Attachment 3

Supplemental to Application: Additional Information for the PSD Application, dated September, 2011, AR I.B.3.a (pages 1,3, i, and pages 1-28 of Appendix B, Energy Answers-GHG BACT Emissions Calculations, Table 10.1, 10.2, 11 through 16 of Appendix C, and Exhibit A, Table 1 to 5)

September 9, 2011

Mr. Steven C. Riva,Chief
USEPA Region 2
Permitting Section, Air Programs Branch
290 Broadway
New York, NY 10007-1866

Subject: Responses to August 4, 2011 Comments
PSD Air Permit Application
Energy Answers Arecibo
Arecibo Renewable Energy Project

Dear Mr. Riva:

Attached for you review is our response to the questions, recommendations, and additional information requested in your August 4, 2011 letter pertaining to the BACT Analysis, proposed Supplemental Fuels, Greenhouse Gas (GHG) BACT Analysis, and emission rate calculations for the proposed Arecibo Renewable Energy Project (AREP) Prevention of Significant Deterioration (PSD) Preconstruction permit application.

Thank you for your prompt attention to this submittal. Should you require further information during your review of this request, please contact me at (347) 351-5248.

Sincerely,

ENERGY ANSWERS ARECIBO

Mark J. Green
Vice President

/Attachments

cc: John L. Hanisch – ARCADIS
Kevin R. Scott, PE – ARCADIS

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Arecibo Renewable Energy Project

Additional Information Requested by EPA for the PSD Air Permit Application

September 2011

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Appendix B

Revised GHG BACT Analysis

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Tables

1. Introduction

Energy Answers' proposed Arecibo Renewable Energy Project (AREP) is designed to process Municipal Solid Waste (MSW) into Process Refuse Fuel (PRF) to generate electricity. The majority of the solid fuel combusted at the facility will be PRF. The facility design also provides for the ability to combust up to 20 percent Auto Shredder Residue (ASR), 20 percent Tire Derived Fuel (TDF), or 50 percent Processed Urban Wood Waste (PUWW). It is anticipated that when these materials are received, they will be blended with PRF up to these ratios until the supply is depleted. The facility would then revert to combusting 100 percent PRF.

The maximum daily amount of non-PRF fuel would be approximately 287 tons per day (TPD) of ASR, 330 TPD of TDF or 897 TPD of UWW. It is anticipated that the actual maximum of 35,000 to 70,000 tons per year of non-MSW fuels will be combusted. Since the actual amounts of the non-MSW fuels are not known at this time, the BACT analysis provides information based on the conservative assumption that any one of the proposed fuel blends could be used for an entire year.

On July 1, 2011, EPA published a Final Rulemaking Notice (76 FR 43490) deferring the applicability of PSD and Title V to the biomass fraction of MSW. Based on this deferral it is not necessary for the AREP facility to evaluate or implement Best Available Control Technology (BACT) for combustion of the biomass portion of MSW or PRF. However, the deferral clearly states that a facility that burns MSW or alternative fuels must still evaluate whether the proposed project triggers PSD and Title V for the non biogenic portion of the fuel. Energy Answers evaluated the proposed project considering the recent rule change. Based on the potential non biogenic portion of the GHG emissions, the facility is subject to PSD review and must submit a BACT analysis. Energy Answers proposes the BACT limits in Table 1.1 below for the proposed AREP.

Table 1.1 Proposed BACT limits

Source	Proposed BACT limit (Non Biogenic CO_2e)	Averaging Time	Monitoring and record keeping
Solid Fuel	74 tons/million lbs steam	12 month rolling average	Monitor total CO_2 and steam with CEMs and calculate non biogenic portion of CO_2e using fuel mix.
Boiler start-up & shut-down	163,273 lbs/hr per boiler	12 month rolling average	Fuel usage & emission factors

Source	Proposed BACT limit (Non Biogenic CO_2e)	Averaging Time	Monitoring and record keeping
Diesel Firewater Pump	386 lbs/hr	12 month rolling average	Fuel usage and AP-42 Emission Factors
Emergency Generator	778 lbs/hr	12 month rolling average	Fuel usage and AP-42 Emission Factors

2. Applicability Analysis

The proposed AREP is considered a major new source and is already subject to PSD for other constituents. Under the Tailoring Rule, the facility is subject to PSD for GHG if there is any potential increase in total CO_2 and if there is an increase of more than 75,000 tons per year of CO_2e. Since EPA deferred applicability for biogenic emissions, only the non biogenic portion of each fuel proposed for use at the facility are regulated and required to be included in the applicability analysis. As stated elsewhere, Energy Answers proposes to combust up to 20% Auto Shredder Residue (ASR), 20 % Tire Derived Fuel (TDF) and/or 50% Processed Urban Wood Waste (PUWW). The emission factors and for each of these fuels were provided in the June 2, 2011 submittal. In this submittal Energy Answers reviewed the emission factors and now proposes using the emission factor in 40 CFR Part 98 Subpart C Table C-1. Additionally, the emission factors for CH_4 and N_2O are addressed in the analysis. The other emission factors remain the same. Table 2.1 provides the list of the emission factors used in the analysis. The biogenic and non biogenic portion of each fuel using the ratios provided in the June 2, 2011 submittal are calculated based on the best estimates available from published references. These ratios have not changed since the previous submittal and are restated in Table 2.2 below.

Table 2.1 GHG Emission Factors for Supplemental Fuels

Fuel	Emission factor GHG (kg/mmBtu)	Source of Information
PRF	CO2: 90.7 CH4: 0.032 N2O: 0.0042	40 CFR Part 98 Table C-1 & C-2
TDF:	CO2: 85.97 CH4: 0.032 N2O: 0.0042	40 CFR Part 98 Table C-1 & C-2
ASR (as plastics)	CO2: 75.0 CH4: 0.032 N2O: 0.0042	40 CFR Part 98 Table C-1 & C-2
PUWW:	CO2: 93.8 CH4: 0.032 N2O: 0.0042	40 CFR Part 98 Table C-1 & C-2

Table 2.2 Percentage of Biomass and non Biomass by Fuel Type

Biomass Content			
Fuel	**Biomass**	**Non Biomass**	**Source**
Processed Refuse Fuel	67.0%	33.0%	Analysis of 2003 Waste Characterization Study – See Exhibit A – Tables 2 & 3
Tire Derived Fuel	20%	80%	See Note 1 below and Exhibit A
Auto Shredder Residue	15.8%	84.2%	See Exhibit A - Table 4
Urban Wood Waste	98.7%	1.3%	See Exhibit A – Table 5

Note 1: From Using used tires as an alternative source of fuel, Catherine Clauzade, Research & Development Department, Aliapur, July 2009. The Aliapur study used the ASTM D6866-10 Standard Test Methods for Determining the Biobased Content of Solid, Liquid, and Gaseous Samples Using Radiocarbon Analysis to determine biogenic fractions; this methodology has been adopted by the US EPA for its Mandatory Reporting of Greenhouse Gases (see, Mandatory Reporting of Greenhouse Gases, 75 Fed. Reg. 79092 [Dec. 17, 2010]). Values in the Aliapur report are given as percent by weight only, and are assumed here to be approximately valid for use as percent by heating value as well. A weighted average of auto tires (18.3% by weight biomass) and truck tires (29.1% by weight biomass) was calculated based on an assumed distribution of 70% auto and 30% truck end-of-life tires in Puerto Rico.

In the February 2011 initial PSD Application, Energy Answers brought forth the concept that MSW would be landfilled if it were not used to fuel the proposed AREP, and that landfilling (which is currently the only final disposal option in Puerto Rico) results in emissions of CH_4, a much more potent GHG. In effect, the proposed AREP would operate as a GHG "sink" by eliminating GHG that would otherwise occur at landfills. Moreover, the proposed AREP would displace energy (electricity) produced by combusting fossil fuels. This effect further reduces GHG emissions on the island.

Although these effects will be realized after the proposed AREP started operation, EPA has determined that the facility cannot take credit for the contemporary increases and decreases in emissions that will occur from diverting MSW from landfills or displacing energy that would otherwise be generated from fossil fuel combustion in the applicability analysis. Consequently, only the GHG emissions originating directly at the facility itself are examined for applicability purposes under the PSD program. Table 2.3 provides information on the non biogenic portion of the GHG emissions associated with burning the PRF to generate electricity. For the non biogenic portion of the fuel, there is a net increase in CO_2 which satisfies the first criteria in the Tailoring rule. Also, the CO_2e is estimated to exceed 75,000 tons. Therefore the proposed AREP is still subject to PSD and is required to do a BACT analysis for the non biogenic portion of the PRF.

Table 2.3: Total Non Biogenic GHG (Tons) - 100% Availability

Fuel Mix	CO_2	CO_2e
100% PRF plus fuel oil from RSCR	291,351	315,242

AREP prepared a BACT analysis for the following equipment:

1. The boilers combusting solid fuel
2. Start-up and shut-down of boilers
3. The Emergency Generator
4. The Fire Pump

As shown in Table 2.4, all of the fuels being considered for normal operations have some biogenic and some non biogenic GHG emissions. The most biogenic GHG emissions occur under the 50% PRF and 50% PUWW scenario and the least amount of biogenic GHG emissions occur with 80% PRF and 20% ASR operating scenario. Since the substitution of alternative fuels is not expected to occur on a continuous basis, the percentages in Table 2 provide a conservative estimate of emissions for each supplemental fuel mix. The table has been revised to include CH_4 and N_2O emissions as well as CO_2e.

Table 2.4: GHG as CO_2e - Maximum Fuel Mixes (100% Availability; Including Fuel Oil)

Scenario	CO_2e Emissions (TPY)			Percentage	
	Biogenic	Non Biogenic	Total	Biogenic	Non Biogenic
100% PRF	587,000	315,242	902,241	65.1%	34.9%
80% PRF; 20% TDF	431,240	453,986	885,226	48.7%	51.3%
80% PRF 20% ASR	371,978	461,142	833,120	44.6%	55.4%
50% PRF; 50% PUWW	763,509	155,765	919,273	83.1%	16.9%

3. GHG BACT analysis

3.1 Introduction

On July 1, 2011, EPA published a Final Rulemaking Notice deferring the applicability of PSD and Title V to the biogenic portion of MSW. Based on this deferral it is not necessary to establish BACT for the biogenic portion of combusting MSW or PRF. As discussed above, the non biogenic portion of the GHG is above 75,000 tons on a CO2e basis and therefore AREP is still required to do a BACT analysis for the non biogenic portion of the PRF. Therefore, AREP has prepared a BACT analysis for the following equipment:

1. The boilers combusting solid fuel
2. Start up and Shut Down of the boilers
3. The Emergency Generator
4. The Fire Pump

Below is a revised 5 Step BACT analysis. This has been modified since the version submitted on June 3, 2011 based on the additional EPA guidance and in response to the questions and comments in the EPA comment letter dated August 4, 2011.

3.2 BACT Analysis for Combusting Solid Fuel

3.2.1 STEP 1: Identify Control Options

There are three options to reduce GHG emissions from MSW or PRF. These are:

1. Carbon Capture and Sequestration
2. Utilization of Biomass Fuel
3. Maximizing energy efficiency while combusting PRF to minimize GHG emissions

Recycling is not included as an alternative control option since recycling is an inherent part of the program and any material recycled will be replaced with combustible material. As a result, there is no net change in the tons burned or the potential GHG emissions realized with recycling.

3.2.2 STEP 2: Eliminate Technically Infeasible Options

3.2.2.1 Carbon Capture and Sequestration

The top option for GHG emission reduction is to use carbon capture and sequestration (CCS). CCS requires three distinct processes:

1. Isolation of the GHG (typically CO_2, the largest component of GHG by mass) from the waste gas stream;

2. Transportation of the captured CO_2 to a suitable storage location; and

3. Storage of the captured and delivered CO_2.

If any one of these three processes is not feasible, then CCS as a whole is not feasible.

<u>CO_2 Capture</u>

There are two pre-combustion CO_2 capture techniques: indirect use of oxygen and direct use of oxygen.

Indirect Use of Oxygen

The indirect approach involves the partial combustion of the RDF with oxygen and steam to produce a synthesis gas ("syngas") composed of carbon monoxide (CO) and hydrogen (H2). This process is known as waste gasification. The CO generated by this process is reacted with steam in a catalytic reactor to yield CO_2 and additional H2. The CO_2 is then separated, usually by a physical or chemical absorption process (options for this separation are discussed below under post-combustion CO_2 capture technologies), resulting in a hydrogen-rich fuel which can be combusted to generate energy.

Waste gasification technology is still in its developmental stage for units on the scale proposed by Energy Answers. Only one operating waste gasification facility could be identified in North America (Ottawa, Canada). This facility is rated for 100 tons per day of waste. Several others are in the development stage in Hawaii, Massachusetts and the Bahamas. However, these proposed projects will operate at feed rates of 150, 10 and 400 tons per day, respectively – much smaller than the approximate 2,106 tons per day feed rate for the proposed Energy Answers facility. Based on the limited number and size of operating facilities, waste gasification has not been demonstrated at the scale required for the proposed Energy Answers facility and is considered not commercially available and therefore, not technically feasible.

Direct Use of Oxygen

The direct approach to pre-combustion CO_2 separation involves substituting oxygen for air during the combustion process (i.e., oxy-firing). This approach produces a higher concentration of CO_2 in the exhaust gas than combustion in air because the approximately 80 percent of gas volume due to nitrogen in air has been removed.

No commercially proven equipment approaching the design requirements for the proposed Energy Answers facility are available. Accordingly, direct, pre-combustion CO_2 separation, oxy-firing, is not technically feasible.

Chemical absorption

This is the most common post combustion method for CO_2 capture. Monoethanolamine ("MEA") solvent has the advantage of fast reaction with CO_2 at low partial pressure (i.e., gas streams with dilute CO_2 concentration). The primary concerns with MEA and other amine solvents are corrosion in the presence of O2 and other impurities, high solvent degradation rates due to reactions with SO2 and NOX, and the large amount of energy required for solvent regeneration. These difficulties can be overcome, and this capture method is technically feasible.

Physical absorption (e.g., Selexol®)

These post combustion absorption processes, which are commonly used for CO_2 rejection from natural gas, operate at high pressure and low temperature. Use of physical absorption for CO_2 capture from combustion exhaust gas would entail a significant amount of gas compression capacity and a significant energy penalty.

These difficulties can be overcome and this capture method is considered technically feasible for this project.

Calcium cycle separation

This is a quicklime-based capture method that yields limestone. When heated, the limestone releases CO_2, producing quicklime again for recycling. Work is still required on sorbent stability after regeneration, therefore this capture method is considered not technically feasible.

Cryogenic separation

This capture method is based on solidifying the CO_2 component of the exhaust stream by frosting it to separate it out. The low concentration of CO_2 in the exhaust gas from Energy Answers' combustion process renders this technology not feasible for this application.

Membrane separation

This method is commonly used for CO_2 removal from natural gas at high pressure and high CO_2 concentration. Membrane technology is not fully developed for low CO_2 concentrations and gas flow at the scale required for the proposed Energy Answers facility. Therefore this separation technology is considered not technically feasible.

Adsorption

This separation method involves feeding the exhaust gas through a bed of solid material with high surface areas, such as zeolites or activated carbon. These materials adsorb CO_2 while allowing nitrogen and other gases to pass through. The bed can be regenerated (desorbed) by exposure to low pressure, high temperature, or by applying a low electric voltage. Adsorption requires either a high degree of compression or multiple separation steps to produce high CO_2 concentration from exhaust gas. This capture method is presumed for the purposes of this analysis to be technically feasible.

<u>Transportation</u>

As discussed below under Storage, carbon storage is possible only in a very limited number of sites – none are nearby the site of the proposed Energy Answers facility. Accordingly, to remain a viable control technology captured CO_2 would have to be transported to a suitable storage site in order to achieve any environmental benefit. Pipelines are the most common method for transporting large quantities of CO_2 over long distances. However, despite there being approximately 3,600 miles of CO_2 pipeline in the United States, none are in or around Puerto Rico. Therefore, transporting captured CO_2 via pipeline is not technically feasible.

Natural gas and other commercial gases are routinely compressed and shipped by cargo vessel. This transportation option is technically feasible.

<u>Storage</u>

There are several options being explored and employed for permanent storage of CO_2. These options include gaseous storage in various deep geological formations (including saline formations, exhausted oil and gas fields, and unmineable coal seams), liquid storage in the ocean, and solid storage by reaction of CO_2 with metal oxides to produce stable carbonates, terrestrial sequestration and ocean storage. Not all of these possible storage options are technically feasible, as discussed below.

Geologic Formations

Geologic formations considered appropriate for CO_2 storage are layers of porous rock deep underground that are “capped” by a layer or multiple layers of non-porous rock above them. In this application pressurized CO_2 is injected into a well drilled into the porous rock below the cap which prevents upward migration and escape of the CO_2.

There are several types of geologic formations in which CO_2 can be stored, and each has different opportunities and challenges as briefly described below:

Depleted oil and gas reservoirs

In general, these formations are characterized by a layer of porous rock with a layer of non-porous rock which forms a dome. This dome offers great potential to trap CO_2 and makes these formations excellent sequestration opportunities.

As a value-added benefit, CO_2 injected into a depleting oil reservoir can enable recovery of additional oil and gas. When injected into a depleted oil bearing formation, the CO_2 dissolves in the trapped oil which reduces the oil's viscosity. This improves the ability of the oil to move through the pores in the rock and flow with a pressure differential toward a recovery well. A CO_2 flood typically enables recovery of an additional 10 to 15 percent of the original oil in place. Enhanced oil recovery (EOR) and enhanced gas recovery are commercial processes and in demand recently with high commodity prices. It is estimated that 50 to 90 billion metric tons of sequestration potential exists in mature oil and gas reservoirs in the United States. However, there are no known oil or gas reservoirs providing CO_2 sequestration opportunities within the immediate vicinity Puerto Rico, but there are oil fields in the Gulf of Mexico that provide EOR CO_2 injection opportunity. These oil fields provide a technically feasible sequestration opportunity for the proposed Energy Answers facility.

Unmineable coal seams

Unmineable coal seams are those that are too deep or too thin to be profitably mined. All coals have varying amounts of methane adsorbed onto pore surfaces, and wells can be drilled into unmineable coal beds to recover this coal bed methane ("CBM"). Initial CBM recovery methods, dewatering and depressurization leave an appreciable amount of CBM in the reservoir. Additional CBM recovery can be achieved by sweeping the coal bed with nitrogen or CO_2, which preferentially adsorbs onto the surface of the coal, releasing the methane. Two or three molecules of CO_2 are adsorbed for each molecule of methane released, thereby providing an excellent storage sink for CO_2. No available coal seams are known to exist in the vicinity of the Puerto Rico. As such, CO_2 sequestration in unmineable coal seams is considered not technically feasible for this analysis.

Saline formations

Saline formations are layers of porous rock that are saturated with brine. They are much more commonplace than coal seams or oil and gas bearing rock, and represent an enormous potential for CO_2 storage capacity. Estimates of sequestration potential in saline formations range from 3,300 to 12,000 billion metric tons. However, much less is known about saline formations than is known about crude oil reservoirs and coal seams and there is a greater amount of uncertainty associated with their ability to store CO_2. Saline formations contain minerals that could react with injected CO_2 to form solid carbonates. The carbonate reactions have the potential to be both a positive and a negative. They can increase permanence but they also may plug up the formation in the immediate vicinity of an injection well. Additional research is required to better understand these potential obstacles and how best to overcome them. Saline formations are known to exist in and around Puerto Rico, but this technology is much less developed or proven compared to EOR. As such, CO_2 sequestration in saline formations will not be considered further in this analysis based on its limited development.

Basalt formations

Basalts are geologic formations of solidified lava. Basalt formations have a unique chemical makeup that could potentially convert injected CO_2 to a solid mineral form, permanently keeping it from the atmosphere. Current research is focused on enhancing and utilizing the mineralization reactions and increasing CO_2 flow within a basalt formation. Although oil and gas-rich organic shale and basalt research is in its infancy, these formations may, in the future, prove to be optimal storage sites for sequestering CO_2 emissions. This CO_2 sequestration technique is considered not technically feasible for the Energy Answers facility due to its limited development, and it will not be considered further in this analysis.

Terrestrial Ecosystems

Terrestrial sequestration is the enhancement of CO_2 uptake by plants that grow on land and in fresh water and, importantly, the enhancement of carbon storage in soils where it may remain more permanently stored. Terrestrial sequestration provides an opportunity for low-cost CO_2 emissions offsets. Early efforts include tree-plantings, no-till farming, and forest preservation. To date, there are no applications that would be large enough to handle the CO_2 emission levels estimated for this project. Therefore, this storage technique is considered not technically feasible for this project.

Ocean storage

Another proposed form of carbon storage is in the oceans. Several concepts have been proposed:

- Dissolution – injects CO_2 by ship or pipeline into the water column at depths greater than 1000 meters where the CO_2 subsequently dissolves;

- Lake – deposits CO_2 directly onto the sea floor at depths greater than 3000 meters, where CO_2 is denser than water and is expected to form a 'lake' that would delay release of CO_2 into the environment;
- Conversion of CO_2 to bicarbonates using limestone; and
- Storing the CO_2 in solid clathrate hydrates already existing on the ocean floor, or growing more solid clathrate.

The environmental effects of ocean storage are generally negative, and poorly understood. Three key problems have been identified:

- Large concentrations of CO_2 can kill ocean organisms;
- Dissolved CO_2 would eventually equilibrate with the atmosphere, so the storage would not be permanent; and
- As CO_2 reacts with the water, it forms carbonic acid which also can kill ocean life.

Even though life appears to be sparse in deep ocean basins, energy and chemical effects in these deep basins are not fully understood. More work is needed to explore the use of these techniques before they are ready for use. Therefore, ocean storage is considered not technically feasible for this project.

3.2.2.2 Utilization of Biomass Fuel (Combusting MSW/PRF to Generate Electricity)

The second option is to use the MSW as a fuel to generate electricity. This option is technically feasible. There are many MSW electric generating sources throughout the United States, and the developer of this project has shown they can successfully permit and construct a project combusting Processed Refuse Fuel (PRF) which is a refined form of MSW. They were the developers and original operators of the SEMASS facility in Massachusetts, and recently received permitting approval for a facility in Baltimore, Maryland.

Recent EPA guidance[1] on determining BACT for reducing CO_2 emissions from bioenergy production, such as the proposed AREP, indicates that utilization of biomass fuel can have energy and economic benefits that should be taken into account when evaluating BACT alternatives. Certain biomass feedstocks may be composed of residue that would otherwise decompose in a 10-15 year time frame to yield a negligible net impact on the carbon cycle. In the case of the proposed AREP, there will be a net benefit to the carbon cycle when contrasting the current alternative of land filling the biomass which, in an anaerobic landfill, produces methane that is 21 times more potent than CO_2 in terms of Global Warming Potential. It will also provide an alternative source of electricity that has a smaller non biogenic footprint than combusting fuel oil which is the primary alternative in Puerto Rico. Utilization of biomass fuel is technically feasible for the proposed AREP.

3.2.2.3 Energy Efficiency

The third option for GHG emission reduction from the proposed Energy Answers facility is pollution prevention via optimizing energy efficiency. A highly efficient combustion process requires less fuel to generate the same amount of energy, which directly impacts the amount of GHG produced. This option is technically feasible. In fact as discussed below, EA has designed one of the most energy efficient units for combusting MSW. Energy efficiency will come from the advanced operating and maintenance procedures and from the inherent design of the system. Each of these is discussed separately below.

3.2.2.4 Operation and Maintenance

The design boiler efficiency at the proposed AREP is 74.95% with 1% margin, calculated via the ASME PTC 4.1 method. The higher the boiler efficiency, the lower the carbon dioxide emissions for a finite production of power. High efficiency is achieved by both design and operation/maintenance strategies as highlighted below:

- Design
  - Economizers - preheat water by recapturing heat in the flue gas

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[1] "Guidance for Determining Best Available Control Technology for Reducing Carbon Dioxide Emissions from Bioenergy Production," USEPA, March 2011.

- Air preheaters - preheat air recapture heat in the flue gas
- Combustor insulation – reduce thermal losses
- Condensate return – reuse condensate, reduces makeup water requirements
- Insulating jackets (surfaces over 120^0F) – reduce thermal losses

All of these help improve the efficiency of the system. The O&M procedures will address:

- **Standard operating procedures**
  A manual will be prepared of Standard Operating Procedures (SOP), which will define the expected normal operation of equipment and the action(s) taken in controlling the equipment. The SOP will list steps for (i) implementation, including precautions, limitations, setpoints, and (ii) startup, normal operation and shutdown. The SOPs have a significant impact on performance, including efficiency, reliability, and operating costs. Each of these parameters change over the life of the facility and some deterioration of the equipment is unavoidable. Deterioration results in (i) higher heat rate, carbon dioxide emissions, and operating costs, and (ii) lower reliability. The rate of deterioration can be curbed by routine inspections, good SOPs, and operations and maintenance (O&M) practices.

- **Repair and Replacement**
  Unplanned system outages will be minimized and reduced in severity through a coordinated maintenance plan consisting of scheduled shutdowns, inspections, and preventive and predictive maintenance that will be implemented based on manufacturer's recommendations, actual equipment performance, and on-line performance data analysis. Specific written maintenance procedures will be prepared and included in the Operating and Maintenance Manual for the MSW storage and processing, PRF storage and handling system, energy recovery system and the ash processing system. These procedures will be updated at least annually.

  The result as discusses in our revised GHG BACT analysis is AREP will burn less fuel than any other Waste to Energy (WTE) facility to generate each MW-hr of electricity.

3.2.2.5 Facility design

The proposed Energy Answers facility has a design heat input capacity of 1,000 million Btu per hour (mmBtu/hr) and a design energy output of 77 megawatts (MW). This establishes the facility's design heat rate as 12.99 mmBtu/MWh (megawatt-hour).

In addition, due to Energy Answers preprocessing of MSW prior to combustion, the PRF that will be combusted by this facility will have a higher heating value than the MSW combusted by many other waste to energy facilities. Based on its design capacity of 2,106 tons per day of PRF, the Energy Answers facility will consume 1.14 tons of PRF to generate one MWh of electricity.

Based on 2008 information provided by the US Department of Energy, Energy Information Agency, the electricity producing facilities that burn MSW are listed in Table 3.2.1 with their energy performance criteria.

The information provided in Table 3.2.1 shows that the proposed Energy Answers facility will use less fuel per MWh than any other of the waste to energy facilities in the United States. Therefore, on an energy efficiency basis, the proposed AREP will be one of the best performing waste to energy facility in the country. At the same time, the proposed facility will emit less GHG per MWh than comparable facilities.

Table 3.2.1: Energy Efficiency for US Waste to Energy Facilities

Plant ID Number	Source Name	Total Nameplate (MW)	2008 Generation (MWhr)	2008 Fuel (tons MSW)	2008 Heat Input (mmBtu)	2008 Heat Rate (mmBtu/MWhr)	Tons MSW/MWhr
---	**Proposed Energy Answers (Design Values)**	**77.0**	**674,520**	**768,690**	**8,760,000**	**12.99**	**1.14**
	Permitted WPB Facility	**96.2**	**788,000**	**1,095,000**	**10,950,000**	**13.896**	**1.390**
10643	Covanta Essex Company	69.8	478,096	919,976	5,785,872	12.102	1.924
51038	MacArthur Waste to Energy Facility	12.5	54,536	162,442	730,977	13.404	2.979
10090	Commerce Refuse To Energy	12.0	71,346	124,512	1,070,290	15.001	1.745
50271	New Hanover County WASTEC	10.5	24,678	95,307	376,474	15.255	3.862
54746	Wheelabrator Falls	53.3	350,553	524,035	5,449,794	15.546	1.495
50878	Wheelabrator Millbury Facility	47.6	321,045	481,756	5,010,117	15.606	1.501
10334	H Power	63.7	329,887	506,840	5,439,222	16.488	1.536
50661	Covanta Haverhill	46.0	322,060	595,328	5,476,433	17.004	1.849
54758	Wheelabrator Lisbon	14.6	115,871	189,829	1,974,226	17.038	1.638
10642	Covanta Hempstead	78.6	566,701	969,401	9,674,838	17.072	1.711
10012	Covanta Warren Energy	13.5	83,965	149,072	1,442,952	17.185	1.775
50051	Penobscot Energy Recovery	25.3	162,458	255,212	2,792,696	17.190	1.571
50662	Onondaga County Resource Recovery	39.5	219,491	348,271	3,787,726	17.257	1.587
50656	Huntington Resource Recovery Facility	28.0	189,082	331,512	3,315,025	17.532	1.753
50960	Union County Resource Recovery	45.0	302,543	550,733	5,308,505	17.546	1.820
10013	Covanta Hennepin Energy	39.5	218,546	365,021	3,835,835	17.552	1.670
50657	Montgomery County Resource Recovery	67.8	331,056	591,268	5,917,208	17.874	1.786
50071	North County Regional Resource	62.3	356,800	583,709	6,377,472	17.874	1.636
52010	Lee County Solid Waste Energy	59.0	283,680	543,257	5,070,669	17.875	1.915
50666	Pasco Cnty Solid Waste Resource Recovery	31.2	184,690	335,119	3,351,128	18.145	1.814
50858	Hillsborough County Resource Recovery	29.0	194,770	351,409	3,576,296	18.362	1.804
50658	Covanta Fairfax Energy	124.0	588,723	1,028,434	10,900,384	18.515	1.747
50887	Wheelabrator South Broward	66.0	452,196	807,046	8,393,003	18.561	1.785
4005	French Island	30.4	67,846	91,274	1,263,249	18.619	1.345
54033	Wheelabrator North Broward	67.6	458,400	825,756	8,587,610	18.734	1.801
50880	Wheelabrator Saugus	53.7	239,478	432,053	4,493,225	18.763	1.804
54625	Montenay Montgomery LP	32.1	199,800	409,215	3,761,906	18.828	2.048
50290	SEMASS Resource Recovery	98.5	590,437	1,125,283	11,131,910	18.854	1.906
50632	Covanta Stanislaus Energy	24.0	119,548	237,426	2,291,341	19.167	1.986
54945	Covanta Mid-Connecticut Energy	90.0	372,601	617,871	7,146,591	19.180	1.658

Plant ID Number	Source Name	Total Nameplate (MW)	2008 Generation (MWhr)	2008 Fuel (tons MSW)	2008 Heat Input (mmBtu)	2008 Heat Rate (mmBtu/MWhr)	Tons MSW/MWhr
10746	American Ref-Fuel of Delaware Valley	90.0	591,963	1,220,242	11,444,381	19.333	2.061
10338	Maine Energy Recovery	22.0	122,719	255,322	2,387,530	19.455	2.081
50630	Covanta Marion Inc	13.1	86,154	183,085	1,681,270	19.515	2.125
50629	Covanta Lake County Energy	15.5	84,327	168,007	1,655,882	19.636	1.992
50877	Wheelabrator North Andover	40.3	236,611	449,624	4,675,929	19.762	1.900
50215	York County Resource Recovery	36.5	224,273	447,491	4,433,917	19.770	1.995
50663	Covanta Alexandria/Arlington Energy	29.0	172,551	352,216	3,491,633	20.235	2.041
10435	Camden Resource Recovery Facility	35.0	170,596	360,177	3,457,648	20.268	2.111
50886	Wheelabrator Spokane	26.0	128,131	251,531	2,615,879	20.416	1.963
1934	Wilmarth	25.0	97,023	168,868	1,984,820	20.457	1.740
10646	American Ref-Fuel of SE CT	16.9	126,576	261,463	2,600,837	20.548	2.066
50885	Wheelabrator Gloucester LP	14.0	93,197	189,581	1,971,547	21.155	2.034
50648	Covanta Bristol Energy	16.3	99,783	193,960	2,122,019	21.266	1.944
10503	Wheelabrator Hudson Falls	14.4	82,584	171,003	1,778,357	21.534	2.071
50649	Covanta Babylon Inc	17.0	101,976	219,738	2,197,238	21.547	2.155
1926	Red Wing	23.0	99,907	177,812	2,167,596	21.696	1.780
2039	Elk River	38.8	158,529	281,465	3,474,265	21.916	1.775
50837	Southeast Resource Recovery	35.6	222,761	678,270	4,971,818	22.319	3.045
10629	Wheelabrator Baltimore Refuse	64.5	319,447	688,634	7,161,530	22.419	2.156
50225	Regional Waste Systems	13.3	72,509	161,484	1,679,350	23.161	2.227
10062	Miami Dade County Resource Recovery Fac	77.0	317,459	837,682	8,041,951	25.332	2.639
50664	Covanta Wallingford Energy	11.0	59,297	153,208	1,526,193	25.738	2.584
50859	Lancaster County Resource Recovery	35.7	218,679	542,289	6,065,122	27.735	2.480
54998	SPSA Waste To Energy Power Plant	60.0	185,399	584,249	5,439,222	29.338	3.151
50875	McKay Bay Facility	14.0	101,948	313,278	3,258,004	31.958	3.073
10344	Charleston Resource Recovery Facility	13.0	59,484	207,608	2,059,430	34.622	3.490
10033	Greater Detroit Resource Recovery	68.4	214,216	663,099	7,812,105	36.468	3.095
50472	American Ref-Fuel of Niagara	50.0	217,344	862,329	7,945,076	36.555	3.968
10118	Harrisburg Facility	24.1	52,991	222,109	2,139,752	40.380	4.191
10250	Bay Resource Management Center	13.6	11,849	122,690	1,425,247	120.284	10.354

3.2.3 STEP 3: Rank Remaining Control Technologies

The third step in the process is to rank the remaining control technologies based on their control effectiveness. Three technically feasible control technologies have been identified: Carbon Capture and Sequestration (CCS), Utilization of Biomass Fuel, and maximizing Energy Efficiency through effective design, operations and maintenance. Table 3.2.2 ranks these three remaining options. As shown, CCS will have highest reduction in GHG emissions. Combusting MSW as PRF in the proposed boilers produces less GHG on both a total mass and non biogenic CO_2e basis as compared to the next most efficient MSW facility currently permitted or in operation. Based on the information in Table 3.2.1, the French Island MSW facility burns 1.345 tons of MSW for every MWhr produced, while the proposed AREP burns 1.14 tons of PRF per MWhr produced, thus making it 15.24% more efficient on a tons per MWhr basis. As compared to the top `12% of the units proposed or in operation, it is 23.2% more efficient. As shown in Table 3.2.1 below, AREP will emit 876,469 tons of CO2 on a mass basis. French Island would emit 15.24% more CO_2, or 101,043 tons to generate the same amount of electricity. The average of the top 12% would emit 1,079,810 tons of CO_2 (23.2% more) to generate the same amount of electricity, based on this data.

Table 3.2.2: Ranking Remaining Control Technologies - Base Case 100% PRF

Ranking	Technology	Non biogenic Before Control Emissions	% Emission Reduction	Total Emissions Non Biogenic After Control	Non Biogenic Emission Reduction
		TPY		TPY	TPY
1	CCS*	291,351	90%	29,135	262,216
2	Biomass Fuel 100% PRF	291,351	67%	96,146	195,205
3**	Energy Efficiency from Design and Maintenance versus next most efficient unit**	335,753	67%	110,799	224,955
	Energy Efficiency from Design and Maintenance versus average of top 12%**	358,945	67%	118,452	240,493

1. Carbon Capture, Control and Sequestration is the most effective method for reducing non biogenic GHG emissions from MSW combustion. It is estimated that approximately 90 percent of uncontrolled GHG can be achieved using CCS.

2. Combusting PRF to generate electricity without add-on controls for GHG is the next best option since it produces the least amount of non biogenic emissions.

3. Minimizing production of GHG by maximizing energy efficiency through Operations and Maintenance while combusting PRF will also help reduce non biogenic GHG. As shown above, the design of the AREP facility will result in lower emissions of non biogenic emissions compared to the existing and permitted facilities, but good operations and maintenance is inherently part of the design of the entire project. Operating at a high efficiency level indicates that less fuel is required to generate power. Maintaining optimal efficiency at the plant has the benefit of lowering the facility's non-biogenic GHG emissions.

3.2.4 STEP 4: Energy, Environmental and Economic Impacts

3.2.4.1 CCS

While CCS is technically feasible, it is costly to implement. The costs to redesign the Energy Answers facility to accommodate any of the absorption or adsorption capture technologies will be significant. In its 2005 report on CCS[1], the IPCC estimated the costs for carbon capture at $53/ton. While these costs were for traditional fossil fuel fired power generators, this represents the only information available on costs.

In addition, according to a report by the US Department of Energy[2], the facility would have to absorb a large parasitic energy load in order to compress the captured CO_2 to the pressures needed for transportation. To raise the pressure of the CO_2 to transportation levels (around 2,000 PSI), would require approximately 2.4 MWhr or around 4 percent of the facility's capacity. Also, according to a study performed by researchers at the University of Houston[3], the costs to deliver compressed CO_2 using ships designed to transport compressed natural gas (CNG) would generate costs ranging from $15 to $65 per ton of CO_2 (i.e., $32,970,162/yr to $142,161,665/yr). According to the 2005 IPCC report, ship transportation costs would range from $10/ton to $28/ton. Averaging the mid-points of the two transportation cost ranges yields a control cost of $29.50/ton.

The IPCC special report on CCS indicates an economic benefit ranging from $10/ton to $16/ton. However, this credit does not factor in long-term monitoring and maintenance costs. Ignoring the long-term costs, the lower end $10/ton is used to reduce the overall control cost for the CCS option.

Altogether, CCS will cost this project $72.5/ton ($53 for capture, $29.5 for transportation, and $10 savings for storage). Other recent GHG BACT analysis were completed for Abengoa Bioenergy plant in Kansas and the Wolverine Clean Energy Venture in MI indicate that the total cost per ton removed would be $71/ton and $126/ton respectively. In either case, the total costs to remove GHG will be prohibitive at somewhere between $58 million and $75 million per year.

Table 3.2.3 Economic Cost of CCS

Technology	Non biogenic Before Control Emissions (TPY)	% Emission Reduction	Non Biogenic After Control	Non Biogenic Emission Reduction (TPY)	Total Emission Reduction (biogenic & non biogenic)	Cost Per ton Removed ($)	Total Cost per Year*
	TPY		TPY	TPY	TPY		
CCS*	291,351	90%	29,135	262,216	794,595	$72.5	$57,608,112

* Total cost per year for CCS is based on 90% reduction in both biogenic (67%) and non biogenic (33%) emissions since both will have to be removed because it is impossible to separate the two streams in the stack.

Total costs are based on removal of both biogenic and non biogenic emissions since it is not possible to remove just the non biogenic emissions. The cost per ton weighted only for the non biogenic CO_2 emissions equates to $219.7 per ton removed.

Additionally, in the "Guidance for determining BACT for reducing Carbon Dioxide Emissions from Bioenergy Production" published in March 2011, EPA states: "EPA recognizes that at present add-on controls for CO_2 are generally expensive technologies, largely because of the costs associated with CO_2 capture and storage. As with other electric generating facilities, these direct costs will generally make the price of electricity from bioenergy used in conjunction with add-on control technologies for CO_2 uncompetitive with electricity from plants with other GHG controls, such as bioenergy alone."

Therefore, CCS is not economically feasible for this project and is not BACT based on cost considerations.

3.2.4.2 Combusting PRF to Generate Electricity

Combusting PRF to generate electricity is a viable option from the energy, environmental and economic impact perspective.

Energy

The proposed AREP is designed to combust PRF and generate electricity. Generating electricity with PRF, which is considered a renewable energy source, helps Puerto Rico achieve its renewable energy Portfolio Standard goal. Generally, this Project is a move for Puerto Rico toward reducing its dependency on fossil fuels for generating power especially because the dominant fuel used for power generation is fuel oil.

Environmental

There are significant environmental benefits to combusting PRF to generate electricity. First it reduces the amount of MSW that goes to a landfill; facilitating the closure of existing landfills that do not meet EPA or local environmental standards. Second, it promotes recycling because the process for producing PRF and managing the ash byproduct recovers metals and a light weight aggregate substitute suitable for reuse, reducing the amount of solid waste that must be landfilled. To the extent that all of the waste cannot be reused, it will be sent to a landfill. Third, it reduces the dependency on fuel oil to generate electricity and helps Puerto Rico achieve its Renewable Energy Portfolio goals for increasing the amount of power on the island generated from renewable fuels.

Biogenic Component

On July 1, 2011, EPA published a Final Rulemaking Notice (76 FR 43490) deferring the applicability of PSD and Title V to the biogenic portion of MSW. Therefore, it is not necessary to evaluate or propose BACT for the biogenic portion of combusting MSW or PRF. However, AREP has prepared the analysis below which shows that combusting MSW or PRF to generate electricity results in a net reduction in the biogenic emissions released into the atmosphere compared to other viable alternatives, which is to landfill the MSW and burn fuel oil to generate the power that is otherwise displaced by the proposed AREP.

Depending on the amount of supplemental fuel, the biogenic component of the fuel is between 50% and 90%. When combusting 100% PRF, the base case, the emissions are an estimated 67% biogenic. These biogenic emissions are part of the net carbon cycle and will be replenished in a 10 to 15 year period. If the biogenic component is not burned to generate electricity, there will be significantly more CO_2e emissions since the only alternative would be to landfill the waste, which will results in emissions of methane (23 times more potent GHG) and CO_2.

Table 3.2.4: Revised Biogenic CO_2e Emissions Summary (tons/yr)*

Emissions Source	100% PRF	80% PRF & 20% ASR
ENERGY ANSWERS FACILITY	587,000	763,509
Transportation emissions to EA Facility	0	0
DISPLACED from existing Landfill disposal	1,319,354	1,319,354
Displaced Oil-fired power plant emissions	0	0
Transportation emissions to existing landfills	0	0
Change In Emissions	-732,354	--555,845

*The case presented in the table represents combusting 100% PRF and also 80% PRF and 20% ASR. These two conditions represent the Base Case (100% PRF) and least Biogenic Emission (80% PRF and 20% ASR) case. All other potential scenarios would be between these two cases.

Note: This table updates information in the original application and accounts for the emissions from an oil-fired power plant that would be displaced by the proposed AREP. 100% of the displaced GHG emissions are non biogenic.

The analysis in Table 3.2.4 above looks at the biogenic emissions from the two viable options for disposal of the MSW that is not recycled. The analysis uses information from the dynamic itinerary and the Material Separation Plan (both of which are already submitted as part of the PSD application) to calculate the total biogenic emissions from these two alternatives. Combusting the PRF will cause a net reduction in CO_2e biogenic emissions for both the base case (combusting PRF) and for the worst case which would be combusting 20% ASR.

Non biogenic Component

The July 1, 2011 FR Notice did not defer the PSD or Title V permitting requirements for the non biogenic portion of MSW or PRF. Therefore, the non biogenic portion is still subject to PSD review and a BACT determination. The non biogenic component of the fuel is between 16% and 55%. When combusting only PRF the non biogenic emissions are 33%. It is not feasible or practical to remove the non biogenic emissions from the exhaust stream. Although there is an increase in non biogenic CO_2e emissions, they are more than offset by the CO_2e emissions that are prevented if the MSW continued to be landfilled. Moreover, CO2e emissions that would occur from generating electricity by using fuel oil or other fossil fuel will be displaced, resulting in a net reduction in GHG emissions for the region. Although there are no direct non biogenic emissions a landfill, the analysis of the environmental benefit of combusting the non biogenic portion of PRF should take into account the reduction in emissions from the transport of the PRF from the MSW transfer stations and the emissions from the fuel oil that would have been burned to generate the electricity produced. The change in transportation emissions are based on the Dynamic itinerary and the Material Separation Plan provided as part of the PSD application.

Table 3.2.5: Revised Non Biogenic CO_2e Emissions Summary (tons/yr)

Emissions Source	100% PRF	80% PRF & 20% ASR
ENERGY ANSWERS FACILITY	315,242	461,142
Transportation emissions to EA Facility	1,187	1,187
DISPLACED from existing Landfill disposal		
Displaced Oil-fired power plant emissions	-712,679	-712,679
Transportation emissions to existing landfills	- 1,722	- 1,722
Change In Emissions	-397,972	-252,072

Note: This table updates information in the original application and includes displaced oil-fired power plant emissions which were not included in the discussion on why GHG BACT should not apply to this facility. It also includes N_2O and CH_4 emissions.

As shown in the Table 3.2.5 above, the net reduction in non biogenic CO_2e from the combusting of MSW or PRF is 397,972 tons per year for the base case and 252,072 tons per year from the worst case.

It is also important to note that, currently, Puerto Rico does not have much diversity in fuels used to generate power. Combusting PRF rather than fuel oil reduces the carbon footprint from electric generation and also reduces Puerto Rico's dependence on foreign oil. In 2010 the Puerto Rico Electric Power Authority (PREPA) reported that power production was generated from 68% petroleum, 8% carbon, 23% natural gas and 1% renewal fuel sources. The agency seeks to produce 10% of its electricity from renewable energy sources by the year 2014, clearly setting a high demand for the development of new and expanded renewable energy generation sources.

Community Outreach

Another component of the BACT analysis is public and agency acceptance of the project. As discussed in the June 3, 2011 response to the initial EPA question on the GHG analysis, a Waste to Energy facility is part of the Dynamic Itinerary developed by Puerto Rico to manage its solid waste. Additionally, the following agencies have endorsed or have no objections to the AREP.

Agencies Letters and Endorsements

1. Environmental Quality Board
2. PR Electric Power Authority
3. Solid Waste Management Authority
4. State Historic Preservation Office
5. Department of Transportation & Public Works
6. PR Industrial Development Company
7. PR Aqueduct and Sewer Authority
8. Department of Natural and Environmental Resources
9. Federal Aviation Administration
10. US Fish and Wildlife Service
11. Institute of Puerto Rican Culture
12. PR Labor Department
13. Department of Agriculture
14. PR Planning Board
15. Land Authority

Staff and Consultants representing the Energy Answers' Arecibo Resource Recovery Project have made numerous presentations starting in July 2010 and have hosted Q&A sessions at various locations throughout Arecibo. In addition, the local radio stations have aired commentaries about the project and have had weekly call-in shows when residents can ask questions and express opinions.

At each community presentation, Energy Answers technical staff introduces the project and provides a description of the technology and details of the project development in Arecibo. A video of the SEMASS Project is shown (in Spanish) for reference purposes and Q&A follows. Table 3.2.6 lists of some of these events.

Table 3.2.6: Community Outreach by Energy Answers

Date	Description	
July 12, 2010	Public Hearing at Arecibo Municipal Assembly	1
August 27, 2010	Community Meeting at Hotel Maracayo in Hatillo	2
September 9, 2010	Meeting at Arecibo Country Club with Project EPC Contractor SNC Lavelin and local business leaders	3
September 17, 2010	Presentation of Project at Catholic University (Universidad Pontificia) in Arecibo	4
October 19, 2010	Tour of SEMASS Resource Recovery Project in Massachusetts by Puerto Rico News Media (El Vocero, Periódico Pulso and El Norte)	5
October 20, 2010	Energy Answers Vice President visits residents of Arecibo	6
October 15, 2010	Community Meeting held at El Mesón de Cheo Restaurant in Arecibo	7
October 21, 2010	Presentation at Arecibo Lions Club	8
October 27, 2010	Community Meeting held at La Unión Restaurant in Arecibo	9
October 27, 2010	EIS Public Hearing at College of Engineers and Land Surveyors in Arecibo	10
November 1,2010	Presentation and meeting with the Arecibo Business Association	11
November 4, 2010	Community Meeting at the Business of Moncho Sánchez in Arecibo	12
November 5, 2010	Meeting at the Community Center in Barrio Factor #2, Arecibo	13
November 11, 2010	Presentation and meeting at the Arecibo Country Club	14
November 15, 2010	Meeting at the Community Center in Abra de San Francisco, Arecibo	15
November 17, 2010	Community meeting in Barrio Miraflores, Arecibo	16
November 30, 2010	Tour of SEMASS Resource Recovery Project in Massachusetts by members of the Arecibo Municipal Assembly	17
December 2, 2010	Meeting of neighbors at the home of Arecibo residents Sra López and Domingo García	18
December 7, 2010	Meeting at the Community Center in Barrio Bajadero, Arecibo	19
December 15, 2010	Meeting at Restaurant Lenel to discuss Host Community Agreement	20
December 16, 2010	Presentation to El Nuevo Día Editorial Board	21

Date	Description	
December 21, 2010	Presentation at Public School in Barrio Factor #5, Arecibo	22
December 21, 2010	Sponsorship of Community Day in Arecibo with Q&A by Energy Answers team	23
December, 2010	Sponsorship of Holiday lights in Arecibo Town Square with Energy Answers team at opening night for Q&A	24
December 22, 2010	Community Meeting held at El Mesón de Cheo Restaurant in Arecibo	25
December 30, 2010	Energy Answers presents trophies to Bajadero Baseball team	26
January 4, 2011	Meeting of neighbors at the home of Arecibo residents Heriberto Lopez in Barrio Sabana Hoyos	27
January 9, 2011	Community Meeting held at Lechonera Restaurant in Barrio Islote, Arecibo	28
January 11, 2011	Tour of SEMASS Resource Recovery Project in Massachusetts by Puerto Rico News Media, Arecibo Business Association Representative and Arecibo Resident	29
January 13, 2011	Meeting at the Community Center in the Housing Community of San Felipe, Arecibo	30
January 25, 2011	Arecibo Mayor Soto presents the project and related economic opportunities to approx 50 community leaders	31
February 15, 2011	Presentation of Project at EPA Sponsored Community Participation Session at Interamerican University in Arecibo	32
March 10, 2011	Meeting at the Community Center in the barrio of Garrochales, Arecibo	33
March 15, 2010	Presentation to a group of students, professors, and members of the academic community at the Arecibo Campus of the Catholic University as part of the Science Week Celebration organized by the College of Science.	34
March 18, 2011	Meeting of neighbors and presentation of project at the home of Arecibo resident Adolfo Martínez in Víctor Rojas	35
March 23, 2010	Meeting of neighbors and presentation of project at the home of Arecibo resident Sra. Hilda Reyes in Cercadillo, Arecibo	36
March 31, 2010	Meeting of neighbors and presentation of the Project at the home of Rosa Portalatín in barrio Sabana Hoyos, Arecibo	37
April 6, 2011	Meeting of neighbors and presentation of the Project at the home of Verónica González in Barrio Arrozal, Arecibo.	38
April 9, 2011	Public hearing held by the Health Commission of the House of Representatives in Arecibo's City Hall.	39
April 14, 2011	Meeting and presentation of the Project to College Students from the National University College in Arecibo	40
April 14, 2011	Meeting of neighbors and presentation of the Project at the home of Sr. Jelly Román in Sector Carreras #2, Bajadero, Arecibo	41

It should also be noted that there are economic benefits including thousands of direct, indirect and induced construction jobs and 150 new well paying full time jobs.

Therefore, considering the above evaluation, the option of generating electricity with the PRF (and supplemental fuels) is a viable and effective alternative for minimizing non-biogenic GHG that should be incorporated in the BACT determination.

Energy Efficiency

As discussed under the technical feasibility section, producing as much electricity as possible per ton of MSW reduces the energy, environmental and economic impact of the project. In doing so, the proposed AREP will be one of the most efficient for generating electrical power per ton of MSW. As discussed above, AREP will burn less tons of MSW per MWhr of electricity generated than any other waste to energy facility.

Therefore, maximizing energy efficiency is a viable option for BACT.

3.2.5 STEP 5: Select BACT

Three control options have been evaluated; combusting MSW to generate electricity, CCS and energy efficiency. CCS is economically infeasible. The other two options are technically and economically feasible. Therefore, combusting PRF to generate electricity and maximizing energy efficiency is proposed as BACT for this project. EPA has deferred the requirement to regulate the biogenic portion of GHG from PSD and Title V, and therefore, the biogenic portion of PRF is not subject to BACT.

The worst case non biogenic emissions from AREP are estimated using emission factors taken from 40 CFR 98 Subpart C Table C-1 for CO_2, and Table C-2 for CH_4 and N_2O and the fuel mix fractions identified previously. The maximum amount of non biogenic GHG emissions for all proposed fuel mixes is 458,996 tons.

Since the facility is designed to produce 6,264 million pounds of steam per year at 100% load, BACT for the non biogenic portion for solid fuels is 74 tons of CO_2 per million pounds of steam.

Localized GHG emissions are not known to cause adverse public health or environmental impacts. Rather, GHG emissions are anticipated to contribute to long-term environmental consequences on a global scale. Accordingly, EPA's Climate Change Workgroup has characterized the category of regulated GHGs as a "global pollutant." Given the global nature of impacts from GHG emissions, NAAQS are not established for GHGs in the Tailoring Rule and a dispersion modeling analysis for GHG emissions is not required. Since localized short-term health and environmental effects from GHG emissions are not recognized, Energy Answers proposes only annual GHG BACT limits for each source of GHG emissions. In addition, since the mix of fuels will vary significantly from day to day and week to week, AREP proposes that compliance be documented on a 12-month rolling average basis. Also, since it is not possible to continuously monitor the total CO_2e or the non biogenic portion of CO_2e AREP proposes that the source use the emission factors from 40 CFR 98 Subpart C to report emissions and document compliance.

3.3 Boiler Start Up and Shut Down

Currently, the only option available for starting and shutting down the boilers is the use of ultralow sulfur No. 2 fuel oil. Since it has already been shown that it is economically infeasible to implement CCS controls as BACT for the boilers, add on controls are not be viable for start up and shut down periods. Therefore, a detailed 5 step evaluation has not been completed here. However, emissions of non-biogenic GHG are minimized by implementing the O&M practices described above. These are designed to maintain a high level of operating time, minimizing the frequency for having to shutdown and startup the boilers. Due to the relatively short duration of startup and shutdown periods, Energy Answers proposes to track the amount of oil used as a means for accounting for GHG emissions during startup and shutdown periods. Using the amount of fuel oil with emission factors for GHG from fuel oil combustion, Energy Answers can calculate GHG emissions as necessary.

3.4 Firewater Pump Engine BACT ANALYSIS

3.4.1 Description of Emission Source

One 335 horsepower (Hp) (kW)) firewater pump engine will be installed at the facility to protect personnel and equipment in the event of a fire. The firewater pump engine will combust diesel fuel and meet the New Source Performance Standard (NSPS) regulation, 40 CFR Part 60, Subpart IIII, *Standards of Performance for Stationary Compression Ignition (CI) Internal Combustion Engines (ICEs)*. Diesel fuel is the only fuel available for the firewater pump and is also required for safety reasons during an emergency. The emergency engine is assumed to operate no more than 500 hours per year including maintenance checks and readiness. The emergency diesel

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Appendix C

Updated Emission Calculations

ENERGY ANSWERS ARECIBO
GHG BACT Emission Calculations
TABLE 10.1

1. GHG from ENERGY ANSWERS power generation:

Firing PRF with Supplemental Fuels:

OPERATING SCENARIO	Fuel	mmBTU/ton	GHG	kg/mmBtu (1)	kg/ton	lb/ton	MAX FUEL USE FACTOR [2]	MAX TPD Used	TPY GHG EMISSIONS 100% capacity
PRF Primary Fuel	PRF	11.4	CO2	90.7	1034	2280	1	2106	**876,119**
		11.4	CH4	0.032	0.36	0.80	1	2106	**309**
		11.4	N2O	0.0042	0.048	0.11	1	2106	**41**
	PRF							2106	**876,469**
AOS 1	TDF	26.87	CO2	85.97	2310	5,093	0.37	330	**307,151**
	(20%) [3]	26.87	CH4	0.032	0.860	1.90	0.37	330	**114.3**
PRF + TDF		26.87	N2O	0.0042	0.113	0.25	0.37	330	**15.0**
	PRF	11.4	CO2	90.7	1034	2,280	0.63	1327	**551,955**
	(80%) [3]	11.4	CH4	0.032	0.36	0.80	0.63	1327	**195**
		11.4	N2O	0.0042	0.048	0.11	0.63	1327	**26**
	PRF + TDF							1657	**859,456**
AOS 2	ASR	38.0	CO2	75	2850	6,283	0.455	287	**329,516**
	(20%) [3]	38.0	CH4	0.032	1.216	2.68	0.455	287	**140.6**
PRF + ASR		38.0	N2O	0.0042	0.160	0.35	0.455	287	**18.5**
	PRF	11.4	CO2	90.7	1034	2,280	0.545	1148	**477,485**
	(80%) [3]	11.4	CH4	0.032	0.3648	0.80	0.545	1148	**168**
		11.4	N2O	0.0042	0.04788	0.11	0.545	1148	**22**
	PRF + ASR							2010	**807,351**
AOS 3	UWW	15.38	CO2	93.8	1443	3,180	0.575	897	**520,804**
	(50%) [3]	15.38	CH4	0.032	0.49	1.09	0.575	897	**178**
PRF + UWW		15.38	N2O	0.0042	0.06	0.14	0.575	897	**23**
	PRF	11.4	CO2	90.7	1034	2,280	0.425	895	**372,351**
	(50%) [3]	11.4	CH4	0.032	0.36	0.80	0.425	895	**131**
		11.4	N2O	0.0042	0.05	0.11	0.425	895	**17**
	PRF + UWW							1792	**893,505**

Notes:

(1) Emission factors taken from 40 CFR 98 Subpart C Table C-1 for CO2, and Table C-2 for CH4 and N2O

(2) Fuel Use factor adjusts the usage rate after considering higher heat values of the fuel and its weight (density) to maintain a total energy input of 1000 mmbtu/hr (2 x 500 mmbtu/hr each boiler) and the weight based usage ratio.

(3) Represents weight-based fraction in the total fuel mix

ENERGY ANSWERS ARECIBO
GHG BACT Emission Calculations
TABLE 10.2

1. GHG from ENERGY ANSWERS power generation:

Firing PRF with Supplemental Fuels:

OPERATING SCENARIO	Fuel	TPY GHG EMISSIONS 100% capacity	GWP	TPY CO2e 100% capacity	BOGENIC FRACTION	MAX BIOGENIC TPY CO2e	NONBIOGENIC FRACTION	MAX NONBIOGENIC TPY CO2	MAX NONBIOGENIC TPY CO2e
PRF Primary Fuel	PRF	876,119	1	876,119	0.670	587,000	0.330	289,119	289,119
		309	23	7,109					7,109
		41	310	12,577					12,577
	PRF	876,469		895,805	0.655	587,000	0.345	289,119	308,805
AOS 1	TDF	307,151	1	307,151	0.2	61,430	0.8	245,721	245,721
PRF + TDF	(20%) (3)	114.3	23	2,630					2,630
		15.0	310	4,652					4,652
	PRF	551,955	1	551,955	0.670	369,810	0.330	182,145	182,145
	(80%) (3)	195	23	4,479					4,479
		26	310	7,923					7,923
	PRF + TDF	859,456		878,790	0.491	431,240	0.509	427,866	447,550
AOS 2	ASR	329,516	1	329,516	0.158	52,064	0.842	277,453	277,453
PRF + ASR	(20%) (3)	140.6	23	3,234					3,234
		18.5	310	5,720					5,720
	PRF	477,485	1	477,485	0.670	319,915	0.330	157,570	157,570
	(80%) (3)	168	23	3,875					3,875
		22	310	6,854					6,854
	PRF + ASR	807,351		826,684	0.450	371,978	0.550	435,023	454,706
AOS 3	UWW	520,804	1	520,804	0.987	514,034	0.013	6,770	6,770
PRF + UWW	(50%) (3)	178	23	4,086					4,086
		23	310	7,229					7,229
	PRF	372,351	1	372,351	0.670	249,475	0.330	122,876	122,876
	(50%) (3)	131	23	3,022					3,022
		17	310	5,345					5,345
	PRF + UWW	893,505		912,837	0.836	763,509	0.164	129,646	149,328

ENERGY ANSWERS ARECIBO
GHG BACT Emission Calculations
TABLE 11

Firing No. 2 Fuel Oil / Distillate Oil Combustion - 100% Non-biogenic GHG emissions

Emission factors taken from 40 CFR 98 Tables C-1 and C-2.

2 x 500 mmbtu/hr boilers (combusting approximately 7142 gph and 424,000 gpy) Assumes 8% operating factor for startup an

	kg/mmbtu	lb/hr	Mass ton/year	GWP	CO2e lb/hr	CO2e ton/year
CO2	73.96	162712	4,830	1	162712	4,830
Methane	0.003	6.6	0.196	23	151.8	4.51
N2O	6.00E-04	1.32	0.039	310	409.2	12.15
Total		162,720	4,830		163,273	4,847

Emission Factors taken from AP-42 Table 3.4-1 for Large Stationary Diesel Engines

670 hp Emergency Diesel Generator for 500 hours

	lb/hp-hr	lb/hr	Mass ton/year	GWP	CO2e lb/hr	CO2e ton/year
CO2	1.16	777	194	1	777.2	194
Methane	6.35E-05	0.043	0.0106	23	0.98	0.24
N2O	---	---	---	310	---	---
Total	1.16	777	194		778	195

Emission Factors taken from AP-42 Table 3.3-1 for Uncontrolled Gasoline and Diesel Industrial Engines

335 hp Diesel Fire Pump for 500 hours

	lb/hp-hr	lb/hr	Mass ton/year	GWP	CO2e lb/hr	CO2e ton/year
CO2	1.15	385.3	96	1	385.25	96
Methane	6.35E-05	0.021	0.0053	23	0.49	0.12
NO2	---	---	---	---	---	---
Total	1.15	385.3	96.3		386	96.4

Emission factors taken from 40 CFR 98 Tables C-1 and C-2.

4.5 mmbtu/hr per RSCR burner. Calculations are for both RSCR units.

	kg/mmbtu	lb/hr	Mass ton/year	GWP	CO2e ton/year
CO2	73.96	1464.4	6,414	1	6,414
Methane	0.003	0.0594	0.260	23	5.98
N2O	6.00E-04	0.01188	0.052	310	16.13
Total		1,464	6,414		6,436

Total for Fuel Oil :	**11,535**	**11,574**

ENERGY ANSWERS ARECIBO
GHG BACT Emission Calculations
TABLE 12

GHG SUMMARY - MAXIMUMS FOR PROPOSED FUEL BLENDS

Annual Steam Rate = 6,264 million lb/yr

	Mass GHG TPY	TPY AS CO2e	MAX TPY BIOGENIC CO2	MAX TPY NONBIOGENIC CO2e	Proposed BACT (Non Biogenic CO2e Emission Rate)*		Total CO2e	
BOILERS - SOLID FUELS:	893,505	912,837	763,509	454,706	74	ton/million lb steam	147	ton/million lb steam
RSCR:	6,414	6,436	0	6,436				
BOILERS - FUEL OIL:	4,830	4,847	0	4,847	163,273	lbs/hr		
EDG:	194	195	0	195	778	lbs/hr		
FWP:	96.3	96.4	0	96	386	lbs/hr		
TOTAL	905,040	924,411	763,509	466,279				

* Based on emission factors taken from 40 CFR 98 Subpart C Table C-1 for CO2, and Table C-2 for CH4 and N2O

ENERGY ANSWERS ARECIBO
GHG BACT Emission Calculations
TABLE 13

2. Displaced GHG from Equivalent Power Generation and Landfill Gas (LFG):

No. 2 Oil-fired Power Plant	7143 gph		
2 x 500 MMBTU/hr Units	62571429 gpy		(140,000 btu/gal)

No. 2 Oil Combustion:

	kg/mmbtu	lb/hr	Mass ton/year	GWP	CO2e ton/year
CO2	73.96	162712	712,679	1	712,679
Methane	0.003	6.6	28.908	23	664.88
N2O	6.00E-04	1.32	5.782	310	1,792.30
Total		162,720	712,713		715,136

Average LFG over 40 yrs:
From EPA's LandGen

	Avg Mg/yr	ton/year	GWP	CO2e ton/year	
Methane	50,410	55,567	21	1,166,906	
CO2	138,300	152,448	1	152,448	
Total		208,015		**1,319,354**	(uncontrolled)

If Methane is flared: Assumes 100% destruction

	Avg Mg/yr	ton/year	GWP	CO2e ton/year	
CO2 (from CH4 combustion)	138,628	152,809	1	152,809	
CO2	138,300	152,448	1	152,448	
Total		305,257		**305,257**	(controlled)

ENERGY ANSWERS ARECIBO
GHG BACT Emission Calculations
TABLE 14

3. Net Greenhouse Gas Impact

GHG Emissions Summary (tons/yr)

Emissions Source	NON-Biogenic CO2e	Biogenic CO2	Max Total GHG	GHG AS CO2e	Non Biogenic 100% PRF	Biogenic 100% PRF
ENERGY ANSWERS FACILITY	461,142	763,509	899,919	924,411	315,242	587,000
Transportation emissions - fuel to EA Facility	1,187	0	1,187	1,187	1,187	0
DISPLACED LANDFILL	0	1,319,354	208,015	1,319,354	0	1,319,354
Displaced Oil-fired power plant emissions	712,679	0	712,713	715,136	712,679	0
Transportation emissions to Landfill	1,722	0	1,722	1,722	1,722	0
Net Change	(252,072)	(555,845)	(21,344)	(1,110,614)	(397,972)	(732,354)

ENERGY ANSWERS ARECIBO
GHG BACT Emission Calculations
TABLE 15

RANKING REMAINING CONTROL TECHNOLOGIES (Total GHG)

Baseline is 100% PRF	CO2 - Mass
	882,883

Ranking	Technology	Before Control Emissions	% Emission Reduction	Total Emissions After Control	Emission Reduction	Cost Per ton Removed ($)	Total Cost per Year*
		TPY		TPY	TPY		
1	CCS*	882,883	90%	88,288	794,595	$72.5	$57,608,112
2	Biomass Fuel 100% PRF	882,883	67%	291,351	591,532	$0	$0
3**	Energy Efficiency from Design and Maintenance versus next most efficient unit**	1,017,434	67%	335,753	681,681	$0	$0
	Energy Efficiency from Design and Maintenance versus average of top 12%**	1,087,712	67%	358,945	728,767	$0	$0

* Total cost per year for CCS is based on 90% reduction in both biogenic(67%) and non biogenic (33%) emissions because both will have to be removed since it is impossibe to separate the two streams in the stack.

** Before control emissions for the next most eficient energy efficiency control options are projections based on the additional tons of MSW which would be needed if the MWHrs were being produced with the next most efficient unit which uses 15.24% more fuel and the average of the top 12% which use 23.2% more MSW to genrate the same MWHrs, therefore generating more GHG and CO2e

RANKING REMAINING CONTROL TECHNOLOGIES (non biogenic GHG)

Baseline is 100% PRF	CO2 - Mass
TPY	882,883

Ranking	Technology	Non biogenic Before Control Emissions	% Emission Reduction	Total Emissions Non Biogenic After Control	Non Biogenic Emission Reduction	Total Emission Reduction (biogenic & non biogenic)	Cost Per ton Removed ($)	Total Cost per Year*
		TPY		TPY	TPY	TPY		
1	CCS*	291,351	90%	29,135	262,216	794,595	$72.5	$57,608,112
2	Biomass Fuel 100% PRF	291,351	67%	96,146	195,205	NA	$0	$0
3**	Energy Efficiency from Design and Maintenance versus next most efficient unit**	335,753	67%	110,799	224,955	NA	$0	$0
	Energy Efficiency from Design and Maintenance versus average of top 12%**	358,945	67%	118,452	240,493	NA	$0	$0

* Total cost per year for CCS is based on 90% reduction in both biogenic(67%) and non biogenic (33%) emissions because both will have to be removed since it is impossibe to separate the two streams in the stack.

** Before control emissions for the next most eficient energy efficiency control options are projections based on the additional tons of MSW which would be needed if the MWHrs were being produced with the next most efficient unit which uses 15.24% more fuel and the average of the top 12% which use 23.2% more MSW to genrate the same MWHrs, therefore generating more GHG and CO2e

ENERGY ANSWERS ARECIBO
GHG BACT Emission Calculations
TABLE 16

Arecibo Renewable Energy Project PSD Permit Application Response to Comments

Plant ID Number	Source Name	Total Nameplate (MW)	2008 Generation (MWh)	2008 Fuel (tons MSW)	2008 Heat Input (mmBtu)	2008 Heat Rate (mmBtu/MWh)	Tons MSW/MWh		
---	**Proposed Energy Answers (Design Value**	**77.0**	**674,520**	**768,690**	**8,760,000**	**12.99**	**1.14**		
4005	French Island	30.4	67,846	91,274	1,263,249	18.619	1.345	15.24%	next highest
	Permitted WPB Facility	**96.2**	**788,000**	**1,095,000**	**10,950,000**	**13.896**	**1.390**	17.99%	
54746	Wheelabrator Falls	53.3	350,553	524,035	5,449,794	15.546	1.495	23.75%	
50878	Wheelabrator Millbury Facility	47.6	321,045	481,756	5,010,117	15.606	1.501	24.05%	
10334	H Power	63.7	329,887	506,840	5,439,222	16.488	1.536	25.78%	
50051	Penobscot Energy Recovery	25.3	162,458	255,212	2,792,696	17.190	1.571	27.43%	
50662	Onondaga County Resource Recovery	39.5	219,491	348,271	3,787,726	17.257	1.587	28.17%	
50071	North County Regional Resource	62.3	356,800	583,709	6,377,472	17.874	1.636	23.20%	Average of top 12%
54758	Wheelabrator Lisbon	14.6	115,871	189,829	1,974,226	17.038	1.638		
54945	Covanta Mid-Connecticut Energy	90.0	372,601	617,871	7,146,591	19.180	1.658		
10013	Covanta Hennepin Energy	39.5	218,546	365,021	3,835,835	17.552	1.670		
10642	Covanta Hempstead	78.6	566,701	969,401	9,674,838	17.072	1.711		
1934	Wilmarth	25.0	97,023	168,868	1,984,820	20.457	1.740		
10090	Commerce Refuse To Energy	12.0	71,346	124,512	1,070,290	15.001	1.745		
50658	Covanta Fairfax Energy	124.0	588,723	1,028,434	10,900,384	18.515	1.747		
50656	Huntington Resource Recovery Facility	28.0	189,082	331,512	3,315,025	17.532	1.753		
10012	Covanta Warren Energy	13.5	83,965	149,072	1,442,952	17.185	1.775		
2039	Elk River	38.8	158,529	281,465	3,474,265	21.916	1.775		
1926	Red Wing	23.0	99,907	177,812	2,167,596	21.696	1.780		
50887	Wheelabrator South Broward	66.0	452,196	807,046	8,393,003	18.561	1.785		
50657	Montgomery County Resource Recovery	67.8	331,056	591,268	5,917,208	17.874	1.786		
54033	Wheelabrator North Broward	67.6	458,400	825,756	8,587,610	18.734	1.801		
50858	Hillsborough County Resource Recovery	29.0	194,770	351,409	3,576,296	18.362	1.804		
50860	Wheelabrator Saugus	53.7	239,478	432,053	4,493,225	18.763	1.804		
50666	Pasco Cnty Solid Waste Resource Recovery	31.2	184,690	335,119	3,351,128	18.145	1.814		
50960	Union County Resource Recovery	45.0	302,543	550,733	5,308,505	17.546	1.820		
50661	Covanta Haverhill	46.0	322,060	595,328	5,476,433	17.004	1.849		
50877	Wheelabrator North Andover	40.3	236,611	449,624	4,675,929	19.762	1.900		
50290	SEMASS Resource Recovery	98.5	590,437	1,125,283	11,131,910	18.854	1.906		
52010	Lee County Solid Waste Energy	59.0	283,680	543,257	5,070,669	17.875	1.915		
10643	Covanta Essex Company	69.8	478,096	919,976	5,785,872	12.102	1.924		
50648	Covanta Bristol Energy	16.3	99,783	193,960	2,122,019	21.266	1.944		
50886	Wheelabrator Spokane	26.0	128,131	251,531	2,615,879	20.416	1.963		
50632	Covanta Stanislaus Energy	24.0	119,548	237,426	2,291,341	19.167	1.986		
50629	Covanta Lake County Energy	15.5	84,327	168,007	1,655,882	19.636	1.992		
50215	York County Resource Recovery	36.5	224,273	447,491	4,433,917	19.770	1.995		
50885	Wheelabrator Gloucester LP	14.0	93,197	189,581	1,971,547	21.155	2.034		
50663	Covanta Alexandria/Arlington Energy	29.0	172,551	352,216	3,491,633	20.235	2.041		
54625	Montenay Montgomery LP	32.1	199,800	409,215	3,761,906	18.828	2.048		
10746	American Ref-Fuel of Delaware Valley	90.0	591,963	1,220,242	11,444,381	19.333	2.061		
10646	American Ref-Fuel of SE CT	16.9	126,576	261,463	2,600,837	20.548	2.066		
10503	Wheelabrator Hudson Falls	14.4	82,584	171,003	1,778,357	21.534	2.071		
10338	Maine Energy Recovery	22.0	122,719	255,322	2,387,530	19.455	2.081		
10435	Camden Resource Recovery Facility	35.0	170,596	360,177	3,457,648	20.268	2.111		
50630	Covanta Marion Inc	13.1	86,154	183,085	1,681,270	19.515	2.125		
50649	Covanta Babylon Inc	17.0	101,976	219,738	2,197,238	21.547	2.155		
10629	Wheelabrator Baltimore Refuse	64.5	319,447	688,634	7,161,530	22.419	2.156		
50225	Regional Waste Systems	13.3	72,509	161,484	1,679,350	23.161	2.227		
50859	Lancaster County Resource Recovery	35.7	218,679	542,289	6,065,122	27.735	2.480		
50664	Covanta Wallingford Energy	11.0	59,297	153,208	1,526,193	25.738	2.584		
10062	Miami Dade County Resource Recovery Fac	77.0	317,459	837,682	8,041,951	25.332	2.639		
51038	MacArthur Waste to Energy Facility	12.5	54,536	162,442	730,977	13.404	2.979		
50837	Southeast Resource Recovery	35.6	222,761	678,270	4,971,818	22.319	3.045		
50875	McKay Bay Facility	14.0	101,948	313,278	3,258,004	31.958	3.073		
10033	Greater Detroit Resource Recovery	68.4	214,216	663,099	7,812,105	36.468	3.095		
54998	SPSA Waste To Energy Power Plant	60.0	185,399	584,249	5,439,222	29.338	3.151		
10344	Charleston Resource Recovery Facility	13.0	59,484	207,608	2,059,430	34.622	3.490		
50271	New Hanover County WASTEC	10.5	24,678	95,307	376,474	15.255	3.862		
50472	American Ref-Fuel of Niagara	50.0	217,344	862,329	7,945,076	36.555	3.968		
10118	Harrisburg Facility	24.1	52,991	222,109	2,139,752	40.380	4.191		
10250	Bay Resource Management Center	13.6	11,849	122,690	1,425,247	120.284	10.354		

EXHIBIT A

Energy Answers International, Inc.
Renewable Energy Project
Arecibo, Puerto Rico

Biogenic Fraction of PRF and Alternative Fuels

TABLE 1
Biogenic fraction of PRF and alternative fuels

	By Weight		By Heating Value	
	Biogenic	Non-Biogenic	Biogenic	Non-Biogenic
Processed Refuse Fuel[1]	67.0%	33.0%	58.2%	41.8%
Tire Derived Fuel[2]	21.5%	78.5%	21.5%	78.5%
Auto Shredder Residue[3]	15.8%	84.2%	13.4%	86.6%
Urban Wood Waste[4]	98.7%	1.3%	99.7%	0.3%

[1] Derived in Tables 2 and 3

[2] From *Using used tyres as an alternative source of fuel*, Catherine Clauzade, Research & Development Department, Aliapur, July 2009. The Aliapur study used the *ASTM D6866-10 Standard Test Methods for Determining the Biobased Content of Solid, Liquid, and Gaseous Samples Using Radiocarbon Analysis* to determine biomass fractions; this methodology has been adopted by the US EPA for its Mandatory Reporting of Greenhouse Gases (see, *Mandatory Reporting of Greenhouse Gases*, 75 Fed. Reg. 79092 [Dec. 17, 2010]). Values in the Aliapur report are given as percent by weight only, and are assumed here to be approximately valid for use as percent by heating value as well. A weighted average of auto tires (18.3% by weight biomass) and truck tires (29.1% by weight biomass) was calculated based on an assumed distribution of 70% auto and 30% truck end-of-life tires in Puerto Rico.

[3] Derived in Table 4

[4] Derived in Table 5

EXHIBIT A

Energy Answers International, Inc.
Renewable Energy Project
Arecibo, Puerto Rico

Biogenic Fraction of PRF and Alternative Fuels

TABLE 2
MSW and PRF composition (% by weight)

Component	Current MSW[1]		Projected Recycling[2]	Removal at Plant[3]	Resultant PRF
Plastics					
Type 1	0.95%				1.27%
Type 2	2.95%				3.95%
Types 3 – 7	6.60%				8.84%
Sub-Total Plastics		10.50%			
Paper/Cardboard					
High Quality Paper	1.15%				1.54%
Low Quality Paper	8.75%				11.72%
Corrugated Carton	8.45%				11.32%
Sub-Total Paper/Cardboard		18.35%			
Metals					
Ferrous Metals	9.60%			70%	3.86%
Non-Ferrous Metals	0.90%				1.21%
Sub-Total Metals		10.50%			
Yard Waste		21.25%	50%		14.23%
Organic Waste		12.85%			17.21%
Construction Debris		16.00%	50%		10.72%
Glass		2.40%			3.21%
HHW		0.50%			0.67%
Other		7.65%			10.25%
Total		100.00%			100.00%

[1] Characteristics of current post recycling MSW are based on *Final Report–Waste Characterization Study*, Autoridad de Desperdicios Sólidos, 2003

[2] Projected additional recycling levels based on current government initiatives

[3] Ferrous metals removed magnetically in the PRF production process

EXHIBIT A

Energy Answers International, Inc.
Renewable Energy Project
Arecibo, Puerto Rico

Biogenic Fraction of PRF and Alternative Fuels

TABLE 3
PRF composition and heating value by by biogenic and non-biogenic fractions

Component	PRF (% by weight)		EAI Report[1] Categories	EIA Report Heating Values (million Btu per ton)	Heat Value of PRF (million Btu per ton)	Heating Values (million Btu per ton) Biogenic	Heating Values (million Btu per ton) Non-Biogenic	% by Weight Biogenic	% by Weight Non-Biogenic
Plastics									
Type 1	1.27%		PET	20.50	0.26		0.26		1.27%
Type 2	3.95%		HDPE	38.00	1.50		1.50		3.95%
Types 3 – 7	8.84%		Avg.of 5 Plastic Categories[4]	27.90	2.47		2.47		8.84%
Sub-Total Plastics		14.06%							
Paper/Cardboard									
High Quality Paper	1.54%		Mixed Paper	6.70	0.10	0.10		1.54%	
Low Quality Paper	11.72%		Newspaper	16.00	1.88	1.88		11.72%	
Corrugated Carton	11.32%		Corrugated Cardboard	16.50	1.87	1.87		11.32%	
Sub-Total Paper/Cardboard		24.58%							
Metals									
Ferrous Metals	3.86%		Non-Combustible	0.00	0.00				3.86%
Non-Ferrous Metals	1.21%		Non-Combustible	0.00	0.00				1.21%
Sub-Total Metals		5.06%							
Yard Waste		14.23%	Yard Trimmings	6.00	0.85	0.85		14.23%	
Organic Waste		17.21%	Food	5.20	0.90	0.90		17.21%	
Construction Debris[2]									
Wood	5.22%		Wood	10.00	0.52	0.52		5.22%	
Plastics	0.83%		Avg. of All Plastic Categories[5]	28.80	0.24		0.24		0.83%
Dirt, masonry rubble, etc	4.66%		Non-Combustible	0.00					4.66%
Sub-Total Construction Debris		10.72%							
Glass		3.21%	Non-Combustible	0.00	0.00				3.21%
HHW		0.67%	NA[6]	0.00	0.00				0.67%
Other[3]									
Textiles	4.82%		Textiles	13.80	0.66	0.66		4.82%	
Rubber	2.46%		Rubber	26.90	0.66	0.13	0.53	0.49%	1.97%
Leather	0.41%		Leather	14.40	0.06	0.06		0.41%	
Misc Inorganics	2.56%		Non-Combustible	0.00	0.00				2.56%
Sub-Total Other		10.25%							
Total		100.00%			11.97	6.97	5.00	66.96%	33.04%
						58.25%	41.75%		

[1] The calculation of PRF heating values follows the methodology presented in the May 2007 report prepared by the Energy Information Administration (EIA) of the US Department of Energy entitled *Methodolgy for Allocationg Municipal Solid Waste to Biogenic and Non-Biogenic Energy.*

[2] Breakdown of Construction Debris based on distribution shown in Table 11D.2 from *Handbook of Solid Waste Management*, George Tchobanoglous and Frank Kreith, 2002, adapted to reflect materials accounted for elsewhere in the PRF composition breakdown.

[3] Breakdown of Other category based on comparing distribution of components presented in the US Environmental Protection Agency report *Municipal Solid Waste in the United States: 2009 Facts and Figures*, with those presented in *Final Report–Waste Characterization Study, Autoridad de Desperdicios Sólidos*, 2003

[4] The weighted average of the heating values for plastic categories 3 through 7 using the respective heating values from the EIA report and using annual quantities for each category from the US EPA report cited in note 3.

[5] The weighted average derived using the same approach described in note 4.

[6] No data is available for determining the heating value of Household Hazardous Waste. Since it is projected to be such a small fraction of the PRF, it is assumed to be non-biogenic with zero heating value.

EXHIBIT A

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Arecibo, Puerto Rico

Biogenic Fraction of PRF and Alternative Fuels

TABLE 4
Auto Shredder Residue (ASR) composition and heating value by by biogenic and non-biogenic fractions

Component[1]	ASR % by Weight	EAI Report[2] Categories	EIA Report Heating Values (million Btu per ton)	Heat Value of PRF (million Btu per ton)	Heating Values (million Btu per ton) Biogenic	Heating Values (million Btu per ton) Non-Biogenic	% by Weight Biogenic	% by Weight Non-Biogenic
Plastics	48.0%	Avg. of All Plastic Categories[4]	28.8	13.84		13.84		48.00%
Rubber[3]	14.0%	Rubber	26.9	3.77	0.81	2.96	2.80%	11.20%
Metals	11.0%	Non-Combustible	0.0	0.00				11.00%
Textiles	13.0%	Textiles	13.8	1.79	1.79		13.00%	
Fines (glass, dirt, etc.)	14.0%	Non-Combustible	0.0	0.00				14.00%
Total	100.0%			19.40	2.60	16.79	15.80%	84.20%
					13.42%	86.58%		

[1] Component breakdown from *LCA as Decision Tool for Sustainable Auto Shredder Residue Management*, Santini et al, Proceedings of the Third International Symposium on Energy from Biomass and Waste, November 2010.

[2] The calculation of ASR heating values follows the methodology presented in the May 2007 report prepared by the Energy Information Administration (EIA) of the US Department of Energy entitled *Methodolgy for Allocationg Municipal Solid Waste to Biogenic and Non-Biogenic Energy*.

[3] The biogenic portion of Rubber is assumed to equal the biogenic portion of Tire Derived Fuel shown in Table 1.

[4] The weighted average of the heating values for all plastic categories using the respective heating values from the EIA report and using annual quantities for each category from the US Environmental Protection Agency report *Municipal Solid Waste in the United States: 2009 Facts and Figures*.

EXHIBIT A

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Arecibo, Puerto Rico

Biogenic Fraction of PRF and Alternative Fuels

TABLE 5
Urban Wood Waste (UWW) composition and heating value by by biogenic and non-biogenic fractions

Component[1]	UWW % by Weight	EAI Report[2] Categories	EIA Report Heating Values (million Btu per ton)	Heat Value of PRF (million Btu per ton)	Heating Values (million Btu per ton) Biogenic	Heating Values (million Btu per ton) Non-Biogenic	% by Weight Biogenic	% by Weight Non-Biogenic
Wood	98.70%	Wood	10.0	9.87	9.87		98.70%	
Soil	0.60%	Non-Combustible	0.0	0.00				0.60%
Plastics	0.10%	Avg. of All Plastic Categories[3]	28.8	0.03		0.03		0.10%
Metals	0.50%	Non-Combustible	0.0	0.00				0.50%
Concrete	0.10%	Non-Combustible	0.0	0.00				0.10%
Total	100.00%			9.90	9.87	0.03	98.70%	1.30%
					99.71%	0.29%		

[1] Component breakdown from *Sources of heavy metal contamination in Swedish wood waste used for combustion* , Krook et al, Waste Management 26 (2006)

[2] The calculation of UWW heating values follows the methodology presented in the May 2007 report prepared by the Energy Information Administration (EIA) of the US Department of Energy entitled *Methodolgy for Allocationg Municipal Solid Waste to Biogenic and Non-Biogenic Energy* .

[3] The weighted average of the heating values for all plastic categories using the respective heating values from the EIA report and using annual quantities for each category from the US Environmental Protection Agency report *Municipal Solid Waste in the United States: 2009 Facts and Figures* .