Hawaii Refinery Task Force – Refinery Closure Report

Adopted November 15, 2013

Interim Report
November 12, 2013

Submitted to:
Hawaii Department of Business,
Economic Development & Tourism

Submitted by:
ICF International
9300 Lee Highway
Fairfax, VA 22031
&
Poten & Partners, Inc.
805 Third Avenue
New York, NY 10022

ICF Contact
Tom O'Connor
757-903-4367

[This Page Intentionally Left Blank]

Table of Contents

List of Exhibits

List of Acronyms and Definitions

b/d	Barrels per day
Blendstocks	Motor gasoline blending components that are to be blended with oxygenates to produce finished gasoline. This can also refer to foreign gasoline that does not meet U.S. specifications and must be blended or re-refined to be sold in the United States.
BTU	British thermal units
CNG	Compressed Natural Gas
Demurrage	The cost of delaying a ship. Busy channels, occupied berths, commercial considerations, lack of shore tankage, pumping limitations, and a host of other eventualities related to how or where a charterer uses a vessel can prevent it from loading or unloading promptly. When they do, the ship's owner charges for a waiting time.[1]
DBEDT	The Hawaii Department of Business, Economic Development, and Tourism
DOE	U.S. Department of Energy
E10	Gasoline composed of a certain proportion of fuel ethanol. E10 indicates gasoline with ethanol content between 5 percent and 10 percent.
E15	Gasoline composed of a certain proportion of fuel ethanol. E15 indicates gasoline with ethanol content between 10 percent and 15 percent.
E85	Gasoline composed of a certain proportion of fuel ethanol. E85 indicates gasoline with ethanol content between 51 percent and 85 percent.
EIA	U.S. Energy Information Administration
EIIRP	Energy Industry Information Reporting Program
EPA	U.S. Environmental Protection Agency
GWh	Gigawatt hour
HECO	Hawaiian Electric Company, Inc.
HELCO	Hawaii Electric Light Company, Inc.
HIBOB	Hawaii Blendstock for Oxygenate Blending
HFFC	Hawaii Fueling Facilities Corporation

[1] Poten & Partners. “Industry Glossary,” Accessed June 4, 2013. http://www.poten.com/Content.aspx?id=17160

HRTF	Hawaii Refinery Task Force
HSFO	High Sulfur Fuel Oil
KIUC	Kauai Island Utility Cooperative
KPLP	Kalaeloa Partners
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LSD	Low Sulfur Diesel
LSFO	Low Sulfur Fuel Oil
LR1, LR2, MR	Long Range 1, Long Range 2, Medium Range Vessel size
Mbbl	Thousand Barrels
Mcfd	Thousand cubic feet per day
MMcf	Million cubic feet
MGY	Million Gallons per Year
MECO	Maui Electric Company, Ltd.
MPG	Miles per Gallon
MWh	Megawatt hour
PHEV	Plug-In Electric Vehicle
RFO	Residual Fuel Oil
SNG	Synthetic Natural Gas
SPM	Single Point Mooring[2]
TBD	Thousand Barrels per Day
ULSD	Ultra-Low Sulfur Diesel
VMT	Vehicle Miles Traveled

[2] While Chevron and HEI both utilize multi-point mooring systems, this report employs the widely-used term "SPM" to refer to both of these systems.

Issues Addressed in the Interim Report

Under Executive Order 13-01, the Hawaii Refinery Task Force is assessing the impacts of changes in Hawaii's refinery capacity and providing advice and recommendations to the Department of Business, Economic Development & Tourism and Governor Abercrombie on matters involving a future fuels ecosystem. For the Interim and Final Reports, the Task Force is conducting analysis of future options for Hawaii fuels supply in the event that one or both refineries close.

There is an urgent need for this analysis. In the recent past, Chevron had indicated that its Hawaii refinery has not financially performed as well as other Chevron assets, calling into question the refinery's future. Prior to the 2013 sale of the Tesoro refinery to Par Petroleum, Tesoro announced that it would cease operations of the refinery after more than a year of attempting to find a buyer. Tesoro's recent sale of its Hawaii refinery to Par Petroleum does not alter the potential for the future loss of one or both refineries, and the risk to Hawaii consumers of associated fuel supply and price disruptions.

This Interim Report builds on the Initial Report presented to the Governor on June 30, 2013. The Initial Report focused on the impacts of the Tesoro refinery closure on Hawaii markets, and recommended actions to consider for mitigating the risks of price anomalies and supply disruptions. Concurrently with the June 18th Hawaii Refinery Closure Task Force meeting, Tesoro announced the sale of the refinery to Par Petroleum. With this announcement, the scope of the Interim Report was refocused to examine the issues which challenge refinery sustainability, and to consider options to mitigate the impacts of the potential loss of one or both refineries. Among other issues, it examines the tensions between the initiatives underway in Hawaii to reduce energy demand, on the one hand, and the economic viability of refineries in the state, on the other. The primary issues addressed in this report include:

1. **Transition Period Status and Refinery Update:** An update on the status of the transition from Tesoro Corporation to Par Petroleum (hereafter referred to as Hawaii Independent Energy or HIE) in the operation of the former Tesoro refinery and distribution assets. This includes an assessment of the roughly five month period of operations during which the Tesoro refinery was closed and petroleum supply from that refinery was replaced with imports.
2. **Hawaii Petroleum Refining Challenges:** Identification of the potential challenges to the profitable operation of the Hawaii refineries stemming from Federal and State regulatory issues, as well as impacts from the Hawaii Clean Energy Initiative (HCEI) and liquefied natural gas (LNG) initiatives to develop renewable and cleaner power generation alternatives, increase energy efficiency , and promote transportation fuel alternatives. Together, these various initiatives may have a significant impact on refinery sustainability in Hawaii.
3. **Refinery Closure Options Analysis:** An evaluation of options which should be considered to: (a) prepare Hawaii for long-term operation on an imported petroleum supply basis; (b) address specific regulatory challenges facing the refineries; and (c) replace lost refinery supply through a combination of energy efficiency, distributed generation, utility-scale renewables, and other approaches.

[This Page Intentionally Left Blank]

Summary Findings

This Interim Report demonstrates that, in the near term, the initiatives underway in Hawaii to replace petroleum based fuels will have a substantive impact on reducing fuels consumption for power generation, including low sulfur fuel oil (LSFO), diesel, and naphtha. Larger impacts may occur by 2025 and 2030, as large scale renewable generation projects, as well as possible LNG importing infrastructure, are financed and developed. Major public funding projects through the end of this decade will continue to focus primarily on reducing the use of fossil fuels for power generation, and will have a much smaller impact on transportation fuels such as gasoline, diesel, and jet fuel by 2020.

The regulatory issues that have been proposed and enacted by the Federal Government and the State of Hawaii, as currently stated, may require substantial reductions in refinery profit margins to comply with the regulations. These regulations are likely to result in the closing of one or both refineries prior to 2020 unless specific regulatory requirements can be modified or addressed by other options.

Key findings of this report include the following:

1. **There are substantial risk factors that could lead to future refinery closures.**

    a. One or both of Hawaii's refineries may not be able to withstand the threats to their profitability before 2020 and will need to close. It is likely that both refineries will close unless some of the regulatory requirements can be mitigated or otherwise offset.

    b. The challenges facing refineries prior to 2020 primarily result from Federal and State regulatory requirements, as well as initiatives such as HCEI, which reduce demand for refinery fuels. In general, these regulatory changes will require refiners to export low sulfur fuel oil (LSFO) into markets such as Singapore, rather than to sell to HECO for power generation. The impact of this shift in LSFO and other sales will be a substantial margin loss.

    c. Taken together, the reductions in fossil fuel usage stemming from renewable generation, energy efficiency and distributed generation, plus existing trends for increasing vehicle CAFE standards, penetration of and electric vehicles, proposed biodiesel and biomass initiatives, and initial development by Hawaii Gas of ISO LNG container plans, will combine to reduce total statewide fossil fuel dependence by 6,220 b/d or 4.9% by 2015; and by 20,660 b/d, or 16.4% by 2020. The bulk of these reductions are in power generation, with an over 50% reduction in fossil fuel usage for electricity by 2020 versus 2012 demand. Greater impacts can be expected after 2020 as additional renewable initiatives and inter-island grid projects may be developed, along with potentially expanded LNG importing.

    d. These impacts could occur as early as 2016 or 2017, when the new EPA Mercury and Air Toxic Standards (MATS) must be met, or they may occur more gradually as renewable power generation projects and energy efficiency initiatives gradually erode demand for fossil fuels for power generation. Other regulatory issues (EPA's Tier 3 gasoline sulfur specifications and Hawaii's greenhouse gas requirements for stationary sources) will, if implemented, impact by 2017 and 2020 respectively.

e. The MATS regulation may require more expensive diesel fuel to be used for power generation rather than LSFO, potentially increasing power costs to Hawaii consumers by as much as $160 million annually (roughly a 5% increase in consumer costs), although HECO will explore blending options with refiners which could reduce this impact by at least half.

f. The Final Report will seek to identify processes for tracking the emissions reductions stemming from HCEI initiatives and other renewable projects. This may provide opportunities for pooling of emissions reductions to help refiners achieve required reductions by 2020. This alternative is provided for in the recent DOH compliance procedures, and may assist refiners in mitigating impacts of compliance.

2. **Accessibility to, and improvements in, the infrastructure for petroleum imports is critical to sustain supply with the refineries closed.**

    a. Hawaii will remain highly dependent on petroleum fuels for transportation (gasoline, diesel, jet fuel, and bunker fuels) through 2020, and likely well beyond. This stems from the fact that the bulk of the clean energy initiatives impact the use of petroleum for power generation, rather than transportation fuels.

    b. In the event that one or both refineries close, the petroleum infrastructure within and around the two refineries (storage tanks, offshore mooring structures, pipelines, etc.) must continue to be accessible to petroleum industry stakeholders to efficiently import and distribute products. These portions of Hawaii's infrastructure are absolutely critical to sustaining petroleum supply on an import basis and must be operational even if the refineries are not. The State may need to be prepared to work with owners of these assets to assure that any refinery closure will not result in a shutdown of these assets.

    c. Future planning for the Barge Harbor, HECO supply, Hawaii Gas supply, etc. should recognize that scenarios must include assessments of the impacts of refinery closures. Projects such as HECO's $30 million pipeline to receive fuel from the Barge Harbor, and other projects to expand fuel distribution flexibility should be evaluated and, if deemed essential, prioritized with expedited permitting. Continued focus on modifying Hawaii's gasoline specifications and resolving Pier 51 priorities, while less urgent now that the HIE refinery is operational, should be prioritized now rather than after another closure announcement, with action plans memorialized.

    d. Creative biomass projects should be supported, particularly those that develop both alternative transportation fuels and low carbon fuels for HECO (e.g., Hawaii BioEnergy, Aina Koa Pono). Some biomass projects could leverage refinery capability to convert the biomass into fuel products, thereby helping to sustain refinery operation while simultaneously working to meet HCEI goals. These types of projects should be jointly pursued by entities such as GIFTPAC and the refiners, with State oversight.

3. **Hawaii Clean Energy Initiatives (HCEI) and other trends are combining to reduce demand for fossil fuels in Hawaii, particularly in the power generation sector.**

    a. Taken together, Hawaii's significant progress in energy efficiency, rapidly increasing distributed generation, and a pipeline of likely utility-scale renewable generation projects are having a significant impact on the state's power sector. In terms of fossil fuel demand, these trends are estimated to displace 5,600 b/d of petroleum product consumption by 2015 and 17,100 b/d by 2020. This would represent a reduction in demand for fossil fuel use in power generation of over 50% from 2012 levels.

    b. By contrast, there will be rather modest effects on the transportation sector over this time period, with Federal CAFE standards and increased penetration of EV, biodiesel and other alternative fuels combining to reduce demand by only 3,600 b/d by 2020. This is a reduction of only 3.7% of current demand for fossil-fuel based transportation fuels in Hawaii.

4. **The gradual phase out of fossil fuels as renewables, bioenergy, LNG, and a connected state power grid develop over the next decade will require very careful planning to ensure stability of the grid and manage costs.**

    a. The development of a robust renewable generation infrastructure beyond 2020, coupled with energy efficiency, distributed generation and a submarine transmission cable between Maui and Oahu that enables greater penetration of renewable generation into the linked power grid, will result in a wholly different Hawaii power infrastructure by 2030. This new energy ecosystem will require the inclusion of resources/technologies to manage the intermittency of renewable power supply, including demand response, energy storage, and quick-start generating units fueled by biofuels or LNG. The integration of these initiatives and the optimization of various energy sources to Hawaii's power supply are major issues that will need to be resolved by the state. The Final Report should include a high level discussion of these and other major challenges in the power sector (e.g. grid reliability, power storage, etc.), and suggest strategies for mitigating key risks and charting a path forward.

    b. The multiple infrastructure initiatives underway in Hawaii to enable renewable fuels, LNG, and expansion of the Barge Harbor are all inter-related, and this makes planning more difficult but also more essential. Coordinated development of these primarily public funded projects is important to: (1) mitigate the exposure to imported fuels stemming from refinery closures; and (2) minimize the potential risk to the state if these major initiatives are not aligned in both technical "syncing" and in timing. For example, determining the proper ratio of renewable resources, conventional resources, storage, etc. for power generation is a key technical question well outside the scope of this study, but vital to future policy and planning. The Final Task Force Report should, at a minimum, attempt to define the key issues that need to be coordinated and suggest a process for doing so.

The remainder of this Interim Report is organized as follows:

- Analysis of the transition operation period and status of the HIE operations;
- Assessment of the challenges facing the petroleum refiners; and
- Detailed discussion of the options for mitigating the potential impacts of refinery closures and helping to reduce the risk of supply and price disruptions.

Transition Period Operation and Refinery Status

The purpose of this section is to provide an update on the petroleum operations during the approximate five month period when the Tesoro refinery was closed, and the completion of the transaction to sell the refinery and distribution assets to Par Petroleum.

Refinery Sale and Restart of Operations

As indicated by various press announcements, the sale of the Tesoro refinery to Par Petroleum was completed on September 25, 2013. Par purchased the shares of Tesoro Hawaii LLC and renamed the company Hawaii Independent Energy, which is operating as a wholly owned subsidiary of Par.

Tesoro and Hawaii Independent Energy (HIE) worked collaboratively to restart the refinery during the summer. Under terms of the agreement, the refinery was turned over to HIE fully operational and with HIE satisfied with the performance of the assets.

Based on discussions with HIE, the refinery was fully operational and producing fuel products prior to the transaction, and operations to this point are as planned. HIE's current plans are to initially operate to meet their customers' demands on Hawaii and then evaluate options for increasing utilization and optimizing refinery performance. HIE officials would not comment on investment plans or other strategies as these are confidential.

HIE is also in the process of reaching out to parties who had contracts with Tesoro to discuss those contracts and business relationships. The status of those discussions is also confidential.

Transition Period Operations

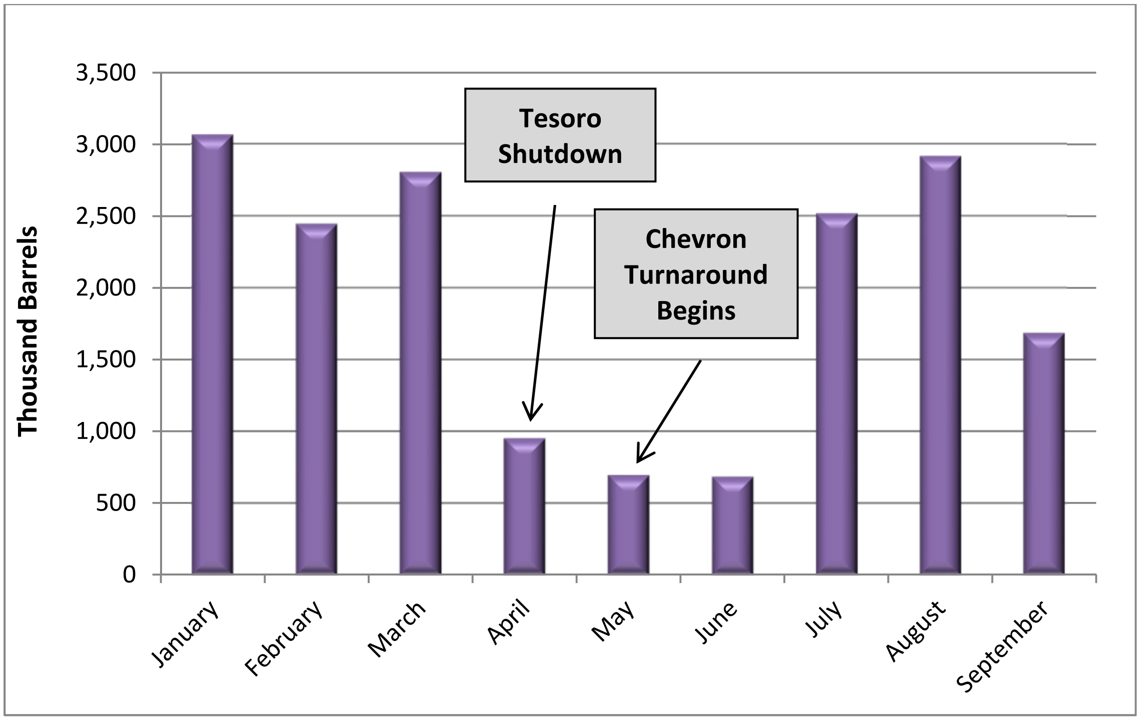
During the approximately five month period during which the former Tesoro refinery was closed, Tesoro supplied its customers with imported products. The import operation is important since it will likely be the primary means of supply in Hawaii should both refineries close. Appendix 1 provides an overview schematic of the Hawaii petroleum supply chain.

Overall, the operation during the transition went very well. There were several issues related to logistics at Pier 51 with the timing of jet fuel deliveries, but sustained supply to airlines was not threatened. Supply to parties in the energy supply chain (KPLP and Hawaii Gas) were maintained by coordination of deliveries and interim contracts.

Import Assessment

Exhibits 1 and 2 below show the trend in crude and product imports in 2013. The crude imports declined in April as Tesoro discontinued crude purchases and then picked up in the late summer timeframe as HIE began bringing cargoes into Hawaii. The crude import level was also impacted by a major Chevron maintenance turnaround in May and June which reduced Chevron crude imports until July.

Exhibit 1: Hawaii Crude Imports, Jan – Sep 2013

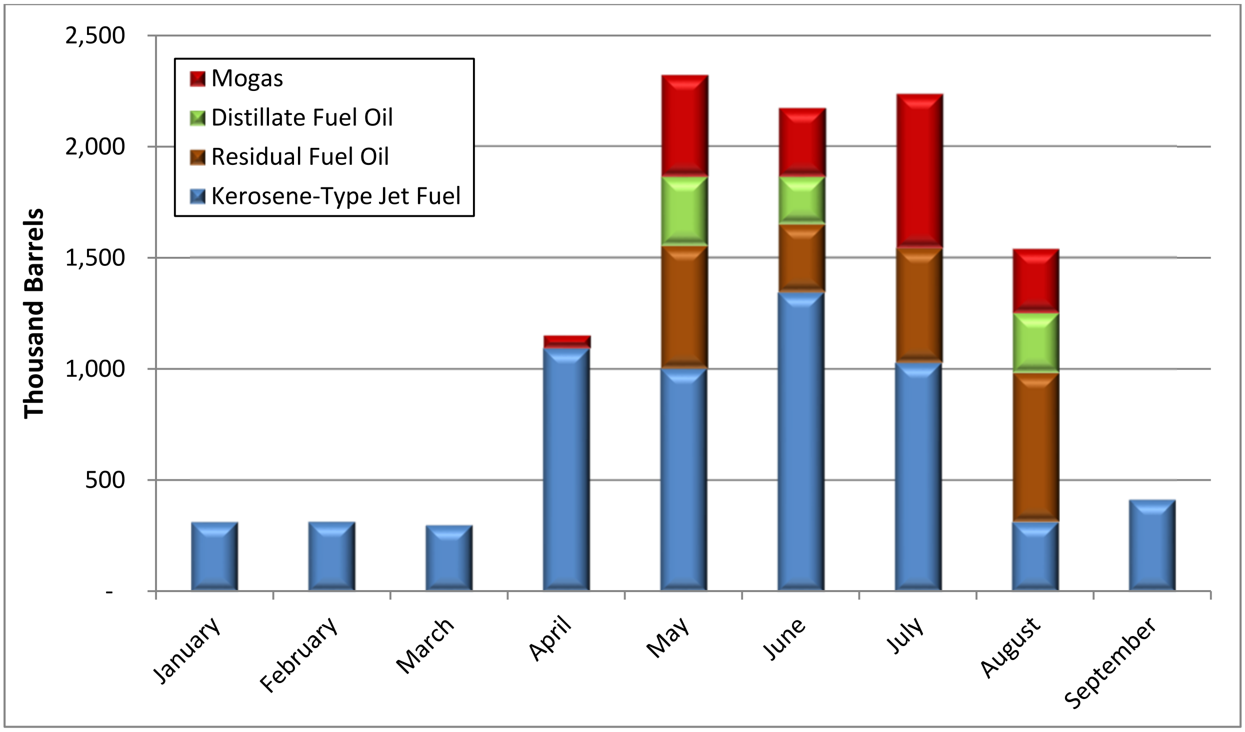


Source: U.S. Customs and EIA.

Initial assessment of the types of crude oil being imported by HIE is that the crude is similar in quality (light, sweet – low sulfur crude oil) to crude that Tesoro purchased. However, Tesoro had purchased over 40% of its first quarter crude supply from Saudi Arabia whereas HIE, to this point, is relying on other market crudes.

Exhibit 2 shows that as crude imports declined, not surprisingly, product imports rose. The exhibit shows a significant increase in jet fuel imports, most of which were from South Korea and some from Japan. Gasoline imports were also primarily from South Korea, but distillate and residual fuel imports were from a mix of Asian and Caribbean sources, and some distillate from Europe.

Exhibit 2: Hawaii Refined Product Imports, Jan – Sep 2013



Sources: EIA Form-814 (Jan-July).
Poten & Partners (Aug-Sep).

The imports cited in these charts are foreign imports which are recorded through U.S. Customs and tracked by the Energy Information Administration (EIA). These do not include movements into Hawaii from mainland sources which would need to be on Jones Act vessels. Jones Act movements are not tracked by EIA, nor are the volumes or types of products carried on these vessels. Shipping records, however, indicate that over this period a number of Jones Act vessels discharged product in Hawaii.[3,4] These deliveries occurred primarily in April, June, and September. It is very possible that both Tesoro and Chevron used these vessels to move product from their West Coast refineries into Hawaii to cover the transition (Tesoro) and turnaround (Chevron). Jones Act vessels also routinely discharge ethanol, so some of these movements were likely ethanol.

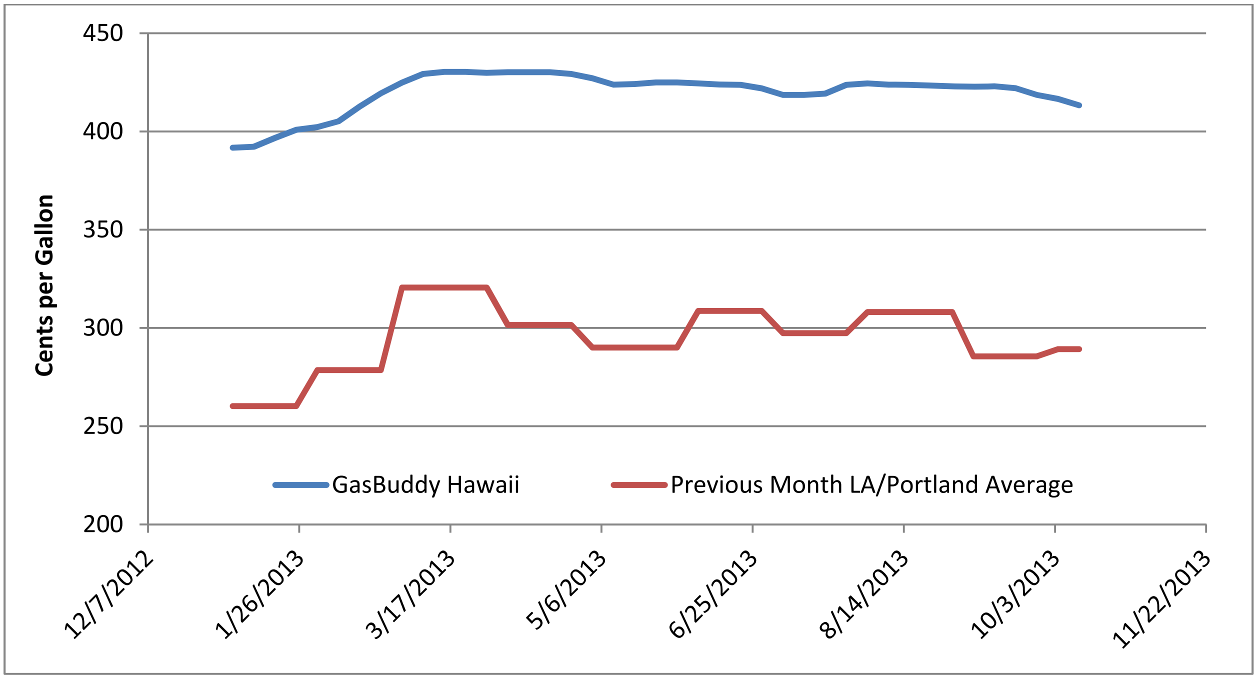
The product imports shown in Exhibit 2 are therefore low versus the actual supply deliveries into Hawaii. However, it would be speculative to estimate the specific volumes moved into Hawaii on the Jones Act vessels. Regardless, it is evident that Tesoro and Chevron took actions to sustain supply into Hawaii over this period.

[3] Vessels included the Overseas Tampa, Boston and Anacortes, the Mississippi Voyager, Empire State and Florida Voyager
[4] Poten & Partners

Gasoline Prices

Examination of Hawaii retail prices against West Coast mainland wholesale markets in ICF's initial report showed that there was minimal indication of any price anomalies due to the transition operation. Exhibit 3 extends the data from late May through September 2013, and there remains no indication that the import based operation has affected the retail price Hawaii consumers pay for fuel. (Note: this exhibit plots the mainland wholesale price from the previous month to account for transportation time to Hawaii. Retail prices are significantly higher due to taxes, dealer costs, trucking, and profits.)

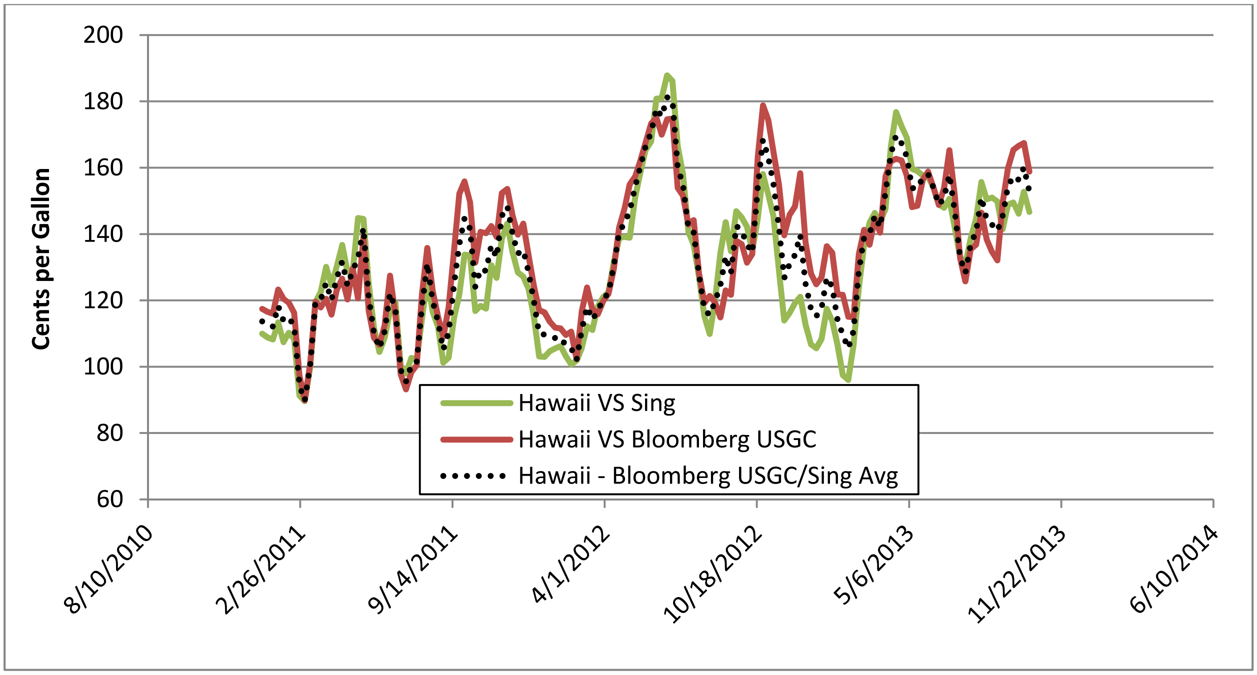
Exhibit 3: Hawaii Retail (Weekly) and Mainland Wholesale (Previous Month) Gasoline Price



Source: GasBuddy Honolulu, HI Regular Gasoline pricing; Bloomberg Los Angeles (LA) 85.5 octane CARBOB Prompt Gasoline pricing (ticker symbol: MOGLCB85 Index); Bloomberg Portland Sub-octane Gasoline Pricing (ticker symbol: MOGHS87P Index).

Exhibit 4 additionally compares the Hawaii retail prices with Singapore and U.S. Gulf Coast wholesale prices. The trend has been relatively stable over the transition period compared to longer term history. Note that, as with Exhibit 3, the retail prices in Hawaii are significantly higher since we are comparing a retail price (with all taxes, dealer costs and profits, and trucking) with a wholesale price.

Exhibit 4: Hawaii Gasoline Spreads vs. USGC/Singapore



Source: GasBuddy Honolulu, HI Regular Gasoline pricing; Bloomberg U.S. Gulf Coast (USGC) CBOB 87-octane Gasoline pricing (ticker symbol: MOIGC87P Index); Bloomberg Singapore 92 Gasoline Pricing (ticker symbol: MOGFM92S Index).

The gasoline pricing results are not surprising because Tesoro generally maintained the wholesale contract terms to its customers. Any actions of distributors or retail dealers to increase price margins over cost did not appear to occur.

Overall the transition operation worked well. While a five month period is not a guarantee of long term sustainability, it does indicate that with proper advance planning and knowledge of demand trends Hawaii consumers can acquire products in the market. The impact of a long term market without any local refinery supply could create upward pressure on transportation fuel prices if Hawaii is competing with Asian markets for fuels supply. This is one reason the interim outlook through 2020 should consider reasonable actions to meet regulatory requirements in a cost effective way for refiners.

[This Page Intentionally Left Blank]

Hawaii Petroleum Refining Challenges

The Hawaii Refinery Task Force (HRTF) is charged with assessing the impacts on Hawaii if one or both of the refineries that supply Hawaii close. The purpose of this section is to identify some of the major challenges faced by the Hawaii refineries and to confirm the necessity to prepare for potential closures.

Refinery Profitability

In recent years both Chevron and Tesoro have indicated that the performance of their Hawaii refinery assets have been poor, and that they may need to consider closure. Clearly, Tesoro made that decision in early 2012, announcing they would seek to find a buyer for the refinery. Failing that, Tesoro announced in very early 2013 that they would close effective May 1, 2013.

Accurate determination of a refinery's profits from an outside party is difficult. Specific data required to do that is not available, however, the refinery's crude runs, size, and process configuration are public record, and in some cases refiners such as Tesoro provide some high level data on refinery profitability and cost.[5] Tesoro reported approximate profits of about $0.50 per barrel in 2010 and 2011, increasing to $1.50 per barrel in 2012[6] (Chevron does not report estimated profits by specific refinery). Various studies in the past 10 years, including the Stillwater report for DBEDT in 2003 and the ICF reports done for the Hawaii Public Utility Commission in 2007 through 2009 (the "PIMAR" reports) have noted the competitive weakness of the Hawaii refinery assets. Simply put, the two refineries are small, required to process expensive sweet (low sulfur) crude oil, and are configured to meet Hawaii's unusual product demands (in comparison to the United States as a whole). This configuration is highly leveraged to production of low valued residual fuel to meet Hawaii's utility and bunkering demands, and high jet fuel demands.

The residual fuel oil yield of Hawaii refineries is roughly 25% of crude oil processed, compared to below 4% for the U.S. refineries as a whole. Consequently, Hawaii refiners are required to purchase expensive crude and produce a lower valued product (residual fuel oil). The configuration of the refineries is in fact ideally suited for Hawaii, but the ability to maintain profitability is challenging.

This report will assume that the refinery base level profits are weak, but sufficient to maintain a marginally profitable operation. A specific estimation of the current profits for each refiner is not critical to the conclusions of this study.

[5] Tesoro Investor Relations, Refineries by Region, http://phx.corporate-ir.net/phoenix.zhtml?c=79122&p=irol-supplementalFinancial
[6] These are the differences between gross margin and manufacturing cost in the Refineries by Region table for Mid Pacific

Threats to Refinery Profitability

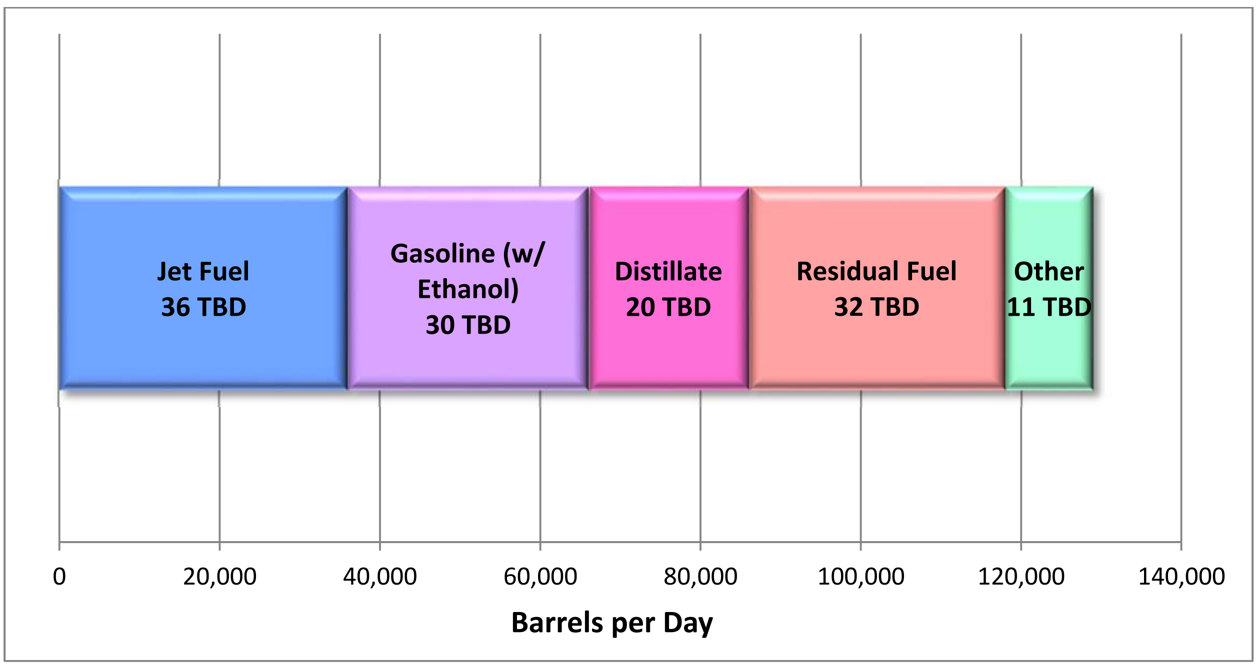
Fundamentally, refiners will make more money when product markets are "tight", meaning supply to consumers is short, and make less money when products are "long", meaning refiners may need to discount the price of products to move their inventory. Their profits are also impacted by their operating reliability and their costs of operation.

Hawaii's demands have generally matched the collective refinery supply, although refinery jet fuel production has typically been about 70-80% of Hawaii's total jet fuel demand, requiring roughly a cargo per month of jet fuel to be imported.

This historical "balance" in Hawaii will potentially be changing in coming years for a number of reasons. Some of these stem from Federal EPA requirements on refiners and/or utilities, and some from Hawaii based initiatives such as the Hawaii Clean Energy Initiative (HCEI), Hawaii greenhouse gas (GHG) requirements from stationary sources and the potential development of LNG imports in Hawaii. A number of these regulations and initiatives may lead to a reduced demand for Hawaii refinery supply, potentially requiring the refineries to reduce processing throughput or export the specific product that becomes "long" to other markets.

Hawaii demand for petroleum products in 2012 is presented below in Exhibit 5. ICF has estimated these volumes based on data from EIA, Hawaii gasoline tax records, and EIIRP data. The exact level of demands is not as important as the relative quantity of the volumes and the impact of the anticipated changes from the initiatives noted above.

Exhibit 5: Estimated 2012 Hawaii Product Consumption



Source: EIA, Hawaii Gasoline Tax Records, and EIIRP. Includes approximately 3 TBD of ethanol.

A list of the major challenges and potential impacts on the refiners is below. More information on these impacts, as well as possible mitigation options, is discussed in the next section of the report.

1. **Federal EPA Tier 3 Gasoline Standards:** This regulation is anticipated to be final before the end of 2013. It will require all U.S. refiners to produce gasoline with 10 parts per million sulfur or less on an annual average basis by 2017. The standards also require vehicle changes which do not impact refiners. This regulation could impact both refiners, but the largest impact may be on Chevron, based on their lack of existing hydrotreating capacity. Reducing sulfur level in refinery gasoline is generally controlled by adding hydrogen treating[7] to gasoline blendstocks, or exporting higher sulfur blending components. The former could require substantial investment and the latter is a downgrading of product realizations (resulting in lower revenue).

2. **Federal EPA Mercury and Air Toxics Standards (MATS):** New standards implemented by EPA for non-continental[8] boilers could require HECO boilers currently burning low sulfur residual fuel oil (LSFO) to shift to diesel fuel to meet the standards. These standards are to be implemented by 2015, although states may allow an additional two years for utilities to prepare for the standard.

   Based on records from EIA, in 2012, HECO and KPLP purchased 23,600 barrels per day (b/d) of LSFO on Oahu to generate the bulk of the power requirements on the island. Refinery production was used to meet these demands. The refineries also produced bunker fuels (similar to LSFO but higher sulfur content) to meet ship fueling requirements in Hawaii.

   If MATS requires full conversion of LSFO to diesel fuel, the refiners will need to procure the diesel fuel and provide the fuel to HECO. This action will have significant ramifications for Hawaii in two ways:

   - Diesel fuel will be more expensive than LSFO and, because diesel has a lower energy content (measured in British thermal units, or BTU), about 8-9% more fuel will be required. The refiners will need to procure the diesel fuel, transport to Hawaii, and deliver through refinery storage (similar to LSFO). This action will increase the cost of fuel to Hawaii consumers by about $160 million annually versus LSFO.
   - The refineries will no longer have customers for LSFO, and therefore will need to export the produced volume to other markets, most likely Singapore (the U.S. has no demand for LSFO). Based on a comparison of sale prices to HECO by both refiners from 2010 to 2012 (this is public information) and estimating sales to KPLP at similar price levels, the refiners will collectively lose about $212 million annually by discounting the fuel to breakeven in the Singapore market. As a yardstick, the 2012 profit level reported by Tesoro was about $1.50 per barrel or roughly $100 million at about 70 thousand barrels per day (TBD) crude runs.

---

[7] Hydrotreating processes use hydrogen and high temperatures and pressures in the presence of catalysts to extract sulfur from various refinery process streams and modify or crack hydrocarbon molecules.

[8] Power generating boilers in Hawaii, Puerto Rico and Guam

3. **Hawaii State GHG Reduction Initiative:** In 2007 Hawaii became the second state in the nation to take the step of passing an enforceable greenhouse gas emissions cap. Act 234 of 2007 mandates that state greenhouse gas emissions be reduced to 1990 levels, or below, by 2020. The Hawaii Department of Health (DOH) has recently modified the regulation to require a reduction of 16% GHG from 2010 levels by January 1, 2020 for individual facilities.

   Implementation of these rules as currently structured may not fully reflect the significant reductions refineries (and utilities) have made from 1990 emissions levels. In addition, a requirement to reduce refinery emissions by 16% based on 2010 emissions would require a significant reduction in refining production and possible shutdown of some refinery process units to achieve lower combustion of fuel and thereby lower emissions. Since refineries, like many industrial facilities, lose revenue when under-utilized, profits will be impacted since fixed costs (labor, maintenance, etc.) do not change as revenue is lowered.

4. **Reduced demand resulting from increasing energy efficiency and renewable generation:** HCEI has the goals of reducing electricity demand by 30% by 2030 and increasing the share of renewable energy generation to 40% of net sales by 2030. These ambitious goals, and the programs and projects that will help meet them, will profoundly change Hawaii's energy mix and have a significant impact on the economics of refinery operations.

   As noted above, both reductions in electricity demand and expanded development of renewable energy will reduce demands for refinery LSFO on Oahu (and diesel and naphtha in neighbor islands). These reductions will trigger the need for the refineries to export LSFO to other markets and incur substantial losses, which will increase with the success of the HCEI initiatives. ICF analysis indicates that the combination of energy efficiency initiatives, distributed generation, and likely utility-scale renewable generation and biomass projects will reduce demand for fossil fuels for power generation by approximately 17,100 b/d by 2020, or roughly 51% of 2012 consumption.

5. **Conversion of Power Generation Facilities on Oahu from Liquid Fossil Fuels to LNG:** A number of parties in Hawaii are interested in developing LNG infrastructure in Hawaii. The scope of the infrastructure required could be extensive, but most analysis focuses on using LNG in lieu of fossil fuels for Oahu power generation. There are various scenarios for this to occur. But the end result of these analyses is that LNG use by HECO or KPLP will directly reduce LSFO demand from the refineries, again significantly impacting refinery profit levels. However it appears that LNG impacts will be minor compared to the impact of regulatory issues and HCEI initiatives by 2020.

An important fact is that for every 1,000 barrels per day reduction in demand for LSFO, refinery annual profit levels will be reduced by roughly $8 million. The impact on Chevron and HIE may not be identical for the same reduction in demand because the selling price to customers may be different but, for both refiners, even this 1,000 barrel per day reduction is a significant income impact. As an example, assuming the Hawaii LSFO could be sold in Singapore as 0.3% sulfur LSWR (low sulfur waxy resid) at the 2010 to 2012 average of $98.10, the refiners would directly lose roughly $17 per barrel compared to Hawaii utility sales prices (roughly $115 per barrel), plus pay over $6 per barrel freight to Singapore, or a loss of about $23 per barrel compared to current sales levels to utilities.

In summary, some of these regulations and initiatives can have a very serious effect on refinery profitability. There are some possible mitigation options for these issues, which are discussed in the next section, however, in some cases these options may simply reduce the impact or shift the timing of the regulation or initiative. The primary option that Hawaii will need to prepare for is the potential closure of one or both refineries, in all likelihood before 2020.

[This Page Intentionally Left Blank]

Refinery Closure Options Analysis

While the Hawaii Clean Energy Initiative and other policies and programs are focused on displacing petroleum based fossil fuels with cheaper and/or more environmentally friendly fuels, the two existing refineries operated by Chevron and Hawaii Independent Energy still provide more than 90% of Hawaii's fuel needs. Accordingly, an immediate priority of the Task Force is to examine the potential for supply and price disruptions for the remainder of the decade and to offer options to mitigate those risks.

The urgency for Hawaii to fully understand and prepare for the potential refinery closures cannot be overstated. Both refineries have been under economic pressure stemming from the need to purchase high cost crude oil, high operating costs due to relatively small refinery size, and increasing regulatory impacts on the refining business. At some point, declining demand for power generation and transportation fuels stemming from conservation efforts and the Hawaii Clean Energy Initiative will exacerbate the problem.

The urgency to do so now reflects a range of factors, including:

- The long lead time and consensus of approach that are necessary to enable critical fuel-related infrastructure initiatives such as the Kalaeloa Barge Harbor expansion and master plan development, and separate efforts to evaluate the facilities necessary to import LNG.
- The need for access to refinery storage and distribution assets for imported fuel supply, particularly if one or both refineries are closed, to ensure a reliable, cost effective supply of fuels to Hawaii consumers.
- Pending and proposed environmental compliance requirements that may entail significant capital costs and risks to refining operations if changes or amendments are not initiated and approved in the near term. The most pressing concerns deal with: 1) Federal Tier 3 gasoline sulfur standards; 2) potential need to discount LSFO for export if Federal EPA requirements for MATS for non-continental power plants are in place; and 3) proposed Hawaii regulations on stationary source greenhouse gas emissions.
- Initiatives to increase renewables into the Hawaii power generation base, reduce power demands through efficiency and distributed generation, or to develop substitutes for low sulfur fuel oil (e.g. biofuels or LNG), primarily replace only a portion of the refinery output. The complexity of finding cost effective alternatives to the fuel mix that may not be addressed by current initiatives like the Hawaii Clean Energy Initiative, including fuels such as gasoline, naphtha, diesel, and jet fuel.

To help inform the State's strategy for managing the transition to this new energy ecosystem, this Interim Report, as well as the Final Report, must therefore focus on: (1) assessing the impact of specific environmental compliance requirements that present immediate challenges to refinery operations, and exploring possible mitigation strategies; and (2) identifying the critical infrastructure and facilities that must remain operational to support both the current and future energy needs of Hawaii.

Analysis Assumptions

The base case for this analysis is 2012 petroleum supply (refinery produced and imports, including ethanol) and demands. Consequently, in the base case, both refineries are operating.

The base case also assumes a certain level of activity for movement of petroleum supply at the Kalaeloa Barge Harbor. Product moves from the Barge Harbor piers to the neighbor islands to supply fuel products (gasoline, diesel, jet fuel, naphtha) for transportation needs as well as power generation.

Additionally, there are movements of products, including bunker fuels, to Honolulu Harbor locations and periodic imports of products into the Barge Harbor piers, either to help cover refinery maintenance periods or as may be imported by Aloha Petroleum or others.

The base case uses an estimated volume demand in Hawaii as shown in Exhibit 5.

Option Cases to be Evaluated

For the remainder of the decade (2013 to 2020), four options are evaluated in detail which may work to assure supply for Hawaii consumers in the event of refinery closures. Where relevant, we estimate the potential of each option to reduce demand for fossil fuels against the 2012 base case. The options discussed are:

1. Develop a robust and secure fuel importing infrastructure plan that can accommodate shutdown of one or both refineries;
2. Identify possible strategies to mitigate impacts of specific regulatory issues: (a) Tier 3 gasoline regulations; (b) MATS regulations; and (c) Hawaii GHG regulations;
3. Identify the potential for HCEI initiatives, which have been codified into state law, to reduce fossil fuel requirements for power generation or transportation fuels; and
4. Explore potential for LNG development to displace a portion of refinery supply.

Option 1: Develop a Robust and Secure Fuel Infrastructure Plan That Can Accommodate Shutdown of One or Both Refineries

The threats to refinery profitability discussed above are sufficient that there is concern that one or both refineries will close by 2020. This section examines the infrastructure options if Chevron or HIE close and no buyer is found to continue refinery operations. In this case, it is generally assumed that a buyer will be found for the refinery distribution assets, which include the refinery storage tanks, offshore mooring structure (SPMs)[9], associated pipelines, distribution terminals, and service stations throughout Hawaii.

[9] The term “SPM“ stands for “Single Point Mooring.” To be precise, Chevron utilizes a 7-point mooring system and HEI also utilizes a multi-point mooring system. For simplicity, this report refers to all offshore mooring systems as SPMs.

This is a critical assumption because the inability to utilize the refinery distribution assets may preclude the ability to import the volumes of fuel required to meet Hawaii's energy needs.

To clarify, the recent Tesoro closure occurred after more than a year of attempts to sell the refinery and distribution assets. Once the refinery closed (May 1, 2013), Tesoro continued to supply fuels to customers meeting contractual obligations. Tesoro arranged for the purchase and import of gasoline blendstocks, diesel, naphtha, jet fuel, and LSFO as required during the transition period. Tesoro continued to negotiate with some parties for a sale of the refinery and/or the distribution assets, and ultimately found a buyer in Par, who will operate the refinery and distribution assets as Hawaii Independent Energy.

However, absent Par, Tesoro had indicated that they were having discussions with other parties who were interested in purchasing the distribution assets. While the prospective buyer's intent cannot be known, these parties may have taken over the Tesoro "transition" role and managed the importing of fuels, distribution, and sales to the former Tesoro customers. Alternatively, the buyers could also simply lease the use of the purchased facilities to interested parties to arrange imports and distribution throughout Hawaii. In both of these models, the continued access to refinery tanks, the SPMs, and distribution pipelines would be sustained.

While the likelihood of finding a buyer for the distribution assets is not small, since many companies own and operate such assets worldwide, there is a considerable risk to the state if no buyer is found and the assets are shut down and inventory sold. Consequently, this section assesses options to mitigate the impacts of two scenarios: (1) where there are refinery closures and distribution assets are sold to a third party; and (2) where there is a complete closure of the refinery (or refineries) as well as shutdown of distribution assets.

Asset Analysis

Paramount in this analysis is the identification of specific assets which are critical infrastructure to the safe and sustained supply of fuels to Hawaii. The transition period operation by Tesoro demonstrated that with proper management of imported supply and a commitment to fulfill customer requirements, the refinery itself may not be critical infrastructure. The following refinery assets appeared to be critical to management of an import operation:

Tesoro

- Offshore SPM to receive imported supply (also can load cargoes)
- Internal refinery storage tanks to hold imported products for pipeline shipment to Honolulu or movements to Barge Harbor for neighbor island supply
- Honolulu pipeline and pipeline infrastructure to the Barge Harbor
- Storage and pipeline access to Hawaii Gas and KPLP for naphtha and LSFO (alternative naphtha access may be desirable via Barge Harbor)

Chevron

- Offshore SPM to receive imported supply (also can load cargoes)
- Internal refinery storage tanks to hold imported products for pipeline shipment to Honolulu or movements to Barge Harbor for neighbor island supply
- Honolulu pipeline and pipeline infrastructure to the Barge Harbor
- Storage and pipeline access to HECO facilities for LSFO supply

Loss of both refineries may, based on the experience with the five month Tesoro transition, be manageable if all the above assets are operational and customer supply sustained through imports. However, the shutdown of both refineries could have a significant impact on the traffic through the Kalaeloa Barge Harbor.

Barge Harbor Issues

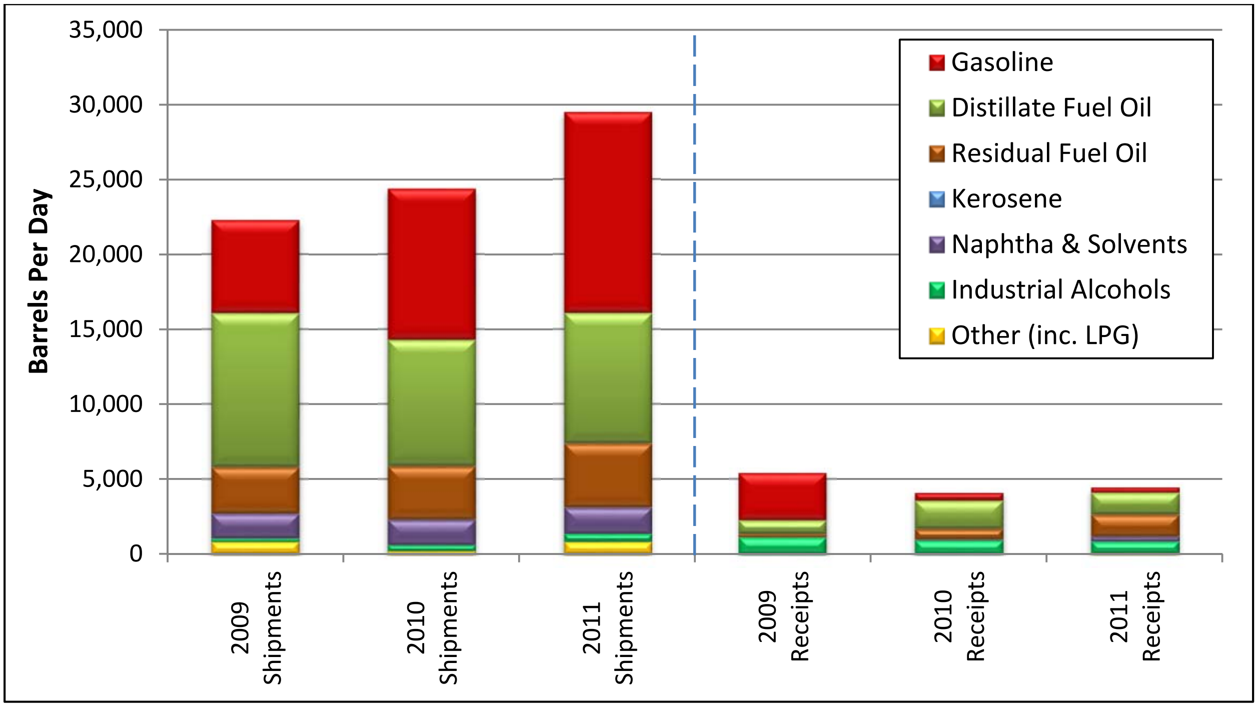
Discussions with Task Force members have identified the Barge Harbor operation as a constraint on petroleum movements in Hawaii. General congestion is one concern, but there are also specific factors involved, such as delays in loading/unloading barges when coal vessels are unloading, due to the impact on pier access.

The Barge Harbor is the source point for loading petroleum products and ethanol to neighbor islands, and is the receipt point for ethanol and propane imports. Additionally, refinery operations have periodically required Barge Harbor use to import or export products and feedstock to sustain economic refinery operation. Closure of the refineries will have some offsetting impacts on the Barge Harbor:

- Refinery closure will eliminate movements of unfinished products into and out of the Barge Harbor;
- Absence of refinery maintenance outages will eliminate the periodic need to import finished products through the Barge Harbor;
- Loss of propane and naphtha supply from the refineries will increase deliveries of these products through the Barge Harbor (although naphtha may be manageable through an SPM); and
- Periodic imports of product may occur at the Barge Harbor if there are scheduling conflicts at the SPM, or if other parties (e.g., Aloha) opt to import into their storage at Kapolei.

Analysis of the net impact is problematic because information that would identify the base case operation (for example, 2012 actual Barge Harbor movements) is not readily available and would need to include both in and out movements as well as the size of the specific vessels involved and pier utilizations. Data from the Army Corp of Engineers (ACE) show Barge Harbor movements from 2009 to 2011 in terms of thousands of barrels per day (See Exhibit 6). This chart gives some perspective on the in and out volumes, but it does not delineate individual cargo movements.

Exhibit 6: Barge Harbor Petroleum Product Shipments and Receipts



Source: US Army Corps of Engineers *Navigation Data Center*.

Moreover, the ACE data includes products into and out of the Tesoro and Chevron offshore mooring facilities, and therefore it is not certain that all the movements shown were specific to the Barge Harbor. The ACE data does include both foreign and domestic movements, and shows an increasing trend from 2010 to 2012 as shown below in Exhibit 7.

Exhibit 7: Summary of Barge Harbor Traffic, TBD

	2009	2010	2011
Total Receipts	5.4	4.1	4.4
Total Deliveries	22.3	24.4	29.5
Total Traffic	27.7	28.5	33.9

Source: US Army Corps of Engineers *Navigation Data Center*.

ICF was not able to gather data to assess the base pier utilization in the Barge Harbor, however, this may be a topic that is being assessed by the DOT/Group 70 team.

In the second scenario, should either one or both refineries NOT sell their distribution assets and in fact eliminate operation of pipelines, refinery storage, and offshore mooring access, the Barge Harbor operation would come under considerable stress as suppliers seek to use whatever access they have to move product into Hawaii. While ICF believes that even the threat of this occurring will motivate parties to be very interested in acquisition of those assets, the Barge Harbor may be an even more vital link in the supply chain until this occurs.

Barge Harbor Master Plan

As a result of this somewhat uncertain long term outlook, the design of the pier and channel modifications will need to provide maximum flexibility for a number of possible scenarios. Work currently being done by the DOT/Group 70 task force on the pier modifications should incorporate the likelihood that one or both refineries are closed in the analysis, which may mean more propane and naphtha imports via the Barge Harbor. The base case should (if not already done) reflect the impact of all current fuel product movements into and out of the Barge Harbor, including refinery unfinished movements and/or volumes to cover product needs during outages as well as ethanol and neighbor island movements. The specific requirements of the Barge Harbor 2040 Plan is not within the scope of ICF's work.

It is important to note that one proposed capital project—the $30 million Kalaeloa pipeline to allow HECO to import through the Barge Harbor directly to HECO storage tanks—may be an important infrastructure addition for Hawaii. There are two reasons for this: 1) the pipeline could allow HECO to have leverage on price negotiations with refiners; and 2) in the event of a complete shutdown of one or both refineries with their associated Oahu infrastructure, this pipeline will, subject to capacity, allow HECO to import fuel themselves to meet requirements. Development of this pipeline would also mean, assuming a refinery closure, that HECO may opt to directly import fuel via the Barge Harbor. This should also (if not already) be a consideration for the DOT/Group 70 team. However, HECO has indicated they must weigh this investment against the potential timing of introduction of LNG into the power generation supply on Oahu. The pipeline may be less critical if LNG infrastructure develops.

Additional Issues with Refinery Closures

Hawaii Gasoline Specifications: As noted in the Phase 1 Report, it is essential that Hawaii's gasoline specifications be consistent with overall U.S. requirements. This will improve access to imported supply when needed in Hawaii, and should be implemented as soon as possible. It is our understanding that the gasoline spec (D4814 1981 version) is codified in law, and it will require that a bill be introduced and passed by the Legislature adopting the appropriate spec(s). Consideration should also be given to have Hawaii adopt ASTM D5599 (2010 version) to make clear the testing methodology for oxygenated motor fuel. We would suggest that these be part of the Administration's legislative package as a housekeeping measure for the upcoming 2014 Session. Industry representatives have indicated to ICF a willingness to work with DBEDT staff and the Department of Agriculture to move this forward.

Jet Fuel Access to Pier 51: Discussions following the June 18th Task Force meeting seem to have resulted in a process where HFFC representatives will work with DBEDT personnel and DOT to identify when it may be critical to jet fuel supply assurance for jet cargoes to have priority. HFFC would present inventory outlook and cargo scheduling to demonstrate risk of outage and DOT would make a decision. With one or both refineries closed, this may be a larger issue. While supply worked well during the Tesoro closure, there were occasions where jet fuel cargoes scheduled a month in advance arrived on time and were held out so that a container vessel that arrived later than scheduled was given priority. This resulted in demurrage cost that gets passed on to the airlines.

In order to assure that a process be in place long term, it should be memorialized and written in DOT internal policy or administrative rules that govern harbor cargo prioritization.

Closure Impact on Military: DoD has indicated that loss of the refineries will not impact their operational readiness or access to fuel. However, since it does remove potential fuel suppliers and sources of local supply such as asphalt, it will directionally increase costs. DoD also notes that the availability of the operating refineries does present an opportunity to consider options to use the refineries to process bio-crudes that may be available to produce cleaner fuels. This could support Military goals for incorporation of biofuels as well as State HCEI goals.

Summary

The key areas to prepare for in the event of closure of one or both refiners are therefore focused on the successful sale of the refinery distribution assets, operation of identified infrastructure noted above, and the development of a Barge Harbor infrastructure that maximizes flexibility to handle cargoes and barges into and out of the harbor. Initiatives to update gasoline specifications and to resolve Pier 51 priorities should also be implemented.

Option 2: Develop Strategies to Reduce Impacts of Specific Regulatory Issues: EPA Tier 3 Gasoline Specification, EPA MATS Regulations, and Hawaii GHG Reduction Initiative

Federal and State regulations play a critical role in protecting Hawaii's environmental and human health. However, as noted in the Hawaii Petroleum Refining Outlook section above, there are several specific regulatory issues that pose particular challenges to refinery sustainability. This section identifies, to the degree possible, potential strategies to reduce the impact of these regulatory actions. These strategies are not intended to abrogate the intent of the regulatory standards to improve the environment; rather there are several issues which may indicate that the regulations as enacted may compel the refiners to incur more costs than necessary to achieve regulatory goals.

EPA Tier 3 Gasoline Specification

As noted earlier, this regulation is anticipated to be final before the end of 2013, and will require all U.S. refiners to produce gasoline with 10 parts per million sulfur or less on an annual average basis by 2017. This regulation will impact every refinery in the U.S. to some degree, however, some may be impacted considerably more than others. Both Chevron and HIE are aware of the regulation and are not in a position to comment, especially as the regulation is not quite final.

In general, refineries with a significant amount of hydroprocessing, such as HEI, may have a greater ability to meet the standard, especially since the refinery also processes light sweet crude. With low sulfur levels in crude and significant removal of sulfur from refinery streams via hydroprocessing, HEI may have minimal cost to meet the Tier 3 regulation.

Chevron produces much of its gasoline from a fluid catalytic cracking (FCC) process. While historically Chevron has also imported very low sulfur crude oil, the cracking process will result in a gasoline blending stock which has sulfur locked into the gasoline molecules. While the sulfur level may be relatively low, the Tier 3 regulations are extremely low, and Chevron may have difficulty meeting the requirements. Chevron has no hydrogen processing capability to remove the sulfur from the FCC gasoline blendstock, or to “pre-treat” the gas oil feedstock that is being cracked.

While ICF does not have access to Chevron’s private data or even whether or not the Tier 3 regulations are a minor or a significant burden to them, in general, refiners who are already processing low sulfur crude oil only have a few options to further lower gasoline sulfur content. These would involve a major investment to add a process unit for hydrogen treating of the FCC gasoline or the FCC gas oil feedstock to remove sulfur. This option will also likely require addition of a hydrogen production process unit to supply the hydrogen. Sulfur reduction may also be achieved by distillation changes to make less gasoline and shift some of the sulfur components into distillate. This may or may not be possible without investment.It is very unlikely that Chevron could justify an investment of several hundred million dollars (rough estimate) to add required process units. Chevron technical staff would of course be able to assess the capability to meet Tier 3 from other options. Chevron has not said publically how Tier 3 may impact them and ICF’s comments on this issue have not been reviewed with Chevron.

In summary, implementation of Tier 3 gasoline requirements will likely have minimal cost implications for HECI, but may meaningfully impact the Chevron refinery performance and profits.

EPA Mercury and Air Toxics Standards (MATS)

As noted earlier, new standards implemented by EPA for non-continental[10] boilers could require HECO boilers currently burning LSFO to adopt other strategies for compliance, including fuels shifting to diesel or biofuels, retirement, or back-end emissions controls. These standards are to be implemented by 2015, although states may allow an additional two years for utilities to prepare for the standard.

Under MATS, EPA developed a standard for emissions of filterable particulate matter (fPM), among other pollutants, at non-continental oil-fired units. EPA based its standard on information provided by HECO and other non-continental utilities under the 2009 Information Collect Request (ICR). Comparing the MATS standard to the updated HECO fPM emission rates shows nearly all of HECO’s units being short of (or emitting higher than) the standard. Should those rates be accurate and the standard hold at 0.03 lb/MMBTU, most of HECO’s units would need to install PM controls, fuel switch if possible, or shut down in order to comply (see Exhibit 8).

[10] Power generating boilers in Hawaii, Puerto Rico, and Guam.

Exhibit 8: Filterable PM Standards for Non-Continental Oil-Fired Units

Company	Unit	Filterable PM (lb/MMBtu)		
		2013 Re-test with Soot blowing (Average)	NC MATS Standard	Delta^ Average Rate - Standard
HECO	K1	0.0971	0.03	0.0671
	K2	0.0724		0.0424
	K3	0.0368		0.0068
	K4	0.0355		0.0055
	K5	0.0723		0.0423
	K6	0.0557		0.0257
	W5	0.0284		(0.0016)
	W6	0.0436		0.0136
	W7	0.0411		0.0111
	W8	0.0297		(0.0003)

Source: Request for Expedited Consideration of Hawaiian Electric Company, Inc.'s April 2012 Petitions for Reconsideration and Stay. Appendix B-1. Submitted: August 14, 2013.

Unlike Tier 3 gasoline regulations, this EPA requirement *indirectly* impacts Chevron and HIE in that the regulation may require HECO and potentially KPLP to shift from purchasing LSFO to Low Sulfur Diesel (LSD). This shift, while indirect, will have a very dramatic impact on the profitability of both refineries. The total sales of LSFO to HECO and KPLP in recent years has averaged about 25,000 b/d (23,600 b/d in 2012). The shift, assuming all volume must be converted to LSD, would require refiners to make the following changes:

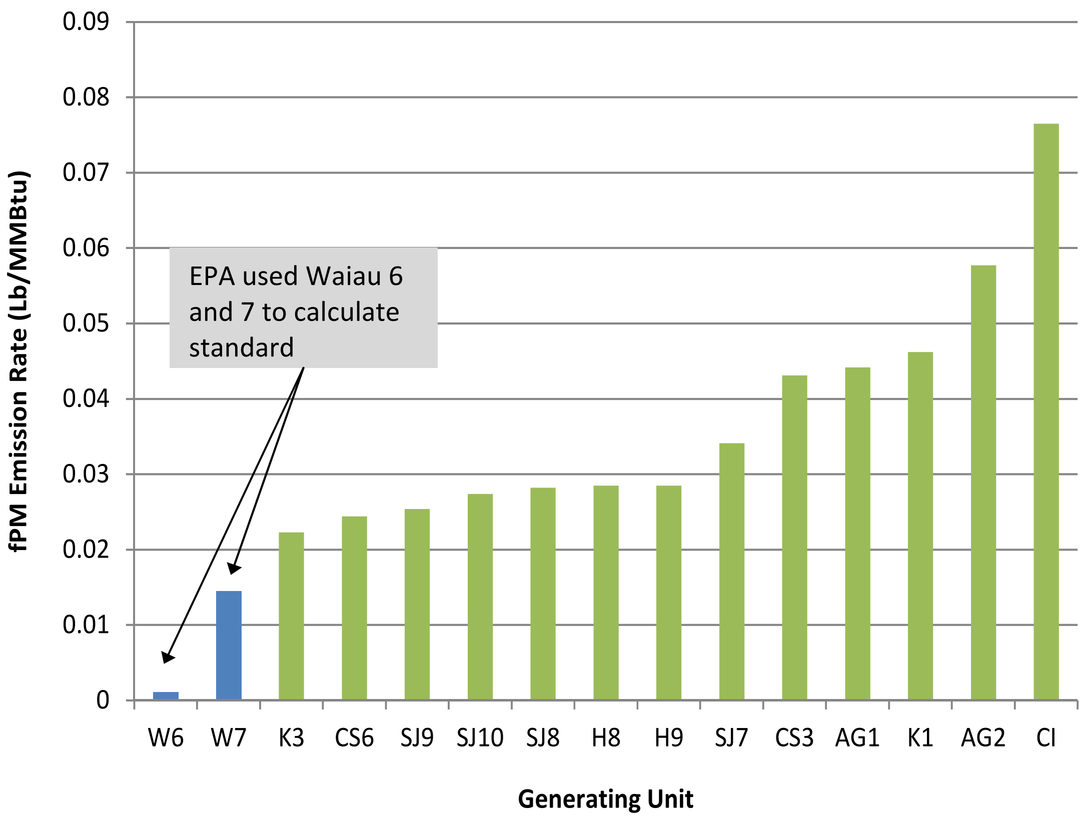
- Purchase and import LSD from Singapore, South Korea, or Los Angeles to replace the volume of LSFO previously sold to the utilities.
- Since LSD has a lower BTU content than LSFO, the refineries would have to purchase 8-9% more LSD than LSFO to meet a similar utility demand.
- The refiners would then also need to export the nominal 25,000 b/d that was being sold to the utilities. The likely sales market would be Singapore, and prices for LSFO type product in Singapore have averaged over the past three years about $10-20 per barrel below the prices that the refineries receive from HECO.
- In addition, the refiners would need to ship the LSFO to Singapore or other markets. Cost to ship to Singapore is about $6.36 per barrel.[11]
- Net loss to refiners would have be about $212 million (shipping plus loss due to reduction in sales price).

[1111] Estimate from Poten and Partners

In addition to these impacts on refineries, HECO could incur additional costs by being required to purchase LSD instead of LSFO. The higher cost of the more refined LSD product, and the need to purchase 8-9% more volume of fuel would increase costs to Hawaii consumers by about $160 million (assuming total incremental costs are charged to consumers).

HECO, with the assistance of DBEDT, has petitioned the EPA Administrator to modify its ruling for non-continental boilers, due to an erroneous calculation of the baseline standard. The standard was established based on test results from all non-continental boilers. These tests showed that the Waiau 6 and 7 boilers were the basis for the standard, however, the Waiau 6 result was abnormally low (see Exhibit 9). On this basis, as well as the potential impact to Hawaii consumers, HECO and DBEDT are hoping to achieve a re-assessment of the standard by EPA.

Exhibit 9: fPM Emission Rates for Non-continental Oil-fired Units from 2009 ICR



Sources: The EPA file identifying units used for standards is located at http://www.epa.gov/ttn/atw/utility/a5_oil_mact_floor_analysis_121611.xlsx.
Unit emission rates provided by HECO to Hawaii State Energy Office.
Note: Unit names for Hawaii boilers are designated with W for Waiau, H for Honolulu, and K for Kahe; other units are located in Puerto Rico and Guam.

Since modifying existing EPA regulations is by no means assured, even with a compelling analysis, other alternatives need to be explored, including seeking some form of a blended solution. This could mean importing LSD and exporting some LSFO, while "blending" a combined product that will meet the new standards. This would significantly stress the existing refinery storage tanks, essentially requiring storage for LSFO, LSD, and a mixed blend (or in-line blending facilities). While this may mitigate the impact, as noted earlier, the refineries would still lose roughly $8 million annually for each 1,000 barrels per day of LSFO that must be exported.

Alternatively, HECO could install particulate matter scrubbers on the boilers with the most significant problems. This will require cost pass through to consumers, but it may be below the potential annual cost of up to $212 million for refiners to substitute LSD for LSFO. The potential scrubber cost assessment is not part of this study.

Note that KPLP is not required to meet MATS criteria, as MATS does not apply to combustion turbines. However it is not clear the refiners can logistically manage imports of large volumes of low sulfur diesel, exports of LSFO and potential storage and blending constraints, in particular to meet KPLP's requirements for LSFO and potential HECO blending requirements. Further analysis between the refiners, HECO and KPLP will define possible alternatives and quality control issues once it is confirmed that the MATS regulation must be met.

Hawaii State GHG Reduction Initiative

DOH draft rules had set a baseline of 25% emissions reductions by 2020 based on 2010 emissions numbers for individual facilities. DOH, in response to comments, has recently modified this requirement down to a 16% reduction. The proposed rules provide options for parties to partner with each other to meet the required reductions. Parties may also petition the Director to justify an alternative cap if it can be demonstrated that other control options cannot achieve the goals. This change increases the likelihood that the refineries will be able to comply with the reduction in emissions.

The ability to partner among facilities may be very useful to utilities, especially given the phase-in of renewable power projects and demand reduction initiatives as part of the HCEI. The progress that HECO and others make in reducing GHG emissions may provide pooling opportunities to allow the state to achieve its GHG reduction goals without requiring refiners to further reduce GHG reductions from the refineries. This will be contingent on the utilities satisfying their reductions first, but the pace of HCEI initiatives may generate tradable credits which may mitigate the need for costly refinery compliance measures. That said, more clarity is needed on the processes and rules underlying the potential for partnering.

Implementation of these rules as currently structured may still not fully reflect the significant reductions refineries (and utilities) have made from 1990 emissions levels. The calculation methodologies used to assess the base case for industries may no longer be the best methodology given the fact, that beginning in 2011, EPA mandated all industries to report GHG emissions using a procedure specifically developed for each industry by EPA. These results indicated that, in Hawaii, GHG emissions were about 9.2 million tons CO_2e in 2011. Refinery emissions were about 1.05 million tons CO_2e (see link below).

Link to EPA Database of GHG Emissions from Large Facilities:
http://ghgdata.epa.gov/ghgp/main.do#/facility/?q=Find%20a%20Facility%20or%20Location&st=HI&fc=&fid=&sf=11001000&lowE=0&highE=23000000&g1=1&g2=1&g3=1&g4=1&g5=1&g6=0&g7=1&g8=1&g9=1&g10=1&s1=1&s2=1&s3=1&s4=1&s5=1&s6=1&s7=1&s8=1&s9=1&s201=1&s202=1&s203=1&s204=1&s301=1&s302=1&s303=1&s304=1&s305=1&s306=1

This link also shows the calculation methodology used by EPA, which was based on actual emissions data from the refineries, utilities, etc. These data represent the most complete and accurate source for the calculations, and it is difficult to see why these base data could not be used in a similar manner for Hawaii. It would appear prudent to track GHG reduction trends by monitoring the annual official reporting of Hawaii data to EPA rather than by using other formula for estimations of greenhouse gases to monitor Hawaii's continued compliance with the DOH regulation. These data from EPA for 2011 are summarized in Exhibit 10 below:

Exhibit 10: Hawaii Carbon Emissions by Source

Industry	2011 GHG Emissions (metric tons CO_2e)	# of Reporting Facilities
Power Plants	7,482,839	15
Refineries	1,051,904	2
Waste	486,766	8
Other	134,560	1
Chemicals	87,397	2
Petroleum and Natural Gas Systems	32,469	2
Metals	0	0
Minerals	0	0
Pulp and Paper	0	0
Total	***9,275,935***	***30***

Source: EPA 2011 Greenhouse Gas Emissions from Large Facilities.

If the reductions of 16% are still required, this will result in a need to reduce refinery throughputs by about 25% or more to lower the combustion heat needed to distill and refine fossil fuels. These reductions would cause the refineries to lose money due to lower revenue from refining (lower throughput) while fixed costs remain unchanged. As noted above, the refiners may also consider working with the utilities to pool their reductions, should such a capability exists. Finally, it should be noted that there is continued uncertainty about the potential penalties that may be levied for noncompliance with agreed reduction targets. More clarity is needed on the future processes and measures for ensuring compliance under the State's GHG reduction initiative.

Option 3: Reduce Fossil Fuel Demand via HCEI Initiatives

This discussion is divided into two subsections: (a) discussion of the Hawaii Clean Energy Initiative and its potential for reducing fossil fuel demand in the power sector; and (b) a discussion of potential measures for reducing fossil fuel demand in the transportation sector, via CAFE standards, EV, and biofuels.

Option 3A: Power Generation Sector

The Hawaii Clean Energy Initiative (HCEI) has the goals of both reducing electricity demand by 30% by 2030 and increasing the share of renewable energy generation to 40% of net sales by 2030. These ambitious goals, and the programs and projects that will help meet them, will profoundly change Hawaii's energy mix and have a significant impact on the economics of refinery operations. At the same time, reducing energy demand and increasing the amount of renewable generation contribute greatly to the state's long-term energy security and clean air goals. This section assesses the impact of Hawaii's planned energy efficiency and renewable energy projects on electricity demand and supply through 2020, and evaluates the impact of these changes on future fossil fuel-based generation.

Hawaii's Current and Projected Electricity Demand

In 2012, total electricity sales in Hawaii were over 9,600 GWh, with 9,206 GWh being provided by the Hawaiian Electric Companies and 433 GWh by KIUC.[12] A breakdown of sales by county is shown below.

Exhibit 11: 2012 Total Electrical Energy Sales in Hawaii by County

Island	2012 Sales (MWh)
Oahu (HECO)	6,975,996
Maui (MECO)	1,144,832
Hawaii Island (HELCO)	1,085,171
Kauai (KIUC)	433,159
Total	**9,639,157**

Source: 2012 Renewable Portfolio Standard Status Reports (for the year ended 12/31/12).

Projections for future electricity demand in 2030 vary widely, depending on which assumptions are employed. For instance, the Hawaiian Electric Companies' *2013 Integrated Resource Planning Report* (IRP) developed four alternative scenarios based on variations in two key variables: 1) the price of oil and 2) public policy on renewables. Projected demand in 2030 for each of these scenarios is shown in Exhibit 12 below.

Exhibit 12: Projected 2030 Sales from the Four IRP Scenarios

IRP 2013 Scenario	Projected 2030 Sales (MWh)
No Burning Desire	13,633,000
Stuck in the Middle	9,880,000
Moved by Passion	8,549,000
Blazing a Bold Frontier	5,941,000

Source: 2013 Integrated Resource Planning Report, Hawaiian Electric Companies, Revised August 1.

[12] 2012 Renewable Portfolio Standard Status Reports (for the year ended 12/31/12).

The 2013 IRP further states that "due to high fuel costs, effective energy efficiency programs, customer self-generation of electricity, and economic conditions, utility sales and peak load have declined for several years and are expected to be relatively flat (Stuck in the Middle IRP Scenario) or continue to decline (Blazing a Bold Frontier IRP Scenario) in the future." As such, the projections included in those two scenarios are seen by many stakeholders as the most likely of the four to occur.

Reduced Electricity Demand Due to Energy Efficiency Measures

An important driver of reduced energy demand is the State's Energy Efficiency Portfolio Standard (EEPS). The 2009 session of the State Legislature enacted Act 155, codified as HRS § 269-96, which established the EEPS and set a target of 4,300 GWh/year of electricity use reductions statewide by 2030. According to DBEDT, which proposed the 4,300 GWh figure in legislation, this figure was derived by calculating 30% of the sum of the baseline electricity sales forecasts from the Hawaiian Electric Companies' third Integrated Resource Planning ("IRP") processes ("IRP-3") and KIUC's 2005 IRP, extrapolated to 2030.[13]

The EEPS defined four "performance periods" and established interim goals for electricity reductions during each of these periods. The first performance period is 2009 through 2015, thereby making 2008 the baseline year for purposes of EEPS evaluation, and annual energy savings are allocated in a linear fashion (approximately 195 GWh in reductions each year). Annual targets are shown in Appendix 2 and the interim goals for each performance period are listed in Exhibit 13 below.

Exhibit 13: EEPS Electricity Reduction Targets, by Performance Period

EEPS Performance Period	Years	New Energy Savings (MWh/year)	Cumulative Energy Savings from Baseline (MWh/year)
First Period	2009-2015	1,375,000	1,375,000
Second Period	2016-2020	975,000	2,350,000
Third Period	2021-2025	975,000	3,325,000
Fourth Period	2026-2030	975,000	4,300,000

Source: PUC Docket No. 2010-0037

Based on a review of Hawaii Energy status reports and discussions with SEO and Hawaii Energy staff, it appears that the state is on target to meet its near-term energy efficiency goals. Between 2009-2012, energy efficiency initiatives have already reduced energy demand by approximately 800 GWh.[14] The continued implementation of these initiatives will enable the state to meet its interim energy savings goals of 1,375 GWh by 2015 and 2,350 GWh by 2020. Given progress to date, this will result in additional electricity reductions of around 575 GWh between 2013 and 2015 (i.e. 1,375 target minus 800 GWh achieved by 2012) and an additional 975 GWh by 2020.

[13] PUC Docket No. 2010-0037

[14] Estimate based on discussions with JFA Consulting, which calculated total EEPS savings as part of its ongoing work with the PUC.

Increased Renewable Energy Generation

Under Hawaii's Renewable Portfolio Standard (RPS), the state's electric utilities are obligated to meet the following percentages of "renewable electrical energy" sales:

- 10% of net electricity sales by December 31, 2010;
- 15% of net electricity sales by December 31, 2015;
- 25% of net electricity sales by December 31, 2020; and
- 40% of net electricity sales by December 31, 2030.[15]

As of 2012, the state is well on its way to meeting its initial targets, owing to a combination of utility-scale renewable energy projects and widespread distributed generation by utility customers. The Hawaiian Electric Companies achieved 13.9% renewable energy target in 2012 and expect to achieve 18% by the end of 2013, well ahead of the 15% RPS requirement for 2015.[16] KIUC is achieving its renewable generation goals even more rapidly, achieving 16.7% renewable generation in 2012.[17]

Hawaiian Electric Companies Scenario Forecasts

The Hawaiian Electric Companies' 2013 IRP scenario analysis yielded optimistic forecasts about their ability to meet future RPS requirements. The "Blazing a Bold Frontier" and "Stuck in the Middle" scenarios predicted RPS greater than 40% in 2018 and 2022, respectively, well ahead of the 2030 deadline. For reference, the forecasted renewable energy generation levels for 2015 and 2020 from both of these scenarios are presented in Exhibit 14 below, showing both the contribution of distributed generation (NEM/FIT) and utility-scale generation. Note that these figures include consolidated forecasts for the HECO-HELCO-MECO system, but do not include KIUC.

Exhibit 14: Forecasted RE Generation in 2015 and 2020 from IRP Scenarios

Time Frame	Stuck in Middle Scenario (MWh)	Blazing a Bold Frontier Scenario (MWh)
2015 Forecasted RE Generation	**2,117,000**	**2,302,000**
NEM/FIT	236,000	433,000
Net RE Generation	1,881,000	1,869,000
2020 Forecasted RE Generation	**3,556,000**	**3,711,000**
NEM/FIT	596,000	1,092,000
Net RE Generation	2,960,000	2,619,000

Source: 2013 Integrated Resource Planning Report, Hawaiian Electric Companies, Revised August 1, 2013

[15] 2013 Integrated Resource Planning Report, Hawaiian Electric Companies, Revised August 1, 2013 (ES-7)
[16] 2013 Integrated Resource Planning Report, Hawaiian Electric Companies, Revised August 1, 2013 (ES-7)
[17] KIUC Annual RPS Status Report for the year ending December 31, 2012.

Distributed Generation

The most striking renewable energy growth in Hawaii over recent years has been in the area of distributed generation, particularly rooftop solar. Key drivers of this expansion have included high local electricity prices, State and Federal tax credits, and declining costs for solar technology. The Hawaiian Electric Companies estimate that 12,215 solar systems were added in their service areas in 2012, exceeding the previous ten years combined. In 2012, customers of the Hawaiian Electric Companies generated 182,638 MWh of distributed renewable energy, and KIUC customers generated 6,925 MWh. While customer renewable generation continues to grow rapidly, for the purposes of this analysis, ICF has chosen to adopt the more conservative estimate of future distributed generation forecasted by the Stuck in the Middle scenario. Combining this IRP forecast with a proportional increase among KIUC customers yields a conservative estimate of future distributed generation of 244,948 MWh by 2015 and 618,598 MWh by 2020.

ICF Estimates of Likely Utility-Scale Renewable Generation by 2015 and 2020

While the Hawaiian Electric Companies 2013 IRP and other sources list a wide range of proposed renewable energy projects as likely to contribute to future generation capacity, many of these projects may not actually come fully online by 2020. For our estimate of likely utility-scale renewable generation potential, ICF sought to go beyond these forecasts by examining the pipeline of proposed new utility-scale renewable generation projects to determine which of those projects were likely to actually come online over the next seven years, and include only those projects in our estimates of expected renewable generation capacity in 2015 and 2020.

ICF began by compiling a list of renewable generation projects planned in Hawaii that combined 1) the list of Renewable Projects in Progress presented in Table ES-2 of the 2013 IRP; 2) a list of planned renewable projects in Kauai, maintained by the State Energy Office; and 3) several additional renewable projects recently made public via PUC dockets. The full list is presented in Appendix 3.

For each project, ICF then considered its current stage of development, based on publicly available information, progress in obtaining PUC approval, progress in acquiring site control, and permit status, and consulted with SEO staff and industry stakeholders to categorize it as either “likely to come online by 2015” or “likely to come online by 2020.” In cases where projects were either unlikely to come online by 2020 or there was insufficient information to make that determination, ICF categorized it as “TBD” and did not include the project’s potential generation capacity in our totals of Estimated MWh/year.

Of the 30 projects in ICF’s list, 11 projects were listed as TBD, including three of the four HECO “RFP Projects” and the proposed Lanai Wind project. While these projects are significant in scale and have the potential to greatly contribute to the state’s renewable generation potential, the complexities associated with the proposed undersea cable and the uncertainty of their timing did not allow us to confidently include them in our estimates of likely renewable generation by 2020. As a result, ICF’s estimates of likely renewable generation in 2015 and 2020 are considerably more conservative than those presented in the IRP.

ICF's analysis of these proposed projects (see Exhibit 15) found that 15 new utility-scale projects are likely to come online between now and 2015, representing 404,811 MWh/year of new renewable generation. Between 2016-2020, another 5 projects—including the project(s) resulting from the ongoing 50MW HELCO geothermal request for proposals (RFP) and several hydro projects proposed for Kauai—are likely to come online, providing an additional 701,819 MWh of new renewable power. Given that Hawaii already produced 1,134,389 MWh of utility-scale renewable energy in 2012 (1,093,596 MWh by the Hawaiian Electric Companies and 40,793 MWh by KIUC)[18], these estimates of new projects coming online would bring total renewable energy produced in Hawaii to over 1,500 GWh/year by the end of 2015, and over 2,200 GWh/year by the end of 2020.

Exhibit 15: Likely New Utility-Scale Renewable Generation in Hawaii, by 2015 and by 2020

Likely Time Frame	Number of Projects	New RE Generation Added (MWh/year)	Cumulative RE Generation (MWh/year)
Existing RE Projects (2012)	29	-	1,134,389**
Added by 2015	15	404,811	1,539,200
Added by 2020	5	701,819	2,241,020
Total	**54**	**1,106,631**	

Source: Data sources: State Energy Office Renewable Energy Projects Directory (https://energy.ehawaii.gov/epd/public/energy-projects-list.html); 2013 Integrated Resource Planning Report (Hawaiian Electric Companies, August 2013); Hawaii Public Utilities Commission Document Management System (DMS); media outlets; regulatory agency postings and notices; discussions with SEO staff and industry stakeholders.
** HECO RPS Status Report for the year ending December 31, 2012.

As stated above, the values in Exhibit 15 do not include three of the four RFP projects or the proposed Lanai Wind project, as ICF is uncertain that they will come online by 2020. If those projects were to become operational, they have the potential to contribute significantly to the state's total renewable generation capacity. As Hawaii continues to pursue its ambitious goals to increase renewable energy to 40% and beyond, the state will confront a range of challenges related the intermittency of renewable resources, the need for energy storage, and inter-island transmission. ICF's final report will include a high level discussion of these challenges and potential strategies for mitigating key risks.

Overall, utility-scale renewable generation projects alone are expected to contribute 1,790 b/d of fossil fuels demand reduction in 2015, and 4,960 b/d by 2020. Oahu is home to a variety of renewable generation projects that are estimated to produce approximately 208 GWh of electricity by 2015 and a total of 414 GWh by 2020. Assuming this reduces residual fuel oil (the vast majority of liquid fuel consumed on Oahu for power generation), this would reduce demand by nearly 900 b/d in 2015 and over 1,780 b/d by 2020. The Big Island is home to multiple large renewable projects. In addition, by 2015, the Hu Honua project is expected to produce biomass for power generation that would contribute

[18] KIUC and HECO PRS Status Reports for the year ending December 31, 2012.

over 100 GWh of electricity. By 2020, geothermal projects resulting from the HELCO RFP are expected to supply nearly 400 GWh of electricity.

Summary of Energy Efficiency, Renewable and Distributed Generation Impacts on Power Sector

Taken together, Hawaii's major initiatives in energy efficiency combined with increasing distributed generation and a pipeline of likely utility-scale renewable generation projects coming online over the next seven years produce a significant impact on the state's power sector. Exhibit 16 shows these cumulative impacts by sector for 2015 and 2020.

Exhibit 16: Cumulative Impacts of Energy Efficiency and Renewable Energy by 2015 and by 2020 (MWh/year)

Source	Cumulative Added 2013-2015 (MWh/year)	Cumulative Added 2013-2020 (MWh/year)
Energy Efficiency Savings	575,000	1,550,000
Distributed Generation	244,948	618,598
Utility-Scale Renewables	404,811	1,106,631
Total	**1,224,760**	**3,275,229**

Source: HECO RPS Status Report for the year ending December 31, 2012.

In terms of fossil fuel demand, these changes in total are estimated to displace 5,600 b/d of petroleum product consumption by 2015 and 14,900 b/d by 2020. These estimates do not reflect the 24 million gallon per year (mgy) Aina Koa Pono renewable diesel plant nor do they reflect the 22 mgy Hawaii Bioenergy plant. Both plants will contribute portions of their production for power generation and are discussed in further detail later in this report.

Option 3B. Transportation Sector

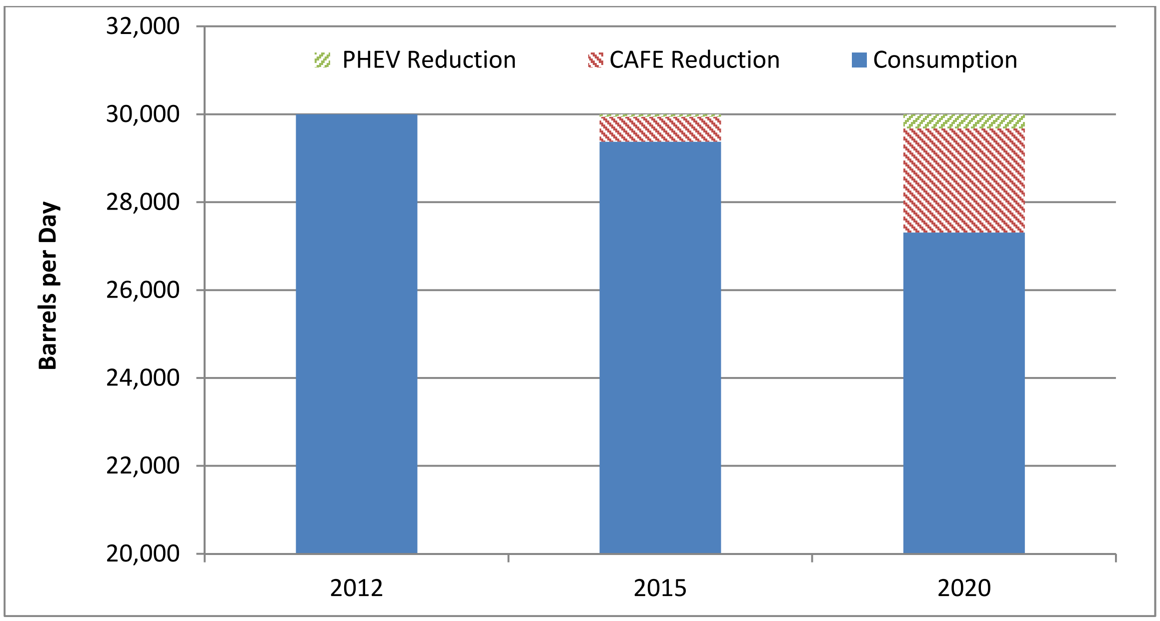
In addition to the HCEI goals and programs related to power generation, there are a number of possible options to increase supply and reduce demand for fossil fuel based transportation fuels. These options include both existing policies that are in place at the Federal level and goals for Hawaii contained within the HCEI. In general, these initiatives will take some time to implement and will not be able to provide the level of fossil fuel displacement that renewables and LNG do for power generation. Nonetheless, there are opportunities to displace some volume of fossil fuel demand and to potentially develop policies and projects to grow supply in the Hawaii market.

The amount of transportation fuel related demand reduction will stem from policies such as Federal CAFE standards, increased use of electric vehicles, and biodiesel use in diesel fuel. In addition, recent PUC approval of creative projects such as Hawaii Bioenergy's proposal to develop a biomass facility on Kauai to produce jet fuel for Alaska Airlines and DoD, and to supply low carbon bio-residue to HECO indicates that opportunity does exist to develop multi-sector initiatives. The impacts of various initiatives are presented below.

Impact of Corporate Average Fuel Economy (CAFE) Standards

In August 2012, the U.S. Environmental Protection Agency (EPA) and the National Highway Traffic Safety Administration (NHTSA) finalized the Greenhouse Gas Emission Standards and CAFE standards for cars and light trucks model years (MY) 2017 through 2025. These fuel efficiency standards are scheduled to increase steadily throughout the period and reach 54.5 mpg by 2025.[19] ICF's analysis of the impact of Federal mandates to increase CAFE standards indicates that normal Hawaii fleet turnover (including a steady increase in the state's vehicle population) will result in a reduction of gasoline demand from 2012 levels of 513 b/d by 2015 and 2,133 b/d by 2020 (not including ethanol). An additional, substantive increase in CAFE standards occurs in 2025 (54.5 mpg). This change may begin impacting Hawaii volumes by 2030.

Exhibit 17: Gasoline Consumption and Reduction from CAFE and PHEVs



Sources: 2013 Integrated Resource Planning Report. Hawaiian Electric Companies. June 28, 2013. Integrated Fuel Plan.
Energy Information Administration.
Hawaii Liquid Fuel Tax Records.
ICF Analysis.

Note that, in developing this assessment, ICF assumed that new vehicle registrations and vehicle miles travelled continued at historical pace, and that vehicles leaving the fleet achieved average fleet miles per gallon.

[19] EPA and NHTSA, "Rulemaking for 2017-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards." http://www.epa.gov/otaq/climate/documents/420f12051.pdf

Impact of Electric Vehicle Growth

Based on HECO's IRP forecast[20], it is anticipated that plug-in electric vehicles in the state will grow from less than 1,000 in 2012 to over 22,000 by 2020. Using HECO's assumption of 7,300 annual vehicle miles travelled on the electric motors of these vehicles, results in an estimated decrease in gasoline demand of 289 b/d by 2020.

Hawaii may wish to consider developing additional incentives for consumers to promote adoption of electric vehicles, or accelerate use of EVs for Hawaii State transportation fleets. Hawaii is uniquely suited for EV growth due to its limited driving range and developing renewable power generation options to help manage demand growth. However, even with incentives, the cost of electric vehicles and the very high cost of electricity in Hawaii may make it difficult to accelerate EV usage above the forecast developed by HECO.

Use of Biodiesel

Hawaii has had limited development of biodiesel in transportation fuels. Biodiesel is currently used for power generation by HECO at the Campbell Park generator and by MECO at the Maalaea facility (in 2012). Though some biodiesel is produced at facilities, such as Pacific Biodiesel, from waste cooking oil, the majority of biodiesel used in Hawaii is produced on the mainland and shipped to Hawaii. The average cost of the Maalaea biodiesel was over $270 dollars per barrel in 2012[21], and volumes were about 2,500 barrels for the year. This was a very high cost of fuel, considering fossil fuel-based diesel prices in 2013 at the same location averaged about $141 per barrel. Biodiesel used on Oahu at the Campbell Park facility totaled 74,110 barrels at an average cost of $254 per barrel. Fossil fuel diesel used for power generation on Oahu was $129 per barrel.

The high cost of biodiesel delivered in Hawaii may make it difficult to support initiatives to increase biodiesel usage in transportation fuels. An instructive case is that of New York City, where the City was able to develop a strong biodiesel growth program by mandating biodiesel usage in heating oil (at 2% levels), and using biodiesel in the numerous city fleet vehicles. Biodiesel blends are currently used in 6,100 of 9,074 diesel units (approximately 68 percent).[22] In September 2013, the City began the full implementation of the biodiesel fleet plan by enacting Introductory Bill 1061-A-2013, requiring the use of B5 in all diesel vehicles and equipment year-round.[23] These efforts have stimulated supply into New York City and generated local supply development.

This model, using conversion of state and local government vehicle fleets to a modest biodiesel blend, and then gradually working to expand the use to all diesel-powered vehicles at levels of 2% or 5%, may

[20] 2013 Integrated Resource Planning Report. Hawaiian Electric Companies. June 28, 2013.
[21] EIA-923 data, http://www.eia.gov/electricity/data/eia923/
[22] City of New York, 'Biomass-Based Diesel and Heating Fuel Substitute Opportunities in New York City: DRAFT,' Appendix 2, November, 2013.
[23] New York City Council, 'Introductory Bill 1061-A-2013,' September 2013, accessed http://legistar.council.nyc.gov/Legislation.aspx.

be a relatively low-risk but proactive means to grow an alternative fuel option for diesel fuel. Having a "known" demand outlet may foster development of in-state biodiesel production and associated jobs and economic growth.

For this study, ICF assumed that biodiesel initiatives could be developed to require up to 5% biodiesel use in all diesel transportation fuels by 2020, including Military. The study shows the impact of that requirement on 2020 fossil fuel demands, reducing fossil fuel demand by about 293 b/d.[24] Practically, the growth will likely only occur with strong leadership on the initiative, use of mandates for investor certainty, and continuation of producer incentives. It should also be noted that military initiatives may prefer green renewable diesel over biodiesel. The Leading by Example initiative could assist in this effort, beginning with some city or State fleets.

Initiatives could also be developed to include modest levels of biodiesel in the 130 million gallon per year marine diesel market. Even at 2% levels this could be an additional 170 b/d demand reduction.

Ethanol Initiatives

As noted in the Phase 1 report, ethanol usage in Hawaii is essentially at the maximum assuming an E-10 limit (10% ethanol in gasoline). Options may exist to move beyond E-10 to E-15 or E-20, or to consider going to E-85. However, there are a number of issues which have been holding back progress in this development both in Hawaii and on the mainland. Increasing ethanol usage to E-15 or higher, especially E-85 will require that the fuel only be burned in flex-fuel vehicles, which have engines designed to operate on the higher ethanol-concentrated fuels. Moreover, service stations may need to modify underground tanks and pumps, and these can be significant costs to independent dealers, even branded independent dealers. Despite access to sugar cane and high gasoline prices, investments in ethanol production in Hawaii has been minimal, so it is clear that any additional ethanol would need to be imported to provide the added oxygenates to meet higher blend levels. Consumer acceptance of the higher blends will also be challenging due to engine manufacturer warranties, which do not cover usage of ethanol blends over 10%, as well as the higher cost per gallon on a BTU basis (E-85 only provides 70% of the mileage of conventional gasoline).

Even if progress is made on a few of these hurdles, we do not anticipate significant growth in ethanol usage beyond E-10 in Hawaii.

Other Alternative Fuel Options

There are several projects underway to produce fuels from biomass in Hawaii.

Hawaii Bioenergy has developed a project to use eucalyptus trees as a biomass source for a production facility on Kauai.[25] The company has arranged a sales agreement for a bio-jet product for sale to Alaska Airlines. In addition, the PUC has approved under specific conditions the sale of fuel produced from the

[24] Assuming 90 million gallons annually on-road and Military demand (DBEDT June 2013 "Hawaii Energy Facts and Figures")
[25] See http://www.travelweekly.com/Hawaii-Travel/Alaska-Airlines-will-purchase-biofuel-from-Hawaii-firm/

biomass to HECO. Products will be transported from Kauai to Oahu. This project is scheduled for completion by 2018, and is expected to produce roughly 1,400 b/d at expected throughput levels.

Similarly, Aina Koa Pono LLC is developing a project on the Big Island[26] to use Eucalyptus, invasive species, and waste products to produce biomass for conversion into a renewable fuel for supplying 90% of HELCO's current use of fossil fuel at the Keahole power plant, the island's largest electric generation unit. This project is awaiting review from the Public Utilities Commission. The project will provide 24 million gallons per year of renewable diesel and gasoline fuel (about 1,565 b/d).[27]

These projects provide multiple benefits, including jobs, clean fuels, and reduced dependence on fossil based fuels. Use of production from these facilities for displacing fossil fuels from power generation assets would be additional power generation from renewables over and above that cited in Exhibit 16.

Development of other projects like this which use collaboration between Hawaii business parties should also be explored. Project initiatives under consideration by the GIFTPAC group (Green Initiative for Fuels Transition Pacific) involving the Military, State, HECO, and others could involve collaboration with existing Hawaii refineries to use hydrotreating capability to produce green fuels from biomass feedstock. This type of project would leverage the refineries to be part of the solution, and may to some degree offset impacts of other HCEI initiatives which may reduce demand for fossil based fuels.

Initiatives which integrate a refinery with some form of biomass/biocrude processing would need specific and direct discussions with the refineries so that the refiners can consider the potential advantages of participating and evaluate costs and revenue potential. However, the potential to convert an existing refinery into a facility that enables cleaner fuel production while still supplying needed transportation fuels should be a priority to evaluate.

Option 4: Explore Potential for LNG Development to Displace a Portion of Refinery Supply

As the state explores a range of potential options to replace refinery supply during the transition period, LNG has the potential to displace some portion of the residual fuel oil currently being used for power generation. LNG burns cleaner, generates power much more efficiently than LSFO and has recently had a price advantage over crude oil based hydrocarbons, thereby potentially providing several benefits to Hawaii consumers. In addition, an LNG importing infrastructure would enable other businesses, such as Hawaii Gas and the refineries to utilize potentially lower cost supply for customers or for refinery fuel. LNG infrastructure also positions Hawaii longer term to adopt alternative transportation fuels, such as CNG for passenger vehicles and LNG for heavy duty trucks and marine vessels.

However, development of an LNG receipt terminal and infrastructure in Hawaii is a significant undertaking requiring considerable capital and buy-in from multiple stakeholders. A number of major actors in the energy space have expressed interest in developing LNG receipt capability in Hawaii,

[26] http://www.ainakoapono.com/?page_id=64
[27] Reported in the DBEDT June 2013 Report, "Hawaii Energy Facts and Figures", page 6

including Hawaii Gas and HECO. For this report, ICF is attempting to assess the potential for LNG to displace fossil fuel usage in the period through 2020.

Conversion to LNG supply for Hawaii Gas and/or HECO would be controlled by the Public Utilities Commission. Both parties are studying the issue and assessing plans.

Current Plans: Hawaii Gas

Based on a presentation from November 2012[28], and further fleshed out through contact with Hawaii Gas, the company has a plan for the introduction of LNG to Hawaii. Starting in 2013-2015, Hawaii Gas will begin by rotating 20 ISO LNG containers and one or two vaporizers on and off the Island of Oahu, with the aim of displacing approximately 6% of the company's synthetic natural gas (SNG or "syngas") production. The vaporized natural gas would substitute for syngas in the gas grid around greater Honolulu. Given that this plan would serve Hawaii Gas utility customers, it would need to receive PUC approval.

Based on ICF estimates of the SNG plant's naphtha consumption, the impact of these conversions would be a reduction of approximately 100 b/d in naphtha consumption by the syngas plant.[29]

Following the successful completion of the initial rollout, Hawaii Gas would continue growing its number of ISO containers to as many as 140 by 2016-2018, and establishing both a permanent staging area and installing a greater number of vaporizers to allow for the injection of vaporized natural gas into the grid at multiple locations. This could allow additional displacement of naphtha. An additional 10% to 15% of SNG demand displacement would further diminish naphtha consumption by another 160-240 b/d, or roughly 300 b/d in total by 2020. Depending on the capacity of the logistical chain to handle the increasing fleet of ISO containers, Hawaii Gas could continue expanding this program, perhaps up to 1,000 b/d by 2020. Hawaii Gas will further develop their plans in collaboration with other stakeholders and the PUC.

Current Plans: HECO and Others

In addition to Hawaii Gas, HECO and possibly others are studying options for large-scale importation of LNG to Hawaii. The ultimate scale of the undertaking would in great measure depend on the level of interest and engagement of the various major stakeholders in the state.

The development of further infrastructure may require the PUC, HECO, and others to concur on a long term forward plan for full scale LNG development, including terminal storage. Furthermore, a large-scale

[28] *LNG Implementation Planning: A Plan to Serve the State of Hawaii* presentation. The Gas Company/Hawaii Gas, Honolulu, Hawaii, 29 November 2012. Available at http://www.slideshare.net/civilbeat/hawaiigas-lng-presentation

[29] Based on total natural gas delivered as reported by the Energy Information Administration for Hawaii, along with the process efficiency of the SNG plant energy conversion efficiency from *Report to the Hawaii Public Utilities Commission: Renewable Energy Annual Report Required by Act 30 (SLH 2010)*. The Gas Company, Honolulu, Hawaii, 30 March 2012. p.4 Available at: http://puc.hawaii.gov/wp-content/uploads/2013/04/CY2011-Act-30-Report-PUC-The-Gas-Co.pdf

LNG project in Hawaii would require the appropriate regulatory and business model structure, providing assurance for the viability of long-term investment in such infrastructure.

There are a number of options to consider when planning to invest in LNG receiving facilities, most of which have already been utilized elsewhere around the world. ICF has reviewed some of the alternatives and provides a summary and comments in Appendix 4.

A full analysis of the LNG question is beyond the scope of this study. However, whatever option Hawaii chooses, it is necessary that it allow for the storage and trans-loading of LNG to facilitate both inter-island movement of the fuel, and to compensate for possible interruptions in supply caused by weather or other factors.

Potential Role of Natural Gas in Hawaii's Power Generation

In terms of total potential natural gas demand, power generation is the state's largest target market; 73% of electricity generated in the state came from plants fueled by petroleum products. Hawaii's petroleum consumption for power generation accounted for *nearly 56% of total U.S power generation from petroleum in 2012.* Total fossil fuel consumption in Hawaii for power generation in 2012 was over 33,000 b/d.[30]

It is most likely that the initial LNG conversions would take place on Oahu, where the LNG will be vaporized into natural gas and be distributed to current operating power plants. Further conversions on the neighbor islands would depend on the delivered cost of LNG transported in ISO containers.

As on the U.S. mainland, natural gas could be a complementary fuel for the increasing penetration of renewables into the electricity grid. It is an important consideration that traditional steam generation cannot easily respond to fluctuations created by the intermittent nature of renewable generation, particularly wind and solar, which are susceptible to the vagaries of weather and can come on and off at very little notice. Furthermore, to achieve the HCEI goals of 40% renewables penetration in the power grid and demand reductions of 30%, Hawaii may see renewable generation be a higher percentage of supply on the good days/hours, and much lower in evenings and/or calm periods for wind. Such fluctuations would, in turn, require either massive battery storage capacity, or fossil-fuel generation that is capable of rapidly responding to fluctuating demand. Appendix 5 discusses some of the benefits and issues which might stem from the use of LNG to achieve more efficient power generation beyond 2020.

It will be important that the Final Task Force Report discuss the issues associated with the confluence of renewable power generation, energy efficiency, and distributed generation with the potential use of LNG for coordination of grid control. In addition, use of storage options, as well as biomass-based power generation, may be competitive options for grid control.

[30] *Electric Power Monthly with Data for December 2012*. Energy Information Administration, Washington, DC, February 2013. p. 122. Available at: http://www.eia.gov/electricity/monthly/current_year/february2013.pdf

Other LNG Considerations

With domestic and Canadian gas prices remaining low, and with a number of LNG export facilities being planned, the potential economics to import LNG may have some attraction. In particular to displace less efficient fossil fuels such as LSFO. However, there are a wide range of complex issues and tradeoffs surrounding LNG use that include sourcing options, transportation, destination terminal location and type, grid integration alternatives, costs of delivered LNG vs LSFO, efficiency advantages and so on that will require deliberative planning. It will be important to understand how use of LNG for power generation and/or grid control may or may not enable additional intermittent renewable generation in Hawaii.

Finally, the presence of LNG also can create opportunity to optimize the delivery of natural gas and provide alternatives for propane supply in Hawaii. Adequate and reliable LNG supply could enable Hawaii Gas to shutter their SNG facility and eliminate purchases of naphtha, and also to provide the refineries (if they are operating) with low cost fuel to enable them to alternatively market distillates and residuals currently used for process heat and combustion. Reliance on propane imports could also be reduced. Appendix 6 includes a more detailed assessment of issues related to the impact of LNG in Hawaii on the natural gas and propane markets. It may be possible to progress these initiatives without major LNG infrastructure investment for cargo deliveries.

Option 5: Other Possible Considerations

Several other options were examined and deemed not to have significant potential at this time.

Jones Act Relief: The Jones Act requires all domestic product to and from Hawaii to be shipped on U.S. Flag vessels. This is a long term regulation that is intended to protect the U.S. Maritime industry, and is only rarely waived (most recently during Hurricane Sandy.)[31] Several Task Force members have suggested that with the Jones Act waived, Hawaii may have more access to domestic supply as foreign flag vessels are typically much lower cost to charter than Jones Act vessels. Moreover the Jones Act fleet has been rather static and additional demand, particularly with a refinery closed, could result in difficulty locating available vessels.

Appendix 7 shows a brief overview of the Jones Act fleet. For the first time in a number of years, there are new vessels being constructed and planned, in large measure due to the need for moving shale oil crude from the Gulf Coast to East Coast refiners and other destinations. Having more vessels increases the potential for moving lower cost shale oil crude to Hawaii as well as moving products, however the transportation cost will still be higher than foreign flag vessels.

[31] From the Maritime Administration's website: "To encourage a strong U.S. Merchant Marine for both national defense and economic security, the Jones Act (46 U.S.C. § 55101) requires that merchandise being transported by water between U.S. points must travel in U.S.-built and U.S.-citizen owned vessels that are registered in the United States."

ICF believes that it is unlikely that any blanket waiver could be granted for Hawaii petroleum movements. There is an argument that Hawaii's isolation and proximity to Asian markets differentiates it from other states, however, the same argument could be made for all container vessels that are critical to Hawaii supply, so the Jones Act waiver could have a very large impact on the maritime industry and will likely be vigorously opposed if sought.

From the import analysis it is clear that the refiners have used Jones Act vessels from time to time, in part because it is the only way they can integrate their West Coast refineries with Hawaii. So the cost savings of having an option to use foreign flag vessels would help the refiners, or any other supplier, looking to take advantage of increasing levels of exports from the U.S. refinery system.

Finally, Jones Act waiver petitions are typically sought on an individual cargo basis by a specific petroleum supplier who cannot locate an available Jones Act vessel for a movement. A broad waiver covering Hawaii would be extremely unusual and would require the endorsement of the Secretary of Homeland Security, DOT, MARAD (the Maritime Administration within DOT) and likely the White House.

Integration of the Two Refineries: Some Task Force members have suggested that integration of the two refineries may provide some synergies that could result in a more competitive combined refinery. This is a suggestion that would be driven by the refining parties themselves, not the State. The benefits of this could be credible, including:

- More effective gasoline blending with a full range of gasoline blendstocks;
- Yield optimization; and
- Potential closure of one crude unit as demands decline in Hawaii.

However there are a number of other issues that would work against these benefits:

- The refineries are more than a mile apart and it would require a number of pipelines to simply connect the key streams. Integration of controls, coordination of blending stock flows, and fuel systems would be more complex.
- Combined refinery would still have to purchase very expensive crude, have a high fuel oil yield and be vulnerable to renewable replacement of LSFO and other fuels.
- May not be able to reduce costs significantly as manpower needs may not change (except perhaps senior management).
- One would assume that both Tesoro and Chevron have already considered this. Certainly Chevron had ample time to evaluate Tesoro.
- Given the regulatory issues facing Hawaii refiners, there is minimal upside to consider purchase of the other as the regulatory issues would still be there.
- Placing all the Hawaii refining capacity with one refinery may make FTC approval difficult, and, if approved, might require divestment of service stations of one party. It could also make Hawaii more exposed to wholesale market price upward pressure.

Overall, it is difficult for ICF to see that yield and possible cost savings would drive one refiner to purchase the other.

Total Impact of Options on Fossil Fuel Demand

The total impact from the options discussed above is summarized in Exhibit 18 below. The values shown represent the reduction in demand for fossil fuels of the designated products from the 2012 base year. Note that the 2020 column is a cumulative amount, i.e. covering the period 2013–2020.

Exhibit 18: Cumulative Reduction of Fossil Fuel Consumption vs. 2012 Base Year (b/d)

	2015 (b/d)	2020 (b/d)	Product
CAFE Impact (w/ increased vehicles)*	513	2,133	Gasoline (ex. ethanol)
PHEV*	50	289	Gasoline (ex. ethanol)
PHEV Offset*	(35)	(240)	Residual/Distillate
Biodiesel Transport	--	293	Diesel
Hawaii Bioenergy/Aina Koa Pono	--	2,988	Jet/Residual/Diesel
Renewable Generation	1,793	4,960	Residual/Distillate
Energy Efficiency	2,644	7,020	Residual/Distillate
Distributed Generation	1,156	2,919	Residual/Distillate
Use of LNG	100	300	Naphtha
Total	**6,221**	**20,662**	

*Only represents the decrease in gasoline consumption and does not reflect decreased consumption of ethanol.
PHEV Offset represents incremental electricity demand from adoption of EVs.
Sources: *2013 Integrated Resource Planning Report*. Hawaii Electric Companies. June 28, 2013.
Energy Information Administration.
Hawaii Liquid Fuel Tax Records.
PUC Docket No. 2010-0037.
Hawaii State Energy Office renewable energy projects directory.
ICF Analysis.

The reductions expected by 2015 are relatively modest, given that they only incorporate changes implemented over a three year period from the baseline year of 2012. By 2020, reductions are rather significant, resulting in a 16.4% decline from 2012 total fossil fuels demand, primarily in LSFO, diesel, and gasoline. This decreased demand will somewhat reduce the need to import products should both refineries close, although Hawaii would still be heavily dependent on imports, particularly for transportation fuels.

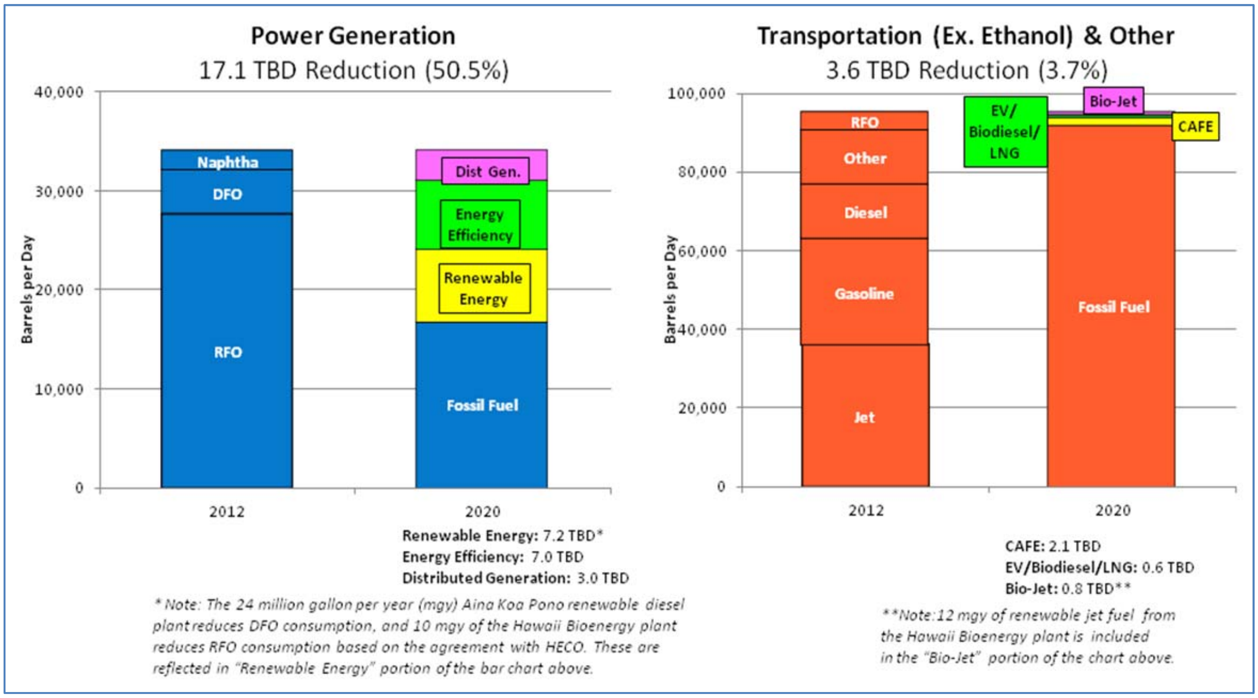
As shown above, these reductions are primarily driven by initiatives related to power generation, including energy efficiency, distributed generation, and utility-scale renewables. The limited reductions in the transportation sector result primarily from increased CAFE standards.

The realization of these projected reductions will be dependent upon the successful implementation of the HCEI initiatives and other options as described herein, however, they are not unreasonable to expect. While the biodiesel usage for transportation included here is a stretch goal, our estimates for distributed generation and Hawaii Gas' LNG initiatives may both be somewhat understated.

Obviously the growth in supply of these alternative fuels and energy sources will work against refinery profitability, however, the regulatory challenges presented by the Tier 3 Gasoline specifications, MATS regulations, and Hawaii GHG initiative have the potential to trigger refinery closures before the HCEI initiatives begin to significantly impact refiners.

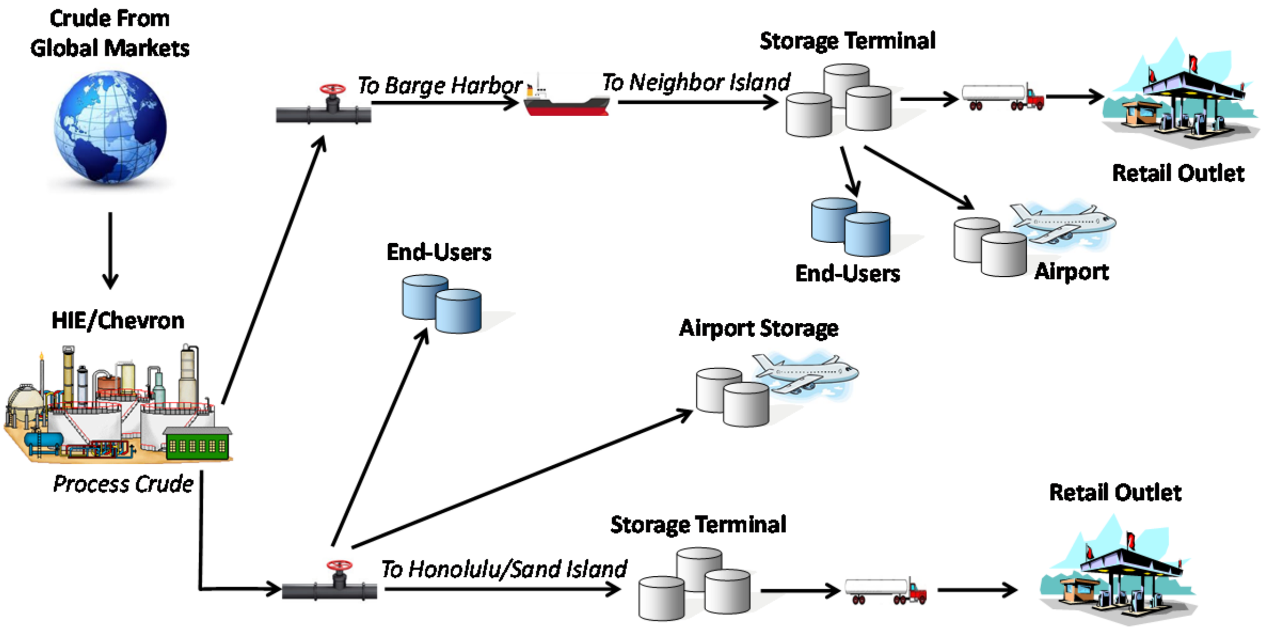
Exhibit 19 graphically presents the total reductions in fossil fuel demand resulting from all of the options discussed above, separated into two categories: (1) Power Generation; and (2) Transportation & Other (with "other" referring to refinery byproducts such as asphalt, naphtha, and propane not used for either power generation or transportation purposes).

Exhibit 19: Total Impact of Options on Fossil Fuel Demand by 2020



The combination of Hawaii's energy efficiency, distributed generation, and utility scale renewables initiatives will have a significant effect on the power generation sector, reducing demand by 17.1 TBD by 2020. This represents a reduction of over 50% of current demand for fossil fuels for electricity generation. By contrast, there will be rather modest effects on the transportation sector, with CAFE standards and increased penetration of EV, biodiesel and other alternative fuels combining to reduce demand by only 3.6 TBD by 2020, or 3.7% of current demand for fossil-fuel based transportation fuels.

Appendix 1: Hawaii Petroleum Supply Schematic



Source: Created by ICF, with graphics from:
Globe - http://www.bolgianocapital.com/resources/
Refinery - http://abkldesigns.com/clipart2/indust4.html
Tanker Truck - http://dir.coolclips.com/Industry/Resources/Oil_and_Gas/Petroleum_and_Gas_Transportation/Tanker_truck_indu0425.html
Airplane - http://studentweb.cortland.edu/Jamie.Vacheresse/project%205/5-workscited.html
Service station - http://www.clipartguide.com/_pages/0511-1003-1600-0715.html
Pipeline segment - http://www.canstockphoto.com/illustration/valve.html
Marine tanker -

Appendix 2: Hawaii's Annual Energy Efficiency Targets

Year	GWh Goal	% of Baseline (2008)
First Performance Period		
2009	196.5	1.38
2010	196.5	1.37
2011	196.4	1.37
2012	196.4	1.37
2013	196.4	1.37
2014	196.4	1.37
2015	196.4	1.37
Total	**1,375**	**9.6**
Second Performance Period		
2016	195	1.36
2017	195	1.36
2018	195	1.36
2019	195	1.36
2020	195	1.36
Total	**975**	**6.8**
Third Performance Period		
2021	195	1.36
2022	195	1.36
2023	195	1.36
2024	195	1.36
2025	195	1.36
Total	**975**	**6.8**
Fourth Performance Period		
2026	195	1.36
2027	195	1.36
2028	195	1.36
2029	195	1.36
2030	195	1.36
Total	**975**	**6.8**
Grand Total		
2030	4,300	30%

Source: PUC Docket No. 2010-0037

Appendix 3: Expected New Utility-Scale Renewable Generation Projects

ICF compiled a list of utility-scale renewable generation projects planned in Hawaii by combining the following sources: (1) the list of Renewable Projects in Progress presented in Table ES-2 of the 2013 IRP; (2) a list of planned renewable projects in Kauai, maintained by the State Energy Office; and (3) several renewable projects recently made public via PUC dockets. For each project, ICF then considered its current stage of development, based on publicly available information, progress in obtaining PUC approval, progress in acquiring site control, and permit status, and consulted with SEO staff and industry stakeholders to categorize it as either "likely to come online by 2015" or "likely to come online by 2020." In cases where projects were either unlikely to come online by 2020 or there was insufficient information to make that determination, ICF categorized it as "TBD" and did not include the project's potential generation capacity in the totals of Estimated MWh/year.

Project Name	Technology	Island	Year Expected	Nameplate Capacity (MW)	Estimated MWh/year	Data Source
Honolulu Airport Emergency Gen.	Biofuel	Oahu	By 2015	8.0	3,000	Hawaiian Electric 2013 IRP
Hu Honua Biomass	Biomass	Hawaii	By 2015	21.5	107,000	Hawaiian Electric 2013 IRP
Green Energy	Biomass	Kauai	By 2015	6.7	47,647	SEO Website
Low-Cost Projects (awaiting waiver)	Solar	Oahu	By 2015	43.0	64,000	Hawaiian Electric 2013 IRP
Mililani South PV	Solar	Oahu	By 2015	20.0	27,000	Hawaiian Electric 2013 IRP
Anahola Solar	Solar	Kauai	By 2015	12.0	21,082	SEO Website
KRS2 Solar (Koloa)	Solar	Kauai	By 2015	12.0	21,082	SEO Website
15MW HECO PV Project (awaiting waiver)	Solar	Oahu	By 2015	15.0	21,000	PUC Docket No. 2013-0360
Kalaeloa RE Park	Solar	Oahu	By 2015	5.0	7,000	Hawaiian Electric 2013 IRP
Mountain View PV	Solar	Oahu	By 2015	5.0	7,000	Hawaiian Electric 2013 IRP
Kalaeloa Home Lands	Solar	Oahu	By 2015	5.0	7,000	Hawaiian Electric 2013 IRP
Actus Sunpower	Solar	Oahu	By 2015	5.0	7,000	Hawaiian Electric 2013 IRP
HCDA Projects	Solar	Oahu	By 2015	5.0	7,000	Hawaiian Electric 2013 IRP
Kalaeloa Solar One (CSP)	Solar	Oahu	By 2015	5.0	5,000	Hawaiian Electric 2013 IRP
Honua Power	Waste-to-Energy	Oahu	By 2015	6.0	53,000	Hawaiian Electric 2013 IRP
Schofield Barracks Distributed Gen.	Biofuel	Oahu	By 2020	50.0	44,000	Hawaiian Electric 2013 IRP
RFP Hawaii Island Geothermal	Geothermal	Hawaii	By 2020	50.0	389,000	Hawaiian Electric 2013 IRP
Proposed hydro projects in Kauai *	Hydro	Kauai	By 2020	25.4	106,724	SEO Website
Proposed wind project	Wind	Oahu	By 2020	25.0	88,095	PUC Docket No. 2012-0094
Low-Cost Project (awaiting waiver)	Wind	Oahu	By 2020	21.0	74,000	Hawaiian Electric 2013 IRP
Hawaii Bioenergy	Biofuel	Kauai	TBD	-	TBD	PUC Docket No. 2011-0369
Aina Koa Pono	Biofuel	Hawaii	TBD	TBD	TBD	PUC Docket No. 2012-0185
Cellana Biofuel Project	Biofuel	Maui	TBD	-	TBD	SEO Website
Tradewinds Biomass	Biomass	Hawaii	TBD	3.6	TBD	Hawaiian Electric 2013 IRP
Mahinahina Biomass	Biomass	Maui	TBD	4.5	TBD	Hawaiian Electric 2013 IRP
OTEC International	OTEC	Oahu	TBD	100.0	TBD	Hawaiian Electric 2013 IRP
RFP Oahu non-firm renewable	TBD	Oahu	TBD	200.0	700,000	Hawaiian Electric 2013 IRP
Maui County Waste-to-Energy	Waste-to-Energy	Maui	TBD	TBD	TBD	Hawaiian Electric 2013 IRP
Lanai Wind	Wind	Oahu	TBD	200.0	778,000	Hawaiian Electric 2013 IRP
			Total	**853.7**	**2,584,631**	

Sources: 2013 Integrated Resource Planning Report, Hawaiian Electric Companies, Revised August 1, 2013. Hawaii State Energy Office Renewable Energy Projects Directory (https://energy.ehawaii.gov/epd/public/energy-projects-list.html); Hawaii Public Utilities Commission Document Management System (DMS); media outlets; regulatory agency postings and notices; and discussions with SEO staff and industry stakeholders..

*** Kauai Hydro Projects:** This row represents a combination of several proposed hydroelectric projects in Kauai. Project capacity and timing for many of these proposed projects is uncertain, however, after discussions with the prospective developers and KIUC, SEO's best estimate of the total potential for these projects is 25.4 MW, or 106,724 MWh/year. While development is not guaranteed, the proposed projects included in these sums are: Kalepa / East Kauai Water Users; Puu Opae; Upper Puu Lua Power Project; Kekaha Menehune; Anahola Water Project; and Olokele River Hydro.

Appendix 4: LNG Investment Options

Offshore Buoy-Based System –All the regasification takes place on a dedicated Floating Storage Regasification Unit (FSRU) ship that connects to the buoy on an as-needed basis, and a sub-sea pipeline runs from the buoy to shore delivering pipeline-quality gas directly into the grid. Such a system, the Northeast Gateway operated by Excelerate Energy, has already been active in Massachusetts Bay since 2008. It is located 13 miles off shore, in approximately 280 ft. of water.

Single-Berth FSRU – This configuration requires a dedicated berth with a high-pressure natural gas pipeline connection. This option requires placement closer to shore. As in the Offshore Buoy system, a FSRU is required to regasify the LNG, and the gas flows directly from the ship into the natural gas grid. The ship delivering LNG to the site docks alongside the FSRU (with the FSRU serving as the delivery ship's dock) and offloads its cargo onto the FSRU.

Double-Berth FSRU – Similar to the option above. In the double-berth option, the delivery vessel has a dedicated berth at the dock, usually across from the FSRU. The LNG is transferred across the berth, with both ships secured to their berths.

On-Shore LNG Regasification and Storage – This is the most common option, as well as the most capital intensive. The facility would require a site of approximately 100 acres, in addition to a dock in relatively calm waters. At least one tank would be built on-site, with a capacity of 200,000 cubic meters to ensure continuing supply in the event a delivery tanker was not able to come to port in time.

Evaluating the above options involves a number of considerations, including cost and technical feasibility. While a system that requires the lowest initial outlay of capital may sound attractive, the Offshore-Buoy system has significant drawbacks. For continuous natural gas supply, a FSRU would need to be on-station nearly continuously. The leasing of a dedicated vessel for this purpose would add to the operating costs of the terminal, though not to the initial capital required.

Water conditions would in fact likely not allow for the FSRU to remain on station continuously. Unlike the sheltered waters of Massachusetts Bay, any location off-shore in Hawaii is subjected to met-ocean conditions that are not ideal for the transfer of LNG cargo from the delivery vessel to the FSRU in open water. Furthermore, there are few locations on Oahu where such a system could be installed. Water depth around Oahu easily exceeds 600 ft. just a mile off shore, with the possible exception of coastal water south of Barbers Point, where Chevron and Tesoro (now Hawaii Independent Energy) have their crude offloading moorings. While the currently deployed Excelerate Energy's Northeast Gateway is found in nearly 300 ft. of water, increasing water depths beyond this dramatically increase the challenges of installing and operating such a system.

A single or dual-berth FSRU option offers improved flexibility for the importer. A dedicated FSRU would allow for uninterrupted gas flow into the Oahu system and for cargo transfers between the FSRU and barges for shipment to the neighbor islands. This option would require a dedicated mooring and some dredging may be required. Due to the sheltered location in the harbor, there would be few issues in receiving cargos on a reliable schedule, and more delivery vessels would be qualified to dock to the FSRU and unload. Unlike a fixed, permanent installation, the single or double-berth FSRU could also be “downsized” in due course, if the demand for natural gas declined in Hawaii.

This, however, should not discount the value of a permanent, on shore regasification and storage facility. While some LNG tankers may not be capable of docking alongside an FSRU, all LNG carriers are capable of delivering their cargos to an on-shore terminal. Furthermore, the initial capital costs of an on-shore facility may be offset by the savings gained from not leasing a dedicated FSRU. That said, an equivalent-sized on-shore terminal will be significantly more expensive and siting of the on-shore terminal will be extremely difficult.

Finally, in the case of Hawaii, any reduction in LNG consumption for power generation that could occur as renewables increase could be offset to some degree by increases in the use of LNG elsewhere in Hawaii’s energy mix. In time, much of the inter-island marine fuel use could move to natural gas, as could fleet vehicles on the islands – whether in LNG or CNG form. The introduction of stricter ECA fuel standards may also lead to greater use of LNG in large cargo vessels, creating demand for LNG bunkering services.

Appendix 5: Use of LNG for Power Generation

Introduction of natural gas to the islands as a replacement for residual or distillate fuel oil presents the electric utilities with an opportunity to replace their legacy steam generating units with modern combined cycle gas turbines (CCGT), simple cycle gas turbines (SCGT), and reciprocating internal combustion engines. Even after planned retirements, it would appear that the youngest generating unit in HECO's fleet would be a boiler/steam turbine put in place in 1981, with the oldest units dating from the 1950's.

While the initial capital outlay would need to be defined, improvements in efficiency could be achieved with a combination of generating units that provides high system efficiencies throughout the entire range of capacity factors. Given the increasing amounts of as-available renewable energy, newer units with better response times will improve the load-following capability of the system.

A further benefit to moving to CCGT technology is the rapid response time for these power plants, which allows the facilities to provide better load-following capacity than anything else currently available aside from outright grid-scale energy storage. Gas turbines from such manufacturers as Alstom, Siemens, or General Electric can ramp up to over 75% of generating capacity in less than ten minutes, and adjust power output by 30MW per minute providing an excellent complement to intermittent renewable generation.

Use of CCGT units would also reduce the energy required to generate a MWh of power, due to the much higher efficiency of CCGT units compared to HECO's oil fired units. This provides both GHG and cost benefits. LNG also improves energy security for Hawaii, as the diversification of energy sources would be increased. Petroleum fuels such as diesel could be used as a back-up fuel should there be any LNG supply disruptions.

While these are sound benefits, the cost of the infrastructure changes required would be substantial, in particular for an onshore storage and regasification facility and associated facilities in the Barge Harbor area for LNG receipt capability. In addition, while LNG may have GHG benefits versus LSFO fuels, it is not a renewable fuel and would not contribute to meeting the HCEI renewable fuel goals.

Appendix 6: Impacts of LNG on Natural Gas and Propane Markets

Delivered Natural Gas and Propane in Hawaii

In the U.S. mainland, both natural gas and propane serve a similar role for domestic and commercial consumers. Space heating accounts for approximately 50% of consumption, with the remainder split between water heating, supplementary space heating, cooking, and other applications. The absence of heating load in Hawaii, in addition to the higher prices, means that residential consumers connected to the gas grid use approximately one-third of the natural gas that average consumers on the US mainland do. According to the EIA, the average residential gas consumer in Hawaii uses just 19.2 thousand standard cubic feet (Mcf) of gas annually, as opposed to an average of 71.5 Mcf on the mainland.[32] Similarly, U.S. Mainland residential propane consumers use on average approximately 400 gallons of propane annually, while residential consumers in Hawaii are estimated to have used on average 130 gallons of propane per household in 2011.[33]

As a general rule, the two fuels are complementary, with propane use concentrated in areas not served by the natural gas grid. One exception to the rule is for consumers in natural-gas served areas on large properties with low gas use, where including the cost of extending the connection to the house in the customer's rate base would negate any benefit in the lower commodity charge. In such circumstances, customers will either continue to stay with propane or, increasingly, opt for an all-electric home.

In fact, in the southern mainland states such as Florida, both propane and natural gas are in general decline as electricity takes over the market for all domestic applications. The relatively warm climate means most homes have air conditioning already, and the electric heat pump is becoming an ever more prevalent feature of new homes, and a common upgrade in homes where the air conditioning or heating systems are in need of replacement. Such homes may choose to retain gas or propane service for supplementary heating, cooking, or water heating.

Hawaii is an exception from the electrification trend primarily because electricity prices in the state are sufficiently high to incentivize continuing use for applications where natural (or in Hawaii's case synthetic) gas or propane can satisfy the load requirement – primarily water heating and cooking.

The gas system in Hawaii is split into two distinct markets: the synthetic gas (SNG) market, and the bottled propane market. In general terms, the SNG market, served by Hawaii Gas, a regulated utility,

---

[32] Customer count totals from Form EIA-176, "Annual Report of Natural and Supplemental Gas Supply and Disposition", Available at: http://www.eia.gov/dnav/ng/ng_cons_num_dcu_nus_a.htm; Consumption by end use from Form EIA-857, "Monthly Report of Natural Gas Purchases and Deliveries to Consumers", Available at: http://www.eia.gov/dnav/ng/ng_cons_sum_dcu_nus_a.htm; ICF calculated use per customer.

[33] ICF estimates based on API's *2011 Sales of Natural Gas Liquids and Liquefied Refinery Gases*. API, Washington DC, 2013.

resembles the natural gas market on the U.S. Mainland, while the bottled propane market compares to the bottled propane market on the U.S. Mainland. What makes the Hawaiian situation unique is that both the SNG and the propane sides are strongly indexed to international petroleum prices.

Altogether, the syngas system is reported to be consuming 1,650 barrels of naphtha per day (2012 figure).[34] In addition to the LNG import plans, and in line with existing statutes, Hawaii Gas is exploring alternatives to petroleum-based feedstock, and in 2011 built a pilot plant producing biogas from renewable feedstock. With a rated capacity of one million gallons per year, the renewable natural gas (RNG) plant has the capacity to displace 65 b/d of conventional feedstock. In 2011, Hawaii Gas was able to displace 2.4% of its total requirement.[35]

The Utility Business

In its most recent company profile, Hawaii Gas states that its "utility business serves approximately 35,000 customers."[36] This segment of Hawaii Gas' business sources its synthetic gas (syngas) at Hawaii Gas' own catalytic plant located in Campbell Industrial Park. The Synthetic Natural Gas (SNG) plant, located next to the former Tesoro refinery (now owned by Hawaii Independent Energy), consumes naphtha produced at the refinery, converting it to a primarily methane stream that exhibits combustion characteristics similar to pipeline natural gas in the continental U.S. Its energy content, at approximately 1,030 BTU per standard cubic foot, is just slightly above the 1,022 reported by the EIA as average for the U.S. in 2011.[37]

Hawaii Gas delivers the produced SNG to its customers via a pipeline system that originates at the SNG plant, and serves the greater Honolulu area on Oahu. While the current feedstock for the SNG plant is composed of the naphtha stream from the adjacent refinery (the new refinery owners have renewed the supply agreement), during the shutdown period, Tesoro continued to provide feedstock to Hawaii Gas by finding alternative sources of supply. Furthermore, as noted above, the company is currently piloting a new process to produce renewable natural gas (RNG). The RNG plant, co-located with the SNG plant, converts renewable feedstock, primarily composed of vegetable and animal oils, into a gas stream that can serve as a supplement to SNG.

As an additional back-stop in case of conventional service disruptions, Hawaii Gas has also began rolling out skid-mounted LNG vaporizing equipment capable of gasifying LNG into pipeline-quality gas. The LNG is expected to be brought to Oahu from the mainland in ISO containers sized to fit on standard container cargo vessels. These containers can then be moved either to a centralized area near the propane-air

---

[34] "Future Oil-Product Demand." Chapter 2. Draft. FACTS.

[35] *Report to the Public Utilities Commission: Renewable Energy Annual Report*. The Gas Company, Honolulu, HI, March 30, 2012. p. 5 Available at: http://puc.hawaii.gov/wp-content/uploads/2013/04/CY2011-Act-30-Report-PUC-The-Gas-Co.pdf; ICF estimates approximately 10,000 of these customers are in fact served by pipeline-delivered propane sourced from a central propane tank rather than SNG.,

[36] *Company Profile: An Introduction to Hawaii Gas*, Hawaii Gas, Oahu, 2013. Available at: http://www.hawaiigas.com/media/20550/hawaiigas-company-profile.pdf. p.7

[37] *Natural Gas Annual 2011*. Energy Information Administration, Washington, DC, 2013. Available at: http://www.eia.gov/naturalgas/annual/pdf/nga11.pdf. p.196

facility, which currently serves as a back-up for the gas system, or to locations throughout the greater Honolulu area where there is access to the gas mains, and the gas can be vaporized and injected into the system.

The ability of the Oahu gas grid to currently receive regasified LNG is proof of the capacity of the system to accommodate natural gas sourced from a central LNG regasification plant, were such a facility to be built on Oahu. The SNG facility currently consumes an estimated 613 thousand barrels of naphtha annually; and, according to the EIA, deliveries into the Hawaii Gas' utility grid were about 2,687 MMcf of SNG for delivery to customers.[38] Hawaii Gas filings with the Public Utilities Commission state an 86% process efficiency, , suggesting process heat losses of over 14%.[39] With naphtha consistently selling above crude oil at a $/MMBTU basis, the final cost to consumers, which includes the commodity cost in addition to the capital and operating costs of the SNG plant, is not surprisingly an order of magnitude above the average U.S. mainland price.[40]

At current levels of natural gas (SNG) consumption, ICF estimates Hawaii Gas would require approximately 54 thousand tonnes of LNG per year – the equivalent of one standard charter LNG carrier per year.[41]

Propane

Based on production figures reported in the EIIRP system, in addition to imports, total supply of propane for consumption in Hawaii was approximately 3,400 barrels per day in 2012. Throughout 2010, 2011, and 2012, Hawaii Gas, as the only importer, brought in eight to nine cargos per year, averaging 55 thousand barrels each (2.3 million gallons). By the end of 2013, Hawaii Gas' statewide storage capacity will have expanded by 540 thousand gallons to over 3 million gallons, bringing its total gas energy supply on hand in Hawaii to more than 30 days.[42] In addition, Hawaii Gas operates two LPG barges, the 424,000 gallon Huki Kai and the 490,000 gallon Pono Kai.[43]

[38] "Future Oil-Product Demand." Chapter 2. Draft. FACTS. Form EIA-914, "Monthly Natural Gas Production Report", Energy Information Administration, Washington, DC 2007-2013. Available at: http://www.eia.gov/dnav/ng/ng_cons_sum_dcu_SHI_a.htm

[39] *Report to the Hawaii Public Utilities Commission: Renewable Energy Annual Report Required by Act 30 (SLH 2010)*. The Gas Company, Honolulu, Hawaii, 30 March 2012. p.4 Available at: http://puc.hawaii.gov/wp-content/uploads/2013/04/CY2011-Act-30-Report-PUC-The-Gas-Co.pdf

[40] For 2012, the Energy Information Administration reports residential delivered natural gas at 52.86 c/MMcf. This is over five times above the national average of 10.68 c/MMcf, Available here: http://www.eia.gov/dnav/ng/ng_pri_sum_a_EPG0_PRS_DMcf_a.htm

[41] Oahu "natural gas" consumption, as per EIA's Form-914, plus 5% consumed by the regasification facility. Standard charter LNG vessel assumed capacity of 125,000 cubic meters, the equivalent of 56.3 thousand tonnes.

[42] "Press Release: Hawaii Gas Increases Propane Storage Statewide." June 26, 2013. Available at: http://www.hawaiigas.com/news/press-releases/2013/hawaii-gas-increases-propane-storage-statewide.aspx

[43] Information provided to ICF by Hawaii Gas.

Refineries on Oahu maintain sufficient propane storage to maintain regular refinery operations, and sell their output directly to Hawaii Gas and other propane retailers (with Hawaii Gas being by far the largest propane retailer in the state).

On the U.S. mainland, consumers of propane, particularly for residential and commercial applications, are found predominantly off the natural gas grid. Regionally, the largest number of legacy residential propane consumers is found in the South Region. This region, and especially the South Atlantic Census Division, has been poorly served by the natural gas grid, and this trend is most pronounced outside metropolitan areas. Due to both the relatively warmer climate, and increasing penetration of electric heat pumps, this region has become a declining market for propane. For growth, the propane industry is looking to New England, where a combination of colder weather, poor natural gas grid reach, and increasingly stringent environmental regulations on the use of heating oil have combined to create positive market conditions for propane.

While Hawaii in terms of energy demand resembles the U.S. South, with its warm climate and relatively high air conditioning demand, the state also boasts the highest residential electricity prices in the country. On average, Hawaiian residential customers paid 37.27 cents per kilowatt hour in 2012 – more than double the 17.35 c/kWh residential customers paid in Connecticut, the highest-priced state on the U.S. mainland (Alaska residents paid 17.38 c/kWh), and triple the 11.88 c/kWh average U.S. price for electricity delivered to residential consumers.[44]

These high electricity prices, the absence of indigenous natural gas resources, and a very limited natural gas (or, in Hawaii's case, syngas) infrastructure have produced a unique energy profile that has led to an unexpectedly high penetration of propane for non-space heating use. At just below 55,000 residential and commercial customers, propane is found in about 10% of Hawaiian homes (not including homes using propane for outdoor grilling). This compares to about 7% of homes in Florida or Arizona.[45]

Furthermore, unlike any jurisdiction on the U.S. mainland, Hawaii also has a number of micro-grids, over which Hawaii Gas distributes propane from centrally-located tanks. An estimated 7,000 residential and commercial customers receive propane in this manner. All this capacity can be expected to shift to natural gas were it to become available. This would directly offset a portion of the nearly 16 million gallons of propane imported on average over the three previous years.[46]

Off-grid propane use by residential and most commercial customers may not present an attractive opportunity for natural gas conversions due to the high costs of either extending the natural gas grid to these customers, or converting their use to CNG – neither of which would likely be justified by the low

---

[44] *Electric Power Monthly with Data for December 2012*. Energy Information Administration, Washington, DC, February 2013. p. 122. Available at: http://www.eia.gov/electricity/monthly/current_year/february2013.pdf

[45] Calculations based on ICF estimates of 2011 state-level residential propane accounts and total household numbers from the 2011 American Community Survey.

[46] Three year average calculated on the basis of propane imports reported for Honolulu, Hawaii in EIA's Company Level Imports database (reported on EIA From-814. Company Level Imports, Energy Information Administration, January 2010 – December 2012. Available at: http://www.eia.gov/petroleum/imports/companylevel/

levels of consumption in these sectors. Among the largest commercial propane users, whose consumption of energy might exceed the equivalent of 2.3 Mcfd of natural gas, deployment of CNG might become an option in time, but the roll-out would most likely take place at a pace similar to the adoption of CNG vehicles in Hawaii to capitalize on shared infrastructure.

Natural gas could, however, serve the off-grid institutional (and very large commercial), industrial, and agricultural energy consumers well. A number of large commercial, industrial, and agricultural operations in Hawaii, as a hedge against high electricity prices, have invested in propane or fuel-oil fueled combined heat and power systems. These include hotels, such as the Kauai Marriott Resort or the Westin Kaanapali Ocean Resort Villas, large public facilities such as the Kauai Veterans Memorial Hospital, and large residential developments like the Pohai Nani Retirement Community.[47,48,49]

Altogether, an estimated 5,300 kW of combined heat and power capacity that is currently off the Hawaii Gas grid could switch to CNG- or LNG-delivered natural gas, representing total consumption of nearly 48 thousand barrels per year of propane, and a further 30 thousand barrels of diesel. Were this capacity to be converted to consume natural gas, it would total approximately 7,000 tonnes of LNG demand annually, or about 13% of a standard charter LNG cargo per year.

ICF estimates the backing out of propane use by all grid-connected residential and commercial users, and the largest commercial, agricultural, and industrial users could reduce consumption by an estimated 16 million gallons per year. This would fully offset any propane imports requirement, assuming that both refineries continue operation. With both refineries closed the use of LNG- delivered natural gas could replace about a third of propane demand. Furthermore, the introduction of LNG to Hawaii would halt any forecasted growth in propane consumption in the state, all of which has centered around large-scale CHP deployment that would be fueled by the newly-available natural gas.

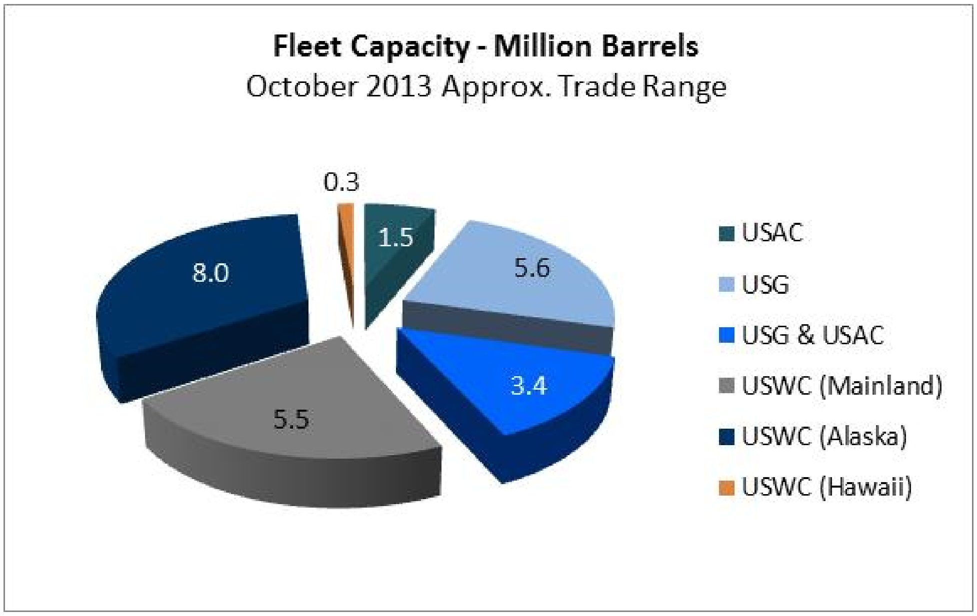
[47] *Propane-fueled combined heat and power Reducing operating costs and emissions at Kauai Marriott Resort and Beach Club Lihue, Kauai Island, Hawaii*. Propane Education & Research Council, Washington, DC. Available at: http://www.propanecouncil.org/uploadedFiles/Council/Research_and_Development/CS_10974_Kauai_Marriott_CHP_web.pdf;
[48] *Resort Hotel Discovers Big Savings with Combined Heat and Power*. Elite Energy Systems, Carson City, Nevada. Available at: http://www.eliteenergysys.com/images/elite_case_study_kaanapali_ocean_resort_north_e.pdf
[49] *Combined Heat and Power Units located in Hawaii*. Department of Energy, Washington, DC. Available at: http://www.eea-inc.com/chpdata/States/HI.html

Appendix 7: Jones Act Fleet Assessment

Jones Act Fleet Composition

The trading ranges for the vessel in the existing Jones Act fleet are shown below. This data is representative of Suezmaxes that are engaged in the Alaska crude oil trade, MR product tankers, and articulated tug barges (ATBs). As of October 2013, the total fleet is 24.2 million barrels.

Vessel Size	Barrel Capacity Range	Fleet Size (Million Barrels)
Suezmax	>800,000	8.0
MR	200,000 – 350,000	9.6
ATB	<200,000	6.6
	Total:	**24.2**



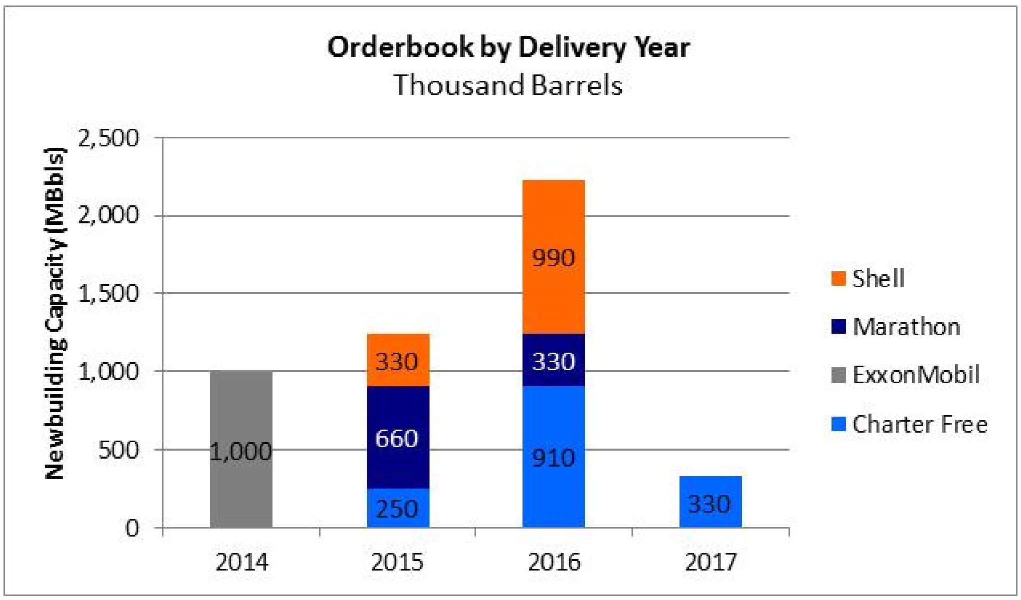
Source: Poten & Partners

Note that the West Coast Mainland fleet typically moves products between major west coast refining centers such as Los Angeles, San Francisco and Puget Sound. The vessels allow refiners to optimize their refinery network and/or trade products with other refiners to assist during refinery outages. There is normally not much movement to Hawaii unless there is a need to provide supply during outages.

Jones Act Fleet Investments

The Jones Act compliant vessels that are currently on order—the "orderbook"—are represented below by charterer. There is 4.8 million barrels of tanker capacity on order, representing a 20% increase in domestic tanker fleet capacity over the next four years. Nearly 1.5 million barrels of the new capacity is uncommitted to a particular service, since it is still not claimed by any particular company on time charter. Most of the capacity is due to deliver in 2016.

Shell's newbuildings will likely work in the U.S. Gulf trading crude oil; one may potentially serve as a shuttle tanker for an offshore oil field. Two of the Marathon newbuildings will likely go into crude oil and one will likely go into the gasoline trade into Tampa, Florida. ExxonMobil's 2014 orders will be dedicated to the Alaska crude oil trade.



Source: Poten & Partners

This is a very significant change from a stable Jones Act fleet for a number of years. About 30% of the new tonnage is being built by ship owners anticipating more requirements; the others are committed by the shipowner for a specific trade.