuels production in Hawaii, DBEDT.

[51] Source: Monthly Energy Trend, READ, DBEDT: The Potential for biofuels production in Hawaii, DBEDT.

[52] Source: Monthly Energy Trend, READ, DBEDT: The Potential for biofuels production in Hawaii, DBEDT.

[53] State of Hawaii, *Driving EVs Forward: A Case Study of the Market Introduction and Deployment of the EV in Hawaii*, 2012. http://energy.hawaii.gov/wp-content/uploads/2011/10/ReportMauiElectricVehicleAlliance_12_20_12.pdf

[54] http://dbedt.hawaii.gov/economic/energy-trends-2/

[55] Level 2 charging is at 240 volts. All electric vehicles are equipped for this type of charging. A "charger" can have one or more ports. The number of "ports" determines how many vehicles each charger can service at a time. One "port" can service one vehicle.

[56] Level 3, also known as "fast charging," can provide an 80% charge for some vehicles in less than 30 minutes, depending on vehicle and charger specifications. Not all vehicles can use fast charging.

[58] Ranging from mid-$30,000 to $40,000.

[59] Fuel cost comparisons show approximate savings between internal combustion engine and electric vehicles. The example shows that fuel costs are lower for the Nissan Leaf than for a comparable gasoline fueled vehicle. Nissan Leaf: 24 kWh battery; 0.34 kWh per mile.

[60] Based on fuel prices, 45% highway, 55% city driving, and 12, 078 annual miles per year from Hawaii State Data Book. http://dbedt.hawaii.gov/economic/databook/

[61] The Hawaiian gazette., October 10, 1899, Page 4, Image 4 http://chroniclingamerica.loc.gov/lccn/sn83025121/1899-10-10/ed-1/seq-4/

[62] EIA https://www.yahoo.com/autos/s/california-washington-lead-other-states-electric-car-ownership-133329346.html

[63] Hawaii State Energy Office, Report to the Maui Electric Vehicle Alliance Driving EVs Forward: A Case Study of the Market Introduction and Deployment of the EV in Hawaii (PDF)

[64] 2014 Annual RPS Reports to the Hawaii PUC. RPS Docket Number: 2007-0008: http://dms.puc.hawaii.gov/dms/.

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[68] Myatt, Carl; *Hawaii, The Electric Century*; 1991

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[71] Source: 2007-2013 Annual RPS Reports to the Hawaii PUC. http://dms.puc.hawaii.gov/dms/. RPS Docket Number: 2007-0008

[72] Kauai Island Utility Cooperative 2013 RPS Report, RPS Docket Number: 2007-0008: http://dms.puc.hawaii.gov/dms/.

[73] http://nhaap.ornl.gov/nsd/

[74] http://energy.hawaii.gov/wp-content/uploads/2011/10/HydroelectricPowerAssess.pdf

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[76] Hawaii State Energy Office data.

[77] Hawaii Electric Light Company, Inc.; "2012 Electricity Production & Purchased Power Summary."

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[79] Hawaii Electric Light Company, Inc.; "2012 Electricity Production & Purchased Power Summary."

[80] For the range of estimated net benefits, i.e., savings, in Net Present Value terms please see DBEDT's *Initial Public Comments in Response to Hawaii Public Utilities Commission Order No. 31356*, Table 1, p 22; NextEra Hawaii LLC's *Initial Public Comments Regarding the Public Interest Benefits of an Oahu-Maui Interisland Transmission System*, Table 1.2, p 8; and the HECO *IRP Action Plan* (Docket No. 2012-0036) Table 108, 109 and 110.

[81] See DBEDT's *Initial Public Comments in Response to Hawaii Public Utilities Commission Order No. 31356* in PUC Docket No. 2013-0169.

[82] See DBEDT's *Initial Public Comments in Response to Hawaii Public Utilities Commission Order No. 31356* in PUC Docket No. 2013-0169.

[83] OpenEI Transparent Cost Database, last accessed Sept. 24, 2014, http://en.openei.org/apps/TCDB/. Based on Intergovernmental Panel on Climate Change (IPCC) Annex 3.

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[86] Data from Ocean Power Technologies, Inc.

[87] NELHA website, http://nelha.hawaii.gov/wp-content/uploads/2013/05/PIP-Aug-2013.pdf.

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[89] Worldwide Smart Grid Spending to Hit $46 Billion in 2015: http://www.treehugger.com/clean-technology/worldwide-smart-grid-spending-hit-464-billion.html

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92 Sum of stated investment in "Existing Smart Grid Projects in Hawaii"

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102 Source: 2007 -2013 Annual RPS, NEM Reports to the Hawaii PUC, http://puc.hawaii.gov/reports/energy-reports/ . DBEDT calculation: solar generation (MWh) divided by HECO net sales (MWh).

103 On April 28, 2014, the Hawaii Public Utilities Commission issued a series of decisions and orders calling for the HECO Companies to provide power supply and distribution resource plans, including resolution of PV interconnection delays. In particular, see decisions, orders, and participant responses in PUC Docket No. 2011-0206 (the "RSWG Docket"); Docket No. 2014-0192 ("the DER docket") and Docket No. 2014-0130 ("Rule 14H Docket"). http://dms.puc.hawaii.gov/dms/index.jsp.

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[131] *Renewable Energy Permitting Barriers in Hawaii: Experience from the Field*, National Renewable Energy Laboratory (March 2013). http://www.nrel.gov/docs/fy13osti/55630.pdf