# *Resources for Renewable Natural Gas Production in Hawai‘i*

**OBJECTIVE AND SIGNIFICANCE**: The purpose of this work was to 1) assess resources for renewable natural gas production in Hawai‘i and 2) compare their potential for renewable natural gas (RNG) production to current levels of fossil derived gas consumption in the State.

**BACKGROUND**: In 2008, the Hawai‘i Clean Energy Initiative began a concerted effort to move Hawai‘i toward a renewable energy future. While early focus has been on electricity from solar and wind, an interest in making use of biorenewable resources has been an ongoing theme across energy sectors, driven by renewable portfolio standards and a commitment to forego new fossil generating assets. This interest is demonstrated by the state legislative and executive branches, county governments, regulated and unregulated energy providers, community stakeholders, and consumers.

RNG is composed primarily of methane derived from carbon of recent biogenic origin, unlike fossil natural gas (NG) that derives from ancient carbon commonly associated with fuels, such as coal or petroleum. Either of these latter two resources can be used to produce synthetic natural gas (SNG) by thermochemical energy conversion methods. In general, RNG has lower life cycle greenhouse gas (GHG) emissions than NG. Depending on resource (feedstock) and production method, net GHG emissions for RNG can range from -50 to 7 kg $CO_{2eq}$ / therm (-480 to 66 g $CO_{2eq}$/MJ)[1,2]. NG has net GHG emissions of about 7.4 kg $CO_{2eq}$ / therm (70.1 g $CO_{2eq}$/MJ)[1]. The production of RNG makes use of biological or thermochemical conversion processes. Both are described in more detail below. Existing sources of biogenic methane in Hawai‘i that could be used to produce RNG are explored. Biomass resources that are used as the carbon feedstock for RNG production are also discussed and their occurrence in Hawai‘i reviewed.

RNG has the potential to directly displace incumbent fossil energy products (substitution) or to be part of a retrofit or new equipment package that would displace both the fossil fuel and end-use conversion technology. An example of the former is substitution of RNG for fossil gas use in process heat applications, whereas an example of the latter is a diesel engine replaced with an engine fueled by compressed RNG.

To provide context for the report, Hawai‘i consumption of fossil energy products with potential for displacement by RNG were reviewed. Data from the U.S. Energy Information Agency (EIA)[3] for 2018, the most recent year with complete reporting, are presented below. Three EIA categories of fossil energy products were identified:

1) natural gas excluding supplemental gas fuels – includes 0.2 trillion Btu (2 million therms, 211 TJ) of imported liquefied natural gas (LNG);
2) natural gas including supplemental gas fuels – includes the LNG from (1) above and synthetic natural gas (SNG) produced from petroleum naptha feedstock, and totals 3.2 trillion Btu (32 million therms, 3.4 PJ); and
3) hydrocarbon gas liquids – includes natural gas liquids and refinery olefins totaling 3.7 trillion Btu (37 million therms, 3.9 PJ).

EIA assumes that hydrocarbon gas liquid (category (3) above) consumed in the residential, commercial, and transportation sectors is propane[4]. In practice, this fraction of the hydrocarbon gas liquid stream is liquefied petroleum gas (LPG), a mixture containing ~90% propane with the balance primarily butane and ethane. Combined, the three sector consumption of LPG totaled 3.3 trillion Btu (33 million therms, 3.5

[1] California Air Resources Board, Low Carbon Fuel Standard Pathway Certified Carbon Intensities, Accessed April 2021. https://ww2.arb.ca.gov/resources/documents/lcfs-pathway-certified-carbon-intensities
[2] 2019, R. Serra, et al., From conventional to renewable natural gas : can we expect GHG savings in the near term?, Biomass and Bioenergy, Vol. 131, Paper 105396. http://dx.doi.org/10.1016/j.biombioe.2019.105396
[3] U.S. Energy Information Administration, 2020, State energy data system (SEDS): 1960-2018 (complete): Hawai‘i State profile and energy estimates – Primary energy consumption. https://www.eia.gov/state/seds/seds-data-complete.php?sid=HI#Consumption
[4] U.S. Energy Information Administration, 2019, State profiles and energy estimates: Technical notes & documentation – updates for 2019; Section 4: Petroleum. https://www.eia.gov/state/seds/sep_fuel/notes/use_petrol.pdf

PJ) in 2018[5]. These data indicate that 2018 LNG and SNG consumption was on equal footing with LPG use on an energy basis.

LNG, SNG, and a fraction of the LPG used in the state are delivered to consumers by Hawai'i Gas' underground pipelines. Those customers not served by pipelines receive LPG in bulk tanks of varying size. The method of delivery is the primary delineation between regulated (pipeline) and unregulated (bulk) gas sales[6].

EIA totals can be compared with locally available data. The following is excerpted from the Annual Renewable Energy Report filed by Hawai'i Gas in accordance with HRS 269-45, Gas Utility Companies Renewable Energy Report[7].

"*Hawai'i Gas' utility gas operations consist of the purchase, production, transmission, distribution, and sale of utility gas, which includes synthetic natural gas [SNG], renewable natural gas [RNG], propane, and liquefied natural gas [LNG], which are clean-burning fuels that produce significantly lower levels of carbon emissions than other hydrocarbon fuels, such as oil and coal. Hawai'i Gas provides a safe, reliable, and economical source of energy to approximately 70,000 residential and commercial customers throughout the State, with almost half of those customers served by the utility system on O'ahu.*

*SNG is produced using naphtha, a byproduct or waste of the existing oil refining process in Hawai'i, steam, water and hydrogen [in large part from recycled wastewater].*"[7]

Hawai'i Gas reports that commercial customers (10% of their base) consume 85% of the gas and residential customers account for the balance[8].

Hawai'i Gas' Annual Renewable Energy Report[7] also includes the following information related to their 2019 production:

- 905,837 barrels of imported oil saved by using SNG instead of electricity;
- 5,446,140 Btu per barrel of oil; and
- For every 1 (one) barrel of therm equivalent SNG, it would require 2.813 barrels of oil for generator fuel.

Using this information and Equation (1), and noting that E2019 oil equivalent is 2.813 times greater than E2019, the energy content of Hawai'i Gas' annual SNG sales from petroleum feedstock, E2019 was estimated at 27.2 million therms (2.87 PJ)[9]. This is comparable to the value of 32 million therms for "natural gas including supplemental gas fuels" reported by EIA[1].

$$E_{2019\ oil\ equivalent} - E_{2019} = E_{imported\ oil\ savings} \qquad (1)$$

Also providing context for the report, Hawai'i Gas reports producing 381,529 therms (0.04 PJ) of RNG from biogas at the Honouliuli wastewater treatment plant (WWTP).

**PROJECT STATUS/RESULTS**: Feedstock resources for RNG production by biological (e.g. anaerobic digestion) and thermochemical (e.g. gasification) conversion methods in Hawai'i have been reviewed. Estimates of resources for biological production (wastewater, landfills, food waste) have the potential to support 13.2 million therms per year (1,390 TJ $y^{-1}$, note that 1 therm = 100,000 Btu) of RNG production statewide (Table 1, on the following page). Similarly, estimates of the combustible portions of construction and demolition waste and municipal solid waste have the potential to generate 70.8 million therms per year (7,470 TJ $y^{-1}$) of RNG production statewide. Honolulu has the largest resource base for these urban waste streams. Underutilized agricultural land resources in the state could support substantial RNG

[5] U.S. Energy Information Administration, 2020, State energy data system (SEDS): 1960-2018 (complete): Hawai'i State profile and energy estimates – Full reports & data files, all consumption estimates in Btu. https://www.eia.gov/state/seds/seds-data-complete.php?sid=HI#Consumption
[6] Department of Commerce and Consumer Affairs, State of Hawai'i, 2021, Gas energy services. https://cca.hawaii.gov/dca/gas/
[7] Hawai'i Gas 2019 Renewable Energy Report, Report to the Hawai'i PUC in accordance with Hawaii Revised Statutes [HRS] § 269-45.
[8] Hawai'i Gas website. https://www.hawaiigas.com/
[9] U.S. customary units and International System (SI) units are included throughout the report, anticipating different preferences by prospective readership.

production from dedicated energy crops (~1,000 to 2,000 therms per acre per year (260 – 520 GJ ha-1 $y^{-1}$)), although agronomic suitability of specific candidate energy crops would need to be evaluated and confirmed.

The estimates of potential RNG feedstock resources and RNG product provided in this report do not take into consideration factors including: economics, accessibility of a resource, availability of complementary factors of production, or the political, social, cultural, or regulatory environment. These factors would need to be considered in order to assess viability. Location of resources and access to infrastructure needed to implement successful RNG production, transmission, and distribution would necessarily depend on site-specific details, which are also not included in this report.

This work was completed in 2021 and the results of this study is available in the technical report: "**Resources for Renewable Natural Gas Production in Hawai'i**."

*Funding Source*: Energy Systems Development Special Fund

*Contact*: Scott Turn, sturn@hawaii.edu

*Last Updated*: November 2021

Table 1. Summary of RNG potential (million therms RNG/year) from resources in Hawai'i.

| Resource Type | Maui | Kaua'i | Hawai'i | Honolulu | State Total |
|---|---|---|---|---|---|
| Livestock Manure | * | * | * | * | * |
| Wastewater Treatment Plants | – | 0.02 | 0.06 | 1.8 | 1.9 |
| Landfill Gas | 2.2 | 1.0 | 0.6 | 2.5 | 6.2 |
| Food Waste portion of MSW | 1.8 | 0.5 | 2.3 | 0.5 | 5.1 |
| Combustible portion of MSW | 12.7 | 6.8 | 18.9 | 3.8† | 42.3 |
| CDW | - | - | - | 28.5 | 28.5 |
| Agricultural and Forestry Residues | ‡ | ‡ | ‡ | ‡ | ‡ |
| Energy Crops | § | § | § | § | § |
| Totals⅀ | >17 | >8 | >22 | >37 | >84 |

* Insufficient number and size of animal feeding operations to justify methane production and recovery
† Estimated amount that is currently landfilled exclusive of HPOWER use.
‡ Insufficient available agricultural residues and ongoing forestry harvesting residues.
§ Underutilized agricultural land resources in the State could support substantial RNG production from dedicated energy crops (~1,000 to 2,000 therms per acre per year).
⅀ Totals would be larger with implementation of energy crop based RNG production.