THE FACTS ABOUT LNG FOR HAWAIʻI

FINDINGS AND RESULTS OF A GLOBAL INVITATION TO BID

JANUARY 2016
Executive Summary

As the only regulated gas utility in our state, Hawaii Gas is committed to Hawaii’s clean energy future. We support the State’s goal of 100% RPS (Renewable Portfolio Standards) by 2045 and believe there are multiple pathways to achieve this. It is important to reduce Hawaii’s dependence on oil; swiftly decrease carbon emissions to meet more stringent federal Environmental Protection Agency (EPA) requirements; and quickly decrease energy costs, which are the highest in the nation. Achieving this complex transformation requires collaboration among many parties, including government, regulators, Hawaii’s utilities and energy industry, and businesses and residents.

There has been much discussion about the use of natural gas in Hawai‘i, brought to the state in the form of liquefied natural gas or LNG. Hawaii Gas began exploring alternative fuels about five years ago to diversify its fuel supply and enhance reliability for our customers. In 2014, the Company initiated a competitive bidding process to determine the cost of supplying natural gas to Hawai‘i and for a third party to own and operate an offshore floating storage and regasification unit (FSRU), which stores LNG and converts it back into natural gas for customer use.

**Competitive Bid Process**

The request for proposals was intentionally designed to be an interim solution to provide near-term cost and emissions benefits as part of the State’s plan to achieve 100% RPS by 2045 and therefore requested the following:

- LNG pricing over a 15-year contract period with the ability to reduce the quantity of LNG purchased each year to accommodate increasing amounts of renewable generation and not impede the transition to renewable energy
- Third party ownership and operation of an FSRU over a 15-year contract period

By the fall of 2015, Hawaii Gas received over 20 proposals from some of the largest and most reputable providers of LNG in the world. Proposals were reduced to a few finalists based on a number of criteria, such as price, past performance, availability of existing LNG supplies and having an FSRU ready to deploy to Hawai‘i. Finalists then submitted binding proposals from which a single company was selected.

**Findings**

Hawaii Gas can now confirm that natural gas will significantly reduce the cost of energy for its customers. The company estimates that it will reduce its synthetic natural gas (SNG) utility customers’ bills by more than 25%.

Natural gas will also significantly reduce the cost of fuel for electricity producers. Based on the actual amount and cost of fuel consumed on O‘ahu to produce electricity in 2015, LNG would have saved electric utility customers $132 million in fuel costs. Hawaii Gas estimates that natural gas will reduce electricity utility customer fuel costs by about $1.3 billion over a 15-year period. Going forward, we can now say the following about the benefits of natural gas use in Hawai‘i:

1. Natural gas will reduce our SNG utility customer bills by more than 25%;
2. Natural gas will reduce electric utility fuel costs on O‘ahu by approximately 30%; and
3. Natural gas will reduce carbon dioxide greenhouse gas emissions by 30%, which is equivalent to removing more than 250,000, or a quarter of Hawaii’s, passenger vehicles from the road each year.

The LNG project requires federal approval from the Federal Energy Regulatory Commission (FERC) and state approval from the Hawai‘i Public Utilities Commission (PUC). These processes ensure our communities have a voice on the use of natural gas in Hawai‘i and those concerns be properly considered and evaluated. Based on discussion with FERC, Hawaii Gas believes the project can, with State and community support, obtain federal approval within 30 months, enabling the delivery of LNG to Hawai‘i as early as 2019.

Complementing Renewable Energy
The use of modern, efficient natural gas-fueled power generation can also accelerate the use of intermittent solar- and wind-generating resources, and further reduce carbon emissions and fuel consumption. Currently, power generating units that are steam boilers are not flexible enough to accommodate rapid change in demand for electricity due to intermittency of solar and wind resources. Therefore, such generation is always running in the background, consuming fuel because it cannot be turned off when not needed. Instead, it must always run in order to dispatch electricity when the sun isn’t shining and the wind isn’t blowing.

New gas-fueled generators would be better able to accommodate more renewable energy on the grid, because they can more efficiently adjust their output in response to the variability of solar and wind production. For example, the Texas grid has been able to integrate large amounts of new wind power in large part because of its complement of gas-fired generation. Modern, ultra-efficient gas-fired combined-cycle power plants also produce 30% less greenhouse gas carbon dioxide emissions than oil-fueled plants.

LNG Infrastructure
LNG does not require a land-based terminal or storage. The only infrastructure required to deliver natural gas to O‘ahu is the installation of a new mooring system nearby the Chevron and Hawaii Independent Energy mooring systems located off Barbers Point, which are now used to import oil; an FSRU vessel that would be secured to an offshore mooring system and buoy, a subsea pipeline to deliver natural gas to shore and connect with Hawaii Gas’ existing 1,000 miles of pipeline distribution and 5 to 10 miles of new pipeline extensions to serve customers. Combined, the estimated cost of this infrastructure is $200 million and would be fully recovered by the end of the 15-year contract.

This technical approach is the same as that used to provide Boston, MA and several other locations throughout the world with natural gas. Because temporary infrastructure is used to store and gasify LNG, the environmental impacts are minimal.
Conclusion
Natural gas provides a number of benefits to customers and to the environment and can be an integral part of the State’s plan to achieve 100% RPS by 2045. Using natural gas in Hawai‘i does not alter the State’s plan and does not impede the growth of renewable energy. Natural gas provides immediate cost relief and accelerates the reduction of greenhouse gas emissions, diversifying the state’s fuel mix so Hawai‘i is not wholly dependent on imported oil.

Hawaii Gas believes that the findings of its competitive bidding process for LNG supply and FSRU operating services will contribute to meaningful discussions in our community about how natural gas can serve as a viable interim solution for Hawai‘i as our state transitions to 100 percent Renewable Portfolio Standards by 2045.

The next step is for Hawaii Gas to share this information with stakeholders who are interested to determine how natural gas can play a role in accelerating Hawaii’s clean energy future as the state transitions away from oil. The decisions we make today about our clean energy future will have far-reaching impact on Hawaii’s environment, people and future generations. We look forward to discussions and collaboration with others in our community.
Three independent studies by Hawai’i Natural Energy Institute, Hawaii Gas and Hawaiian Electric Company show liquefied natural gas (LNG) can provide significant energy cost savings for Hawai’i.

The Tesoro refinery in Kapolei temporarily shuts down.

In April, Tesoro shuts down its refinery for three months when no buyer had been found. (It restarted operations in June after its purchase by Par Petroleum.)

In March, Hawaii Gas receives approval from the Hawai’i Public Utilities Commission (PUC) to use LNG in limited quantities as a backup fuel for its O‘ahu SNG operations. Its first shipment of containerized LNG arrives at Pier 38 in April.

The Hawai’i Refinery Task Force’s final report, submitted to the State Department of Business, Economic Development & Tourism (DBEDT) in April, concludes that one or both of the state’s refineries are likely to close by 2020. The refineries supply naphtha, which is a feedstock that Hawaii Gas uses to produce its synthetic natural gas.

In August, responses to Hawaii Gas’ LNG Request for Information (RFI) indicate market interest, cost savings, and technical and financial feasibility of LNG for Hawai’i.

In October, Hawaii Gas files an application with the PUC for approval to convert 30% of its synthetic natural gas (SNG) production to LNG. This application is currently before the PUC.

In November, Hawaii Gas launches its Invitation to Bid (ITB) process to more than 50 companies to solicit current detailed market information regarding LNG for Hawai’i.

In September, Hawaii Gas receives firm bids from a pool of the world’s most experienced energy providers and contractors.

In January, Hawaii Gas requests proposals for raw biogas and/or bio-methane from local and national suppliers as part of its ongoing fuel diversification efforts and to further support Hawaii’s clean energy goals.

In January, Hawaii Gas selects a supplier to deliver LNG to Hawai’i and provide FSRU services, contingent on approvals from the Federal Energy Regulatory Commission (FERC) and the PUC.

The State of Hawai’i meets its 100 percent Renewable Portfolio Standards (RPS) goal.
A Proven Approach to LNG

Hawaii Gas has recently completed a competitive global bidding process for the delivery of LNG to Hawaii that attracted over fifty interested parties resulting in over 20 formal proposals. Under the tender, a third party would own and operate an offshore Floating Storage and Regasification Unit (FSRU) that stores LNG and converts it back into natural gas for delivery through Hawaii Gas’ existing pipeline infrastructure. The Hawaii Gas LNG Plan (Proposed Plan) uses proven technology operating throughout the world, including in the US mainland, and relies on existing sources of supply. The Proposed Plan minimizes the amount of new infrastructure required to supply fuel and consists of: 1) an offshore FSRU that would be moored approximately one mile offshore from Barbers Point; 2) an LNG supply vessel (owned and operated by a third party) that would provide LNG to the FSRU approximately once every three weeks; 3) a new buoy in close proximity to two other existing buoys now used to import oil to Hawaii which would be connected to a subsea pipeline to deliver natural gas to shore connecting to Hawaii Gas’ existing gas pipeline network; 4) pipeline extensions to serve the Kalaeloa Partners (independent power producer) and HECO-owned Kahe and Waiau power plants, which are in close proximity to Hawaii Gas’ existing pipelines; and 5) small-scale gas treatment equipment to adjust the energy density of the natural gas.

Based on the results of the competitive bidding process, Hawaii Gas has documented that the cost of natural gas delivered to Hawaii in the form of LNG is less expensive than the fuels the HECO Companies now use to produce electricity, even in the current low oil cost environment. LNG under the Proposed Plan is also significantly less expensive than the blended fuels that the HECO Companies propose to use to meet the U.S. Environmental Protection Agency Mercury and Air Toxic Standards (MATS) rule slated to go into effect in the spring of 2016.

Based on the HECO Companies’ actual 2015 fuel consumption and cost, Hawaii Gas’ Proposed Plan, had it been operating at the beginning of 2015, would have reduced fuel costs by approximately 20 percent, saving ratepayers approximately $130 million. Likewise, had the HECO Companies been using the more expensive blended fuel in 2015, which they will need to do in 2016 to meet environmental compliance requirements, the Hawaii Gas Proposed Plan would have reduced fuel costs by 29 percent or approximately $225 million. These cost savings are no longer speculative; they have been confirmed through a competitive bidding process with final contract negotiation now underway. Even taking into consideration today’s low-cost oil environment and the continued rate of decline in annual fuel consumption due to increased use of renewable energy and energy efficiency gains, Hawaii Gas estimates that Hawaii Gas’ Proposed Plan would result in savings estimated at $1.3 billion over a 15 year contract period as depicted in Figure 1 below.

In addition to meaningful cost savings, the Proposed Plan supports the state’s policy directives to achieve a cleaner energy future. During the 15-year contract term under Hawaii Gas’ Proposed Plan (2019-2034), and as the State transitions from fossil fuel-based generation to 100% renewables, Hawaii Gas believes the use of natural gas will reduce greenhouse gas (GHG) emissions by approximately 30 percent commencing in 2019, which is equivalent to removing over 250,000 cars from Hawaii’s roads each year. LNG will
also support greater penetration of intermittent sources of renewable energy such as wind and solar by powering quick-starting, load-following generation that runs when the sun isn’t shining and the wind isn’t blowing.

Hawaii Gas believes LNG can be used as a bridge fuel for power generation and the contracts under the Proposed Plan have been purposefully set at 15 years. At the end of the contract term, the FSRU will be redeployed outside of Hawaii, and the subsea and land-based pipelines will be taken out of service or repurposed. Natural gas, unlike oil, does not leave significant residual trace, thereby limiting any long-term impact to our communities.

Hawaii Gas believes that a fuel switch to natural gas and new load following generation are essential intermediate steps on the path to achieving Hawaii’s renewable energy future. Until such time that the total system (grid, generation, storage) can be converted to 100 percent renewable power generation, natural gas and load following generation are the most effective choices for Hawaii to complement intermittent solar and wind resources and to meaningfully decrease greenhouse gas emissions while reducing costs to ratepayers.

Finally, Hawaii Gas’ Proposed Plan incorporates a number of key principles that align with the State’s clean energy goals as shown in Table 1.
The Proposed Plan utilizes the existing Hawaii Gas pipeline to distribute natural gas and requires less than 8 miles of new gas pipeline. There is no land-based LNG storage.

All LNG will be stored offshore with no impact on Hawaii’s roads and harbors.

Actual ratepayer savings in 2015 would have been $132 million and will be greater in 2016 and beyond when the HECO Companies switch to more expensive fuel blends.

Preliminary estimates place the total cost of the buoy, subsea pipeline and pipeline extensions at $200 million, which based on projected savings could be recovered in less than two years.

All $200 million in estimated capital costs for the project will be fully recovered in the 15 year period. At contract end, the FSRU leaves Hawaii waters and LNG fuel supply ceases.

Each year, Hawaii Gas can adjust the amount of LNG purchased without penalty in order to accommodate increasing amounts of renewable energy integration.

The Proposed Plan would reduce greenhouse gas emissions by 2.9 billion pounds of carbon dioxide each year, which is equivalent to removing more than 250,000 cars from Hawaii’s roads.

The operational model of utilizing an FSRU is proven and now operating in multiple locations, including the U.S. mainland. Further, Hawaii Gas has secured an existing FSRU that is ready to be deployed to Hawaii.

LNG sources have been secured from multiple locations and are all currently operating so there is no risk in waiting for a project come online.

Under the Proposed Plan, Hawaii Gas would seek approval from and be regulated by the Commission. In this way, all costs and prices are transparent to ratepayers.

By design, the Proposed Plan would operate for 15 years; then, by contract and Commission oversight, be required to terminate.
LNG Fuel Savings

In large part due to the State’s policy leadership, the HECO Companies’ fuel consumption has declined by 21 percent from 2006 to 2015, as shown in Figure 2 below.

Assuming the current trajectory is maintained, the State could achieve 100 percent renewable electric generation by 2045 and reduce fossil fuel consumption to zero. However doing so depends on a large number of factors, such as the rate of renewable generation installed, grid upgrades to control distributed generation resources and the pace that utility and behind the meter energy storage systems can be installed. Based on these factors, the rate of decline in fuel consumption could be faster, slower or continue on the current trajectory. Regardless of the ultimate trajectory, there is a window of at least 15 years during which Hawaii could utilize savings from lower cost natural gas to reinvest a portion of the over $1 billion in savings to accelerate Hawaii’s clean energy transformation.

Table 2 below displays the delivered cost of LNG (LNG alone and inclusive of the FSRU and infrastructure costs) based on various prices for Brent Crude oil. The table also displays the cost of HECO’s fuel blend consisting of LSFO and diesel. Then displays the net savings between a blended fuel and LNG. As shown, LNG is the less expensive fuel even with Brent Crude oil at $20 per barrel.

Figure 2: Hawaii’s fuel consumption for electricity generation.
for Brent Crude oil. The table also displays the cost of HECO’s fuel blend consisting of LSFO and diesel. Then displays the net savings between a blended fuel and LNG. As shown, LNG is the less expensive fuel even with Brent Crude oil at $20 per barrel.

Figure 3 below compares the actual cost of low sulfur fuel oil from 2006 to 2015 with Hawaii Gas’ known cost of LNG in a “backtest”. The formula used to purchase LNG under Hawaii Gas’ Proposed Plan is based on the cost of Brent Crude in dollars per barrel, information that is readily available from the EIA. Reviewing historical numbers, LNG would have been less expensive the majority of time compared to LSFO. We note that Hawaii uses approximately 60 million MMBtu of energy each year to produce electricity. Therefore, each $1/MMBtu in savings results in approximately $60 million in fuel cost savings.

Forecasts suggest that LNG is estimated to be $2 to $3/MMBtu less expensive than LSFO and $2.5 to $5/MMBtu less expensive than a blend of LSFO and diesel in the future, which produces substantial ratepayer savings.

<table>
<thead>
<tr>
<th>Brent Price $/b</th>
<th>Brent Price $/mmBtu</th>
<th>LNG delivered price Oahu * $/mmBtu</th>
<th>LNG All-in Price /1 $/mmBtu</th>
<th>Fuel Blend (60:40) /2 $/mmBtu</th>
<th>Savings vs Fuel Blend $/mmBtu</th>
<th>Savings vs Utility Oil</th>
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</thead>
<tbody>
<tr>
<td>$ 20.00</td>
<td>$ 3.45</td>
<td>$ 3.12</td>
<td>$ 4.32</td>
<td>$ 4.54</td>
<td>$ 0.22</td>
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<td>$ 5.17</td>
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<td>$ 90.00</td>
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<td>$ 14.98</td>
<td>$ 19.86</td>
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</tr>
<tr>
<td>$ 110.00</td>
<td>$ 18.97</td>
<td>$ 15.11</td>
<td>$ 16.31</td>
<td>$ 21.78</td>
<td>$ 5.47</td>
<td>25%</td>
</tr>
<tr>
<td>$ 120.00</td>
<td>$ 20.69</td>
<td>$ 16.45</td>
<td>$ 17.65</td>
<td>$ 23.70</td>
<td>$ 6.06</td>
<td>26%</td>
</tr>
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</table>

*based on hybrid formula offered to HawaiiGas by major seller, mid-2015
/1 des price plus FSRU regas plus all onshore facilities, pipelines, and retrofits
/2 Based on third-party price model with a Henry Hub price of $3/mmBtu
Figure 3: LNG savings as compared to historical fuel costs and estimated future costs.

Forecast & Backcast Brent versus Utility Fuels in Hawaii, $/mmBtu
(Brent, cif; LSFO, 60:40, and LNG at Power Plant)

- Historical Prices: Nominal (Dollars of the Day)
- Forecast Prices: 2015 real dollars (deflated)

Backtest using actual data

- LSFO
- 60:40
- LNG
Figure 4 below displays the yearly and cumulative cost savings as compared to a blend of LSFO and diesel, and it is based on the continuation of the current rate of decline in fuel consumption to produce electricity, shown in Figure 2. The future prices of the blended LSFO and diesel were produced by Facts Global Energy and show that by switching to natural gas, the State could save nearly $1.3 billion from 2019 to 2034.

Figure 4: Estimated cost savings to ratepayers from switching to natural gas.
Hawaii Gas has completed extensive preliminary engineering work to determine the required infrastructure to deliver natural gas to each of the power plants on Oahu. A summary of the infrastructure and costs is shown in Table 3.

Table 3: Hawaii Gas infrastructure and cost estimates.

<table>
<thead>
<tr>
<th>Cost Component</th>
<th>Millions</th>
</tr>
</thead>
<tbody>
<tr>
<td>FSRU Submerged Turret Loading (STL) System</td>
<td>$72</td>
</tr>
<tr>
<td>Subsea Pipeline</td>
<td>$37</td>
</tr>
<tr>
<td>Nitrogen Injection Facility</td>
<td>$25</td>
</tr>
<tr>
<td>Onshore Pipelines and Apperturences</td>
<td>$47</td>
</tr>
<tr>
<td>Other</td>
<td>$19</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$200</strong></td>
</tr>
</tbody>
</table>

The selected offshore FSRU is already in service and would be owned and operated by a third party. The FSRU would connect to a subsea mooring system – similar to the moorings already in place for the two oil refineries. The FSRU would receive cargoes of LNG approximately once every three weeks as shown in Figure 5.
The FSRU is approximately the same size as the conventional crude carriers that currently serve Hawaii. The FSRU would have the ability to receive and store LNG, and would also have the capability on-board the ship to convert the LNG back into natural gas using on-board vaporizers. The FSRU would utilize a closed-loop vaporization process to avoid environmental impacts. Once regasified, the natural gas would be compressed into a pipeline connected to the FSRU using a sophisticated and well-proven buoy system known as a submerged turret loading (STL) buoy that connects securely into the ship. The STL buoy would have a “riser” to provide the needed buoyancy, and would be connected to a hose (umbilical) and pipeline end manifold (PLEM) that then connects into a subsea pipeline that runs along the ocean floor as shown in Figure 6.

Figure 7 below shows the FSRU along with the subsea pipeline, which is intended to run along the ocean floor surface in an area where there is no coral or other environmental concerns for a short distance then horizontally directionally drilled under the ocean floor so as not to impact coral or other sea life. The subsea pipeline would be similar to the pipeline connecting the Chevron and HIE offshore moorings to their respective refineries. Once on-shore, the pipeline would connect to the existing Hawaii Gas pipeline.

**Figure 6: FSRU, submerged turret loading system and subsea pipeline.**

**Figure 7: FSRU shown with subsea pipeline.**
New on-shore pipeline extensions would be required to deliver gas to the Kalaeloa Partners, Kahe and Waiau power plants as shown in Figure 8. All other customers interested in using natural gas could be served using existing Hawaii Gas pipeline infrastructure. Total pipeline extension requirements are estimated to be between 5-10 miles (depending on final route alignments).

Emergency fuel backup (in case of hurricanes, equipment malfunctions or unforeseen supply-ship delivery delays) can be provided by maintaining adequate working-level inventories on the LNG FSRU, by supplying residential and commercial customers using Hawaii Gas’ propane-air system (which already exists) or by maintaining oil-fired fuel storage, which also exists today at power generating facilities. No new land-based LNG or oil storage infrastructure would be required.

As for lingering burdens to the ratepayers – after the 15 year term of these contracts, the LNG supply contract, which requires Commission approval, would terminate after 15 years and has provisions that would allow volumes to ramp down annually and for early termination of the contract if desired. The FSRU charter has provisions which would allow for early termination as well. Financing and other costs would only be required to support active contracts. The ‘stranded asset’ risks are therefore limited.

Figure 8: New pipeline infrastructure.
Permitting and Scheduling

Under Hawaii Gas’ Proposed Plan, permitting for the development of the FSRU would be primarily through an established Federal Energy Regulatory Commission (FERC) process, in close coordination with various federal and state agencies and others. This process incorporates all state and federal environmental compliance requirements (including an environmental impact statement) and provides an opportunity for input and feedback from all interested parties to ensure a collaborative process. A detailed list of applicable Federal, State and Local permits has been developed and considered in formulating the schedule and work plan. Hawaii Gas has received confirmation that similar projects take, on average, 30 months for approval.
Key LNG Contract Terms

Hawaii's energy consumers have been buffeted for decades by high and volatile energy prices. Understanding this, Hawaii Gas has focused on designing LNG supply contracts that dampen price volatility and provide a mechanism for locking in prices over longer terms. Under Hawaii Gas’ Proposed Plan, the LNG supply contract has been purposefully structured to provide the following price stabilization mechanisms:

A six-month price-averaging “lag” – Prices for any one month will be calculated as the arithmetic average of the average monthly prices for the previous six months. This will significantly reduce month-to-month price spikes and volatility.

Hybrid Pricing – The LNG supply contract allows for the supply of gas either on a 100 percent Brent index, or a “hybrid” formula that is based on both US Henry Hub natural gas and Brent crude oil pricing. These indices rarely move in complete alignment and the hybrid option provides greater protection from volatility in one or the other index.

Hedging Options – Both Henry Hub natural gas and Brent crude oil are commodities that can be hedged. Hedging provides a tool that can insure either a fixed price into the future, or the ability to cap price exposure between various upper and lower boundaries for discrete periods of time into the future. This price insurance or protection comes at an incremental cost, but if such long-term price guarantees for some or all of the State’s LNG supply is attractive, hedges for as long as 10 or 15 years are possible. Hawaii Gas has investigated this option and the economics at which hedges today are possible and would be pleased to provide further discussion of these possibilities. By hedging Brent Crude oil we can in effect hedge the natural gas delivered to Hawaii. Doing so makes it possible to “lock-in” the cost to produce electricity over an extended period.
Conclusion

With the completion of Hawaii Gas’ competitive bidding process for LNG supply and FSRU operating services and the technical evaluation of infrastructure, Hawaii Gas can demonstrate that natural gas is less expensive than the existing and proposed oil-based fuels used by HECO to produce electricity in Hawaii. Natural gas, as a bridge fuel, provides several benefits directly aligned with and in support of the State’s clean energy goals and ratepayer relief including cost savings, accelerated reduction in emissions and increased use of intermittent renewable energy sources of generation such as solar and wind.