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Consolidated Asset Management Services

Hamakua Energy, LLC
45-300 Lehua Street, P.O. Box 40 • Honokaa, Hawaii 96727 • ph 808.775.1711 • fax 808.775.1801

November 14, 2018

Marianne Rossio, P.E.
Hawaii Department of Health
Clean Air Branch
2827 Waimano Home Road
Hale Ola Building, Room 130
Pearl City, Hawaii 96782-1487

Subject: Revised GHG Reduction Plan
Hamakua Energy Plant
45-300 Lehua Street, Honokaa, Hawaii
Hamakua Energy LLC
Covered Source Permit (CSP) No. 0243-01-C

Dear Ms. Rossio:
Hamakua Energy, LLC has reviewed options to meet the GHG reduction goals set forth in HAR §11-60.1-204 and is pleased to submit the enclosed GHG Reduction Plan.

I certify that I have knowledge of the facts herein set forth, that the same are true, accurate and complete to the best of my knowledge and belief, and that all information not identified by me as confidential in nature shall be treated by the Department of Health as public record. I further state that I will assume responsibility for the construction, modification, or operation of the source in accordance with the Hawaii Administrative Rules (HAR), Title 11, Chapter 60.1, Air Pollution Control, and any permit issued thereof.

If you have any questions, please contact Kevin Monahan at (661) 393-0885.

Sincerely,

Kevin Monahan
Asset Manager

Attachment: Biodiesel Test Plan – Hamakua Energy Plant
Cc: Dale Hamamoto

Hamakua Energy LLC
Hamakua Energy Power (HEP) Facility
45-300 Lehua Street
Honoka'a, Hawai'i 96727

Greenhouse Gas Emissions Reduction Plan
GHG (ERP – Revision 1)

October 29, 2018

Table of Contents

Summary of Revisions

- Minor changes throughout to increase clarity and correct grammatical errors,
- Revised Section **1.1 - Background** – Addressing Lower East Rift Zone eruption and shutdown of Puna Geothermal Ventures.
- Revised Section **2.3 - GHG Facility-wide Emissions Cap** – Explaining that Hamakua Energy can only certify its own GHG emissions data, that each entity in the GHG Partnership is responsible for certifying its respective GHG emissions data, and referencing impending Hamakua Energy biodiesel test burn request and CSP minor modification application to store and fire biodiesel.
- Revised Section 3.1 – **Partnering with Other Power Producers in Hawai'i** – Referencing no interisland power connections and load shift to Hamakua Energy due to loss of PGV output. Revising discussion of regulatory approval or disapproval to include regulatory agencies in general.
- Revised Section 3.3 – **Fuel Switching, Including Biogenic Fuels** – Referencing loss of PGV output as a factor in evaluating use of biodiesel at the HEP Facility; conforming changes in Section 3.7, Section 5.2.
- Revised Section 3.6 – **Restrictive Operations** – Referencing effects of loss of PGV output and increased dispatch of HEP Facility on Restrictive Operations.
- Revised Appendix B – **ERP Partnership Baseline CO_2e Emissions and Proposed CSP Limits** – Provided by Hawaiian Electric Company, Inc. with revised title; showing adjustments to ERP baseline CO_2e emissions and CO_2e emissions ERP cap for partnership and certain partnership members; showing no change to HEP individual baseline CO_2e emissions or proposed CO_2e emissions ERP cap.

1. INTRODUCTION

1.1 Background

Hamakua Energy, LLC (Hamakua Energy) owns and operates the 65 megawatt (MW) electric generation Hamakua Energy Power facility (HEP Facility)[1] located at Honoka'a on the Hamakua Coast of Hawai'i Island. The HEP Facility supplies electricity to the Hawai'i Electric Light Company, Inc. (Hawai'i Electric Light) in accordance with a Power Purchase Agreement (PPA), under which, among other things, Hawai'i Electric Light determines when and to what load to dispatch the HEP Facility.

Hamakua Energy acquired the HEP Facility from Hamakua Energy Partners, LP effective November 24, 2017. The HEP Facility has been in operation since 2000 and operates pursuant to Covered Source Permit (CSP) No. 0243-01-C, which was transferred from Hamakua Energy Partners to Hamakua Energy effective November 24, 2017. Among other requirements, the HEP Facility is subject to Hawai'i's greenhouse gas reduction regulations set forth in Hawai'i Administrative Rules (HAR) §11-60.1-201 et. seq. (The Greenhouse Gas Reduction Rule). Prior to the transfer, Hamakua Energy Partners had submitted a proposed Greenhouse Gas Emission Reduction Plan (GHG ERP) for the HEP Facility to the Hawai'i Department of Health (DOH) as required by HAR §11-60.1-204. However, DOH had not accepted the proposed GHG ERP, in part due to the DOH's disagreement with Hamakua Energy Partners' proposed baseline year and GHG emissions reductions approach.

At a meeting on September 29, 2017, Hamakua Energy informally advised DOH Clean Air Branch representatives that, upon successful acquisition of the HEP Facility, it would submit a revised GHG ERP to DOH with a baseline year of 2010 and that it intended to meet the facility-wide GHG emissions cap by 2020 through (i) partnering, (ii) use of biofuels, and, if necessary, (iii) by restrictive operations. Subsequent to the transfer of ownership, Hamakua Energy confirmed its selection of 2010 as the HEP Facility's GHG emissions baseline year and its compliance intentions in a

[1] The HEP Facility has a "nominal" capacity of 65 megawatts as described in its Covered Source Permit. However, by terms of the Power Purchase Agreement with Hawai'i Electric Light, the "Firm Capacity" of the HEP Facility is 60 megawatts.

letter to DOH dated December 7, 2017. By letter dated January 2, 2018, DOH approved Hamakua Energy's selection of the HEP Facility's 2010 GHG emissions for determining its facility-wide GHG emissions cap.

In discussions with DOH staff about compliance issues and challenges, Hamakua representatives raised concerns about the effects natural disasters might have on achieving the GHG emissions reduction requirements, particularly the requirement to reduce GHG emissions by at least 16 percent below 2010 GHG emissions (what Hamakua Energy called "low probability – high consequence events"). Despite these concerns, Hamakua Energy submitted its GHG ERP to DOH on March 28, 2018. In brief, the GHG ERP identified 2010 as the baseline year, with GHG compliance limits being met by partnering with the Hawaiian Electric Companies, use of biodiesel, and, if necessary, restrictive operations. Barely a month later, on May 3, 2018, the volcanic eruption began in the Lower East Rift Zone (LERZ) in the Puna District of Hawai'i Island.

Among other things, the LERZ volcanic eruption threatened the Puna Geothermal Ventures geothermal electrical generation plant (PGV), which resulted in the shutdown of PGV operations. Eventually, the volcanic eruption engulfed part of the PGV facility and currently it is unknown when, if ever, PGV will resume operations.

Pursuant to a power purchase agreement with Hawai'i Electric Light Company, PGV generated approximately 25 to 30 percent of Hawai'i Electric Light's electric power. The loss of PGV's generation imposed a two-fold strain on Hawai'i Island, and therefore on other generating facilities on the island: First, the loss of 25 to 30 percent of generation requires Hawai'i Electric Light to generate more electric power as well as purchase incrementally more from HEP. Due to losing PGV's energy, Hawai'i Electric Light significantly increased the dispatch of the HEP Facility to levels greater than four to five times (i.e., 4-5X) higher than experienced prior to the LERZ volcanic eruption. Second, PGV produced renewable energy. Replacing renewable energy with primarily fossil fuel generation substantially increased the challenges of meeting Hawai'i's GHG reduction requirements.

Although at its current operating level HEP would exceed the proposed GHG Facility-wide Emissions Cap of 153,699 (short) tons per year, and in fact would exceed the Baseline Annual Emissions rate of 182,975 (short) tons per year based on 2010, as proposed in HEP GHG ERP dated February 28, 2018, HEP has nonetheless determined that it will retain the identical proposed values in this revised GHG ERP. Partnering and the use of biodiesel will be HEP's primary methods of meeting its Facility-wide GHG Emissions Cap on an annual basis. To assure that biodiesel would be available as a control technology for GHG compliance at the earliest possible time, HEP has accelerated its efforts to modify its covered source permit (CSP) to enable biodiesel operation, and to secure a source of biodiesel for day to day operations.

In a separate filing, the HEP facility is requesting authorization to perform a biodiesel test burn. Based on the results of the test burn, the HEP facility plans to submit an application to DOH to approve a minor modification to its CSP to allow the use of biodiesel as necessary to meet Hawai'i' Island's electricity needs. Ultimately, this approach helps ensure that Hawai'i Island residents will have an adequate supply of electricity while helping to ensure that GHG emission reduction targets are met.

1.2 Purpose

Hamakua Energy respectfully submits this revised Greenhouse Gas Emissions Reduction Plan (GHG ERP) to DOH as required by HAR §11-60.1-204. The GHG Control Assessment in this plan is required by HAR §11-60.1-204(d)(2) to determine if the proposed facility-wide GHG emission cap, consisting of a 16% reduction of carbon dioxide equivalent (CO_2e) emissions from the 2010 baseline year, is attainable.

1.3 HEP Facility Description

The HEP Facility is located at 45-300 Lehua Street in Honoka'a, Hawai'i. The HEP Facility is situated on part of the former Hamakua Sugar Plantation and Mill property immediately northwest of the Haina Camp and approximately one mile north of the Town of Honoka'a. The total facility area is approximately 22.8 acres. Figure 1 and Figure 2 provide a site location map.

The HEP Facility consists of two Combustion Turbine Generators (CTs), two Heat Recovery Steam Generators (HRSGs), one Steam Turbine Generator (STG), and associated auxiliary equipment systems. Figure 3 provides a site layout map that depicts the location and facility equipment and ancillary operations.

The HEP Facility has the capability to burn low-sulfur petroleum fuels and uses naphtha as the primary low-sulfur petroleum fuel, with ultralow sulfur diesel (ULSD) used for startup. Naphtha and ULSD produced at Island Energy Services' O'ahu refinery are delivered by barge to the port of Hilo, Hawai'i, and are then transported by truck approximately 45 miles to the HEP Facility. Naphtha is stored in two storage tanks, each with a capacity of 1.4 million gallons. Diesel is stored in a 359,000 gallon capacity tank, with a "day tank" having a capacity of 10,000 gallons used for backup fuels and for startups.

Major equipment at the HEP Facility includes:

- Two (2) 23 megawatt General Electric LM2500 Combustion Turbines generators (CTs), each with a maximum heat input of 231 MBtu/hour, and each with a water injection system for control of NOx emissions. The CTs are fired primarily on naphtha, with ULSD burned during startup.
- Two (2) "unfired" Aalborg Engineering Heat Recovery Steam Generators (HRSGs), each with a selective catalytic reduction (SCR) system (with ammonia injection) for control of NOx

emissions. The heat source for the HRSGs is the hot exhaust gas from the CTs.

- One (1) 19 MW (nominal) Steam Turbine Generator (STG).
- One (1) 1,250 kW "black start" diesel engine generator using ULSD.
- One (1) emergency fire pump using ULSD.
- Two (2) 1.4 million gallon external floating roof petroleum tanks for storage and transfer of naphtha (or gasoline).
- One (1) 359,000-gallon tank for ULSD storage and transfer.
- One (1) 10,000 gallon day tank for storage and transfer of liquid fuels.
- One (1) multi-cell cooling tower.
- One (1) anhydrous ammonia system consisting of one 12,000 gallon storage tank (10,000 gallons usable capacity), fill station, controls, monitoring and alarms and associated piping, valve and instrumentation.

Figure 1 - Site Location - Hawai'i Island

Figure 2 - Site Location - Honoka'a

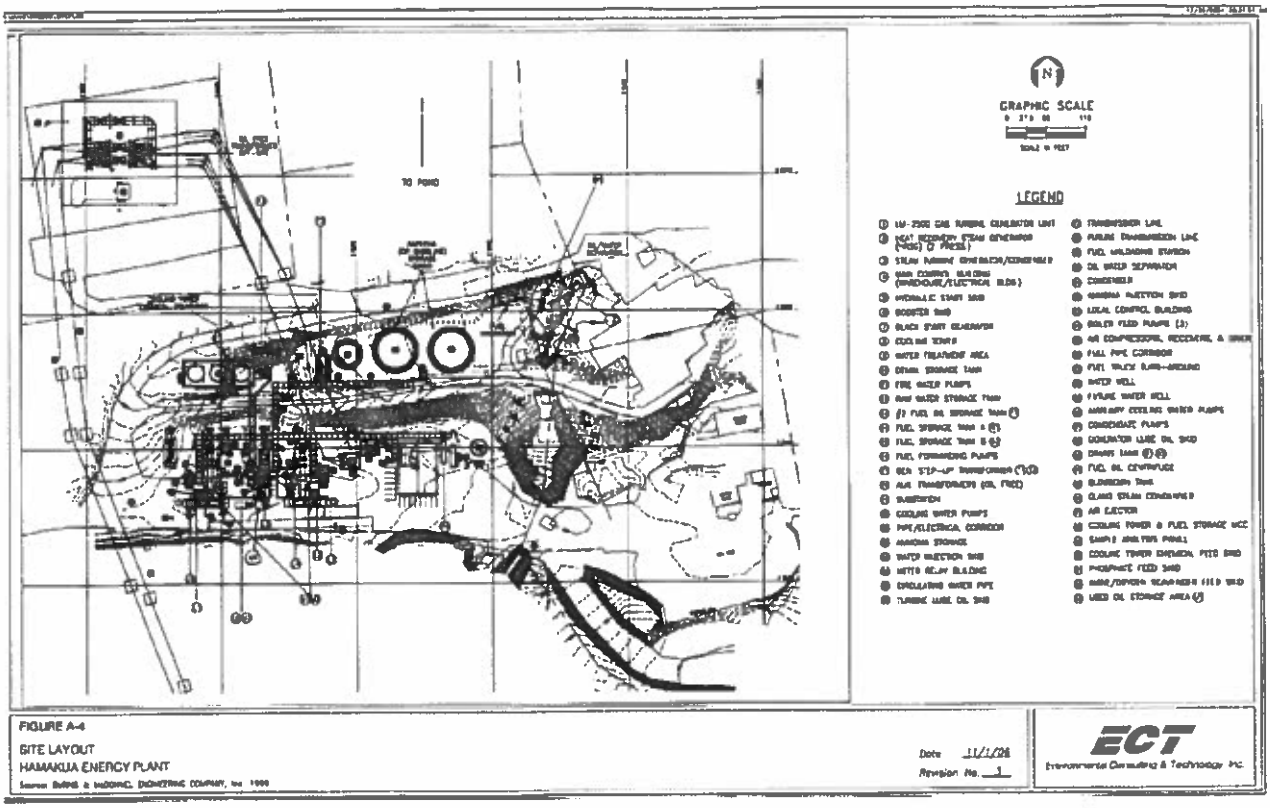

Figure 3 - Site Layout

2. REGULATORY BASIS

2.1 Regulatory Background

As stated in Section 1.1, the HEP Facility is subject to the Greenhouse Gas Reduction Rule. Under the Greenhouse Gas Reduction Rule, the HEP Facility is required to prepare and submit for approval to DOH a GHG ERP in accordance with HAR §11-60.1-204 (d). The GHG ERP consists of:

(1) Establishing a facility baseline GHG emission rate (HAR §11-60.1204(d)(1));

(2) Establishing a facility-wide GHG emission cap (§11-60.1-204(d)(2));

(3) Performing a GHG emissions control assessment, which consists of identifying available control measures (§11-60.1-204(d)(3)), identifying technically feasible control measures (§11-60.1-204(4); evaluating the control effectiveness and cost of feasible control measures (§11-60.1204(d)(5); and identifying the proposed GHG emissions control strategy for the facility (§11-60.1-204(d)(6)).

2.2 GHG Baseline Emissions Rate

Hamakua Energy has selected 2010 annual GHG emissions as the HEP Facility GHG emissions baseline: 182,975 (short) tons per year (tpy) of CO^2e.

2.3 GHG Facility-wide Emissions Cap

In accordance with HAR §204(c), Hamakua Energy has established a facility-wide GHG emissions cap of 153,699 (short) tons per year (tpy) of CO_2e to be achieved by 2020.

As noted in Section 1 of this GHG ERP, in accordance with HAR §11-60.1204(d)(6)(A), Hamakua Energy has chosen partnering as a primary element of its GHG emissions control strategy for the HEP Facility. Details of the partnering arrangement are found in Section 3, including reference to the aggregate GHG emissions cap for the partnership. The proposed GHG Emissions Caps for the partnership and the respective partners are presented in Appendix B, ERP Partnership Baseline CO_2e Emissions and Proposed CSP Limits." Appendix B in this GHG ERP Revision 1, is slightly different from that presented in HEP's GHG ERP of February 28, 2018. However, the GHG Facility-wide Emissions Cap has not changed.

With reference to Appendix B, it is important to emphasize that Hamakua Energy is able only to certify its own GHG emissions for the 2010 baseline year and for the proposed CO_2e emissions cap. It is Hamakua Energy's understanding that each of the other partners referenced in Appendix B is responsible for certifying its respective emissions data for partnership purposes.

Also, as noted in Section 1, Hamakua Energy is requesting authorization from DOH to perform a test burn of biodiesel fuel.

[2] United States Environmental Protection Agency, *"Prevention of Significant Deterioration and Title V Permitting Guidance for Greenhouse Gases,"* page 17, 1990 Workshop Manual.

Based on the test burn results, Hamakua Energy will apply for a minor modification of its CSP to allow storing and firing biodiesel to produce electricity.

2.4 GHG Emissions Control Assessment

The GHG control assessment referred to in Section 2.1(3) is similar to the United States Environmental Protection Agency's best available control technology (BACT) analysis required under the federal Clean Air Act (CAA). Section 169(3) of the CAA defines BACT as:

> "... *an emission limitation based on the maximum degree of reduction of each pollutant subject to regulation under this chapter [of the Clean Air Act] emitted from or which results from any major emitting facility, which the permitting authority, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such facility through application of production processes and available methods, systems, and techniques, including fuel cleaning, clean fuels, or treatment or innovative fuel combustion techniques for control of each such pollutant.*"

In accordance with EPA BACT guidance,[2] the analysis presented employs the EPA-preferred "top-down," five-step analysis process to determine the appropriate emission control technologies and/or emissions limitations:

- Step 1 - Identify All Control Technologies
- Step 2 - Eliminate Technically Infeasible Options
- Step 3 - Rank Remaining Control Technologies by Control Effectiveness
- Step 4 - Evaluate Most Effective Controls
- Step 5 - Select BACT

Although this GHG ERP control assessment employs the top-down BACT analysis, there are "unique" issues in the analysis for GHG that do not arise in BACT for criteria pollutants (EPA, 2011b). For example, EPA recognizes that the range of potentially available control options for Step 1 of the BACT process is currently limited and emphasizes the importance of energy efficiency in BACT reviews. Specifically, EPA states:[3]

[3] United States Environmental Protection Agency, "*PSD and Title V Permitting Guidance for Greenhouse Gases,*" March, 2011.

> *"The application of methods, systems, or techniques to increase energy efficiency is a key GHG-reducing opportunity that falls under the category of "lower-polluting processes/practices." Use of inherently lower-emitting technologies, including energy efficiency measures, represents an opportunity for GHG reductions in these BACT reviews. In some cases, a more energy efficient process or project design may be used effectively alone; whereas in other cases, an energy efficient measure may be used effectively in tandem with end-of-stack controls to achieve additional control of criteria pollutants."* [4]

Where EPA requirements are concerned, EPA provides permitting authorities with the discretion to use energy-efficient measures as "the foundation for a BACT analysis for GHGs . . ." [5]

The following sections present the GHG assessment conducted for the HEP Facility's CTs and HRSGs. It utilizes information from various reference and research documents developed by or for various government entities including the EPA, the Department of Energy's National Energy Technology Laboratory, the Interagency Task Force on Carbon Capture and Sequestration.

Also note, the HEP Facility has two insignificant GHG emission sources: (1) a black start generator; and (2) an emergency fire pump. These are not included in the GHG Control Assessment as stated in Section 3.

3. IDENTIFY ALL CONTROL TECHNOLOGIES

Hamakua Energy LLC investigated available control measures for reducing greenhouse gas emissions at the HEP Facility. The sole focus of this investigation was on the combustion turbines, HRSG, and steam turbine generator (STG). There are no potential GHG emissions reductions available from the storage tanks or cooling tower since they do not contain or generate GHG emissions. The potential GHG reductions available from the black start generator and the emergency fire pump are minimal, since they are of relatively small fuel-burning capacity compared to the CT-HRSG-STG combination, and they are generally operated only several hours per year, and by permit operated less than 52 hours per year.

[4] Ibid.

[5] Ibid.

Our review of the potential control measures for the CT, HRSG, and STG included:

- Partnering with Other Power Producers
- Carbon Capture and Storage
- Fuel Switching, Including Biogenic Fuels
- Energy Efficiency Upgrades
- Combustion or Operational Improvements
- Restrictive Operations
- Planned Upgrades, Overhaul or Retirement of Equipment
- Regulatory Mandates, Emission Standards and Binding Agreements

3.1 Partnering with Other Power Producers in Hawai'i

Hamakua Energy approached Hawai'i Electric Light[6] regarding a partnership for purposes of compliance with the Greenhouse Gas Emissions Rule, and Hamakua Energy and Hawai'i Electric Light subsequently agreed to include the HEP Facility as a member of the Hawaiian Electric Companies' GHG partnership.

There are no electric grid interconnections between any of the Hawaiian Islands. The power generation facilities operating on each island are interdependent by virtue of being interconnected to the same electric grid on each island. If one or more of them cannot produce their scheduled power output, the other facilities on the specific island must generate more power to make up for the shortfall. An unscheduled outage that takes a major generating unit offline for a period of time can significantly shift loading, and consequently the GHG emissions, from one facility to another. This is precisely what has happened on Hawai'i Island with the loss of PGV's electric power generation.

As indicated in Appendix B, "ERP Partnership Baseline CO_2e Emissions and Proposed CSP Limits," the aggregate GHG emissions cap for the Partnership Facilities would be 7,023,258 (short) tons per year, and the respective GHG Facility-wide Emissions Cap for the HEP Facilities would be 153,699 (short) tons per year.

[6] Hamakua Energy and Hawai'i Electric Light have executed a partnership agreement. Other members of the partnership for purposes of GHG compliance include Maui Electric Company, Ltd., Hawaiian Electric Company, AES Hawaii, and Kalaeloa Energy Partners LP. Such other members' participation in the partnership is documented in separate agreements between the independent power producers and the utilities serving the applicable islands.

If the partnership becomes unavailable for any reason, including, but not limited to regulatory agency disapproval, Hamakua Energy will rely on the other control measures identified in this GHG ERP to meet its GHG emissions cap of 153,699 (short) tons per year.

3.2 Carbon Capture and Storage

Carbon Capture and Storage (also known as carbon capture and sequestration or CCS), includes a range of technologies that capture carbon dioxide (CO_2) from the burning of carbon-based fuels for power generation, and from the manufacturing of steel, cement and other industrial facilities, and transport it by either pipeline or ship for underground storage.

According to the U.S. Department of Energy's National Energy Technology Laboratory (NETL), there are commercially available CO_2 capture technologies that are being used in various industrial applications. There are several options for capture and several options for transport and use or storage of captured carbon described in the referenced literature; however, these technologies are not commercially available for implementation on fossil fuel power plants for three primary reasons:

(1) They have not been demonstrated at the scale necessary for power plant application.

(2) Current CO_2 capture technologies require so much power that they substantially compromise the capability of a facility to generate and meet its electric power obligations.

(3) The relative cost of current capture technologies are excessive compared to other control technologies.

Review of the BACT/LAER/RACT[7] Clearinghouse uncovered no power plants that use CCS for greenhouse gas emissions removal.

Review of the following GHG BACT analyses also helped to confirm that CCS is not currently technically or economically feasible for combustion turbines or other fossil fuel burning power plants:

- CPV Valley Energy Center in New York State (2012) – 630 MW combined cycle electric generating facility burning natural gas and No. 2 fuel oil.
- Empire District Riverton Unit 12 in Kansas (2013) – 150 MW combined cycle electric generating facility burning natural gas.

[7] Per common EPA terminology, BACT = Best Available Control Technology, LAER = Lowest Achievable Emissions Rate, and RACT = Reasonably Achievable Control Technology.

- AES Huntington Beach Generating Station in California (2012) – 939 MW combined cycle electric generating facility burning natural gas.
- Portland General Electric Company in Oregon (2010) – 300 MW reciprocating engine-driven generators and a simple-cycle combustion turbine.

In addition, CCS was not identified as a "demonstrated measure" in EPA's GHG Abatement Measures analysis for existing power plants.[8]

3.3 Fuel Switching, Including Biogenic Fuels

The HEP Facility is currently capable of receiving, handling, storing, and operating on a variety distillate liquid fuels, including No. 2 oils (e.g., diesel or ULSD) and naphtha. ULSD is typically used for startup due to its "lightoff" characteristics, and then operation is switched to naphtha because it is less expensive. It would be fairly straightforward to substitute a biofuel such as biodiesel (or a blend of No. 2 oil and biodiesel) as the fuel properties are similar. The most significant changes may involve change-out of gasket and tubing materials that may not be compatible with biofuels. According to their manufacturer, the CT engines are capable of operating on biodiesel or blends of biodiesel and No. 2 oils without modification to the generators themselves.

Fuel Options

Hamakua Energy has reviewed fuel switching options and/or co-firing a variety of "clean fuels" at the HEP Facility for purposes of GHG emissions compliance.

Natural Gas. Switching from naphtha to natural gas, or co-firing natural gas with naphtha, could lower GHG emissions for the CT generators at the HEP Facility from about 150 to 110 (short) tons per year of GHG emissions for every MBtu of fuel burned, or a decrease of about 40 (short) tons per year or approximately 28%. The State of Hawaii, however, produces no natural gas and has no proven gas reserves. Hawai'i has the lowest total natural gas consumption in the nation and the lowest per capita consumption of natural gas.

Liquefied Natural Gas (LNG) and Liquid Propane Gas (LPG). The use of LNG in quantities sufficient to support power generation in Hawai'i has

[8] EPA, June 10, 2014, *Technical Support Document (TSD) for Carbon Pollution Guidelines for Existing Power Plants: Emission Guidelines for Greenhouse Gas Emissions from Existing Stationary Sources: Electric Utility Generating Units*

been evaluated and considered by the Hawai'i Gas Company and the Hawaiian Electric Companies in recent years. However, there are presently no commercial activities to produce and/or deliver LNG at the scale needed for commercial viability. LNG is not currently available nor expected to be available on Hawai'i Island in quantities sufficient to support power generation at the HEP Facility. Similarly, LPG also is not available or expected to be available in sufficient quantities. The control technology alternative to use gaseous fuels at the HEP Facility would be reassessed if and when LNG and/or LPG become available in sufficient quantities for power generation on Hawai'i Island, including infrastructure for the receiving, handling, storage, and delivery of the fuels to the HEP Facility.

Synthetic Natural Gas (SNG). Synthetic natural gas is currently produced on O'ahu, however distribution of that synthetic gas is limited to parts of O'ahu. Hawai'i State energy policies encourage the development of synthetic natural gas production using biomass as a feedstock, however, there is currently no production of synthetic gas using biomass in the state in significant enough quantities to support a power plant the size of the HEP Facility.[9]

Liquid Biogenic Fuels (e.g., biodiesel). As described above, the HEP Facility would be capable of operating on liquid biogenic fuels (e.g., biodiesel), or blends of biogenic liquid fuels having similar fuel properties (e.g., blend of ULSD and biodiesel). Hamakua Energy views the use of liquid biogenic fuels at the HEP Facility to be a reasonable control technology alternative for GHG emissions compliance especially in view of the loss of PGV's output and the resulting increased dispatch of the HEP Facility. Also, should partnering with other power producers in Hawai'i become unavailable, liquid biogenic fuels would be a the primary control technology. As noted in Section 1 and Section 2.3, Hamakua Energy is currently requesting authorization from DOH to perform a test burn of biodiesel fuel. Based on the test burn results, Hamakua Energy will apply for a minor modification of its CSP to allow storing and firing biodiesel to produce electricity.

Facility Modifications for Fuel Switching

Biodiesel. As described above, qualifying the use of biodiesel at the HEP Facility is expected to be a relatively straightforward process.

LNG or LPG. The HEP Facility could be converted to operate on gaseous fuels such LNG or LPG, but this would require significant modifications to the facility. LNG would typically be delivered to the site in isotainers. Isotainers would be filled at an LNG production facility either on the mainland or another country and shipped to Hawai'i Island via either Hilo

[9] U.S. Dept. of Energy, State Energy Profile - http://www.eia.gov/state/analysis.cfm?sid=HI (last updated October 19, 2017

Harbor or Kawaihae Harbor. Then isotainers would be trucked to the HEP Facility where they would be stored prior to use. Major modifications would have to be made to the CTs in order to utilize LNG. The fuel delivery system would have to be changed to allow for either LNG only or for duel fuel (e.g., LNG and diesel/naphtha). The combustors and fuel nozzles on the CTs would have to be changed to different models. The control system would have to be modified to accommodate the LNG and dual fuel process. The modifications to the CTs alone would cost approximately $2 million each. In addition, a gasification facility would have to be designed for and constructed at the HEP Facility, and empty isotainers trucked back to the port to be shipped back to the LNG supplier. Several hundred isotainers would have to be in service and in transit through every stage of the process to make this work.

CSP Modifications for Fuel Switch

The CSP would have to be modified to allow the HEP Facility to operate on fuels other than No. 2 oil (such as ULSD) or naphtha.

Once the CSP is modified to allow operation on biodiesel, and if biodiesel is available on Hawai'i Island in sufficient quantities, then Hamakua Energy plans to substitute biodiesel for ULSD for startups of the combustion turbines. Moreover, depending on the availability and commercial terms for larger quantities of biodiesel to be delivered to the HEP Facility, Hamakua energy may employ increased usage of biodiesel at the HEP Facility to the benefit of Hawai'i Electric Light's customers.

3.4 Energy Efficiency Upgrades

The HEP Facility is a combined cycle plant that uses waste heat from the General Electric LM2500 combustion turbines (CTs) to produce steam in the heat recovery steam generators (HRSGs). Electric generators are connected to each CT and the steam turbine. This combined cycle operating mode is a very efficient power plant thermal cycle. Accordingly, there is very limited opportunity for significant additional energy efficiency upgrades that would result in meaningful reductions in GHG emissions.

Combined-cycle power plants such as the HEP Facility are generally about 30% more energy efficient than simple-cycle plants, and accordingly, produce about 30% less GHG emissions for every kilowatt of energy produced. Even though the HEP Facility may be operated in either a combined-cycle or simple-cycle mode, historically the HEP Facility has

overwhelmingly been dispatched by Hawai'i Electric Light to operate in combined-cycle mode as illustrated below.

Hamakua Energy - Net Generation

Year	Simple Cycle MWH	Combined Cycle MWH	Total MWH	Simple Cycle %	Combined Cycle %
2010	0	286,176	286,176	0.0%	100.0%
2011	1,504	214,366	215,870	0.7%	99.3%
2012	0	231,240	231,240	0.0%	100.0%
2013	0	167,665	167,665	0.0%	100.0%
2014	0	182,292	182,292	0.0%	100.0%
2015	0	224,284	224,284	0.0%	100.0%
2016	0	131,165	131,165	0.0%	100.0%
2017	0	145,070	145,070	0.0%	100.0%

The LM 2500 combustion turbines are among the most efficient engines available in the industry. Based on discussions with representatives from General Electric, there are no energy efficiency upgrades available for the combustion turbines in use at the HEP Facility. The only option for energy efficiency upgrades for the CT's may be complete equipment replacement. Complete equipment replacement would "redefine the source" and the EPA has stated in various guidance documents that inherently lower emitting processes and practices that would redefine the emissions source need not be considered for Best Available Control Technologies (BACT) reviews.[10] Approximately every 50,000 operating hours (i.e., equivalent to approximately six calendar years) each of the HEP Facility's CT's is taken out of service for a complete overhaul by a qualified contractor such as the General Electric Company. Similarly, approximately every four running years the STG is inspected and overhauled. These overhauls tend to return the CTs and STG to thermal efficiencies typical of new equipment.

The HRSG's are periodically inspected by HRST Inc., a company known throughout the industry for performing these types of inspections. According to the HRST Inc., there are no energy efficiency upgrades available for the HRSG's at the HEP Facility.

In summary, by design, operating practices, and maintenance practices the HEP Facility is a very efficient power generating facility. Moreover, there is very little opportunity to improve the thermal efficiency, and no means to improve the thermal efficiency by an amount sufficient to satisfy the GHG emissions reduction requirements for the HEP Facility.

[10] EPA, "Prevention of Significant Deterioration and Title V Permitting Guidance for Greenhouse Gases", page 26. EPA-457/B-11-001, March 2011.

3.5 Combustion or Operational Improvements

Based on discussions with representatives from General Electric, the original equipment manufacturer of the CTs, there are no combustion or operational improvements available for the CTs at the HEP Facility. Since there is no supplementary firing in the HRSGs and no combustion takes place in the HSRG's or the STG, combustion improvements are not available for these units.

3.6 Restrictive Operations

Prior to the LERZ eruption in May 2018 and the subsequent shutdown of the PGV facility and the loss of at least 25 percent of the electrical generation capacity on Hawai'i Island, Hawai'i Electric Light had published forecast power production for the HEP Facility for the future years in its Power Supply Improvement Plans.[11] Based on those forecasts, the HEP Facility was expected to consistently be operated at levels that result in annual GHG emissions well below its facility GHG emissions cap of 153,699 (short) tons per year (tpy) of CO_2e through 2030, the year in which its PPA with Hawai'i Electric Light is scheduled to terminate.

With the loss of PGV's output, however, Hawai'i Electric Light has been dispatching the HEP Facility at levels that could cause it to exceed its GHG Facility-wide Emissions Cap. Accordingly, as discussed above, it would be necessary for the HEP Facility to rely on the applicable GHG control technologies (i.e., Partnering with Other Power Producers in Hawai'i, Fuel Switching Including Biogenic Fuels, and/or Restrictive Operations) to assure compliance with the GHG conditions in the CSP.

As discussed in more detail below Restrictive Operations would be the least desirable GHG control technology option. The HEP Facility is one of, if not the most energy efficient power generation facility available on Hawai'i Island and the electric grid of Hawai'i Electric Light. If no other options are available, Restrictive Operations may voluntarily be employed by Hamakua Energy to assure compliance with the GHG permit conditions of the HEP Facility's CSP. This would only occur if Partnering with Other Power Producers in Hawai'i and Fuel Switching Including Biogenic Fuels are unavailable, emergency provisions of the HEP Facility's CSP do not apply, and the HEP Facility would otherwise violate the GHG permit conditions of its CSP.

[11] On July 14, 2017, the Hawai'i Public Utilities Commission accepted the Hawaiian Electric Companies' Power Supply Improvement Plans (PSIPs) Update. Docket No. 2014-0183, Decision & Order No. 34696, July 14, 2017.

Restrictive Operations present other issues:

- The HEP Facility is contractually obligated to Hawai'i Electric Light by its PPA to be available to produce electricity throughout the year. The PPA provides for limited forced (unscheduled) outages. If Restrictive Operations were imposed by Hamakua Energy in order to comply with it's GHG Facility-wide Emissions Cap, then the HEP Facility may not be available for dispatch to levels requested by Hawai'i Electric Light, and consequently, the cost to produce electric power to meet the needs of Hawai'i Electric Light's customers would be higher than it would be otherwise.
- Under the PPA with Hawai'i Electric Light, Hamakua Energy may have to pay penalties for lower availability and/or higher forced outage rates that are proportional to the degree of Restrictive Operations that it imposed on the HEP Facility.
- In a most extreme circumstance, there may not be sufficient power generation on Hawai'i Island to meet the demand of customers resulting in power outages.

3.7 Planned Upgrades, Overhaul, or Retirement of Equipment

Hamakua Energy has no planned upgrades or retirements of major equipment at the HEP Facility. As noted earlier, however, the Hamakua Energy does plan for and execute routine periodic overhauls for the CTs and the steam generator and these periodic overhauls help ensure the reliability and efficiency of the HEP Facility. Additionally, as noted above, Hamakua Energy is pursuing the option of firing with biodiesel, which may entail making minor fuel handling adjustments in order to accommodate biodiesel at the HEP Facility.

3.8 Outstanding Regulatory Mandates, Emission Standards, and Binding Agreements

There are no outstanding regulatory mandates, emission standards, or binding agreements that will reduce GHG emissions from the HEP Facility.

3.9 Other GHG Reduction Initiatives That May Affect the HEP Facility's GHG Emissions

Except for Partnering with Other Power Producers in Hawai'i, Fuel Switching Including Biogenic Fuels, and Restrictive Operations, as

discussed above, Hamakua Energy has no other GHG reduction initiatives planned for the HEP Facility.

4 TECHNICALLY FEASIBLE MEASURES

The three (3) technically feasible measures for compliance with GHG conditions of its CSP in order of priority are: (1) Partnering with Other Power Producers in Hawai'i, (2) Fuel Switching Including Biogenic Fuels, and (3) Restrictive Operations. Hamakua Energy has executed a GHG Partnering Agreement with Hawai'i Electric Light. Partnering will constitute the primary control measure for GHG compliance. Secondly, Hamakua Energy is committed to qualifying the HEP Facility to operate on biodiesel and/or a blend of biodiesel and ULSD, and plans to initiate efforts for qualification in 2018. Thirdly, if and only if there is no alternative to meet the GHG permit conditions of its CSP, Restrictive Operation would be implemented.

If LNG or LPG becomes available on Hawai'i Island in sufficient quantities for power generation, the technical and commercial feasibility of using LNG and/or LPG at the HEP Facility would be reevaluated.

5 CONTROL EFFECTIVENESS AND COST EVALUATION

The relative cost effectiveness for the feasible control measures is discussed below.

5.1 Partnering with Other Power Producers in Hawai'i

As a member of the above-described GHG Reduction Partnership, Hamakua Energy would be responsible for seeking and implementing changes to its operations for the benefit of customers of Hawai'i Electric Light. In particular, with the increasing amounts of renewable energy generation on Hawai'i Island, the HEP Facility becomes a more valuable resource when it can be scheduled and dispatched with more flexibility similar to a "peaking" generating unit. To achieve this flexibility, changes to the CSP would be needed to allow more than one startup per day per CT. Accordingly, pursuant to the GHG Reduction Partnership agreement with Hawaii Electric Light, Hamakua Energy would seek Department of Health approval to modify its CSP to potentially allow more than one startup per day per CT. It would also be beneficial to shorten the startup times (i.e., the duration from startup initiation to turnover of dispatch to System Operation of Hawai'i Electric Light). This may involve physical

modifications to equipment and/or procedural changes at the HEP Facility. Accordingly, in accordance with the GHG Reduction Partnership agreement, Hamakua Energy would evaluate and implement appropriate changes (including CSP modifications if applicable) pursuant to its GHG Reduction Partnership agreement with Hawai'i Electric Light Company, Inc.

5.2 Fuel Switching or Biogenic Fuels

As described above, Hamakua Energy is committed to seek qualification of the HEP Facility for operation on biodiesel and/or blends of biodiesel and ULSD. The qualification process will include three parts: (1) organization of a pilot test including procurement of biodiesel, modification of equipment at HEP Facility to facilitate use of the biodiesel from a temporary storage tank, contracting for emissions testing, and coordination with Hawai'i Electric Light Company for dispatch; (2) implementation of pilot tests at multiple load points, including emissions testing at each load point; and (3) compilation of pilot test results and preparation and submission of a modification to the CSP.

As noted above, in view of the loss of PGV's output and the resulting increased dispatch of the HEP Facility, Hamakua Energy has already begun the process of requesting approval to perform a biodiesel test burn. Based on publicly available technical reports for the use of biodiesel at other facilities similar to the HEP Facility, Hamakua Energy anticipates that the HEP Facility will ultimately be permitted to fire the CTs with biodiesel.

If biodiesel becomes available on Hawai'i Island in quantities sufficient for sustained power generation at reasonable commercial terms, then Hamakua Energy may consider operating the HEP Facility on an everyday basis using biodiesel.

If biodiesel becomes available on Hawai'i Island in quantities sufficient for sustained power generation, the GHG Partnership Agreement is void or otherwise not in effect, and emergency conditions of the GHG permit conditions of the CSP do not apply, then the HEP Facility may be operated on using biodiesel for purposes of GHG compliance. Depending on the price of biodiesel at such time relative to naphtha, this could result in higher-priced energy being made available to the customers of Hawai'i Electric Light. There would not be an incremental cost to Hamakua Energy in this instance because the PPA with Hawai'i Electric Light provides for compensation to Hamakua Energy based on the delivered price of the fuel being utilized at the HEP Facility.

5.3 Restrictive Operations

Restrictive Operation is the least desirable GHG control option because it may result in higher-priced energy being made available to the customers of Hawai'i Electric Light, and/or in the worst case, result in regional blackouts. The cost for Restrictive Operation to Hamakua Energy may have two components: (1) reduced energy sales; and (2) increased penalties for reduced service availability. The potential costs to Hamakua Energy for Restrictive Operation would vary depending on the degree of Restrictive Operation that would be implemented. The cost of lost energy sales would be very difficult to predict and would depend on the price of fuel at the time and the load to which the HEP Facility would have otherwise been dispatched if Restrictive Operation was not implemented.

6 PROPOSED CONTROL STRATEGY

As detailed above, Hamakua Energy's control strategy for GHG emissions compliance in order of priority for implementation would be: (1) Partnering with Other Power Producers in Hawai'i, (2) Fuel Switching Including Biogenic Fuels, and (3) Restrictive Operations, absent any relief for emergencies.

Appendix A

REFERENCES

Government reference documents:

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CH2MHill. 2012. *BACT Determination for the Huntington Beach Energy Project.*(Website: http://www.energy.ca.gov/sitingcases/huntington_beach_energy/documents/applicant/AFC/Volume%202%20Appendices/HBEP_Appendix%205.1D_BACT%20Determination.pdf)

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TRC Environmental Corporation. 2012. *CPV Valley Energy Center 630 MW Combined Cycle HEP Facility PSD and Part 201 Air Permit Application Supplement.* (Website: http://www.cpvvalley.com/pdfs/CPV_Valley_FEIS/Volume_II_FEIS_CPV_Valley_Energy/Appendix%203/Appendix_3B_Part1.pdf)

Appendix B

Table A-1: ERP Partnership Baseline CO_2e Emissions and Proposed CSP Limits (1)

Company	Covered Source	Baseline CO2e Emissions (metric tpy)	Baseline CO2e Emissions (tpy)	CSP Limits CO2e Reduction (%)	CSP Limits CO2e Reduction (tpy)	CSP Limits CO2e Lim (tpy)
Hawaiian Electric (HE)	Kahe	2,518,411	2,776,073	23.1%	642,321	2,133,752
	Waiau	974,642	1,074,359	24.8%	266,074	808,286
	Honolulu	121,208	133,609	100.0%	133,609	0
	CIPGS	13,559	14,946	-259.6%	-38,794	53,740
HESubtotal		3,627,821	3,998,988	25.1%	1,003,210	2,995,77
Maui Electric (ME)	Kahului	209,414	230,839	33.0%	76,206	154,633
	Maalaea	562,012	619,512	25.8%	159,649	459,864
	Palaau	25,615	28,236	6.3%	1,782	26,454
ME Subtotal		797,041	878,587	27.0%	237,636	640,951
Hawai'i Electric Light (HEL)	Kanoelehua-Hill	202,106	222,784	22.6%	50,328	172,456
	Keahole	173,623	191,387	-26.6%	-50,821	242,208
	Puna	90,438	99,691	68.2%	67,944	31,747
	Shipman	9,246	10,192	100.0%	10,192	0
HEL Subtotal		475,413	524,053	14.8%	77,642	446,411
Hawaiian Electric Companies		**4,900,275**	**5,401,629**	**24.4%**	**1,318,488**	**4,083,14**
AES Hawai'i		**1,525,526**	**1,681,605**	**-0.6%**	**-10,000**	**1,691,60**
Hamakua Energy Power		**165,992**	**182,975**	**16.0%**	**29,276**	**153,699**
Kalaeloa Partners, LP		**993,198**	**1,094,813**	**0.0%**	**0**	**1,094,81**
Partnership Total		**7,584,991**	**8,361,022**	**16.00%**	**1,337,764**	**7,023,25**

Notes:

(1) Excludes biogenic CO2 emissions.

(2) Selections of facility emissions baselines are described in the individual GHG Emission Reduction Plans for the Hawaiian Electric Companies, AES Hawai'i, Kalaeloa Partners, LP (KPLP), and Hamakua Energy Power (HEP).

(3) CIPGS (Campbell Industrial Park Generating Station) is designated as the Main CSP for the Hawaiian Electric Companies' Emissions Reduction Plan