PROJECT REPORT

THE PROCTER & GAMBLE PAPER PRODUCTS COMPANY

CONSTRUCTION AND OPERATING PERMIT APPLICATION

ADDENDUM WITH GHG BACT ANALYSIS

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LIST OF TABLES AND FIGURES

1.1. BIOMASS COGENERATION BOILER – CO_2e BACT

On July 1, 2011, EPA signed the Deferral for CO_2 Emissions from Bioenergy and Other Biogenic Sources under the Prevention of Significant Deterioration (PSD) and Title V Programs to defer permitting of these sources for a three-year period. On July 12, 2013, federal appellate judges vacated EPA's deferral rule for the GHG permitting of biomass-fired units. Therefore, in subsequent discussions with GAEPD, P&GPP understands that GAEPD would like to obtain a GHG BACT analysis submitted for the new biomass cogeneration boiler (maximum heat input capacity of 1,037 MMBtu/hr).

The proposed project includes installation of a biomass boiler with combined heat and power that is designed to generate renewable energy to P&GPP site as well as the power grid. It is important to note that Sterling entered into this project with P&GPP as part of the Georgia Power Integrated Resource Plan. This approach was to aid GA Power in replacing combustion of the fossil fuel natural gas with a renewable energy source (i.e., biomass wood products). Since the cogeneration boiler must be fired using biomass or it will not be viable, use of other fuels as alternative "control options" were eliminated in Step 2 of this evaluation (See Section 1.1.1.3 for more detail).

Since there will be a significant emissions increase of GHGs from the Biomass Boiler, a BACT analysis for GHGs is being conducted on this unit. For a combustion unit, GHG emissions of CO, CH_4, and N_2O are anticipated as a result of the combustion processes; therefore, a BACT review must be conducted for CO_2e. The following sections outline Steps 1 through 5 of the BACT analysis for GHGs.

The U.S. EPA issued several new guidance documents related to the completion of GHG BACT analyses. The following guidance documents were utilized as resources in completing the GHG BACT evaluation for the proposed project:

- *PSD and Title V Permitting Guidance For Greenhouse Gases*, March 2011 (hereafter referred to as General GHG Permitting Guidance)[1]
- *Guidance For Determining Best Available Control Technology For Reducing Carbon Dioxide Emissions from Bioenergy Production*, (March 2011) (hereafter referred to as Bioenergy Permitting Guidance)[2]

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[1] U.S. EPA, Office of Air and Radiation, Office of Air Quality Planning and Standards, (Research Triangle Park, NC: U.S. EPA EPA-HQ-OAR-2010-0841-0001, March 2011). http://www.epa.gov/nsr/ghgdocs/ghgpermittingguidance.pdf

[2] U.S. EPA, Office of Air and Radiation, Office of Air Quality Planning and Standards, (Washington, DC, March 2011). http://www.epa.gov/nsr/ghgdocs/bioenergyguidance.pdf

- *Available and Emerging Technologies for Reducing Greenhouse Gas Emissions from Industrial, Commercial, and Institutional Boiler,* October 2010 (hereafter referred to as GHG BACT Guidance for Boilers)[3]

To complete the GHG BACT evaluation, P&GPP also relied on additional resources such as:

- Boiler specifications provided by Sterling
- RBLC database – Searching the newly enhanced RBLC database returned three results on permitting decisions for large biomass boilers (< 250 MMBtu/hr) in Process Code 11.120, for CO_2e.[4] The three results each showed energy efficient design and good operating and maintenance procedures as BACT.

1.1.1. Identification of Potential CO_2e Control Techniques (Step 1)

The following potential CO_2e control strategies for the Biomass Boiler were considered as part of this BACT analysis:

- Carbon capture and storage (CCS)
- Selection of the most efficient biomass boiler technology
- Selection of lowest carbon fuel
- Installation of energy efficient options for the biomass cogeneration boiler
- Fuel Switching - According to the GHG BACT Guidance for Boilers, fuel switching is only applicable to coal-fired and oil-fired boilers; therefore it is not addressed further in this application.
- Combined heat and power, or cogeneration

1.1.1.1. Carbon Capture and Storage

EPA's General GHG Permitting Guidance suggests that carbon capture and storage (CCS) be evaluated as an available control for substantial, large projects such as steel mills, refineries, and cement plants where CO_2e emissions levels are in the order of 1,000,000 tpy CO_2e, or for industrial facilities with high-purity CO_2 streams.[5] However, EPA explained that "[t]his does not mean CCS should be selected as BACT for such sources." The proposed biomass boiler does not produce a concentrated CO_2 stream. Nonetheless, CCS is evaluated as a control option for the proposed project.

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[3] U.S. EPA, Office of Air and Radiation, Office of Air Quality Planning and Standards, (Research Triangle Park, NC: October 2010). http://www.epa.gov/nsr/ghgdocs/iciboilers.pdf

[4] http://cfpub.epa.gov/RBLC/

[5] General GHG Permitting Guidance at 42-43.

CCS is a multi-stage control strategy that involves the separation and capture of CO_2 emissions from the GHG emission unit's exhaust, pressurization of the captured CO_2, transportation of the pressurized CO_2 via pipeline, and finally injection and long-term geologic storage of the captured CO_2. Though at varying stages of development, several different technologies have demonstrated the potential to separate and capture CO_2. To date, some of these technologies have been demonstrated at the laboratory scale only, while others have been proven effective at the slip-stream or pilot-scale. Numerous projects are currently planned for the full-scale demonstration of CCS technologies.

According to the U.S. EPA guidance for PSD and Title V Permitting of Greenhouse Gases, CCS

> *…is a promising technology in the early stage of demonstration and commercialization. While it should be identified as an available control measure in the first step of BACT for the large combustion source in these high GHG emitting sectors (Fossil-Fuel Fired Power Plants, Cement Production, and Iron and Steel Manufacturing), it is currently an expensive technology and unlikely to be selected as BACT in most cases.*[6]

It should be noted that the "high GHG emitting sectors" identified in the guidance document do not include biomass boilers of the size and nature proposed by P&GPP.

In addition to the U.S. EPA permitting guidance for GHG, white papers for GHG reduction options were reviewed for discussion of CCS technologies. In the Industrial, Commercial, and Institutional Boiler GHG reduction white paper, a brief overview of the CCS process is provided and the guidance cites the Interagency Task Force on Carbon Capture and Storage for the current development status of CCS technologies, which is further discussed in this section.[7,8]

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[6] US EPA, Office of Air Quality Planning and Standards, "PSD and Title V Permitting Guidance for Greenhouse Gases", March 2011, p. 37.

[7] US EPA, "Available and Emerging Technologies for Reducing Greenhouse Gas Emissions from Industrial, Commercial and Institutional Boilers," October 2010, p. 26, http://www.epa.gov/nsr/ghgdocs/iciboilers.pdf

[8] "Report of the Interagency Task Force on Carbon Capture and Sequestration," August 2010, http://fossil.energy.gov/programs/sequestration/ccstf/CCSTaskForceReport2010.pdf

In the aforementioned Interagency Task Force report on CCS technologies and in a recent update to that report issued in June 2013[9], a number of pre and post combustion CCS projects are discussed in detail; however, many of these projects are in formative stages of development and are predominantly power plant demonstration projects (and mainly slip stream projects). Capture-only technologies are technically available; however, the limiting factor is typically the lack of a geographic formation or pipeline for the carbon to be permanently sequestered.

Beyond power plant CCS demonstration projects, the report and the Carbon Capture and Sequestration Database (maintained by MIT)[10] also discuss industrial CCS projects that are being pursued under the Industrial Carbon Capture and Storage (ICCS) program.

At present, these research and development industrial deployments are in various stages of planning, completion, and testing. However, these projects are backed by government funding and selected for their proximity to available CO_2 pipelines and geologic formations appropriate for sequestration.

1.1.1.2. Selection of the Most Efficient Biomass Boiler Technology

There are several options available for boiler technology selection including the following types of boilers (listed in order of decreasing efficiency ratings), with stoker boilers and fluidized bed boilers being the two most commonly used for biomass combustion:[11]

- Fluidized Bed Combustion – Air is blown through a bed of inert material; once the bed is "fluidized" fuel is then introduced into the bed for combustion
- Suspension Combustion – Fuel is blown into the combustion chamber through specially designed burners which mixes air with fuel
- Stoker Combustion – The fuel is typically introduced into the combustion chamber by a moving grate
- Pile Combustion – A furnace with fixed grate inside the combustion chamber where fuel is piled onto the grate

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[9] "Carbon Capture and Sequestration: Research, Development, and Demonstration at the U.S.

Department of Energy", June 10, 2013, http://www.fas.org/sgp/crs/misc/R42496.pdf

[10] http://sequestration.mit.edu/tools/projects/index.html

[11] U.S. EPA Combined Heat and Power Partnership, *Biomass Combined Heat and Power Catalog of Technologies, September 2007, http://www.epa.gov/chp/documents/biomass_chp_catalog_part5.pdf, Chapter 5, p. 31*

Of the fluidized bed boilers, there are two general types: CFB and BFB. The main difference between a BFB and CFB is the fluidization velocity which is higher for a CFB boiler. A CFB boiler's technology separates and captures fuel solids embedded in the high velocity exhaust gas, returning them to the bed for complete combustion. BFB boiler technology operates at relatively low gas stream velocities and with coarse bed size particles. The bed is "fluidized" by adding excess air and recirculated gases which pass through the bed in the form of bubbles.

While other boiler technologies are technically feasible for biomass combustion, P&GPP has selected a fluidized bed boiler as optimal for this project. Furthermore, best combustion takes place in a fluidized bed boiler compared to other boiler types because the fuel particles are in a fluidized state and mixed appropriately with air.[12] The turbulence in a fluidized bed boiler combined with the thermal inertia of the bed material provide for complete, controlled, and uniform combustion. These key characteristics of a fluidized bed boiler are important in thermal efficiency maximization, char minimization, and control of emissions.[13] Due to these attributes of fluidized bed technology and because fluidized bed technology exhibits a higher boiler efficiency than other technologies capable of combusting solid fuel, allowing for a higher power and steam output from the boiler system[14], it is the best technology fit for P&GPP's project.

Furthermore, operation of a fluidized bed boiler system will maximize the overall efficiency of the power generation and thermal energy production. According to EPA:

> *By using waste heat recovery technology to capture a significant proportion of this wasted heat, CHP systems typically achieve total system efficiencies of 60 to 80 percent for producing electricity and thermal energy.*
>
> *Because CHP is more efficient, less fuel is required to produce a given energy output than with separate heat and power. Higher efficiency translates into:*

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[12] United Nations Environment Programme, Division of Technology, Industry, and Economics – Energy Branch, *Technical Study Report on Biomass Fired Fluidized Bed Combustion Boiler Technology For Cogeneration*, *September 2007*, http://www.unep.fr/energy/activities/cpee/pdf/FBC_30_sep_2007.pdf, p 14-17.

[13] U.S. EPA Combined Heat and Power Partnership, *Biomass Combined Heat and Power Catalog of Technologies, September 2007, http://www.epa.gov/chp/documents/biomass_chp_catalog_part5.pdf, Chapter 5, p. 36*

[14] U.S. EPA Combined Heat and Power Partnership, *Biomass Combined Heat and Power Catalog of Technologies, September 2007, http://www.epa.gov/chp/documents/biomass_chp_catalog_part7.pdf, Chapter 7, p. 84*

- Lower operating costs
- Reduced emissions of all pollutants
- Increased reliability and power quality
- Reduced grid congestion and avoided distribution losses

EPA further explains that a CHP system's efficiency depends on the technology used to generate the electricity and thermal energy, the system design, and how much of the thermal energy is used by the site. Typically, CHP systems that employ a steam turbine achieve efficiency of about 80 percent.

The following list illustrates that operation of a steam turbine (as proposed by P&GPP) typically achieves the highest efficiency compared to other types of devices that convert fuels to electrical or mechanical energy:

- Steam Turbine: 80 percent
- Diesel Engine: 70-80 percent
- Natural Gas Engine: 70-80 percent
- Gas Turbine: 70-75 percent
- Microturbine: 65-75 percent
- Fuel Cell: 65-80 percent[15]

1.1.1.3. Selection of the Lowest Carbon Fuel

For GHG BACT analyses, low-carbon intensity fuel selection is the primary control option that can be considered a lower emitting process. The biomass boiler will combust biomass (woody biomass) as a primary fuel with natural gas as the fuel fired during startup and periods of interrupted biomass supply. The boiler will typically combust biomass with a low moisture content of approximately 40 percent.

It is important to note that Sterling entered into this project with P&GPP as part of the Georgia Power Integrated Resource Plan. This approach was to aid GA Power in replacing combustion of the fossil fuel natural gas with a renewable energy source (i.e., biomass wood products). Since the cogeneration boiler must be fired using biomass or it will not be viable, use of other fuels as alternative “control options” were not considered in this evaluation.

[15] http://www.epa.gov/chp/basic/efficiency.html

Therefore, firing natural gas as a primary fuel is not considered a viable option. Other "clean fuels" options are not required to be considered according to the General GHG Permitting Guidance since that would fundamentally redefine the source by requiring the permit applicant to switch to a primary fuel type other than the type of fuel that the applicant proposes to use for its combustion processes.[16]

1.1.1.4. Installation of Energy Efficiency Options on the Biomass Boiler

Operating practices that increase energy efficiency are a potential control option for improving the fuel efficiency of the Biomass Boiler and therefore, providing benefit with respect to GHG emissions.

In October 2010, the U.S. EPA provided a white paper that addresses control technologies, energy efficiency measures, and fuel switching options for industrial, commercial and institutional boilers. The energy efficiency options listed in the GHG BACT Guidance are:

- Burner replacement (for existing units)
- Boiler maintenance
- Boiler process control
- Condensate return
- Reduction of flue gas quantities
- Minimizing boiler blow down
- Reduction of excess air
- Selection of steam turbine

Additionally, the General GHG Permitting Guidance references several energy efficiency benchmarking tools. These tools contain performance benchmarking information, and may be useful in considering energy efficient technologies and processes if the information is specific and relevant to the Biomass Boiler.

Table E-1 summarizes the results of reviewing these benchmarking resources for relevance to the proposed project:

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[16] US EPA, Office of Air Quality Planning and Standards, "PSD and Title V Permitting Guidance for Greenhouse Gases", November 2010, p. 29.

Table E-1. Energy Efficiency Benchmarking Resources[17]

Resource	Summary	Relevance to Biomass Boiler
Energy Star – Energy Performance Indicators (EPIs)[18]	EPIs are now under testing by pulp and paper industry manufacturing plants, but not yet available. The Pulp and Paper Manufacturing Focus partnership's website references an Energy Management Guide which is also the main reference document in the General GHG Permitting Guidance.	No available benchmarking tools; Energy efficiency options discussed in Energy Management Guide are addressed in Section 6.6.5.
DOE Industrial Technologies Program (ITP)[19]	ITP's Forest Products Industry of the Future (IOF) strategy includes combined heat and power (CHP) as best practices to improve the overall energy efficiency.	Project involves a CHP system.
Lawrence Berkeley National Laboratory Industrial Energy Analysis Program[20]	Emerging Energy-Efficient Industrial Technologies[21] recommends CHP systems for the utility industry.	Project involves a CHP system.
European Union (EU) Energy Efficiency Benchmarks[22]	EU developed a methodology for the free allocation of emission allowances in the EU Emissions Trading System (ETS) post 2012 based on a benchmarking study for numerous industries.	EU's benchmarking study for the pulp and paper industry does not provide energy efficiency options for consideration for boiler/turbine systems comparable to P&GPP's proposed project.

1.1.1.5. Combined heat and power, or cogeneration

Combine heat and power (CHP) involves the production of heat and electricity from a single facility. Industrial, commercial, and institutional boilers operating at high annual operating factors and maintaining a steady thermal load are potential candidates for cogeneration. Such boilers may be equipped with steam turbines or heat recovery steam generators (HRSGs) to generate power for use

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[17] US EPA, Office of Air Quality Planning and Standards, "PSD and Title V Permitting Guidance for Greenhouse Gases", November 2010, p 22-23 and Appendix J.

[18] http://www.energystar.gov/buildings/facility-owners-and-managers/industrial-plants/measure-track-and-benchmark/energy-star-energy

[19] http://www1.eere.energy.gov/industry/forest/tools.html#bp

[20] http://industrial-energy.lbl.gov/

[21] Emerging Energy-Efficient Industrial Technologies, October 2000, http://ies.lbl.gov/iespubs/46990.pdf

[22] http://ec.europa.eu/clima/policies/ets/cap/allocation/docs/benchm_co2emiss_en.pdf

on-site or for sale to the power market. CHP is technically feasible for this project and is being employed by P&GPP on the biomass boiler and turbine system.

1.1.2. Elimination of Technically Infeasible Control Options (Step 2)

1.1.2.1. Carbon Capture and Storage

While potentially available for certain high purity CO_2 streams, CCS is technically infeasible for the biomass boiler for the following reasons:

Capture and Compression - Power Demand

CO_2 capture is achieved by separating CO_2 from emission sources where it is then recovered in a concentrated stream that can be sequestered. In a pre-combustion CO_2 capture scenario, the fuel is converted in a gasification plant into gaseous components. In this scenario the CO_2 can be captured before the gas is mixed with the air in a combustion turbine; thus in this instance the CO_2 stream is concentrated and at a high pressure.

Conversely, in a post-combustion capture scenario (such as would be necessary for the capture of CO_2 from the proposed biomass boiler), CO_2 is exhausted in the flue gas at atmospheric pressure and a lower concentration relative to the pre-combustion capture scenario. The post-combustion CO_2 capture scenario is problematic because the low pressure and dilute concentration means a high volume of gas needs to be treated. Additional challenges stem from the impurities in the flue gas that tend to negatively affect the ability to adsorb CO_2,[23] and the compression of CO_2 would require a substantial auxiliary power load, resulting in additional fuel consumption (and additional CO_2, CH_4, and N_2O emissions) to generate the same amount of heat.[24]

Sequestration - Lack of Sequestration Sink (Geologic or Pipeline)

While capture-only technologies may be available and demonstrated on pilot scales, a remaining hurdle is the availability of a mechanism (pipeline or geologic formation) to permanently sequester the captured gas. As shown in the Interagency Report, there is no existing pipeline available in

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[23] Carbon Sequestration - CO_2 Storage, U.S. Department of Energy http://www.netl.doe.gov/technologies/carbon_seq/core_rd/co2capture.html.

[24] Report of the Interagency Task Force on Carbon Capture & Storage, August 2010, p. 29.

Georgia for nearby CO_2 transport. The closest existing pipeline (partially completed with proposed extensions) is located hundreds of miles away in Mississippi and Louisiana.[25]

In 2009, the U.S. Department of Energy (DOE), National Energy Technology Laboratory granted the University of South Carolina funds for geologic characterization of the South Georgia Rift basin that extends from South Carolina into Georgia for CO_2 storage. This three year research period will begin with a geologic storage assessment and estimate of CO_2 storage capacity (ending in September 2013). Subsequent years of study will determine regional characterization of target CO_2 storage formation and finally site-specific characterization with installation of a test hole and evaluation of leakage pathways.[26,27] Since the availability and proximity of such geologic formations is unknown, carbon storage in the South Georgia Basin formation or any other candidate geologic sequestration site is not considered to be a technically feasible option for reducing CO_2 emissions from the biomass boiler at this time.

Based on the aforementioned technical challenges with capture, compression and storage of CO_2, CCS as a combined technology is not considered technically feasible as BACT for reducing CO_2 emissions from the biomass boiler. Accordingly, CCS is eliminated as a potential control option in this BACT assessment for CO_2 emissions due to technical infeasibility.

1.1.2.2. Selection of the Most Efficient Biomass Boiler Technology

Each of the boiler technologies listed in Step 1 are technically feasible.

1.1.2.3. Selection of the Lowest Carbon Fuel

Additional firing of a lower carbon fuel (natural gas, the proposed startup fuel) is not a feasible option for CO_2e control of the biomass boiler due to the description of the project as part of the GA Power Integrated Resource Plan in Section 1.1.1.3.

1.1.2.4. Installation of Energy Efficiency Options on the Biomass Boiler

Each of the aforementioned energy efficiency options in Step 1 is technically feasible for CO_2e control of the biomass boiler, with the exception of replacement burners as this is a new installation.

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[25] Report of the Interagency Task Force on Carbon Capture & Storage, August 2010, Appendix B-1.

[26] http://www.netl.doe.gov/publications/factsheets/project/FE0001965.pdf

[27] Geologic Characterization of the South Georgia Rift Basin For Source Proximal CO_2 Storage, October 2010, http://www.netl.doe.gov/publications/proceedings/10/rcsp/presentations/Thur%20am/Brian%20Dressel/Waddell.2010%20South%20Carolina%20Partnerships%20Meeting%20Presentatio.pdf.

1.1.2.5. Combined heat and power, or cogeneration

CHP is technically feasible for this project and is being employed by P&GPP on the biomass boiler and turbine system.

1.1.3. Rank of Remaining Control Technologies (Step 3)

Boiler technology selection, lower carbon fuel selection, installation of energy efficient options, and combined heat and power operation are the remaining technically feasible control options for minimizing CO_2e emissions from the biomass boiler. It is unclear which option has a more significant impact on emissions of CO_2e from the facility.

The boiler technology selection can be ranked in terms of overall energy efficiency for biomass boilers. The most commonly used technologies are detailed in Table E-2 and were briefly discussed in Step 1 of the CO_2e BACT. Each technology is briefly described and an estimate for boiler and/or overall system efficiency is also summarized.

Table E-2. Summary Of Efficiencies Of Boiler Energy Conversion Technologies[28]

Technology	Description	Boiler Efficiency	Overall System Efficiency
Fluidized Bed Combustion	Most efficient and versatile method; air is blown through bed of inert material ; once the bed is "fluidized", fuel is introduced into the bed for combustion	As high as 80-82%	
Suspension Combustion	Fuel blown into the combustion chamber through specially designed burners which mixes air with fuel	Up to 80%	
Stoker Combustion	Fuel is typically introduced into combustion chamber by a moving grate	65-75%	20-25%
Pile Combustion	Furnace with fixed grate inside the combustion chamber where fuel is piled onto the grate		As low as 20%

Stoker boilers and fluidized bed boilers are the two most commonly utilized technologies for biomass combustion.[29] The main difference between stoker and fluidized bed boilers is the efficiency of fuel consumption. Stoker boilers can have 30 to 40 percent carbon in the ash with additional VOC and CO exhausted in the flue gases. Comparatively, fluidized bed boilers typically achieve close to 100 percent fuel consumption. This increase in boiler efficiency allows for a somewhat higher power and steam output from the boiler system.[30] A more efficient system creates a cost savings, as well as an emissions reduction, since a lesser amount of fuel is combusted in the CFB boiler, as compared to the amount of fuel necessary to provide the same power and steam output in a less efficient boiler. Therefore, selection of a fluidized bed boiler for biomass consumption can be ranked as the highest energy efficient selection.

Installation of energy efficient options in conjunction with the fluidized bed boiler selection will then be evaluated in Step 4 of the BACT analysis.

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[28] United Nations Environment Programme, Division of Technology, Industry, and Economics – Energy Branch, *Technical Study Report on Biomass Fired Fluidized Bed Combustion Boiler Technology For Cogeneration*, *September 2007*, http://www.unep.fr/energy/activities/cpee/pdf/FBC_30_sep_2007.pdf, p 14-17.

[29] U.S. EPA Combined Heat and Power Partnership, *Biomass Combined Heat and Power Catalog of Technologies, September 2007, http://www.epa.gov/chp/documents/biomass_chp_catalog_part5.pdf, Chapter 5, p. 31*

[30] U.S. EPA Combined Heat and Power Partnership, *Biomass Combined Heat and Power Catalog of Technologies, September 2007, http://www.epa.gov/chp/documents/biomass_chp_catalog_part7.pdf, Chapter 7, p. 84*

1.1.4. Evaluation of Most Stringent Controls (Step 4)

1.1.4.1. Selection of the Most Efficient Biomass Boiler Technology

Fluidized bed technology is the most efficient of boiler technologies and will be used for the project. There are no adverse impacts associated with this technology.

A GHG emissions reduction benefit (which also applies for CH_4 and N_2O) is that the proposed fluidized bed biomass boiler and steam turbine generator will allow the P&GPP plant to become largely self-sufficient with respect to electrical power, and will generate enough to sell electricity to the grid. In all likelihood, this energy being generated from a renewable fuel source will displace coal generated electricity on the grid.

1.1.4.2. Selection of the Lowest Carbon Fuel

While natural gas may be a lower emitting carbon fuel than biomass, combustion of clean biomass (as a primary fuel), is a renewable fuel that has clean energy and GHG benefits, and has financial benefits to the facility in terms of cost reductions. This assertion is supported by U.S. EPA in the General GHG Permitting Guidance:

> *Even before EPA takes further action, however, permitting authorities may consider, when carrying out their BACT analyses for GHG, the environmental, energy and economic benefits that may accrue from the use of certain types of biomass and other biogenic sources (e.g., biogas from landfills) for energy generation, consistent with existing air quality standards. In particular, a variety of federal and state policies have recognized that some types of biomass can be part of a national strategy to reduce dependence on fossil fuels and to reduce emissions of GHGs.*

The combustion of biomass as a fuel is environmentally beneficial since biomass is a renewable fuel source and contributes to additional renewable energy on the grid. Reliance on natural gas as the primary fuel would eliminate the renewable energy benefits of the overall project as this would simply mean the displacement of one fossil-fuel with another fossil fuel, as opposed to allowing for the increased reliance on a renewable energy source.

Furthermore, Sterling and P&GPP entered into this project as part of the Georgia Power Integrated Resource Plan, where the intent is to replace fossil fuel (natural gas) consumption with a renewable fuel source. Combusting natural gas as the primary fuel source would prevent the project from being completed as part of the Georgia Integrated Resource Plan.

Therefore, combustion of biomass demonstrates significant environmental and energy benefits when considering the impacts to climate change, GHG emissions, and renewable energy generation. It also meets the intent of the project in partnership with the Georgia Power Integrated Resource

Plan. In addition to the carbon benefits of biomass fuel, the selection of the backup/secondary fuel, natural gas, is the lowest CO_2 emitting fuel that could be relied upon.

1.1.4.3. Installation of Energy Efficiency Options on the Biomass Boiler

No adverse energy, environmental, or economic impacts are associated with boiler selection and energy efficient operating practices for reducing CO_2e emissions from the biomass boiler. The environmental benefits include fuel savings and reduction of GHG emissions, as well as other criteria pollutant emissions, due to the efficiency gains.

1.1.5. Selection of CO_2e BACT (Step 5)

Because it is feasible to utilize several control options simultaneously, ultimately BACT will consist of a combination of those technologies that were not eliminated in Step 4, which are detailed below. P&GPP is proposing that the operation of a CHP system with several energy efficiency options constitutes BACT for the biomass boiler. These energy efficiency options are summarized in Table E-3.

Table E-3. Summary Of Energy Efficiency Options for biomass boiler[31]

Energy Efficiency Option	Features of Biomass Boiler
Combined heat and power	Since P&GPP is installing a CHP system, the plant will use waste heat recovery technology to capture a significant proportion of this wasted heat, achieving higher total system efficiencies for producing electricity and thermal energy. Because this CHP system is more efficient, less fuel is required to produce energy output and therefore, emissions of all pollutants, including GHGs, will be lower.
Steam Turbine Selection	P&GPP is in the process of considering high efficiency turbines for generating electricity for the P&GPP site as well as for distribution on the grid. Features of the selected turbine will include high thermal efficiency, integrated control system, period shutdowns for maintenance and efficiency optimization, and use of operating procedures and practices for good operating and maintenance practices.
Boiler maintenance	This boiler and auxiliary equipment will be maintained per the boiler manufacturer's recommendations.
Boiler process control	The boiler will have a CEMS for measuring all combustion air and

[31] Provided to Joe Sullivan and Aimee Andrews (Trinity) from Gil Waldman (Sterling) via conference call on July 26, 2013.

Energy Efficiency Option	Features of Biomass Boiler
	monitoring of O_2 and CO_2 in the flue gas.
Condensate return	Steam usage at the boiler for air pre-heating will be collected as condensate and returned to the boiler system. The main steam that passes through the turbine generator will be condensed in a new condenser, and a high percentage of condensate will be returned to the boiler system. P&PGG will also send a high percentage of condensate back to Sterling's boiler system.
Reduction of flue gas quantities	Boiler passages and ducts will be seal welded to reduce and/or avoid any flue gas leakage. In addition, installed combustion controls will minimize the gas flow.
Minimizing boiler blow down	Blowdown flow will be adjusted to minimize blowdown rate when necessary. The plant will maintain good control of water chemistry to reduce blowdown rate and control solids buildup.
Reduction of excess air	Combustion air and flue gas will be adjusted as necessary to optimize combustion efficiency and minimize excess air.
Blow down steam recovery	Blowdown from this boiler will be limited to about 1% of the boiler steam flow by good water treatment practices. Blowdown will be piped to a blowdown flash tank where heat energy can be recovered.
Improved boiler insulation	The new fluidized bed boiler will be insulated with top quality insulation to manufacturer's specifications to minimize heat loss.
Flue gas heat recovery	An economizer and flue gas heat recovery air heater will be installed to recover energy from the flue gases.

In order to construct a GHG BACT limitation, P&GPP consulted GAEPD's recently issued PSD permits, all of which contained an annualized CO_2e BACT limit. Therefore, P&GPP proposes a CO_2e BACT emission limit of 906,290 tpy of CO_2e on a 12-month rolling average basis from the biomass boiler. P&GPP derived the proposed BACT emission limit on the basis of vendor heat input estimates and EPA emission factors for CO_2, CH_4, and N_2O emissions from the proposed fuel blend. Emission calculations are provided in Appendix B of the application.

Compliance with the proposed BACT limit will be demonstrated based on fuel consumption measured and recorded. CH_4 and N_2O emissions will also be calculated and included towards the CO_2e limitation.