Metrics for Measuring Progress under the Hawai‘i Clean Energy Initiative:

Hawai‘i Clean Energy Status Model 2013

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Task 4.2 Report 2: HCEI Metric Report

Prepared for the
Hawai‘i Energy Policy Forum

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Hawaii Clean Energy Status Model

2013

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Prepared by KEMA, Inc.

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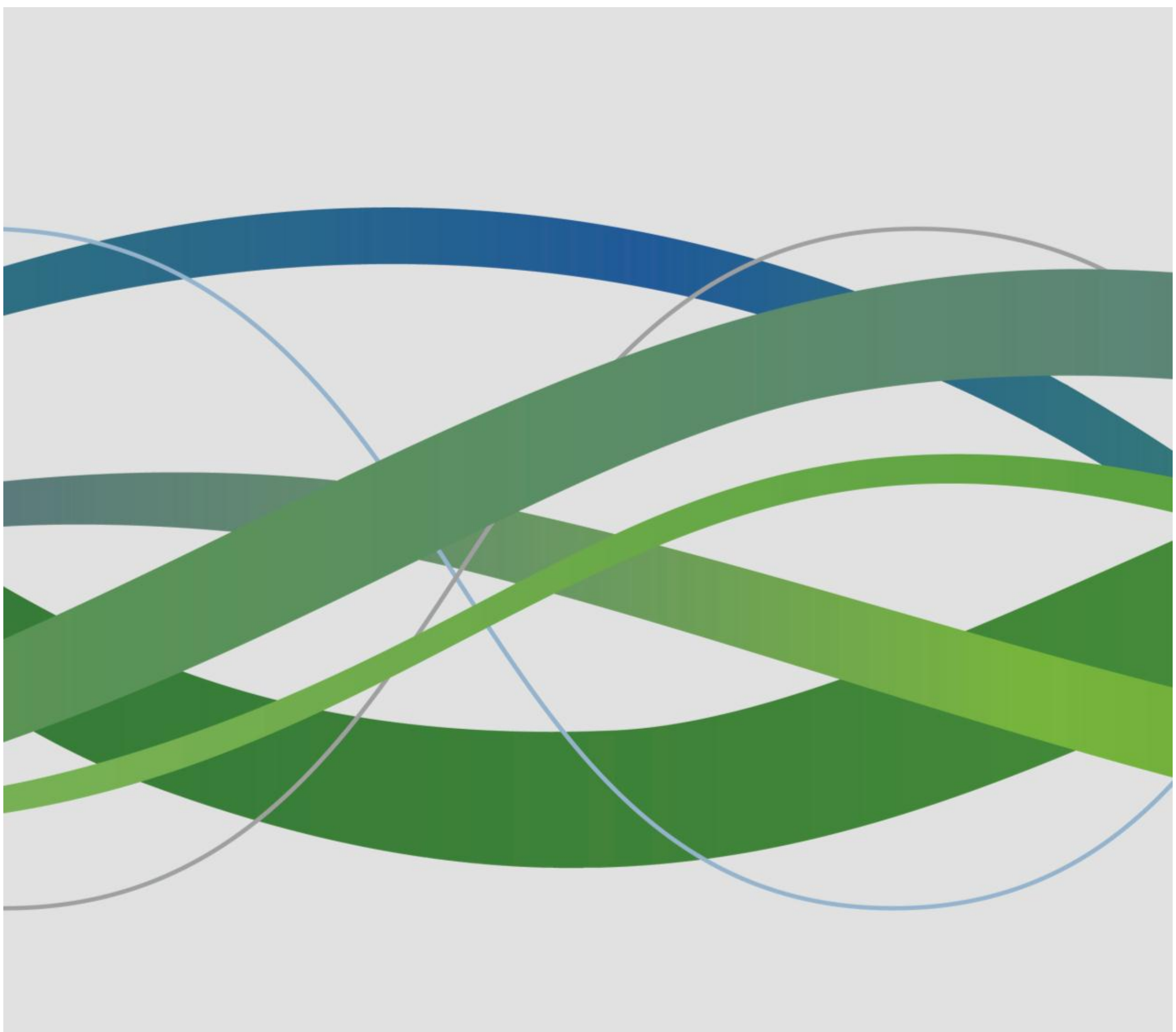

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1. Executive Summary

1.1 Overview

The Hawaii Energy Policy Forum (HEPF) is overseeing a multi-phase project to develop meaningful metrics and status reports to measure Hawaii's progress towards its clean energy goals. The initial phase of the process utilized a series of facilitated meetings from a broad spectrum of Hawaii stakeholders to identify what types of information should be measured to characterize Hawaii's progress. A second phase of the project defined seventeen metrics, grouped into four general categories: overall status/progress indicators; attainment of underlying objectives; status of attainment of state standards; and progress on projects and programs.

This report documents and presents the third phase of the project. This phase, undertaken by HEPF and DNV KEMA, includes: refinement of the metric definitions; collection, verification, and documentation of the detailed data necessary to calculate the metrics; identification of methods to maintain and update the data on an ongoing basis; and presentation of the metric values.

To facilitate on-going reporting an Excel model was developed to store data, and to calculate and track the status of each metric. The model provides the ability to update inputs and export outputs as needed. In addition, it includes functional graphics to assist with the portrayal of the metrics and underlying data for purposes of development and review. Subsequently, a separate phase of the HEPF project will focus on developing status reports and presentation graphics to communicate the metrics effectively.

The HEPF metrics attempt to be comprehensive. The key focus of this effort was identifying data sources, reviewing the available data and highlighting any gaps between the data required for the metrics and the data available. Any gaps or limitations of the available data are noted in this report along with recommendations for future research.

1.2 Organization of Report

This report is designed to describe the methodology used to build the energy status model, cite sources used, provide instructions to update the model, and capture a few preliminary findings. Section 2 discusses data used, and assumptions made throughout the model. It also discusses the life cycle analysis methodology developed to evaluate energy content and emissions for each fuel. Section 3 presents detailed calculations, data gaps, update instructions, and preliminary results. This report concludes, in Section 4, with overall comments and recommendations.

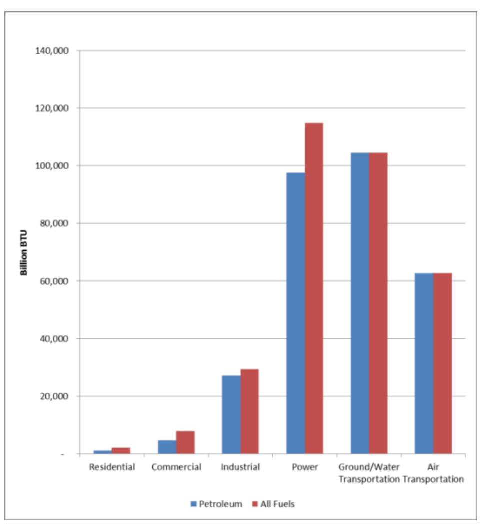
1.3 Key Findings

Central to this analysis was locating data that were rigorous, comprehensive, and specific to Hawaii. After conducting a thorough review of numerous public data sources and datasets, DNV KEMA selected datasets from the U.S. Energy Information Administration (EIA) and Hawaii's Department of Business, Economic Development, and Tourism (DBEDT). In addition, to meeting the criteria noted earlier, these data are publically available enabling HEPF to publicize and share findings from this report and model. While these datasets are respected throughout the industry, data discrepancies were discovered throughout the building of this model. These issues are detailed in Section 2 and Section 3.

The model for each metric was built to be easily updated. Input tabs and cells are color coded to clearly identify where new data should be pasted and cell formulae are written to automatically incorporate updated input data. In addition, each metric has an "Update" tab that includes links, instructions, and expected release date for all input datasets. This information is also included in Section 3 of this report.

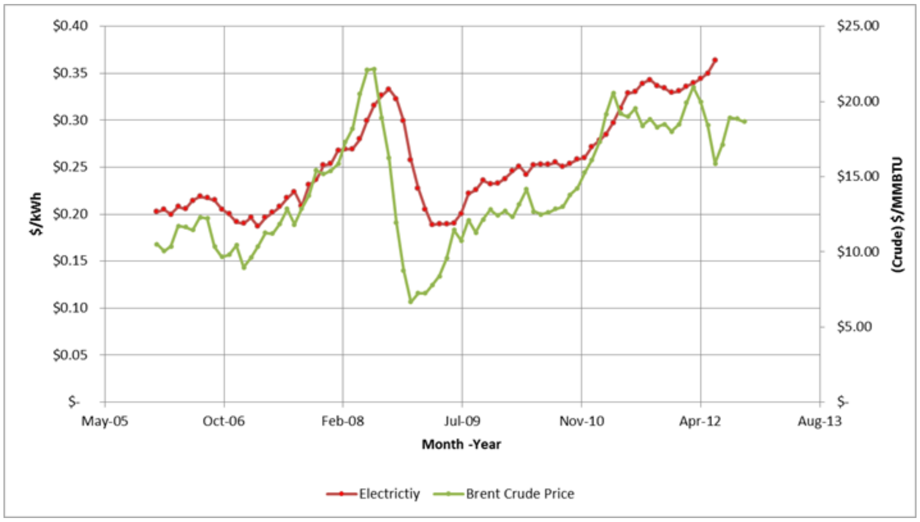
To demonstrate the content, scope and granularity of the model, a handful of example charts generated by the model for each of several metrics is presented here. Figure 1, below, is a representation of metric one: *Energy Content in Hawaii by Sector*. The model allows users to compare fuel consumption of each individual fuel type in a given year to total energy consumption in that year. In Figure 1, petroleum consumption is shown on the blues bars to the left and total energy consumption is represented by the red bars on the right. The model also provides a means to examine data for this metric using several other charts according to user-selected parameters. These include fuel type, end-use sector and denomination by population or economic indicators.

Figure 1: Life cycle energy content petroleum and total fuel consumption by sector



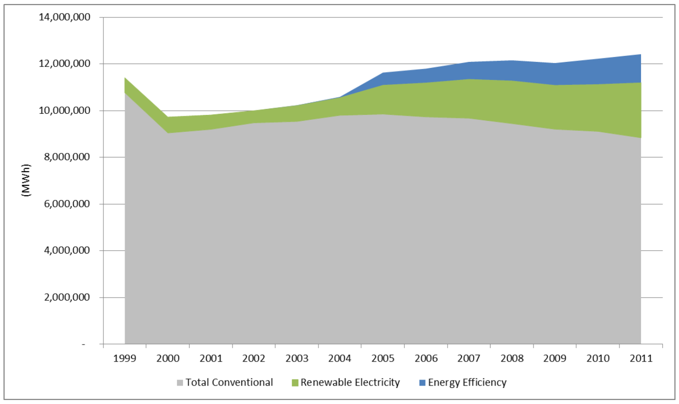
In Figure 2, a chart from metric five shows the price of electricity for the state relative to the price of crude oil from 2005 to 2010. Electricity price closely mirrors crude oil price. The model allows the user to chart similar data for each fuel type and includes calculation and charting of the correlation between the price of each fuel type and oil prices.

Figure 2: Electricity Price Compared to Crude Oil Price



Finally, Figure 3 shows Hawaii's progress toward Renewable Portfolio Standard (RPS) and Energy Efficiency Portfolio Standard (EEPS) goals as produced by metrics ten, eleven, and twelve. Two versions of RPS are calculated and displayed in the model representing two standards established by Hawaii statutes. The first standard includes both renewable generation and energy displacement technologies. Beginning January 1st, 2015, the State will no longer consider energy efficiency or displacement technologies, such as solar hot water heating, toward attainment of the standard. Therefore, this model provides both calculations for RPS. The figure below shows substantial progress being made toward RPS and EEPS goals.

Figure 3: Conventional Generation, Renewable Generation, and Energy Savings



1.4 Conclusion

UHERO and HEPF have compiled a robust and comprehensive set of metrics to analyze and understand Hawaii's past, present, and future energy portfolio. The tracking model was built to be periodically and methodically updated. Instructions to do so are included within the model as well as in this report. As a result of this work, Hawaii now has a centralized instrument to track its clean energy goals. It is expected that this model will serve as a tool to give policy makers, economists, industry experts, and the public insight into the status of Hawaii's energy portfolio and progress towards State energy goals.

2. Methodology

This section details the structure of the model, data used in the model, and the life cycle analysis methodology used in two of the metrics.

2.1 Model Structure

The spreadsheet model developed for this report is designed with four basic sections for each of the sixteen metrics: Interactive, Dashboard, Calculations, and Inputs. These are organized as groups of one or more page tabs for each metric. A user is able to use the Interactive tab to view summary tables, graphics, and when available, select from drop down menus or check boxes to explore the data. The Dashboard tab includes the tabular presentation of each metric, and each is organized and formatted for easy export. This enables HEPF to take data from the model and plug it into other tools, graphics, and reports. The Calculation tabs contain all necessary formulas and documentation and notation.

The model was designed to make updating as simple and fast as possible. Input tabs throughout the model are colored in red. Within the tabs, old data are orange and cell blocks where updated data are expected to be placed are colored green. Additionally, a documentation file includes links, cell references, expected release dates of new data, and instructions on updates. A ZIP file titled “Input Files.zip” includes all inputs files used to create this version of the model.

The model utilizes the detailed calculations provided by UHERO in a report prepared for HEPF wherever possible. In an effort to maintain consistency, DNV KEMA makes every attempt to use the same variable names and sources that were established in developing the metrics. Due to the realities of data collection, however, translating formulas into a functioning model was a dynamic exercise. In some cases, calculations and data sources were altered slightly to best capture each metric’s intent. All data issues and formula modifications are detailed throughout the model as well as in this report.

2.2 Data Sources

Petroleum, Synthetic Natural Gas, Coal, and Electricity

As petroleum-based products dominate Hawaii’s energy mix, the accuracy and usefulness of these calculations depended heavily on a robust petroleum dataset (EIA SEDS 2013). In developing this model, DNV KEMA explored many avenues to aggregate the most detailed and accurate data available. As was recommended by UHERO/HEPF in defining the metrics, EIA was found to have the most comprehensive and widely accepted public source of data.

SEDS, EIA’s state-level database, provides consumption data for all conventional fuels from 1960 through 2010 for the State of Hawaii. The root EIA webpage contains import data for the major fuels entering Hawaii from foreign sources.

One of the biggest challenges throughout the development of the model was finding detailed data on the quantity and origin of domestically sourced petroleum products. These data are not provided in the SECS/EIA database. Conversations with DBEDT, EIA, NETL, and others, revealed that such data are currently confidential and unavailable to the public. DNV KEMA found that foreign petroleum import data and total state consumption figures are available in granular detail from EIA (EIA SEDS 2013). Using form EIA-814, EIA collects monthly foreign imports of crude oil and petroleum products from US importers (EIA 2013). Consumption figures are built on a large body of survey data and assumptions (EIA SEDS 2012).To infer domestically sourced petroleum (which is not available publicly)foreign imports were netted out of total consumption.

Reliable, directly reported data regarding domestic-sourced petroleum is valuable in two important ways. First, using direct instead of calculated numbers allows for a comparison of total imports to EIA's estimates for total consumption. This removes the need to rely on the assumptions employed in EIA's consumption data and thereby increases the accuracy of the estimate. Second, the energy and carbon content for the entire life cycle of the fuel are different between the various countries where oil is extracted and refined. The model differentiates between fuels sourced from different countries in determining total energy and carbon content of fuel imports to the State. Since the model can only calculate domestically sourced petroleum by indirect derivation from total consumption, tracing the upstream life cycle contributions of these fuels is not possible in granular detail. Therefore, the model assumes that domestically-sourced fuel is extracted from the United States and is assigned an averaged baseline coefficient to determine life cycle embedded upstream energy and carbon contents. Sources and assumptions for the life cycle analysis portion of the model are detailed later in this section.

Biofuels

At the time of this writing, regularly reported public data that track the origin of ethanol or biodiesel in the State of Hawaii have not been identified. In addition, currently available reported data for the biodiesel dataset are not differentiated by the sector where the fuel was consumed. For Ethanol, data were taken from EIA consumption data, using the same approach as conventional fuels. Since most ethanol is delivered as a 10% additive to motor gasoline, EIA provides gasoline consumption with and without ethanol (EIA SEDS 2012). Biodiesel data are not provided by EIA, but were taken from DBEDT's monthly energy trends report.

In anticipation of the future availability of more detailed biofuels data, DNV KEMA has included functionality in the model to estimate biodiesel that is acquired locally, purchased from foreign sources, and purchased from domestic sources. Each source has a unique life cycle coefficient to better estimate total life cycle emissions and energy content. Additionally, the model has a factor that can break out total biodiesel consumed between ground and water transportation and power sectors when supporting data become available.

Renewable Generation and Energy Efficiency

The three companies operated by HECO, including HECO, HELCO, and MECO, produce an annual report to the PUC that details their renewable generation, energy efficiency savings, and other energy displacement. From 1999-2004, the report only provides total renewable generation data. Starting in 2005, it details the site of generation and also provides savings due to displacement technologies. A separate filing from KIUC provides these data for Kauai.

One issue for reporting concerns how to categorize customer-side generation. Starting in 2015, displacement technologies, except customer-side generation, will no longer count toward RPS goals. To account for this the model calculates both the pre-2015 and the post-2015 definitions of RPS. For example, in the post-2015 version, customer-side generation is classified as a component of the RPS and is not counted towards the EEPS to avoid double counting.

Life Cycle Analysis

The first and third metrics quantify the additional emissions and energy content of each fuel's complete life cycle. From our research of life cycle analysis for fossil based fuels, we found NETL, EPA, and UHERO have the most comprehensive and detailed analyses on this subject. Based on the data collected from NETL, Table 1 shows the stages where source data could fully or partially apply to Hawaiian conditions (represented in green) and stages where further research is needed to accurately characterize Hawaiian specific emissions (represented by blue cells).

Table 1: LCA Calculation Gaps

	Raw Material Acquisition	Raw Material Transport	Refining / Production	Final Transport	End Use
Petroleum					
Coal					
Natural Gas					
Biofuels					

= Hawaii Specific = Some Data Hawaii Specific = Non-Hawaii Specific

Table 2 and Table 3 provide emission factors for each state in the life cycle for each fuel. NETL reports were particularly useful since their analysis included LCA data for a variety of countries. Given the access to country specific fuel imports provided by EIA, our analysis was able to use a handful of country specific emission factors. This approach ensured increased the rigor of upstream emission estimates. These are all listed with further detail in the "Metric 1,3.xlsx" file.

All of the LCA carbon factors used in the model and reported in the tables below are greenhouse gas emissions carbon dioxide equivalents (CO2e). CO2e includes upstream contributions from methane, nitrogen compounds and other greenhouse gases.

Table 2: LCA Emissions by Fuel Source

Fuel	Unit	Total WTT (Well to Tank)			
		Stage 1: Raw Material Acquisition / Extraction	Stage 2: Raw Material Transport	Stage 3: Refueling / Liquid Fuels Production	Stage 4: Product transport and Refueseuling / Finished fuel transport
Coal	kgCO2e/MMBTU	11	1.3		
Petroleum	kgCO2e/MMBTU	6.9	1.3	8.4	1.0
Diesel	kgCO2e/MMBTU	6.6	1.3	9.5	0.9
Gasoline	kgCO2e/MMBTU	7.3	1.4	9.8	1.1
Jet Fuel	kgCO2e/MMBTU	6.8	1.3	6	1
Natural Gas, Ave Gas	kgCO2e/MMBTU	10	2.9		

Table 3: LCA Emissions by Biofuel Type

Fuel	Unit**	Total WTT (Well to Tank)			
		Stage 1: Feedstock Production	Stage 2: Feedstock Logistics	Stage 3: Conversion	Stage 4: Distribution
Crude Palm Oil (Malaysia	kgCO2e/MMBTU	8.5	16.5	11.0	1.1
Oil Palm - Biofuel (Malaysia)	kgCO2e/MMBTU	8.5	15.5	11.0	2.2
Soyben (US)	kgCO2e/MMBTU	65.2	-19.4*	6.2	3.9
Soybean (Exclude Soy, US)	kgCO2e/MMBTU	65.2	7.4	6.2	3.9
Oil Palm (Local)	kgCO2e/MMBTU	8.5	15.5	11.0	0.1
Jatropha (Local)	kgCO2e/MMBTU	4.6	8.0	6.2	0.1
* Negative value indicates credits given due to utilization of soybean by-products					
** Units Converted from CO2e/MJ to kgCO2e/MMBTU using factor of (0.000948 x 1000)^-1					

3. Metrics

This section discusses calculations, data issues, update procedures, and preliminary results for each metric in the model. All metrics are designed with a similar structure, including an interactive tab, a dashboard tab, calculation tabs, data input tabs, and assumption tabs. The first three metrics paint a big picture, detailing fuel use, statewide expenditure, and carbon content. These metrics report energy and carbon content both including and excluding the upstream life cycle stages. Metrics four through eight report on price and cost level data. These metrics quantify Hawaii's dependency on petroleum, review clean energy jobs data, and asses the pricing volatility inherent in the state's portfolio. Metrics nine through seventeen summarize renewable energy and energy efficiency activity throughout the state. They compile existing renewable generation, track progress toward state goals, and reveal annual trends in carbon emissions. The model was designed to easily incorporate annual data updates.

3.1 Metric 1: Fossil and Energy Content of Hawaii fuel use (BTU) per capita

Overview

Metric one calculates Hawaii energy consumption. In this metric, energy consumption is defined as the fuel used directly by each sector (residential, commercial, industrial, ground transportation, air transportation, and power). The model displays total energy consumption, energy consumption per GSP, and energy consumption per Hawaii's de facto population. In addition to the energy consumed throughout the state, the metric calculates energy embedded in the upstream life cycle stages for each fuel. Table 4 details the calculations as they appear in the model.

Table 4: Calculations in Metric 1

Calculation	Title	Notes
$\frac{LFE_{(c,s,y)}}{PO_{(y)}}$	Life Cycle Fossil Fuel Energy Content per Person [Billion BTU/Person]	$\boldsymbol{LFE}_{(c,s,y)}$ = Hawaii Fossil Energy Content (Calculation) [Billion BTU] $\boldsymbol{PO}_{(y)}$= Hawaii population by year (Census) [Population]
$\frac{LFE_{(c,s,y)}}{GSP_{(y)}}$	Life Cycle Fossil Fuel Energy Content per Hawaii GSP [Billion BTU/$]	$\boldsymbol{LFE}_{(c,s,y)}$ = Hawaii Aggregate Fossil Energy Content (Calculation) [Billion BTU] $\boldsymbol{GDP}_{(y)}$= Hawaii GSP by year (Census) [$]
$LFE_{(c,s,y)} = EC_{(c,s,y)} \times LCEF_{(c,y)}$	Life Cycle Fossil Fuel Energy Content [Billion BTU]	$\boldsymbol{EC}_{(c,s,y)}$ = Energy consumption by energy source, sector, and year (EIA) [Billion BTU] $\boldsymbol{LCEF}_{(c,y)}$ = Life emissions factor by energy source and year (Calculation) [%]
$LCEF_{c,y} = 100\% + UEF_{c,y}$	Life Cycle Emissions Factor [%]	$\boldsymbol{UEF}_{c,y}$ = Calculation [%]
$UEF_{(c,y)} = \frac{UEC_{(c,y)}}{I_{(c,y)}}$	Upstream Energy Factor [%]	$\boldsymbol{UEC}_{(y,f)}$ = Upstream Energy Content by energy source and year (Calculation) [MMBTU] $\boldsymbol{I}_{(c,y)}$ = Imports by energy source and year (EIA) [MMBTU]

$UEC_{(c,y)} = \frac{UE_{(c,y)}}{CCEF_{(c)}}$	Upstream Energy Content [MMBTU]	$UE_{(MMBTU,c,y)}$ = Upstream Emissions by energy source and year (Calculation) [$kgCO_{2e}$] $CCEF_{(c)}$= Carbon Content Emissions Factor by energy source (EPA) [$kgCO_2$/MMBTU]
$UE_{(c,y)} = \sum_{o \in Origin} I_{(c,o,y)} \times UMF_{(c,o,y)}$	Upstream Emissions [$kgCO_{2e}$]	$I_{(c,o,y)}$ = Imports by energy source, origin country, and year (EIA) [MMBTU] $UMF_{(c,y)}$ = Upstream Emissions Factor by energy source, origin country, and year (NETL and UHERO) [$kgCO_{2e}$/MMBTU]

Issues and Data Gaps

All fossil fuel and ethanol import and consumption data come from EIA. Biodiesel consumption data are provided by DBEDT. For each fuel, foreign imports were assigned a life cycle coefficient and, where possible, a domestic coefficient was also assigned. Coefficients are taken from a series of the most recent NETL life cycle analysis reports. While foreign import figures were publically available, domestically purchased fuel figures were not. Using consumption as the base, we netted out foreign imports to infer domestic purchases.

At the present time, there are gaps in biofuel data, most of which impact this metric. EIA only considers ethanol energy content in its motor gasoline consumption (EIA SEDS 2012). If ethanol is used for any other purpose, or if E85 stations are installed, these assumptions should be reviewed and changed. Biodiesel data are sourced from DBEDT, whose earliest figures for biodiesel appear in the end of 2010. As new data become available, the model will be more useful in tracking the effects of biodiesel. Yet none of the sources currently detail the origin of purchased biodiesel. The impacts that the origin of biodiesel has on the life cycle calculation could be substantial. The life cycle coefficient for biodiesel that is derived from reused cooking oil would be smaller than biodiesel sourced from dedicated crops and shipped for fuel use. For now, the model provides a set of factors as inputs that can be used to account for biofuel origin when this information becomes available. Currently, all origins have the same life cycle coefficient, which was taken from a potential study published by UHERO in 2012 called “Life cycle Analysis of Biofuels Implementation in Hawaii”. This is designed to be easily updated when additional data are available.

Finally, we recommend an improvement in the “Carbon Content Emissions Factor” (CCEF) variable. This is an input that converts upstream emissions, in $kgCO_{2e}$ to an equivalent MMBTU. However, this variable is in $kgCO_2$, rather than $kgCO_{2e}$. This will cause a slight overestimate in upstream energy content. A resolution would be to find an average $kgCO_{2e}$/MMBTU factor in the next iteration of this model.

Update Procedures

The datasets necessary to update metric one are listed in Table 5. When updating, it is important to verify that columns and rows are pasted exactly as they are in the current version of the model since formulae are written to automatically incorporate the new data. If additional columns or rows have been added to the source files, they should be moved to the bottom or far right of the existing cell block. Metrics one and three draw from the same input data, so once these updates have been made for metric one, metric three will also be using the most recent data. It is estimated that each dataset will take about twenty-five minutes to find, download, and input into the model.

Table 5: Data Sources and Notes for Metric 1

Tab	Date of Release	Source	Notes	Freq
Imports_Petrol	25th of each month	http://www.eia.gov/petroleum/imports/companylevel/archive/	Check that columns are the same	M
DBEDT	7th of each month	http://hawaii.gov/dbedt/info/economic/data_reports/energy-trends	Look for "Monthly Energy Trends" link. Biodiesel is presented by DEBDT on a monthly basis. EIA will begin to report on biodiesel in 2011. Check that rows are the same	M
EIA Consum	June 28th	http://www.eia.gov/state/seds/seds-states.cfm?q_state_a=HI&q_state=Hawaii#undefined	Click on "Consumption" heating. Download "All Consumption Estimates" CSV for Hawaii only. This is in the right column of links. Check that rows are the same	A
GSP Deflator	End of November	http://www.ers.usda.gov/datafiles/International_Macroeconomic_Data/Historical_Data_Files/HistoricalGDPDeflatorValues.xls		A
GSP	June 5th	http://www.bea.gov/	Go to the "Interactive Data" tab, Select GDP & Personal Income under Regional Economic Data heading. Expand Gross Domestic Product By State, and click "Gross Domestic Product". Use NAICS from 1997 forward. Do not update row 4 - it is only for 1963-1994;	A

Population	Unknown	http://www.quandl.com/UHERO-University-of-Hawaii/40_Y-Population-Hawaii-Statewide-annual	Make sure to get De Facto Population. Click on De Facto Population, then click download. You must create a free account and be logged in to download. Make sure columns are in the same order	A
LCEFbyFuelType	Unknown	http://www.netl.doe.gov/energy-analyses/pubs/NETL%20LCA%20Petroleum-based%20Fuels%20Nov%202008.pdf	No updates expected, but if new numbers become available, update tables for Jet Fuel, Gasoline, and Diesel	NA
LCEFbyFuelType	Unknown	NG-GHG-LCI.pdf	No updates expected, but if new numbers become available, update tables for Natural Gas	NA
LCEFbyFuelType	Unknown	http://www.uhero.hawaii.edu/assets/20120531_BiofuelLCAReportFinal_kt.pdf	No updates expected, but if new numbers become available, update tables for Coal; See Table7: Emission factors for different stages of fuel processing (g CO2-eq/MJ)	NA
LCEFbyFuelType	Unknown	http://www.netl.doe.gov/energy-analyses/pubs/NG-GHG-LCI.pdf	No updates expected, but if new numbers become available, update tables for Coal; See figure 3-8 for data	NA
LCEFbyFuelType	Unknown	http://www.netl.doe.gov/energy-analyses/pubs/EthFrBioLCA101811Pres.pdf	No updates expected, but if new numbers become available, update tables for Ethanol; See Slide 26 for data	NA
CarbonCoefficients	Unknown	http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2010-Annexes.pdf	No updates expected, but if new numbers become available, update tables for all fuels, available throughout document	NA

Preliminary Results

In the interactive tab for metric one, results can be displayed as total fuel consumed, fuel consumed per real GSP, and fuel consumed per de facto population. Figure 4 below presents total fuel consumed in Hawaii. The blue area excludes life cycle energy content and the green line includes it.

Figure 4: Energy Content of Hawaii Fuel Use

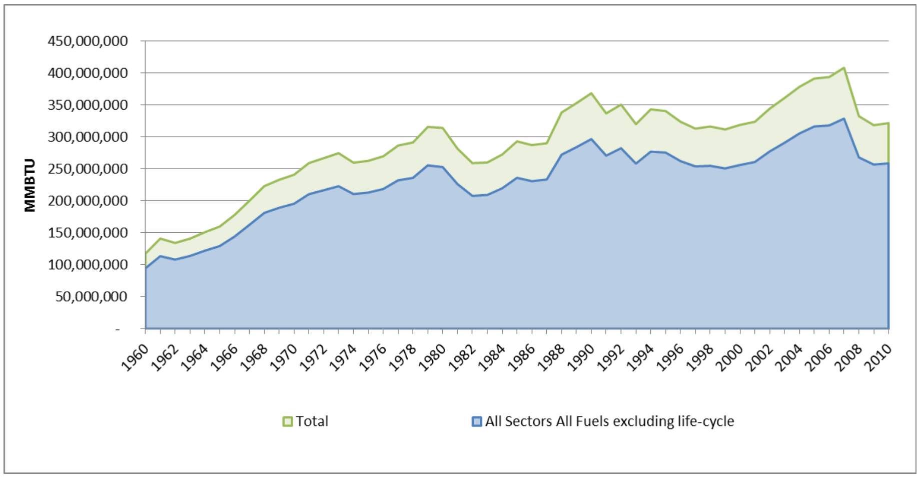
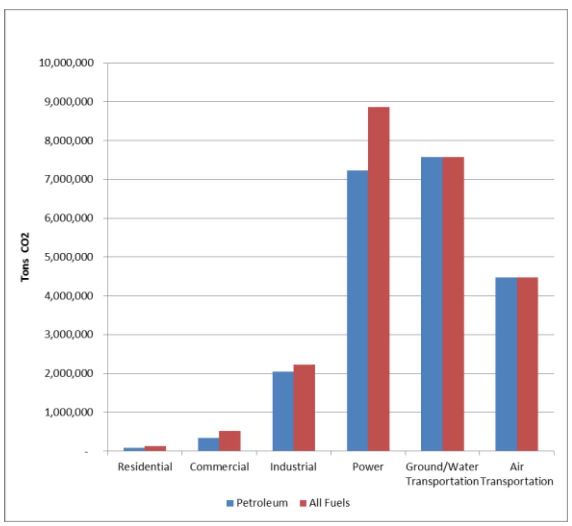


Figure 5 breaks out the consumption of petroleum for each sector and compares it to the consumption of all fuels for each sector. Note that these fuel quantities are for direct fuel consumption. Total direct residential, commercial, and industrial consumption are fairly low because electricity is not considered a fuel.

Figure 5: Life Cycle Carbon Content of Petroleum Compared to All Fuels Consumed in 2010



3.2 Metric 2: Expenditures on imported fuels to Hawaii

Overview

The second metric lists the expenditures on fuels from 1990 to the present and breaks these data out by fuel type. Due to the current limitation in granularity of domestic data, the model does not currently calculate domestic petroleum purchases differently from foreign imports, however, the model is configured to be able to handle this differentiation if the data do become available in the future. Calculations for this metric are detailed in Table 6.

Table 6: Calculations for Metric 2

Calculation	Title	Notes
$EIF_{(c,m)} = Im_{(c,m)} \times P_{(c,m)}$	Expenditures on Imported Fuels [$]	$Im_{(c,m)}$ = Fuel Imports by energy source and month (EIA) [MMBTU] $P_{(c,m)}$ = Price by energy source and month (EIA) [$/MMBTU]
$EIF_{(c,y)} = \sum_{m=1}^{12} EIF_{(c,m)}$	Annual Expenditures on Imported Fuels [$]	$EIF_{(c,m)}$ = Expenditures on Imported Fuel by energy source and month (EIA) [$]
$Im_{(c,y)} = \sum_{m=1}^{12} Im_{(c,m)}$	Annual Fuel Imports [MMBTU]	$Im_{(c,m)}$ = Fuel Imports by energy source and month (EIA) [MMBTU]
$APIF_{(c,y)} = \frac{EIF_{(c,y)}}{Im_{(c,y)}}$	Average Price of Imported Fuel [$/MMBTU]	$EIF_{(c,m)}$ = Expenditures on Imported Fuels by energy source and month (EIA) [$] $Im_{(c,m)}$ = Fuel Imports by energy source and month (EIA) [MMBTU]

Issues and Data Gaps

This metric uses EIA import, consumption, and pricing data for petroleum, coal, and ethanol products. Biodiesel consumption and pricing data are taken from DBEDT. As is done in metric one, foreign imports are subtracted from consumption to estimate domestic purchases. A significant drop in foreign imports appears in 2009. A review of the data reveals that a Tosoro refinery claimed to have purchased significantly less petroleum than in 2008 and/or 2010. EIA has agreed this data point should be considered an outlier. Nevertheless, this anomaly reveals the most conspicuous discovered instance of the limitations in relying upon EIA consumption and import data.

Update Procedures

The datasets necessary to update metric two are listed in Table 7. When updating, it is important to verify that columns and rows are pasted exactly as they are in the current version of the model since formulae are written to automatically incorporate the new data. If additional columns or rows have been added to the source files, they should be moved to the bottom or far right of the existing cell block. It is estimated that each file will take about twenty-five minutes to find, download, and input into the model.

Table 7: Data Sources and Notes for Metric 2

Tab	Date of Release	Source	Notes	Freq
EIA Expdtr	June 28th	http://www.eia.gov/beta/state/seds/seds-data-complete.cfm?sid=HI#Prices & Expenditures	In web page, click on "Prices and Expenditures"; click on "All Price and Expenditure Estimates" CSV. Check that all rows are the same	A
EIA Consum	June 28th	http://www.eia.gov/state/seds/seds-states.cfm?q_state_a=HI&q_state=Hawaii#undefined	In web page, click to expand "Consumption"; click on "All Consumption Estimates" CSV. Check that all rows are the same	A
DBEDT	7th of each month	http://files.hawaii.gov/dbedt/economic/data_reports/energy-trends/Monthly_Energy_Data.xlsx	Look for "Monthly Energy Trends" link. Biodiesel is presented by DEBDT on a monthly basis. EIA will begin to report on biodiesel in 2011. Check that rows are the same	M
Imports	25th of each month	http://www.eia.gov/petroleum/imports/companylevel/data/import.xls	Check that columns are the same	M
CoalForeignImports	May-13	http://www.eia.gov/coal/archive/coal_historical_imports.xls	Need to sort and copy only for port in Honolulu, HI. If full link doesn't work, try http://www.eia.gov/coal/data.cfm#imports; Check that columns are the same	Q
DomesticCoalImports	Jan. Apr, Jul, Oct	http://www.eia.gov/coal/distribution/quarterly/	Update the most recent quarter at the bottom of the list. Use the "By Destination State" file; Check that columns are the same	Q

EthanolMonthly	Jan. Apr, Jul, Oct	http://www.afdc.energy.gov/fuels/prices.html	This is a PDF; use average Gulf Coast price for Ethanol E85 in table 7 for each month included in the average	Q
BrentCrudeMonthly	30th of each month	http://tonto.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=RBRTE&f=M	Click Download Data (XLS File)	M
ResFuelOilMonthly	30th of each month	http://tonto.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMA_EPPR_PWG_NUS_DPG&f=M	Click Download Data (XLS File)	M
JetFuelMonthly	30th of each month	http://tonto.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EER_EPJK_PF4_RGC_DPG&f=M	Click Download Data (XLS File)	M

Preliminary Results

The interactive tab contains charts and a table that detail the results from this metric. Figure 6 displays total expenditures, separating foreign imports from total expenditures. At a basic level, expenditures appear to be increasing substantially starting in 2003. The chart is also important in highlighting the challenge of using EIA's data (see in particular 2009 expenditures on foreign-sourced fuel imports).

Figure 6: Expenditures on Imported Fuels

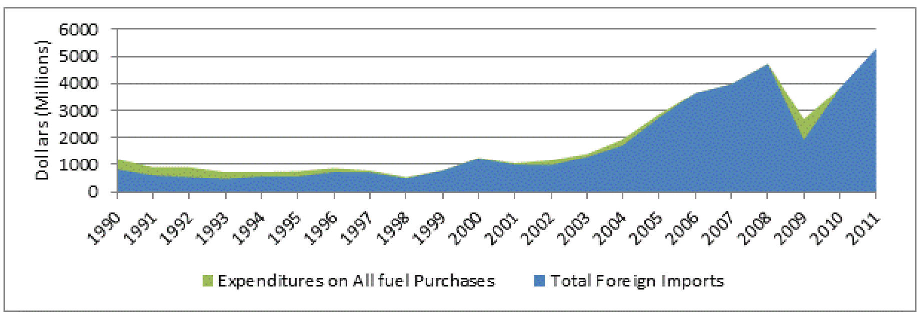
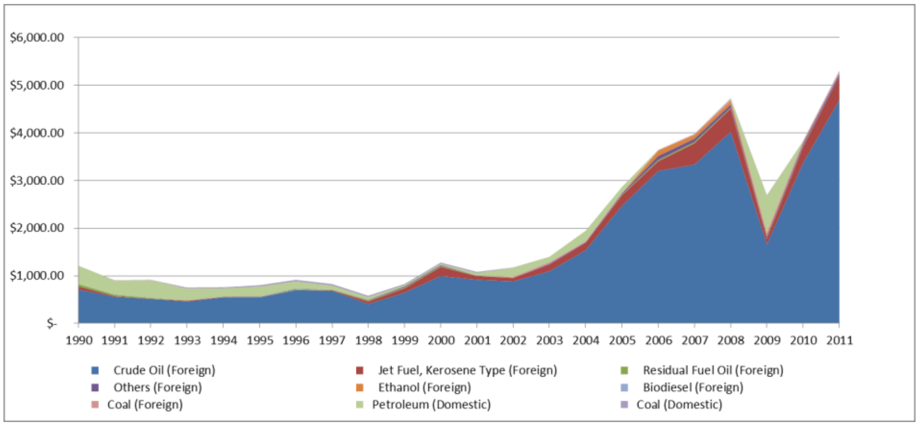


Figure 7 breaks out fuel expenditures by fuel source for 2010. As expected, the majority of expenditures were in crude oil. Following the recent news that Tesoro is closing their refinery in Hawaii, it is expected that a reduction in crude and an increase in refined petroleum products will result.

Figure 7: Expenditures per Fuel Source



Similar to metric one, ethanol, and particularly biodiesel, have less data available than petroleum. In this metric, we do not attempt to plot the cost of local fuels differently than domestic fuels, as we simply do not have sufficient data. If these detailed data become available, however, the model is configured to take these updates into account.

3.3 Metric 3: Carbon content of Hawaii fossil fuel use

Overview

The calculation of carbon content is closely tied to energy content, calculated in metric one. For each type of fuel, our model uses $kgCO_{2e}$/MMBTU coefficients to convert energy content into carbon content. Calculations can be seen in Table 8. Since each fuel has different carbon contents and different life cycle coefficients, if Hawaii's portfolio mix changes in the coming years, the ratio of energy content to carbon content will change.

The carbon content stated in this metric includes upstream life cycle contributions including production of methane, nitrogen and other greenhouse gas producing compounds quantified according to greenhouse gas CO_2e equivalent coefficients.

Table 8: Calculations for Metric 3

Calculation	Title	Notes
$LFE_{(c,s,y)} = EC_{(c,s,y)} \times LCEF_{(c)}$	Life Cycle Emissions [Metric Tons CO_{2e}]	$\boldsymbol{EC}_{(c,s,y)}$ = Energy Consumption by energy source, sector, and year (EIA) [Billion BTU] $\boldsymbol{LCEF}_{(c)}$ = Life Cycle Emissions Factor by energy source (Calculation) [Metric Tons CO_{2e}/Billion BTU]
$FCE_{(c,s,y)} = EC_{(c,s,y)} \times EF_{(c)}$	Fossil Fuel Carbon Emissions (Tailpipe) [Metric Tons CO_{2e}]	$\boldsymbol{EC}_{(c,s,y)}$ = Energy Consumption by energy source, sector, and year (EIA) [Billion BTU] $\boldsymbol{EF}_{(c)}$ = Emissions Factor by energy source (EPA) [Metric Tons CO_{2e}/Billion BTU]
$LCEF_{c,y} = 100\% + UEF_{c,y}$	Life Cycle Emissions Factor [%]	$\boldsymbol{UEF}_{c,y}$ = Calculation [%]
$UEF_{(c,y)} = \frac{UEC_{(c,y)}}{I_{(c,y)}}$	Upstream Energy Factor [%]	$\boldsymbol{UEC}_{(y,f)}$ = Upstream Energy Content by energy source and year (Calculation) [MMBTU] $\boldsymbol{I}_{(c,y)}$ = Imports by energy source and year (EIA) [MMBTU]
$UEC_{(c,y)} = \frac{UE_{(c,y)}}{CCEF_{(c)}}$	Upstream Energy Content [MMBTU]	$\boldsymbol{UE}_{(MMBTU,c,y)}$ = Upstream Emissions by energy source and year (Calculation) [$kgCO_{2e}$] $\boldsymbol{CCEF}_{(c)}$= Carbon Content Emissions Factor by energy source (EPA) [$kgCO_2$/MMBTU]
$UE_{(c,y)} = \sum_{o \in Origin} I_{(c,o,y)} \times UMF_{(c,o,y)}$	Upstream Emissions [$kgCO_{2e}$]	$\boldsymbol{I}_{(c,o,y)}$ = Imports by energy source, origin country, and year (EIA) [MMBTU] $\boldsymbol{UMF}_{(c,y)}$ = Upstream Emissions Factor by energy source, origin country, and year (NETL and UHERO) [$kgCO_{2e}$/MMBTU]

Issues and Data Gaps

As metric three uses much of the same data as metric one, the sources of data are almost identical. It uses EIA's foreign import and consumption data and DBEDT's consumption data for biofuels. NETL provides life cycle factors for all fuels except biofuels, for which we use the potential study from UHERO. Again, similar to metric one, these calculations are susceptible to the incongruity between EIA's import and consumption data. Also as was true for Metric one, the differences between life cycle emissions of local biofuels versus imported biofuels is not provided here, and it has the potential to be significant.

Update Procedures

The datasets necessary to update metric three are listed in Table 9. Note that they are the same as metric one and do not need to be updated again if metric one already has the most recent data.

Table 9: Data Sources and Notes for Metric 3

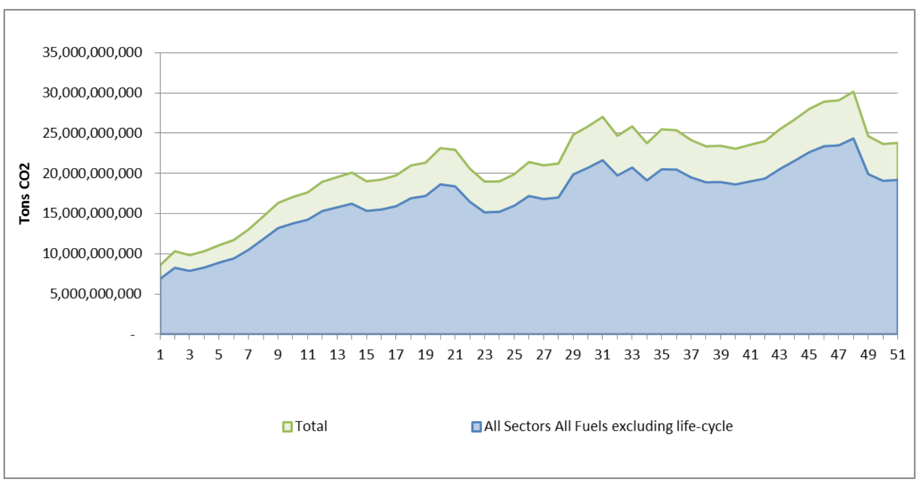
Tab	Date of Release	Source	Notes	Freq
Imports_Petrol	25th of each month	http://www.eia.gov/petroleum/imports/companylevel/archive/	Check that columns are the same	M
DBEDT	7th of each month	http://hawaii.gov/dbedt/info/economic/data_reports/energy-trends	Look for "Monthly Energy Trends" link. Biodiesel is presented by DEBDT on a monthly basis. EIA will begin to report on biodiesel in 2011. Check that rows are the same	M
EIA Consum	June 28th	http://www.eia.gov/state/seds/seds-states.cfm?q_state_a=HI&q_state=Hawaii#undefined	Click on "Consumption" heating. Download "All Consumption Estimates" CSV for Hawaii only. This is in the right column of links. Check that rows are the same	A
GSP Deflator	End of November	http://www.ers.usda.gov/datafiles/International_Macroeconomic_Data/Historical_Data_Files/HistoricalGDPDeflatorValues.xls		A
GSP	June 5th	http://www.bea.gov/	Go to the "Interactive Data" tab, Select GDP & Personal Income under Regional Economic Data heading. Expand Gross Domestic Product By State, and click "Gross Domestic Product". Use NAICS from 1997 forward. Do not update row 4 - it is only for 1963-1994;	A
Population	Unknown	http://www.quandl.com/UHERO-University-of-Hawaii/40_Y-Population-Hawaii-Statewide-annual	Make sure to get De Facto Population. Click on De Facto Population, then click download. You must create a free account and be logged in to download. Make sure columns are in the same order	A
LCEFbyFuelType	Unknown	http://www.netl.doe.gov/energy-analyses/pubs/NETL%20LCA%20Petroleum-based%20Fuels%20Nov%202008.pdf	No updates expected, but if new numbers become available, update tables for Jet Fuel, Gasoline, and Diesel	NA

LCEFbyFuelType	Unknown	NG-GHG-LCI.pdf	No updates expected, but if new numbers become available, update tables for Natural Gas	NA
LCEFbyFuelType	Unknown	http://www.uhero.hawaii.edu/assets/20120531_BiofuelLCAReportFinal_kt.pdf	No updates expected, but if new numbers become available, update tables for Coal; See Table7: Emission factors for different stages of fuel processing (g CO2-eq/MJ)	NA
LCEFbyFuelType	Unknown	http://www.netl.doe.gov/energy-analyses/pubs/NG-GHG-LCI.pdf	No updates expected, but if new numbers become available, update tables for Coal; See figure 3-8 for data	NA
LCEFbyFuelType	Unknown	http://www.netl.doe.gov/energy-analyses/pubs/EthFrBioLCA101811Pres.pdf	No updates expected, but if new numbers become available, update tables for Ethanol; See Slide 26 for data	NA
CarbonCoefficients	Unknown	http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2010-Annexes.pdf	No updates expected, but if new numbers become available, update tables for all fuels, available throughout document	NA

Preliminary Results

Figure 8 shows total emissions from fuels used in Hawaii. The blue area represents direct emissions from the burning of the fuel, while green represents embedded, upstream emissions.

Figure 8: Total Carbon Content of Hawaii Fuel Use



3.4 Metric 4: Hawaii fuel portfolio cost volatility

Overview

The fourth metric considers the volatility of Hawaii's energy expenditures and portfolio price. This metric compares average monthly prices to average annual price. In addition, it compares the total monthly expenditures to average monthly expenditures (calculated annually). As the price varies month to month, this metric calculates the degree of that variation. Similarly, as statewide expenditures vary from month to month, the metric calculates the degree of that variation in expenditures. It is important to note that this metric considers the electricity costs of each sector. Rather than just considering pricing and costs of direct fuel use, variability here is largely in consideration of electricity prices. Therefore, the costs incurred by the power sector and oil refineries are excluded to avoid double counting. Table 10 and Table 11 detail these calculations.

Based on input from its stakeholder group, HEPF identified the expression volatility in terms of total portfolio cost as a preferred form for this metric in order to best capture progress in energy efficiency gains. As Hawaii decreases energy consumption through efficiency measures, the portfolio cost volatility as measured in this metric will correspondingly decrease. Expression volatility in terms of price is meaningful but is not sensitive to changes in efficiency in customer use. Both metrics (price and portfolio cost) as calculated in the model are sensitive to and account for increases in production and delivery efficiency and the extent to which wholesale electricity purchase and/or fuel procurement contracts are delinked from the price of petroleum.

Table 10: Metric 4, Price Volatility

Calculation	Title	Notes
$EPV_{(s,y)} = \sqrt{\sum_{m=1}^{12} PPD_{(s,m)}}$	Energy Portfolio Price Volatility [$/MMBTU]	$\boldsymbol{PPD_{(s,m)}}$=Portfolio Price Deviation by sector and month (Calculation) [$/MMBTU]
$PPD_{(s,m)} = \left(EPP_{(s,m)} - AEP_{(s,y)}\right)^2$	Portfolio Price Deviation [$/MMBTU]	$\boldsymbol{EPP_{(s,m)}}$ = Energy portfolio price by sector and month (Calculation) [$/MMBTU] $\boldsymbol{AEP_{(s,y)}}$ = Average Energy Price by sector and year (Calculation) [$/MMBTU]
$AEP_{(s,y)} = \frac{\sum_1^{12} EPP_{(s,m)}}{12}$	Average Energy Price [$/MMBTU]^2	$\boldsymbol{EPP_{(s,m)}}$ = Energy portfolio price by sector and month (Calculation) [$/MMBTU]

$EPP_{(s,m)} = \left(\sum_{c \in Sources} P_{(c,m)} \times PW_{(c,s,m)} \right)_{(c,s,m)}$	Energy Portfolio Price [$/MMBTU]	$\boldsymbol{P}_{(c,sm)}$ = Price by energy source and month (EIA and DBEDT) [$/MMBTU] $\boldsymbol{PW}_{(c,s,m)}$ = Portfolio weight by energy source, sector and month (Calculation) [%]
$PW_{(c,s,m)} = \frac{EC_{(c,m)}}{ECp_{(m)}}$	Portfolio Weight [%]	$\boldsymbol{EC}_{(c,m)}$= Energy Consumption by energy source and month (EIA) [Billion BTU] $\boldsymbol{ECp}_{(m)}$= Portfolio consumption by month (EIA) [Billion BTU]
$EC_{(c,s,m)} = EC_{(c,s,y)} \times CW_{(c,m)}$	Monthly Consumption [Billion BTU]	$\boldsymbol{EC}_{(c,s,y)}{}'$= Energy Consumption by fuel by energy source, sector, and year (EIA) [Billion BTU] $\boldsymbol{CW}_{(c,m)}$= Energy Consumption Weight by energy source and month (Calculation) [%]
$CW_{(c,m)} = \frac{EC_{(c,m)}{}'}{EC_{(c,y)}{}'}$	Consumption Weight [%]	$\boldsymbol{EC}_{(c,m)}{}'$= Energy Consumption by energy source and month (DBEDT) [kWh or Barrels] $\boldsymbol{cEC}_{(c,y)}{}'$= Energy Consumption by energy source and year (DBEDT) [kWh or Barrels]

Table 11: Metric 4, Cost Volatility

Calculation	Title	Notes
$ECV_{(s,y)} = \sqrt{\sum_{m=1}^{12} PED_{(s,m)}}$	Energy Cost Volatility [Million $]	$\boldsymbol{PED}_{(s,m)}$=Portfolio Expenditure Deviation by sector and month (Calculation) [Million $]
$PED_{(c,s,m)} = \left(FE_{(c,s,m)} - AEE_{(c,s,y)}\right)^2$	Portfolio Expenditure Deviation [Million $]	$\boldsymbol{FE}_{(c,s,m)}$ = Fuel Expenditures by energy source, sector, and month(Calculation) [Million $] $\boldsymbol{AEE}_{(c,s,y)}$ = Average Energy Expenditures by energy source, sector, and year (Calculation) [Million $]
$FE_{(c,s,m)} = EC_{(c,s,m)} \times P_{(c,m)}$	Fuel Expenditures [Million $]	$\boldsymbol{EC}_{(c,s,m)}$ = Energy Consumption by energy source, sector, and month (EIA & DBEDT) [Billion BTU] $\boldsymbol{P}_{(c,m)}$ = Price by energy source and month (EIA & DBEDT) [Million $/Billion BTU]
$AEE_{(c,s,y)} = \frac{\sum_1^{12} FE_{(c,s,m)}}{12}_{(c,s,m)}$	Average Energy Expenditures [Million $]	$\boldsymbol{FE}_{(c,s,m)}$ = Fuel Expenditures by energy source, sector, and month (Calculation) [Million $]

Issues and Data Gaps

Pricing data is taken from EIA's consumption report, which is provided annually. Since data are only available with annual frequency, the model uses DBEDT's monthly energy report to create weights to estimate monthly consumption. Once monthly fuel consumption figures are calculated, energy prices are given portfolio weights based on each fuel's contribution to a given sector's total consumption.

Update Procedures

Table 12 lists the datasets necessary to update metric four. This process will also update metrics five and eight. When updating, it is important to verify that columns and rows are pasted exactly as they are in the current version of the model since formulae are written to automatically incorporate the new data. If additional columns or rows have been added to the source files, they should be moved to the bottom or far right of the existing cell block. It is estimated that most files will take about twenty-five minutes to find, download, and input into the model. Updating the "Input" tab is the most manual tab in the entire model and requires searching through PUC filings and RPS reports, and entering data line by line. This effort is expected to take around two hours.

Table 12: Data Sources and Notes for Metric 4

Tab	Date of Release	Source	Notes	Freq
EIA Expdtr	June 28th	http://www.eia.gov/beta/state/seds/seds-data-complete.cfm?sid=HI#Prices & Expenditures	In web page, click on "Prices and Expenditures"; click on "All Price and Expenditure Estimates" CSV. Check that all rows are the same	A
EIA Consum	June 28th	http://www.eia.gov/state/seds/seds-states.cfm?q_state_a=HI&q_state=Hawaii#undefined	In web page, click to expand "Consumption"; click on "All Consumption Estimates" CSV. Check that all rows are the same	A
DBEDT	7th of each month	http://files.hawaii.gov/dbedt/economic/data_reports/energy-trends/Monthly_Energy_Data.xlsx	Look for "Monthly Energy Trends" link. Biodiesel is presented by DEBDT on a monthly basis. EIA will begin to report on biodiesel in 2011. Check that rows are the same	M
BrentCrudeMonthly	30th of each month	http://tonto.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=RBRTE&f=M	Click Download Data (XLS File)	M
EthanolMonthly	Jan. Apr, Jul, Oct	http://www.afdc.energy.gov/fuels/prices.html	This is a PDF; use average Gulf Coast price for Ethanol E85 in table 7 for each month included in the average	Q

LPG	30th of each month	http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=eer_epllpa_pf4_y44mb_dpg&f=d	Click Download Data (XLS File)	M
Jet Fuel	30th of each month	http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EER_EPJK_PF4_RGC_DPG&f=M	Click Download Data (XLS File)	M
Jet Fuel	30th of each month	http://tonto.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMA_EPJK_PWG_SHI_DPG&f=M	For Hawaii-specific pricing; Click Download Data (XLS File)	M
GSP Deflator	End of November	http://www.ers.usda.gov/datafiles/International_Macroeconomic_Data/Historical_Data_Files/HistoricalGDPDeflatorValues.xls		A
GSP	June 5th	http://www.bea.gov/	Go to the "Interactive Data" tab, Select GDP & Personal Income under Regional Economic Data heading. Expand Gross Domestic Product By State, and click "Gross Domestic Product". Use NAICS from 1997 forward. Do not update row 4 - it is only for 1963-1994;	A
Inputs	May	http://www.heco.com/vcmcontent/StaticFiles/pdf/2012-05-04_RPS%20Report_2011.pdf	PDF with a fairly manual update. Google HECO RPS REPORT for 2012; Report should contain tables detailing energy savings and renewable generation	A
Inputs	November	http://puc.hawaii.gov/reports/puc-annual-reports	Additional data, particularly for KIUC	A

Preliminary Results

Variation in price and portfolio cost are shown here in two respective tables. Table 13 shows the variation in portfolio price. It can be seen that energy prices for all sectors are less variable in 2006 than in 2008 and 2009. With the exception of ground and water transportation, all sectors return to 2006 variability by 2010.

Table 13: Hawaii Energy Portfolio Price Volatility

$/MMBTU:	2006	2007	2008	2009	2010	2011	2012
Residential	$7.46	$18.78	$25.09	$17.13	$ 5.18		
Commercial	$6.06	$15.80	$21.88	$13.50	$ 3.87		
Industrial (Excl. R	$6.21	$15.42	$23.19	$13.64	$ 4.53		
Ground and Wate	$5.06	$ 4.20	$14.44	$ 8.86	$11.61		
Air Transportatior	$4.83	$ 9.07	$23.24	$ 8.00	$ 4.07		
All Sectors	$4.93	$ 7.73	$17.19	$ 7.95	$ 6.12		

Similar to price volatility, Table 14 shows the volatility of energy expenditures on an annual basis. The results show changes in cost volatility trending in the same direction as price volatility.

Table 14: Hawaii Energy Portfolio Cost Volatility

Million Dollars:	2006	2007	2008	2009	2010	2011	2012
Residential	$ 16.23	$ 24.43	$ 33.86	$ 25.93	$ 13.97		
Commercial	$ 20.48	$ 28.72	$ 41.91	$ 34.48	$ 17.52		
Industrial (Excl. R	$ 20.50	$ 28.94	$ 42.43	$ 31.66	$ 17.56		
Ground and Wate	$ 75.32	$ 78.09	$127.89	$133.96	$ 42.37		
Air Transportatior	$ 56.60	$ 63.11	$132.30	$ 55.78	$ 27.30		
All Sectors	$183.68	$213.93	$348.74	$275.89	$113.89		

3.5 Metric 5: Hawaii energy portfolio price and cost correlation to world crude petroleum price

Overview

The model calculates the correlation of fuel and electricity prices to crude oil prices. We consider correlation of both price and total expenditures for this metric. Table 15 and Table 16 list the calculations for these two versions of the metric. Since consumer level prices and costs in Hawaii are observed to lag world oil prices by one or more months, the model includes a provision to calculate correlations according to user-selected lag periods.

Hawaii's energy portfolio price variability, as measured in Metric 4, is strongly subject to the exogenous influence of world energy prices. Metric 5 attempts to measure how Hawaii's energy portfolio price and costs remain linked to world oil price. As the mix of fuels in Hawaii's fuel portfolio changes and as contracts for wholesale purchase of electricity and fuels are delinked from petroleum prices, the petroleum-price-induced volatility of energy costs to consumers, as measured in this metric, should decrease. As explained regarding Metric 4, one distinction between the price and expenditures expressions of this metric is that, expression as portfolio expenditures is sensitive to impacts from customer energy efficiency.

Table 15: Energy Price Correlation to Crude Oil Prices

Calculation	Title	Notes
$EPPC_{(y)} = CORREL\left(EPP_{(m)}, BOP_{m}\right)$	Energy Portfolio Price Correlation	$\boldsymbol{EPP}_{(m)}$ = Energy Portfolio Price Over Year (Calculation) [$/MMBTU] $\boldsymbol{BOP}_{(m)}$ = Brent Oil Price Over Year (EIA) [$/MMBTU]
$EPP_{(c,m)} = \left(\sum_{c \in Sources} \left(P_{(c,m)} \times PW_{(c,m)}\right)\right)_{(c,m)}$	Energy Portfolio Price [$/MMBTU]	$\boldsymbol{P}_{(c,m)}$ = Price of fuel by energy source and month (EIA and DBEDT) [$/MMBTU] $\boldsymbol{PW}_{(c,m)}$ = Portfolio Weight by energy source and month (Calculation) [%]
$PW_{(c,m)} = \frac{EC_{(c,m)}}{ECp_{(m)}}$	Portfolio Weight [%]	$\boldsymbol{EC}_{(c,m)}$ = Energy Consumption by energy source and month (EIA) [Billion BTU] $\boldsymbol{ECp}_{(m)}$ = Portfolio Energy Consumption by month (EIA) [Billion BTU]
$EC_{(c,m)} = EC_{(c,y)} \times CW_{(c,m)}$	Recalculated Consumption [Billion BTU]	$\boldsymbol{C}_{(c,y)}$= Consumption by energy source and month (EIA) [Billion BTU] $\boldsymbol{CW}_{(c,m)}$= Consumption weight by energy source and year (Calculation) [%]
$CW_{(c,m)} = \frac{EC_{(c,m)}'}{EC_{(c,y)}'}$	Consumption Weight [%]	$\boldsymbol{EC}_{(c,m)}'$= Energy Consumption by energy source and month (DBEDT) [kWh or Barrels] $\boldsymbol{EC}_{(c,y)}'$= Energy Consumption by energy source and year (DBEDT) [kWh or Barrels]

Table 16: Energy Portfolio Expenditure Correlation to Crude Oil Prices

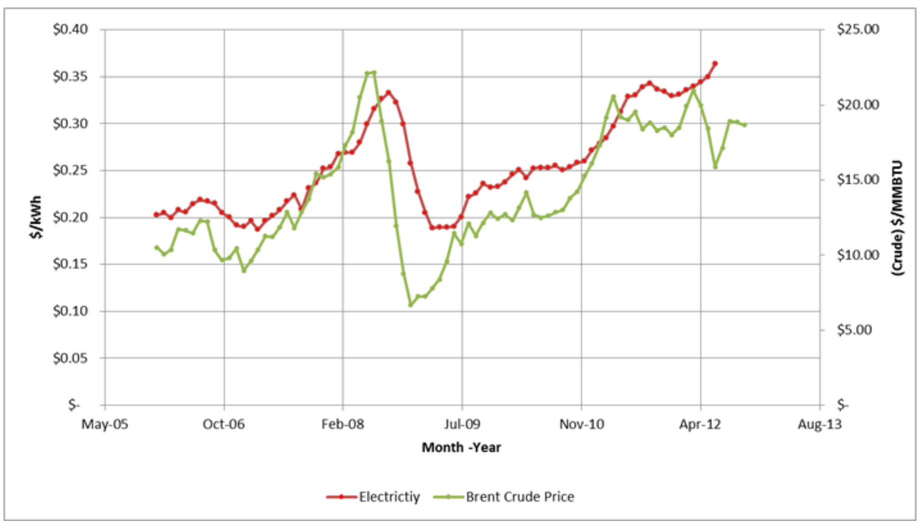
Calculation	Title	Notes
$EPEC_{(y)} = CORREL\left(FE_{(m)}, BOP_{m}\right)$	Energy Portfolio Expenditure Correlation	$\boldsymbol{FE}_{(m)}$ = Monthly Energy Portfolio Expenditures Over Year (Calculation) [$] $\boldsymbol{BOP}_{(m)}$ = Brent Oil Price Over Year (EIA) [$/MMBTU]
$FE_{(c,m)} = EC_{(c,m)} \times P_{(c,m)}$	Fuel Expenditures [$]	$\boldsymbol{EC}_{(c,m)}$ = Energy Consumption by energy source and month (EIA) [Billion BTU] $\boldsymbol{P}_{(c,m)}$ = Price by energy source and month (EIA and DBEDT)

		[$/Billion BTU]
$EC_{(c,m)} = EC_{(c,y)} \times CW_{(c,m)}$	Recalculated Consumption [Billion BTU]	$EC_{(c,y)}$= Energy Consumption by energy source and month (EIA) [Billion BTU] $CW_{(c,m)}$= Consumption weight by energy source and year (Calculation) [%]

Issues and Data Gaps

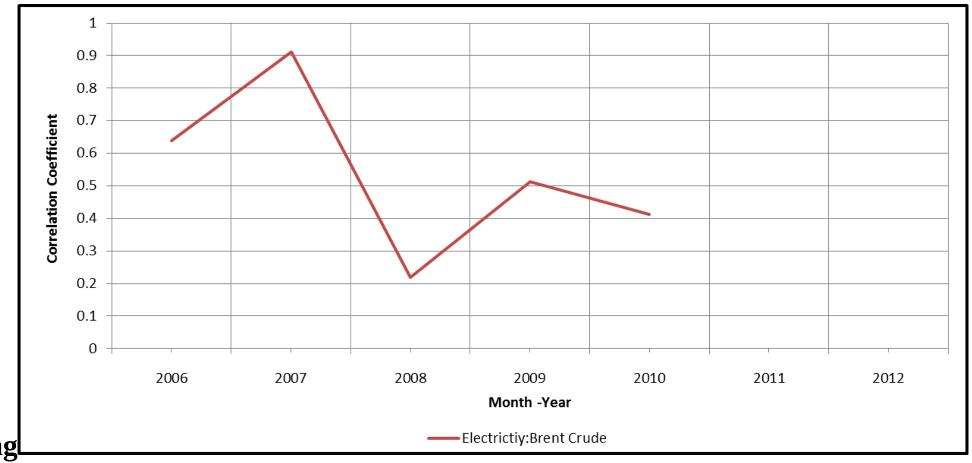
Data for metric five are complete and reliable. However, a lag of about two months is seen between changes in electricity prices and changes in oil prices. This relationship can be seen in Figure 9.

Figure 9: Electricity Price Compared to Crude Oil Price



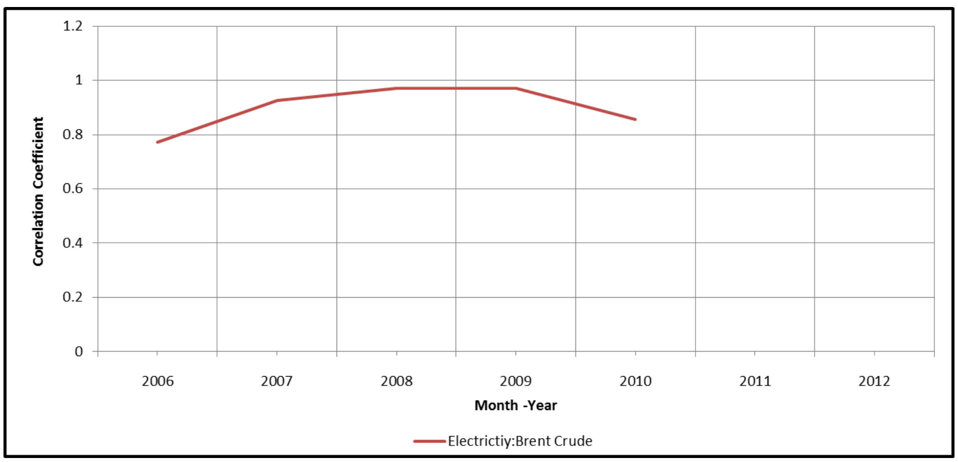
Without shifting the period of electricity prices, Figure 10 shows the correlation of monthly electricity price to Brent crude oil prices. The correlation ranges from around zero up to above 0.8. Correlation of 1 would describe two datasets changing exactly in line with each other.

Figure 10: Correlation of Monthly Electricity Price to Brent Crude Oil Price without 2 Month Lag



To account for this monthly lag, the model includes a "Period Shift" input variable. The variable shifts the pricing of each fuel by the number of months entered. Shifting electricity prices by two months produces a much tighter correlation, as shown in Figure 11.

Figure 11: Correlation of Monthly Electricity Price to Brent Crude Oil Price with 2 Month Lag



Update Procedures

The datasets necessary to update metric five are listed in Table 17. Note that they are the same as metric four and do not need to be updated again if metric four already has the most recent data.

Table 17: Data Sources and Notes for Metric 5

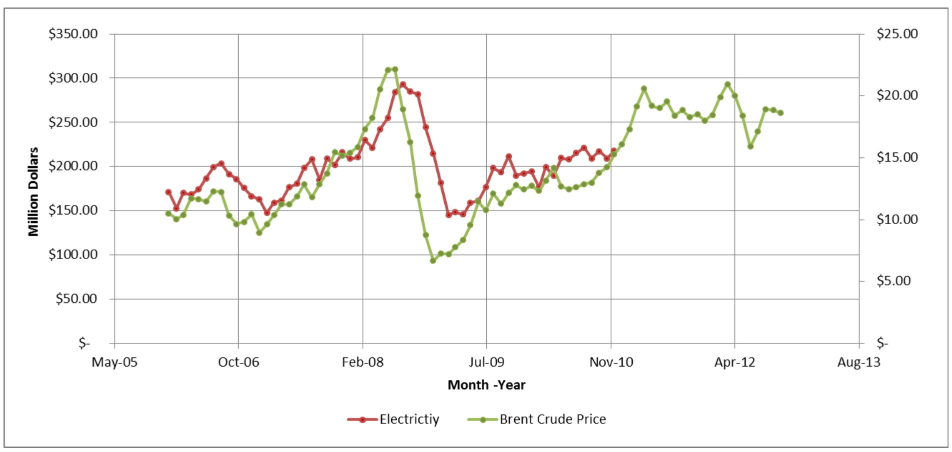
Tab	Date of Release	Source	Notes	Freq
EIA Expdtr	June 28th	http://www.eia.gov/beta/state/seds/seds-data-complete.cfm?sid=HI#Prices & Expenditures	In web page, click on "Prices and Expenditures"; click on "All Price and Expenditure Estimates" CSV. Check that all rows are the same	A
EIA Consum	June 28th	http://www.eia.gov/state/seds/seds-states.cfm?q_state_a=HI&q_state=Hawaii#undefined	In web page, click to expand "Consumption"; click on "All Consumption Estimates" CSV. Check that all rows are the same	A
DBEDT	7th of each month	http://files.hawaii.gov/dbedt/economic/data_reports/energy-trends/Monthly_Energy_Data.xlsx	Look for "Monthly Energy Trends" link. Biodiesel is presented by DEBDT on a monthly basis. EIA will begin to report on biodiesel in 2011. Check that rows are the same	M
BrentCrudeMonthly	30th of each month	http://tonto.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=RBRTE&f=M	Click Download Data (XLS File)	M
EthanolMonthly	Jan. Apr, Jul, Oct	http://www.afdc.energy.gov/fuels/prices.html	This is a PDF; use average Gulf Coast price for Ethanol E85 in table 7 for each month included in the average	Q
LPG	30th of each month	http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=eer_epllpa_pf4_y44mb_dpg&f=d	Click Download Data (XLS File)	M
Jet Fuel	30th of each month	http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EER_EPJK_PF4_RGC_DPG&f=M	Click Download Data (XLS File)	M
Jet Fuel	30th of each month	http://tonto.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMA_EPJK_PWG_SHI_DPG&f=M	For Hawaii-specific pricing; Click Download Data (XLS File)	M
GSP Deflator	End of November	http://www.ers.usda.gov/datafiles/International_Macroeconomic_Data/Historical_Data_Files/HistoricalGDPDeflatorValues.xls		A
GSP	June 5th	http://www.bea.gov/	Go to the "Interactive Data" tab, Select GDP & Personal Income under Regional Economic Data heading. Expand Gross Domestic Product By State, and click "Gross Domestic Product". Use NAICS from 1997 forward. Do not update row 4 - it is only for 1963-1994;	A

Inputs	May	http://www.heco.com/vcmcontent/StaticFiles/pdf/2012-05-04_RPS%20Report_2011.pdf	PDF with a fairly manual update. Google HECO RPS REPORT for 2012; Report should contain tables detailing energy savings and renewable generation	A
Inputs	November	http://puc.hawaii.gov/reports/puc-annual-reports	Additional data, particularly for KIUC	A

Preliminary Results

To consider not only the correlation of Brent oil prices to fuel and electricity, the model includes a correlation of oil prices to monthly expenditures for all fuels and electricity. Figure 12 shows the correlation of electricity expenditures and crude oil prices. Since the lag seen in the price correlation above also applies to expenditures, the "Period Shift" input variable is included in this metric.

Figure 12: Electricity Expenditures Compared to Crude Oil Price



3.6 Metric 6: Green Job Creation

Overview

An important stated objective for the pursuit of clean and renewable energy is the effect of producing desirable "green" jobs. Measuring the attainment of this objective, however, is difficult for several reasons – the most notable being ambiguity in the definition of green jobs and limited available data to review. The Research and Statistics Office of Hawaii's Department of Labor and Industrial Relations (DLIR) recently published a baseline study to define the benefits of tracking green jobs (Matsu 2010). In it, they acknowledge many of the challenges in doing so. As described in their report, despite local and national discussions surrounding green job growth, there is no universal definition of what a green job is. Both DLIP and the United States Bureau of Labor Statistics used the North American Industry Classification System (NAICS) to identify which jobs to consider green. Still, for each study it remains in the author's discretion how to classify the NAICS codes and how to identify positions dealing in sustainability within non-green industries. This causes some discrepancy between reports, although as discussed later, the differences are small.

Issues and Data Gaps

Although BLS was expected to continue publication of the Green Goods and Services survey, the recent reductions in federal spending have prompted BLS to eliminate future reporting. This is an unfortunate development for Hawaii's ongoing status reports. See http://www.bls.gov/bls/sequester_info.htm for further information. The Brookings Institute also tracks "green" jobs and is planning to publish a follow-up to an earlier report on green jobs, but with less granularity than their previous study.

Update Procedures

Since BLS is no longer has funds to administer the Green Goods and Services survey, and Brookings is expected to publish a report without state-level data, no new detailed data for Hawaii is expected. However, these and other agencies should be contacted to monitor the status of green jobs data.

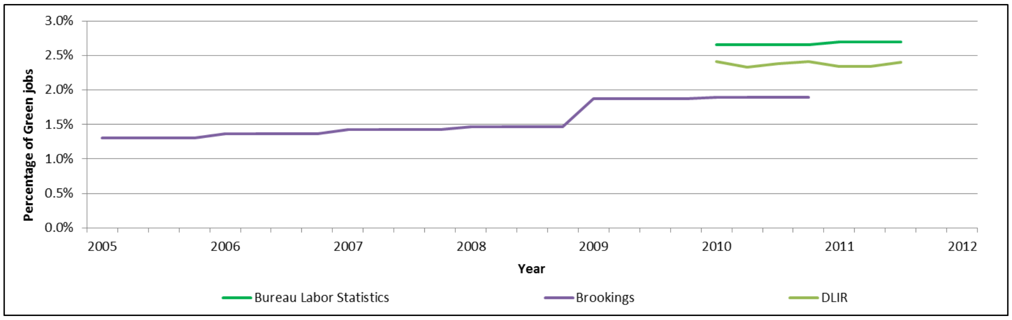
Table 18: Data Sources and Notes for Metric 6

Tab	Date of Release	Source	Notes	Freq
BLS Data	NA	http://www.bls.gov/ggs	Best option, but GGS not expected to continue	NA

Preliminary Results

Figure 13 shows some variability among reports, as discussed earlier, but between all reports, it appears green jobs accounted for 2.0%-2.5% of Hawaiian jobs in 2011.

Figure 13: Number of Green Jobs in Hawaii



3.7 Metric 7: Hawaii energy portfolio supply risk

Overview

The seventh metric expresses the supply risk associated with Hawaii's energy portfolio. There seems to be some consensus amongst HEPF's advisors, however, that quantifying fuel supply risk is not sufficiently feasible or accurate to produce information that is any more meaningful than using the already-developed price volatility information as a proxy to measure fuel supply risk.

It is recognized that the impacts of interruption in fuel supplies for the State of Hawaii could be large and that the costs of these impacts would not be meaningfully measured by historical measures of the quantity or variability in fuel costs. As a matter of measuring progress towards decreasing fuel supply risks, however, Metric 4 and Metric 5 measures progress towards independence from volatile-priced petroleum-based fuel supplies. To the extent that fuel supply risk in Hawaii is primarily a function of reliance on petroleum or that fuel price volatility is a measure of risk, Metrics 4 and 5 may serve as well as any other indicator to measure progress towards reducing Hawaii's fuel supply risks.

Some exploration was performed in developing a metric to measure the economic impacts associated with sharp reductions in global supply. Development of such a metric may ultimately be possible but is left as a subject of future research.

3.8 Metric 8: End-use energy expenditures per unit of income

Overview

The eighth metric analyzes the cost of energy in Hawaii in two ways. First, it measures energy expenditures as a burden to the state as a fraction of Hawaii's annual Gross State Product (GSP). Calculations for this approach are found in Table 19.

A second method, applied only to electricity expenditures, compares actual energy expenditures to expenditures that would have occurred in the absence of progress towards Hawaii's clean energy goals. This metric compares current expenditures to the expenditures that would have existed relative to the baseline year of 2005. This study uses 2005 as a baseline year but the model and can be adjusted as needed. Additionally, any reductions made due to gains in energy efficiency are added back into the hypothetical total energy sold. This methodology is detailed in Table 20.

Table 19: Energy Burden

Calculation	Title	Notes
$EB_{(c,y)} = \frac{TSEE_{(c,y)}}{GSP_{(y)}}$	Energy Burden [%]	$\boldsymbol{TSEE}_{(c,y)}$ = Total State Expenditures by energy source and year (EIA) [$] $\boldsymbol{GDP}_{(y)}$ = Hawaii GSP in year (UHERO) [$]

Table 20: Hypothetical Energy Expenditures Using 2005 Baseline

Calculation	Title	Notes
$\frac{AFE_{(Actual,c,p,y)}}{HFE_{(2005,c,p,y)}}$	Actual Expenditures to Hypothetical Expenditures [%]	$\boldsymbol{AFE}_{(Actual,c,p,y)}$ = Actual Fuel Expenditures in the power sector by year and fuel source (EIA) [$] $\boldsymbol{HFE}_{(2005,c,p,y)}$ = Hypothetical Fuel Expenditures in the power sector by year and fuel source (Calculation) [$]

$HFE_{(2005,e,p,y)} = \frac{HFC_{(2005,e,p,y)} \times P_{(e,y)}}{1{,}000{,}000}$	Hypothetical Fuel Expenditures [Million $]	$\boldsymbol{HFC}_{(2005,e,p,y)}$ = Hypothetical power sector fuel consumption by year and fuel (Calculation) [MMBTU] $\boldsymbol{P}_{(e,y)}$ = Fuel price by year and fuel (EIA) [$/MMBTU]
$HF_{(2005,e,p,y)} = \left(ES_{(y)} + EEG_{(y)}\right) \times HR_{(2005,e,p)}$	Hypothetical Fuel Consumption [MMBTU]	$\boldsymbol{ES}_{(y)}$ = Energy sold in year y (PUC) [Million kWh] $\boldsymbol{EEG}_{(y)}$ = Energy Efficiency Gains by year (PUC) [Million kWh] $\boldsymbol{HR}_{(2005,e,p)}$ = Baseline Heat Rate (Calculation) [BTU/kWh]
$HR_{(2005,e,p)} = \frac{FC_{(2005,e,p)} \times 1000}{BEC_{(2005)}}$	Aggregate Sales Heat Rate [BTU/kWh]	$\boldsymbol{FC}_{(2005,e,p)}$ = Fuel consumed by the power sector in 2005 by energy source (EIA) $\boldsymbol{BEC}_{(2005)}$ = Baseline Electricity Consumption (EIA)

Issues and Data Gaps

Metric eight relies on two sets of data. The first method for this metric utilizes state-level EIA data to sum fuel expenditures. These figures are collected in the model for each fuel and are presented as an aggregate of all sectors. The second considers consumption numbers and uses actual energy sales as provided by the PUC and multiplies these by Dollars/MMBTU, as presented by EIA. EIA's expenditure estimates differ slightly from our recalculated estimates. These two calculations are presented separately from one another and comparisons between the two are not and should not be made. Taken separately from each other, we believe both calculations provide valuable insight.

Update Procedures

The datasets necessary to update metric eight are listed in Table 21. Note that they are the same as metric four and do not need to be updated again if metric four already has the most recent data.

Table 21: Data Sources and Notes for Metric 8

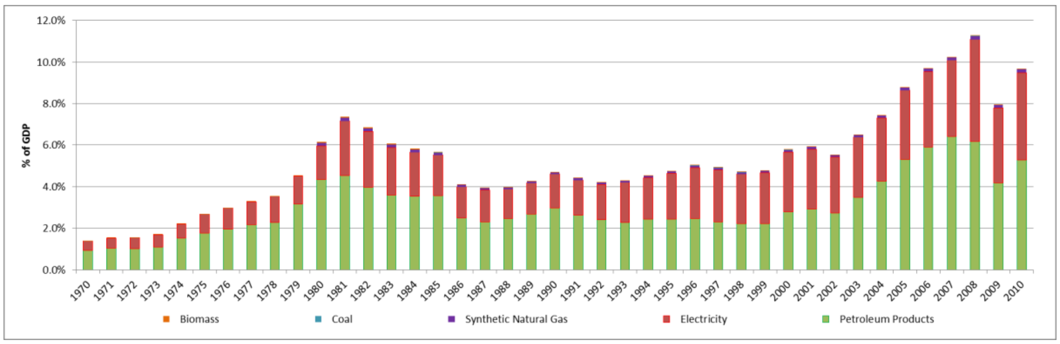
Tab	Date of Release	Source	Notes	Freq
EIA Expdtr	June 28th	http://www.eia.gov/beta/state/seds/seds-data-complete.cfm?sid=HI#Prices & Expenditures	In web page, click on "Prices and Expenditures"; click on "All Price and Expenditure Estimates" CSV. Check that all rows are the same	A

EIA Consum	June 28th	http://www.eia.gov/state/seds/seds-states.cfm?q_state_a=HI&q_state=Hawaii#undefined	In web page, click to expand "Consumption"; click on "All Consumption Estimates" CSV. Check that all rows are the same	A
DBEDT	7th of each month	http://files.hawaii.gov/dbedt/economic/data_reports/energy-trends/Monthly_Energy_Data.xlsx	Look for "Monthly Energy Trends" link. Biodiesel is presented by DEBDT on a monthly basis. EIA will begin to report on biodiesel in 2011. Check that rows are the same	M
BrentCrudeMonthly	30th of each month	http://tonto.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=RBRTE&f=M	Click Download Data (XLS File)	M
EthanolMonthly	Jan. Apr, Jul, Oct	http://www.afdc.energy.gov/fuels/prices.html	This is a PDF; use average Gulf Coast price for Ethanol E85 in table 7 for each month included in the average	Q
LPG	30th of each month	http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=eer_epllpa_pf4_y44mb_dpg&f=d	Click Download Data (XLS File)	M
Jet Fuel	30th of each month	http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EER_EPJK_PF4_RGC_DPG&f=M	Click Download Data (XLS File)	M
Jet Fuel	30th of each month	http://tonto.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMA_EPJK_PWG_SHI_DPG&f=M	For Hawaii-specific pricing; Click Download Data (XLS File)	M
GSP Deflator	End of November	http://www.ers.usda.gov/datafiles/International_Macroeconomic_Data/Historical_Data_Files/HistoricalGDPDeflatorValues.xls		A
GSP	June 5th	http://www.bea.gov/	Go to the "Interactive Data" tab, Select GDP & Personal Income under Regional Economic Data heading. Expand Gross Domestic Product By State, and click "Gross Domestic Product". Use NAICS from 1997 forward. Do not update row 4 - it is only for 1963-1994;	A
Inputs	May	http://www.heco.com/vcmcontent/StaticFiles/pdf/2012-05-04_RPS%20Report_2011.pdf	PDF with a fairly manual update. Google HECO RPS REPORT for 2012; Report should contain tables detailing energy savings and renewable generation	A
Inputs	November	http://puc.hawaii.gov/reports/puc-annual-reports	Additional data, particularly for KIUC	A

Preliminary Results

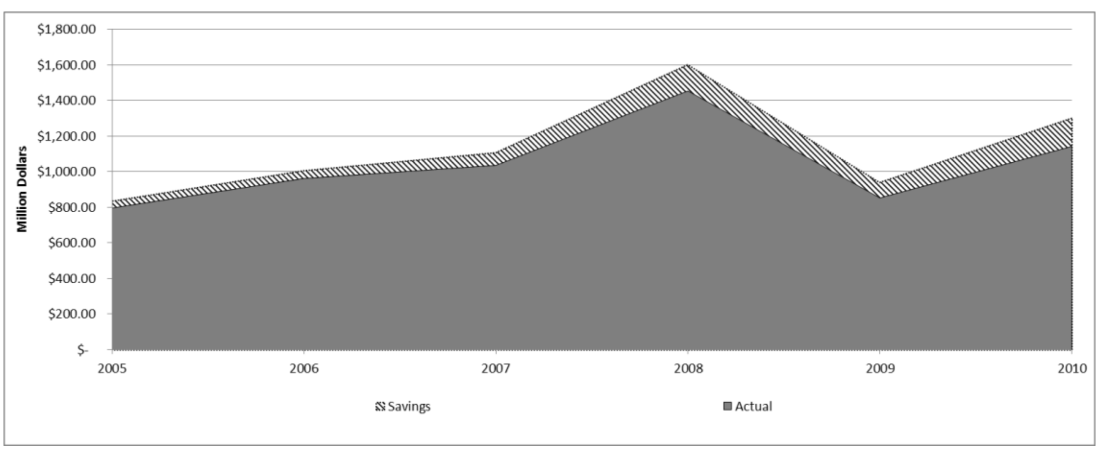
Figure 14 represents the cost of each fuel as a percentage of Hawaii's GSP. Consistent with other metrics that consider electricity, fuel consumption in the power sector and refinery activity in the industrial sector are excluded to avoid double counting. As expected, the chart reveals the vast majority of the burden of fuel cost is found in petroleum and electricity consumption.

Figure 14: Fuel Cost as Percent of Hawaii GSP



The second calculation in this metric considers expenditures saved due to energy efficiency programs and improved generation efficiency. In Figure 15, the solid area represents actual energy expenditures as reported by EIA and the dotted lines show hypothetical expenditures had the energy efficiency savings not been achieved and the aggregate sales heat content remained at the baseline level.

Figure 15: Actual Energy Expenditures Compared to Hypothetical 2005 Aggregate Heat Content without Energy Displacement



3.9 Metric 9: Reducing environmental impacts

Since this metric does not have any calculations, the spreadsheet model does not include a dashboard or interactive tab.

3.10 Metrics 10, 11, and 12: Percentage attainment of Hawaii Energy Goals (RPS, EEPS, and HCEI)

Overview

Hawaii has established a Renewable Portfolio Standard (RPS), an Energy Efficiency Portfolio Standard (EEPS), and a set of Hawaii Clean Energy Initiative (HCEI) goals. Progress towards these goals is reported in metrics ten, eleven, and twelve. Hawaii's RPS requires electric utilities to use generation from renewable sources equal to 15% of net electricity sales by December 31, 2015, 25% by December 31, 2020, and 40% by December 31, 2030. The EEPS requires a reduction of 4,300 GWh due to energy efficiency or displacement technologies by 2030. The HCEI sets a goal (which is not a mandate) that 40% of projected consumption in 2030 will be met by renewable sources and 30% of projected consumption will be reduced by 30% due to energy efficiency. Unlike the RPS and the EEPS which apply only to electricity, the HCEI goals also apply to fuels used in the ground and marine transportation sectors.

Two versions of RPS are displayed in the model reflecting the two versions of the RPS established in Hawaii statutes. The first counts both renewable generation and energy displacement technologies towards meeting the standard. Beginning January 1st, 2015, the standard will no longer include energy efficiency or displacement technologies, such as solar hot water heating, toward the necessary percentage. Therefore, this model provides both calculations for RPS. Figure 16 shows MWh attributed to conventional generation, renewable generation, and energy efficiency.

The model does perform some calculations to track EEPS progress and can be seen in **Error! Not a valid bookmark self-reference.**. Progress is presented in a couple ways. First, savings are expressed as a fraction of the 4,300 GWh EEPS goal as stated in HRS § 269-96(b) legislation. Since the 4,300 GWh goal was calculated as 30% of 2030 projected consumption, the EEPS metric is also presented as a fraction of the corresponding 2030 sales estimate, 14,333 GWh.

Since HCEI goals are similar to RPS and EEPS, much of the necessary data to calculate this metric has already been developed. One necessary addition was to calculate the progress toward reducing petroleum consumption of the transportation sector. The HCEI metric therefore also includes transportation fuel use as a percentage of projected fuel use. Calculations are detailed in Table 23.

Table 22: Energy Efficiency Portfolio Standard

Calculation	Title	Notes
$AGR_{(u,y)} = \frac{TE_{(u,y)} - TE_{(u,y-1)}}{TE_{(u,y-1)}}$	Annual Growth Rate [%]	$TE_{(u,y)}$ = Total Electricity Sold by utility "u" in year "y" (PUC) [MWh] $TE_{(u,y-1)}$ = Total Electricity sold by utility "u" in year "y" (PUC) [MWh]
$ESB_{(u,p,y)} = \frac{ES_{(u,p,y)}}{4{,}300{,}000}$	Electricity Savings of Baseline [%]	$ES_{(u,p,y)}$ = Electricity Savings by utility, program, and year (PUC) [MWh] $4{,}300$ = Established goal as provided in HRS § 269-96(b) (Legislation) [MWh]
$ES2030_{(u,p,y)} = \frac{ES_{(u,p,y)}}{FD_{(2030)}}$	Electricity Savings as percent of 2030 Forecast [%]	$ES_{(u,p,y)}$ = Electricity Savings by utility, program, and year (PUC) [MWh] $FD_{(2030)} = 14{,}333{,}333$ [MWh]
$FD_{(2030)} = 14{,}333{,}333$	Forecast Demand for 2030 [MWh]	$4{,}300{,}000/.3$
$ES_{(u,y)} = \frac{ES_{(u,y)}}{TE_{(u,y-1)}}$	Electricity Savings of Total Energy [%]	$FFEC_{(u,y)}$ = Electricity Savings by utility in year "y" (PUC) [MWh] $TE_{(u,y-1)}$= Total Electricity sold by utility in year "y-1" (PUC) [MWh]
$FFES_{(u,y)} = \frac{ES_{(u,y)}}{TFE_{(u,y-1)}}$	Electricity Savings of Total Fossil Energy [%]	$ES_{(u,y)}$ = Electricity Savings by utility in year "y" (PUC) [Million kWh] $TFE_{(u,y-1)}$= Total Fossil Electricity sold by utility in year "y-1" (PUC) [Million kWh]
$FFEC_{(u,y)} = TFE_{(u,y-1)} - TFE_{(u,y)}$	Fossil Fuel based Electricity Change [MWh]	$TFE_{(u,y-1)}$ = Total Fossil Fuel Electricity sold by utility in year "y-1" (PUC) [MWh] $TFE_{(u,y)}$ = Total Fossil Fuel Electricity sold by utility in year "y" (PUC) [MWh]

Table 23: Transportation Consumption

Calculation	Title	Notes
$TP2030_y = \frac{TPU_{(s,y)}}{TU2030}$	Transportation Fuel Use as Percent of Projected Transportation Fuel Use in 2030	$TPU_{(s,y)}$ = Transportation Petroleum Use using energy source in year y (EIA) [Million Gallons] **TU2030** = Projected Transportation Fuel Demand in 2030 (DBEDT Information Requested by Act 203) [Million Gallons]
$RTPU_y = \sum_{s \in Sources} \frac{RTPU_y}{TPU_{(s,y-1)}} \times 100$	Reduction in Transportation Petroleum Use in year y [%]	$RTPU_y$ = Reduction in Transportation Petroleum Use in year y (Calculation) [Billion BTU] $TPU_{(s,y-1)}$ = Transportation Petroleum Use using energy source in year y-1 (EIA) [Billion BTU]

$RTPU_y = \sum_{c \in Sources} TPU_{(cy-1)} - TPU_{(cy)}$	Reduction in Transportation Petroleum Use in year y [Billion Btu]	$TPU_{(cy-1)}$ = Transportation Petroleum Use using energy source in year y-1 (EIA) [Billion BTU] $TPU_{(cy)}$ = Transportation Petroleum Use using energy source in year y (EIA) [Billion BTU]

Issues and Data Gaps

The Hawaiian Electric Company (HECO) reports data annually regarding kWh generated by renewable energy and displaced through demand-side technologies for its three divisions, HECO, HELCO, and MECO. Kauai Island Utility Cooperative (KIUC) provides similar reports. Values from these reports are documented and presented individually and also were aggregated statewide to summarize attainment of the Renewable Portfolio Standard (RPS), Energy Efficiency Portfolio Standard (EEPS), and Hawaii Clean Energy Initiative (HCEI) goals. These datasets are complete dating back to 2005. Prior to 2005, energy generated by renewable sources is given as a total, but not separated out by type of renewable generation. For energy savings numbers, the earliest reports found were for 2005. If additional data are found, they can be easily updated in the "Inputs" tab.

Finally, all EEPS data and cell formulae are subject to amendment based on the Public Utility Commission's goal setting, which is expected to be released in January, 2014. At that time, the EEPS model can be revised if needed.

Update Procedures

All datasets for metrics ten, eleven, and twelve are used in metrics four, five, and eight, shown in **Error! Not a valid bookmark self-reference.**. If these earlier metrics have already been updated, data within those tabs can be copied and pasted into the related tabs for these metrics. The largest time savings would be in the "Inputs" tab, as this is a very manual update process. If previously updated metrics are used to populate these datasets, update time for each should be around fifteen minutes. If updated using source files, the "Inputs" tab would take around two hours and "DBEDT" and "EIA Consum" would each take around twenty-five minutes. As with all metrics, all columns and rows in the new datasets must be identical to the older datasets. If new columns are found, they should be added to the far right of the cell block and if new rows are added, they should be moved to the far bottom of the cell block.

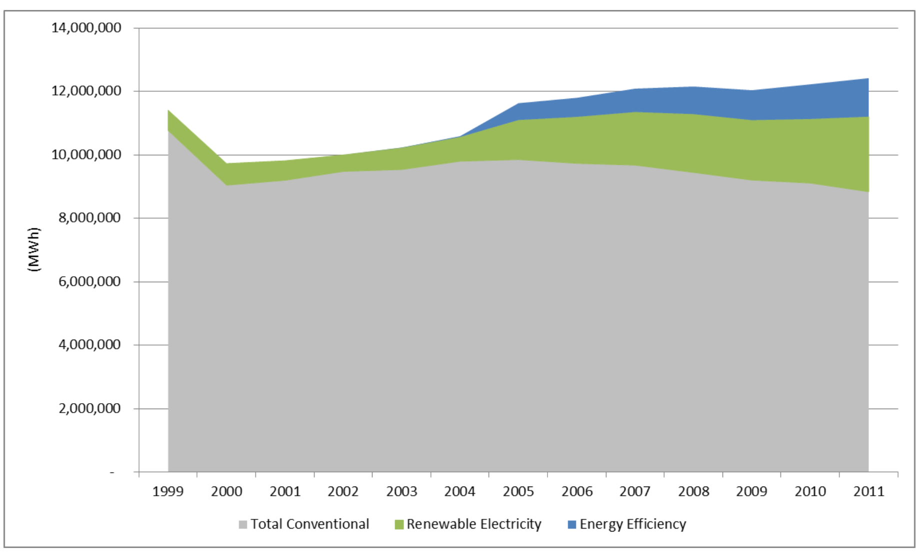
Table 24: Data Sources and Notes for Metrics 10, 11, and 12

Tab	Date of Release	Source	Notes	Freq
Inputs	November	http://www.heco.com/vcmcontent/StaticFiles/pdf/2012-05-04_RPS%20Report_2011.pdf	PDF with a fairly manual update. Google HECO RPS REPORT for 2012; Report should contain tables detailing energy savings and renewable generation	A
DBEDT	7th of each month	http://hawaii.gov/dbedt/info/economic/data_reports/energy-trends	Look for "Monthly Energy Trends" link. Biodiesel is presented by DEBDT on a monthly basis. EIA will begin to report on biodiesel in 2011. Check that rows are the same	M
EIA Consum	June 28th	http://www.eia.gov/state/seds/seds-states.cfm?q_state_a=HI&q_state=Hawaii#undefined	Click on "Consumption" heating. Download "All Consumption Estimates" CSV for Hawaii only. This is in the right column of links. Check that rows are the same	A

Preliminary Results

Hawaii has been making substantial progress towards both renewable and energy efficiency portfolio standards. Figure 16 plots conventional generation, renewable generation and energy savings. Hawaii's RPS requires that 40% of the state's estimated 2030 total energy sales are renewable. Statewide renewable generation, including distributed generation, has grown from 4.5% of 2030 sales projection in 1999 to 8.0% in 2011.

Figure 16: Conventional Generation, Renewable Generation, and Energy Efficiency Savings



Below, Figure 17 shows renewable energy generated as a percent of total sales in 2011 and Figure 18 shows statewide energy saved as a percent of total electricity sales in 2011.

Figure 17: Renewable Energy Generated as Percent of Total Energy Sold in 2011

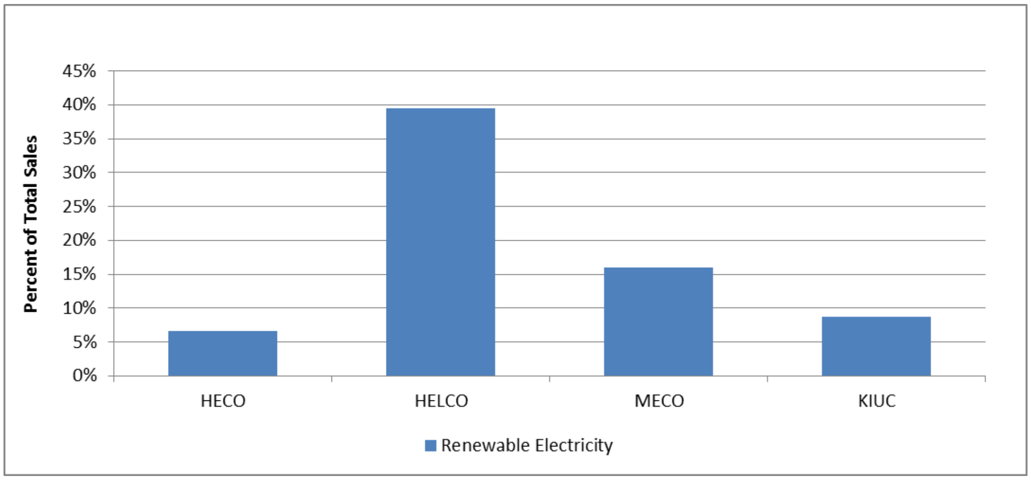


Figure 18: Energy Saved as Percent of Total Energy Sold in 2011

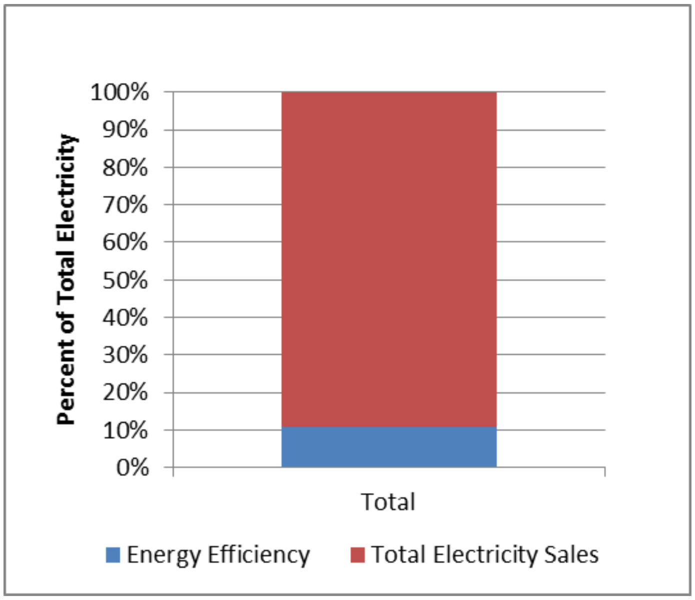
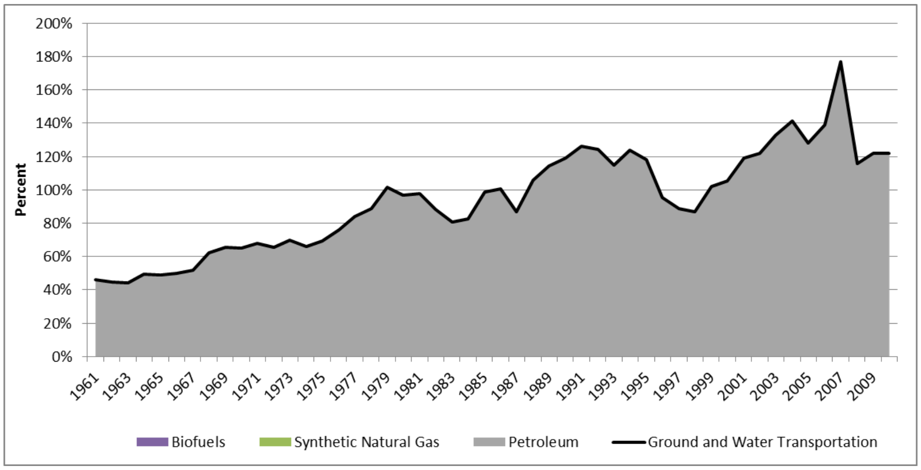


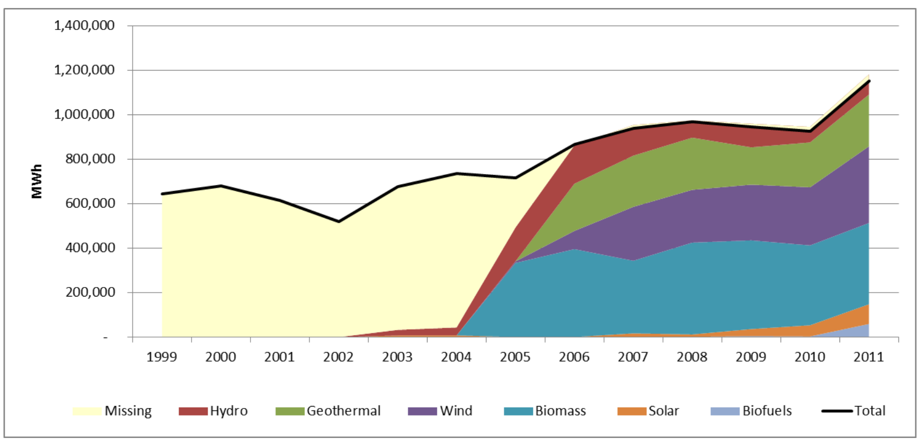
Figure 19 shows the fuel consumption of the transportation sector as a percent of projected 2030 transportation fuel use, broken out by fuel type. This metric is calculated using EIA data. Since DBEDT's earliest biodiesel data is from late 2010, and the most recent EIA consumption level data are for 2010, there is not enough overlap to draw meaningful conclusions. As these data become more available, this chart will become increasingly meaningful.

Figure 19: Annual Percent Reduction in Petroleum Used for Ground and Water Transportation



The final part of this metric calculates generation from local sources, including hydro power, geothermal, wind, biomass, solar, and biofuels. Figure 20 stacks these various fuels to add up to total generation from local fuels. The model allows the user to stack each fuel individually to see the contribution of each fuel without the influence of other methods of generation.

Figure 20: Renewable Generation by Fuel



3.11 Metrics 13 and 14: Current greenhouse gas emissions as a percentage of 1990 emissions and percent of necessary reductions

Overview

Metrics thirteen and fourteen use EPA estimates of Hawaii emissions to express attainment of goals to reduce emissions to 1990 levels. Metric thirteen presents tons of CO_2e emissions in each year after 1990 as a percent of tons of 1990 emissions. The metric is also expressed as percentage progress toward 1990 levels. This calculation is shown in **Error! Not a valid bookmark self-reference.**.

Table 25: Attained Reductions as Percent of Necessary Reductions

Calculation	Title	Notes
$PNRA_y = \frac{GHG_{(y-1)} - GHG_y}{GHG_{(y-1)} - GHG_{1990}}$	Percent GHG Reductions Needed Attained in year y [%]	$GHG_{(y-1)}$ = Greenhouse Gas emissions in year y-1 (EPA) [$MMTCO_2$e] $GHG_{(y)}$ = Greenhouse Gas emissions in year y (EPA) [$MMTCO_2$e] $GHG_{(1990)}$ = Greenhouse Gas emissions in 1990 (EPA) [$MMTCO_2$e]

Issues and Data Gaps

EPA data are consistent with other calculations in our model and are expected to be released into the future. Neither gaps nor other issues are expected to disrupt these metrics.

Update Procedures

Error! Not a valid bookmark self-reference. lists the EPA file that contains all data needed to calculate metrics thirteen and fourteen. The Excel document should be fairly straightforward to update and shouldn't take more than twenty-five minutes to locate, copy, paste, and verify.

Table 26: Data Sources and Notes for Metrics 13 and 14

Tab	Date of Release	Source	Notes	Freq
Emissions	~ July 23	http://epa.gov/statelocalclimate/resources/state_energyco2inv.html	Go to website and download most recent XLS	A

Preliminary Results

This metric tracks the total statewide emissions since 1990. Table 27 shows emissions dropped below 1990 levels from 1991-2002, at which point they increase to and exceeded 1990 emissions until 2007. From 2008-2010, emissions have been between 87%-91% of those in 1990.

Table 27: Emissions as Percent of 1990 Level

Emissions as % of 1990 levels:	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
All Sectors (MMTCO2E)	21.4	19.4	20.3	18.6	19.9	19.7	18.9	18.5	18.4	18.1	18.5	18.9	20.3	21.3	22.4	23.0	23.2	24.0	19.4	18.5	18.6	-	-
All Sectors (% of 1990 levels)	100%	91%	95%	87%	93%	92%	88%	86%	86%	85%	87%	89%	95%	100%	105%	108%	109%	113%	91%	87%	87%	0%	0%

Figure 21 breaks the percentages out by sector, revealing that the largest contributors are the electric power sector and the transportation sector. As with the earlier emission and energy content metrics, industrial, commercial, and residential sectors are considering direct fuel consumption only. Their electricity use is contained in the emissions of the electric power sector.

Figure 21: Emissions as Percent of 1990 Levels

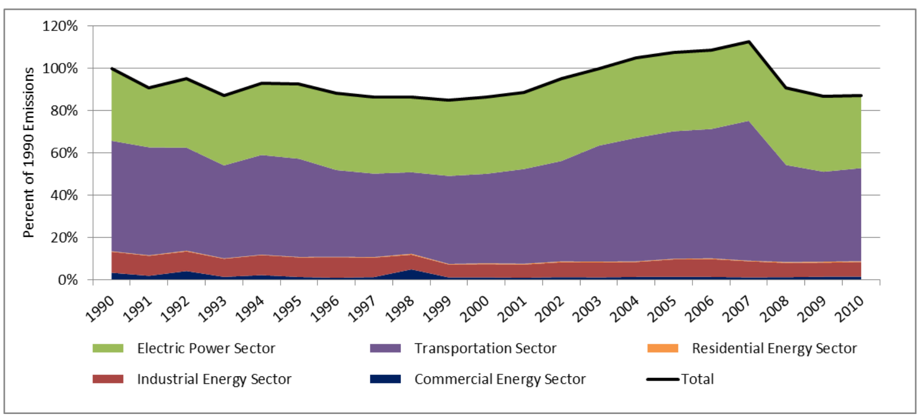
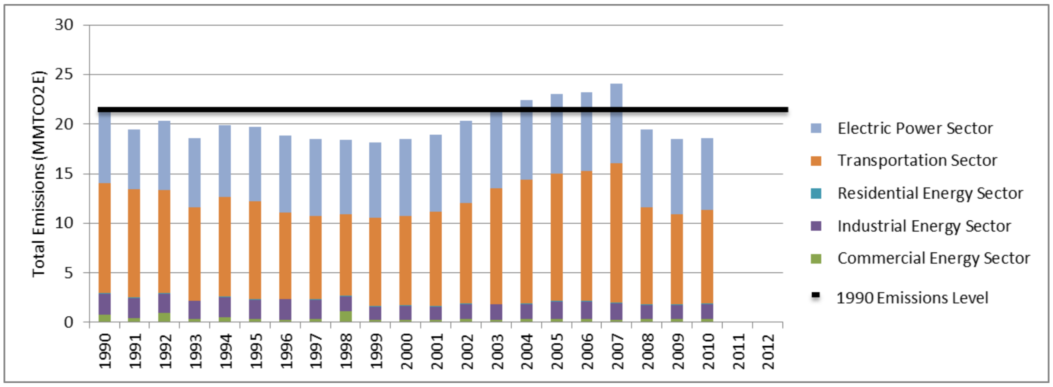


Figure 22 shows annual emissions figures broken down by sector and the black line indicates 1990 levels. Following an increasing trend in emissions from 2000-2007, emissions appear to have returned close to 1990 levels in 2008-2010.

Figure 22: Annual Emissions compared to 1990 Levels



3.12 Metrics 15 and 16: MW of renewable energy projects installed and MWh and MWh per year energy savings from energy efficiency programs

Overview

Metrics fifteen and sixteen tabulate the renewable and energy efficiency projects that are installed.

Issues and Data Gaps

Most data for these metrics are taken from EIA's estimates of installed generation capacity throughout the state. For the majority of utility-owned and third party generation ownership, the source is satisfactory. However, EIA does not provide an accurate report on customer-side photovoltaic capacity. For these data, HECO provides data for their territories and KIUC provides these figures in their NEM filing with the Hawaii Public Utilities Commission.

Update Procedures

The datasets that are needed to update metrics fifteen and sixteen are listed below in **Error! Not a valid bookmark self-reference.**. The "PV" tab is small, but includes manual input of PV capacity numbers from PDF documents. "Existing_capacity_state" is the most important document for metric 15 and should be carefully pasted, after verifying that columns between the new and old datasets match. The "New Plants", "Retirements", "Planned Capacity", "Projects List" and "Projects in Pipeline" tabs are all included to provide further insight, but are not incorporated into the dashboard. Data for the "Planned Capacity" tab was produced by EIA. Although they estimated an update would be available by

November, 2012, it has not yet been released. It is currently unknown whether this dataset will be updated in the future. Each of these tabs should take around twenty-five minutes to update.

The "Inputs" tab is used in metric sixteen and is identical to the "Inputs" tab in metrics four, five, eight, ten, eleven, and twelve. If previously updated metrics are used to populate this dataset, update time should be around fifteen minutes. If updated using source files, the "Inputs" tab would take around two hours.

Table 28: Data Sources and Notes for Metrics 15 and 16

Tab	Date of Release	Source	Notes	Freq
PV	April	http://www.heco.com/portal/site/heco/menuitem.20516707928314340b4c0610c510b1ca/?vgnextoid=3be8e20c52a1b310VgnVCM10000005041aacRCRD&vgnextfmt=default	PDF document has updated PV capacity numbers	A
PV	May	KIUC numbers can be found in NEM Filing to PUC	PDF NEM Filing has updated PC capacity numbers	A
existing_capacity_state	Jan; Aug	http://www.eia.gov/electricity/capacity/	Download "Existing Units by Energy Source" and sort by state. Be sure to align columns correctly	6 MO.
New Plants	Jan; Aug	http://www.eia.gov/electricity/capacity/	Download "Unit Additions" and sort by state. Be sure to align columns correctly; Data not used directly in calculations, but good for reference	6 MO.
Retirements	Jan; Aug	http://www.eia.gov/electricity/capacity/	Download "Unit Retirements" and sort by state. Be sure to align columns correctly; Data not used directly in calculations, but good for reference	6 MO.
Planned Capacity	Supposedly Nov 2012, release not yet seen	http://www.eia.gov/cneaf/electricity/epa/planned_capacity_state.xls	Link should provide most recent list of proposed generation; Data not used directly in calculations, but good for reference	DK
Projects List	Ongoing	https://energy.ehawaii.gov/epd/public/energy-projects-list.html	Link should provide most recent list of proposed generation; Data not used directly in calculations, but good for reference	DK

Projects in Pipeline	last update seen in Oct 2012	http://energy.hawaii.gov/programs/renewable-energy-projects-in-hawaii	Link should provide most recent list of proposed generation; Data not used directly in calculations, but good for reference	DK
Inputs	November	http://www.eia.gov/state/seds/seds-states.cfm?q_state_a=HI&q_state=Hawaii#undefined	Click on "Consumption" heating. Download "All Consumption Estimates" CSV for Hawaii only. This is in the right column of links. Check that rows are the same	A

Preliminary Results

Table 29 shows total installed renewable energy and Table 30 shows total electricity saved from energy efficiency programs. EIA classifies biofuel generation as "Other Biomass". Therefore, in 2009, the jump in Other Biomass is due to the 113 MW Campbell Industrial Park Generating Station biodiesel plant. Beyond summing renewable capacity and energy savings, these metrics do not involve calculations.

Table 29: MW of Renewable Energy Installed in Hawaii

Renewable MW Installed:	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
All Renewables	238	232	190	192	192	196	228	252	261	386	402	474
Geothermal	35	35	35	35	35	35	35	35	35	35	35	35
Hydroelectric	27	26	25	23	23	25	25	25	25	25	25	25
Other Biomass	155	151	110	114	114	114	114	114	114	227	227	227
Other Gases	9	9	9	9	9	9	9	9	9	9	9	12
Solar Thermal and Phot	0	0	0	0	0	2	2	5	14	26	44	83
Wind	12	11	11	11	11	11	43	64	64	64	62	92

Table 30: MWh Energy Saved from Energy Efficiency Programs

MWh Energy Saved:	2004	2005	2006	2007	2008	2009	2010	2011
HECO		292,000	340,000	453,000	604,007	651,278	738,337	821,136
HELCO		49,000	54,000	57,000	47,051	49,760	62,359	76,622
MECO		77,000	82,000	88,000	79,835	88,593	98,813	111,306
KIUC	19,037	20,855	21,349	21,361	19,233	19,217	16,911	18,264
Total	**19,037**	**438,855**	**497,349**	**619,361**	**750,126**	**808,848**	**916,420**	**1,027,328**

3.13 Metric 17: Impacts of state transportation sector initiatives on fuel consumption

Overview

The final metric considers four transportation initiatives that HCEI has set for 2015. They include improving vehicle efficiency, reducing miles traveled, incorporating renewable fuels into the transportation sector, and accelerating the deployment of electric vehicles. As data continue to become available, this metric can be further developed. Emissions and energy consumption from the transportation sector are calculated in earlier metrics.

4. Conclusion

UHERO and HEPF have compiled a robust and comprehensive set of metrics to analyze and understand Hawaii's past, present, and future energy portfolio. DNV KEMA refined the metrics; researched, collected and documented the necessary data; and developed an Excel-based model to track data and perform the necessary calculations and updates. Because the model uses public data, it can be easily and openly shared with all who are interested.

The model incorporates the best data currently publicly available, but limitations still exist for generating several of the metrics. Most significantly, EIA's widely accepted import and consumption datasets do not directly report quantities of domestically sourced fuel. Due to this gap, the model derives domestic purchases from total consumption and foreign imports. While this approach is an acceptable estimate, it is not ideal and may prove to be increasingly problematic as increasing proportions of petroleum supplies are provided from domestic sources with the retiring of Hawaii refinery capacity.

Hawaii is making marked progress towards its various goals, but continues to be heavily dependent on petroleum. This dependency puts the state at risk of exposure to the rises and falls of global petroleum price. As the state continues to invest in renewable generation and displacement technologies, the metrics supported by this report will help inform utilities, the PUC, policy makers, economists, and the public of this progress and related impacts.

HEPF and DNV KEMA welcome and encourage comments on data sources, errata, or general recommendations for future improvement. Comments should be directed to HEPF by email to Carl Freedman at: public@hdamaui.com. The most current updated versions of the report, model and supporting spreadsheets are available for download from the HEPF web site: http://www.hawaiienergypolicy.hawaii.edu/.

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