CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006

CONTENTS

Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

>>
Guyana Bagasse Cogeneration Project
Version 1
April 11, 2007

A.2. Description of the project activity:

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The Guyana Bagasse Cogeneration Project consists of the addition of a more efficient co-generation plant to the ongoing Skeldon Sugar Modernization Project (SSMP) -- a modern sugar factory that will manufacture Very High Pol (VHP) raw sugar. Bagasse is a renewable fuel source, residue from sugarcane processing. (The cogeneration project is the CDM project, which is expected to receive financial payments to be made under the Clean Development Mechanism of the Kyoto Protocol.)

Under the ongoing SSMP project, the existing sugarcane area in the Berbice County will be expanded. The cane supply will come from the Skeldon Estate (expanded from 5,727 to 10,412 ha) and from holdings of private farmers (expanded from 300 to 4,465 ha) who will cultivate cane exclusively for sale to the Guyana Sugar Corporation (GUYSUCO). The Guyana Bagasse Cogeneration Project, consisting of a bagasse-powered cogeneration plant, will be added on to the new Skeldon sugar factory design to allow the simultaneous production of electrical power for internal needs and for sale of excess power to the Berbice regional grid. This cogeneration plant will use bagasse from the sugar factory during the cane crop seasons, and will be equipped with diesel generating capacity for co-firing fuel oil during off-crop periods when bagasse stocks have been exhausted. Under this project scheme, surplus electricity will be generated at an average of 10 MW of electricity delivering approximately 77 GWh per year to the regional grid on a firm power, year-round basis. (In addition to the export, 58.8 GWh per year will be produced for internal use at the sugar mill.)

The cogeneration project will not change the likelihood of the new Skeldon sugar factory being built in the first place and therefore, by itself, will not increase the area of cane that will be cultivated for the sugar factory. The project is essentially an addition to the new sugar mill that will result in increased efficiency in the use of bagasse leading to surplus production of electricity for sale to the grid.

The project will generate Greenhouse Gas Emission Reductions by displacing the use of light fuel oil in diesel engine-driven generators in the Berbice grid operated by the power utility, the Guyana Power and Light Inc. (GPL). As the utility currently has insufficient capacity, there is extensive use of self-generation by industries and households. The project thus has the potential to displace a significant amount of this unregulated and inefficient self-generation as confidence in reliable supply is progressively built over time.

The total project cost is US$ 32.2 million. The project does not involve World Bank financing.

Contribution of Project Activity to Sustainable Development

The cogeneration project will contribute to national sustainable development through the following:

Increased competitiveness: With more efficient energy generation for internal use in the new sugar factory, the cogeneration project will contribute towards increased competitiveness of the country's sugar sector in the world market. The sugar industry generates about 30% of Guyana's agricultural GDP and is the largest net earner of foreign exchange in the country; it thus plays an important role in achieving trade balance.[1]

Decreased dependency on fossil fuel: Bagasse cogeneration is important for the energy strategy of Guyana. Cogeneration is an alternative that allows postponing the installation and/or dispatch of thermal energy generation utilities. With the project assisting the country to facilitate utilization of renewable energy resources such as biomass, the country's dependence on imported petroleum products is reduced.

Creation of local employment: Guyana's sugar-based industry is a major employer of local labor. It directly employs 25,000 people or about 10 percent of the country's labor force. [2]

Sustainable clean energy: Bagasse cogeneration displacing the use of fossil fuel results in a cleaner environment and attracts global climate change benefit support. The sale of the CERs generated by the project will boost the attractiveness of bagasse cogeneration projects and will help to increase the production of clean energy in Guyana.

A.3. Project participants:

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The following are the major Project Participants:

Name of Party involved (*) ((host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Government of Guyana	Guyana Sugar Corporation (GUYSUCO)	No
	The Community Development Carbon Fund	Yes
(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required.		

Host Country: The host country is Guyana and the Designated National Authority is the Hydrometeorological Service of Guyana. The Government of Guyana ratified the Kyoto Protocol in August 5, 2003.

Project Sponsor: Guyana Sugar Corporation (GUYSUCO) is the Project Sponsor and operator of the project (with support from Booker Tate Ltd., a private company in UK). GUYSUCO is a state-owned corporation. It was created in 1976 when the Government of Guyana nationalized and merged the sugar estates operated by Booker Sugar Estates Ltd. and Jessels Holdings to form the sugar corporation. The main business of GUYSUCO is the cultivation of sugar cane and the production of sugar.

Purchasing Party: The Community Development Carbon Fund (CDCF) is purchasing the Emission Reductions (ERs) arising from the Project Activity. The CDCF is a public/private fund initiated by the World Bank in collaboration with the International Emissions Trading Association (IETA) and the United Nations Climate Change Secretariat, to provide carbon finance to small-scale projects in developing countries. The CDCF invests contributions made by governments and companies in projects designed to produce ERs fully consistent with the Kyoto Protocol, aimed at mitigating climate change. The first tranche of the CDCF has been operational since July 2003. With a capitalization of US$128.6 million, the fund was closed to further subscription as of January 15, 2005.

[1] Chapter 9, National Development Strategy (Guyana). www.sdnp.org.gy/nds/chapter9.html

[2] Ibid.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

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Guyana

A.4.1.1. Host Party(ies):

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The host country is Guyana.

A.4.1.2. Region/State/Province etc.:

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The project is located in Berbice County, Region 6.

A.4.1.3. City/Town/Community etc:

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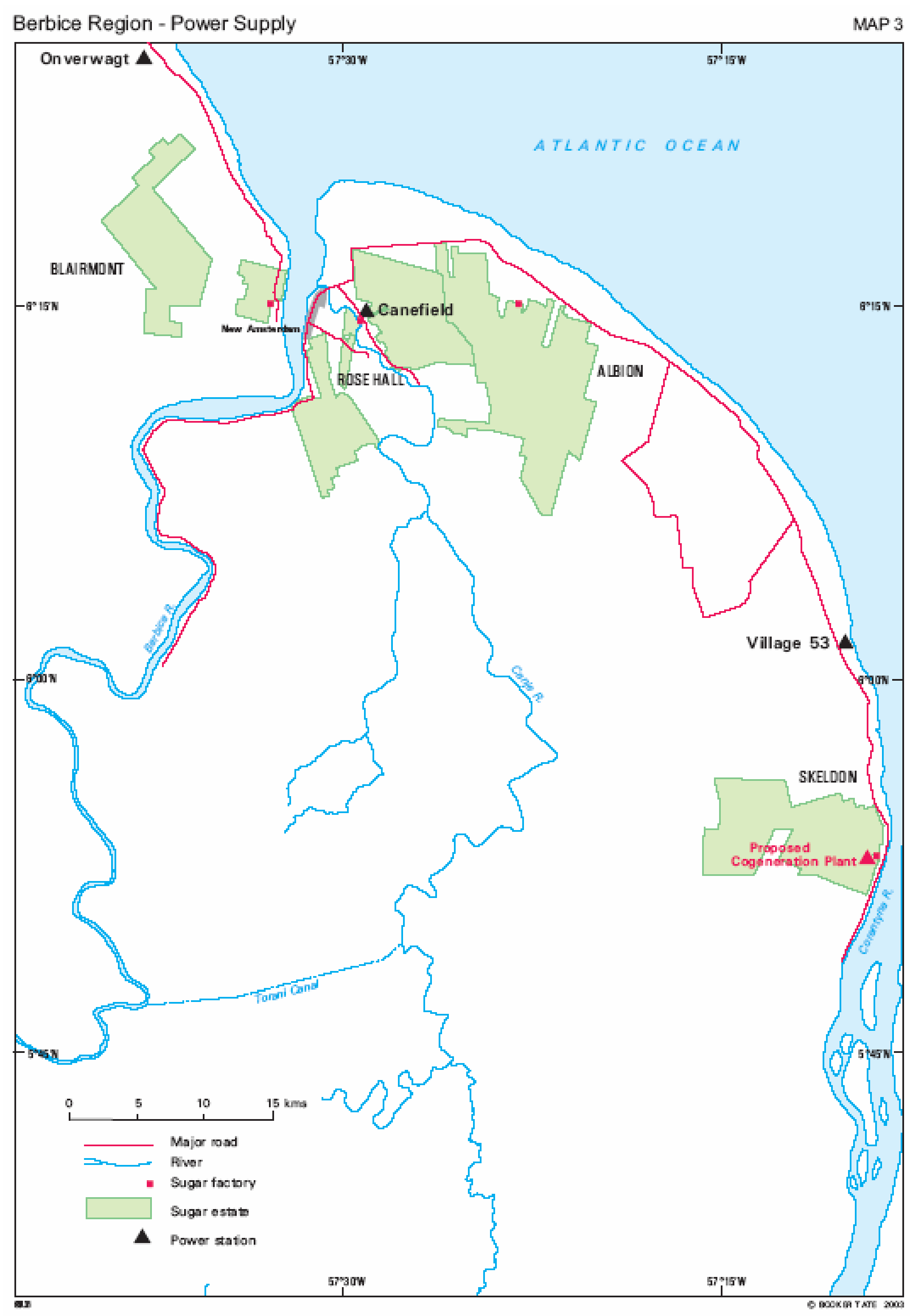
The town of Corriverton.

A.4.1.4. Detail of physical location, including information allowing the unique identification of this project activity (maximum one page):

>>The SSMP is located in the Berbice County on the Correntyne River, at the eastern coastal extremity of Guyana, bordering on Suriname in South America. The project cogeneration plant will be located adjacent to the new sugar factory. The map shown below displays the key factory sections and the power station.



A.4.2. Category(ies) of project activity:

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Sectorial Scope: 1-Energy industries (renewable -/ non-renewable sources).

A.4.3. Technology to be employed by the project activity:

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The project activity will consist of a combined heat and power (CHP) cycle to allow the simultaneous production of electrical power for on-site use in the sugar factory and for sale to the regional grid. The bagasse to be produced after the extraction of sucrose from the sugarcane will be used as fuel in the boilers to generate superheated steam and initiate the cogeneration process. The project's CHP thermal cycle will be based on the Rankine steam cycle.

The Rankine steam cycle is the predominant technology in all parts of the world today for generating megawatt (MW) levels of electricity from biomass. It consists of direct combustion of biomass in a boiler to raise steam, which is then expanded through a turbine. Most steam cycle plants are located at industrial and agro-industrial sites, where the waste heat from the steam turbine is recovered and used for meeting internal needs. Such combined CHP, or cogeneration, systems provide greater levels of energy services per unit of biomass consumed than systems that generate power only.

The project activity will employ the Rankine steam cycle as the basic technology of its cogeneration system. Steam, at 5400 kPa and 485^{0}C, will be generated in two bagasse-fired boilers, each with a maximum continuous rating of 125 t/h. The generation of electrical power will utilise two turbo-alternators: a 15 MW backpressure unit (exhausting at 250 kPa a) and a 15 MW extraction-condensing unit (exhausting at 250 kPa a and 11 kPa a), with the latter for use in the off-crop seasons when the sugar factory cannot take the exhaust steam.

The cogeneration plant will have 15 MW of bagasse-based steam turbine capacity. In addition, it will also include 10 MW of diesel generation capacity: one 2.5 MW diesel set for black-start and standby capability; and one 5MW and one 2.5 MW diesel sets to dedicate to the grid for peaking purposes and for use during off-crop periods if the bagasse supply runs out. Diesel generation for these purposes will allow the cogeneration plant to supply power to the grid on a firm, year-round basis. (See Attachment 1 in Annex 4 for details.) Of the 77 GWh of surplus power to be exported to the grid annually, about 85-90% will be generated directly from bagasse, with the balance from fuel oil during off-crop periods once bagasse stocks have been consumed.

The cogeneration plant will be connected to the GPL transmission and distribution network at Village 53 by a 69 kV overhead line. The existing GPL substation at Village 53 will be upgraded to integrate the new 69 kV supply from the plant's substation into the transmission network. From Village 53 the supply will be transmitted via an adequately rated transmission system to the load centres at New Amsterdam and Corriverton.

A.4.4 Estimated amount of emission reductions over the chosen crediting period:

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Years	Annual estimation of emission reductions in tonnes of CO_2e
2008	26,746.52
2009	44,838.84
2010	52,351.94
2011	49,606.98
2012	48,166.07
2013	46,507.07
2014	44,916.05
Total estimated reductions (tonnes of CO_2e)	313,133.5
Total number of crediting years	7 (3x)
Annual average over the crediting period of estimated reductions (tones of CO_2e)	44,733.36

A.4.5. Public funding of the project activity:

>> There is no Annex I public funding involved in the Guyana Bagasse Cogeneration project activity. The project will not make use of Official Development Assistance (ODA), nor result in the diversion of such ODA.

SECTION B. Application of a baseline and monitoring methodology

B.1. Title and reference of the approved baseline and monitoring methodology applied to the project activity:

>>The approved methodology and the version of the methodology that is used:
ACM0006/Version 04: "Consolidated methodology for grid-connected electricity generation from biomass residues"

The methodologies or tools which the approved methodology draws upon and their version:
ACM002/Version 06: "Consolidated baseline methodology for grid-connected electricity generation from renewable resources"
Version 2 of "Tool for the demonstration and assessment of additionality"

B.2 Justification of the choice of the methodology and why it is applicable to the project activity:

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This methodology is applicable to the project activity due to the fact that (i) the bagasse is largely produced and consumed in the same facility – the SSMP to which the proposed project cogeneration plant will be added to and become part of the new factory complex; (ii) bagasse, which is a by-product of sugarcane processing, is the predominant fuel to be used in the project plant, with supplemental co-firing of fuel oil; (iii) there is no increase in the bagasse production due to the project activity itself; (iv) there will be no bagasse storage for more than one year; and (v) except for transporting bagasse to the project plant, no processing of bagasse is required prior to combustion.

B.3. Description of the sources and gases included in the project boundary

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	Source	Gas	Included?	Justification/Explanation
Baseline	Grid electricity generation	CO_2	Yes	Displacement of fuel oil-based grid electricity by the bagasse-based electricity generated by the project activity
		CH_4	No	Excluded in the approved methodology ACM0006/Version 04 for simplification.
		N_2O	No	Excluded in the approved methodology for simplification.
	Uncontrolled burning or decay of surplus biomass residues	CO_2	No	Approved methodology assumed that CO_2 emissions from surplus biomass residues do not lead to changes of carbon pools in the LULUCF sector.
		CH_4	Yes	There would be surplus bagasse that would be dumped and left to decay if the project cogeneration plant is not built.
		N_2O	No	Excluded in the approved methodology for simplification.
	Heat generation	CO_2	No	$ER_{heat,y} = 0$ as specified in ACM0006/Version 04 for Scenario 3, p. 32.
		CH_4	No	
		N_2O	No	
Project Activity	On-site fossil fuel and electricity consumption due to project activity (stationary or mobile)	CO_2	Yes	Fuel oil co-fired by the project cogeneration plant; electricity consumed is generated internally therefore relevant emissions are accounted for during combustion of fuels to generate power.
		CH_4	No	Excluded for simplification. Approved methodology assumed that this emission source is very small.

		N_2O	No	Excluded for simplification. Approved methodology assumed that this emission source is very small.
	Off-site transportation of biomass residues	CO_2	Yes	Combustion of diesel fuel for transportation of bagasse to the project plant.
		CH_4	No	Excluded for simplification. Approved methodology assumed that this emission source is very small.
		N_2O	No	Excluded for simplification. Approved methodology assumed that this emission source is very small.
	Combustion of biomass residues for electricity and/or heat generation	CO_2	No	Approved methodology assumed that CO_2 emissions from surplus biomass residues do not lead to changes of carbon pools in the LULUCF sector.
		CH_4	Yes	Emissions from the use of bagasse as fuel in the project plant
		N_2O	No	Excluded for simplification. Approved methodology assumed that this emission source is small.
	Storage of biomass residues	CO_2	No	Approved methodology assumed that CO_2 emissions from surplus biomass residues do not lead to changes of carbon pools in the LULUCF sector.
		CH_4	No	Excluded for simplification. Since biomass residues are stored for not longer than one year, this emission source is assumed to be small.
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.

B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

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The baseline scenario for this project activity falls under “Scenario 3” of project type “Greenfield power projects” identified in Table 1 of the ACM0006 methodology. The project activity involves the installation of the proposed cogeneration plant in the newly established SSMP sugar factory. The power to be generated by the project activity in excess of the factory’s internal needs will be sold to the grid. The project activity will use bagasse (374,680 tonnes per year from SSMP and 50,000 tonnes per year from another GUYSUCO-owned mill) for heat and power generation.[3]

The baseline scenario for the Project is the new SSMP factory without the proposed cogeneration plant. In the absence of the project activity, the SSMP factory would have a smaller cogeneration capacity with low efficiency boiler that would be sufficient to generate energy for internal needs only (see Annex 3 for detailed illustration), as is the case of existing sugar mills in the country. (GUYSUCO’s existing factories are not connected to the grid.) As such, there would not be any surplus electricity for export to the grid, and an estimated 50,000 tonnes per year of surplus bagasse that would not be needed for heat generation would be discarded and left to decay, as has been the prevailing practice in the region.

[3] The availability of surplus bagasse from other GUYSUCO-owned sugar mills has been estimated as follows: 65,170 tons per year from Albion; 42,826 tons per year from Rose Hall; and 12,887 tons per year from Blairmont. (This information was provided by the Project Developer to the Validator.)

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality):

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Application of the Tool for the demonstration and assessment of additionality of the Guyana Bagasse Cogeneration Project

Step 1. Identification of alternatives to the project activity consistent with current laws and regulations

The objective of Step 1 is to define realistic and credible alternatives to the project activity that can be (part of) the baseline scenario through the following sub-steps:

Sub-step 1a: Define alternatives to the project activity

1. There is only one realistic and credible alternative to the project activity: i.e. the proposed cogeneration project will not be added to the new sugar factory. Since the integration of the project activity, given its scale, is the one that will allow the factory to generate surplus power for export to the grid, then without it, the displacement of fossil fuel-based power generation in the grid by bagasse-based electricity will not take place.

The project activity is not part of the baseline scenario. The baseline scenario is the SSMP sugar factory without the proposed cogeneration project. Without the project activity, the SSMP sugar factory will have a smaller steam and power cogeneration facility to satisfy its energy needs only; thus, no surplus electricity will be sold to the grid. Bagasse will be combusted in low efficiency boilers and there will be a significant surplus of bagasse that will be dumped and allowed to decay.

The project activity:

A feasibility study of the cogeneration project was undertaken and completed by Booker Tate in 2004[4], and was reviewed by the World Bank. The feasibility study analyzed four engineering designs of the project activity to determine which one would provide the highest returns:

- Scenario 1 – The Base Case and the starting point for the feasibility study; boilers fuelled on heavy fuel oil during the off-crop period when bagasse stocks are exhausted.
- Scenario 2 – The Base Case with ramped increases in power demand and cane availability.
- Scenario 3 – Interrupted power supply during the off-crop period when bagasse stocks are exhausted.
- Scenario 4 – Off- crop power provided from diesel generators when bagasse stocks are exhausted; some peaking power supply is also provided from this source.

In the Base Case scenarios (Scenario 1 & 2), GUYSUCO would be expected to meet its power export obligations to GPL by fuelling the sugar factory boilers on heavy fuel oil during the off-crop periods when bagasse stocks are exhausted. This is the main premise of the feasibility study.

Scenario 2 assumes that the cogeneration plant will not be able to supply as base load all of the 10 MW demand identified in the Berbice Interconnected System (BIS), but only a proportion of it. The balance will be supplied by GPL using diesel generation. This demand is assumed to grow at 5% per year and thus the export load in-crop would be increased yearly over time up to a maximum of 13.8 MW. The export load off-crop is restricted to a maximum of 10 MW.

Scenario 3 assumes steam and electrical generation on bagasse only. During off-crop period and once the stored

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[4] The "Skeldon Sugar Modernization Project: Cogeneration Feasibility Study Final Report," March 2004, made no reference to CDM. The study was nonetheless reviewed by the World Bank, and after this review it was recommended that the project could qualify as a CDM project. (Evidence in document "GUYSUCO Docs" given to Validator.)

bagasse has been consumed, steam generation in the boilers is based on firing heavy fuel oil. The design of the boiler plant balances the requirements of burning bagasse and fuel oil, and thus the boiler efficiency is similar for both fuels. However, the cycle efficiency in the off-crop period rarely exceeds 20 percent and is significantly lower than that of diesel engine generation. Therefore, at the national level, the generation of electricity using heavy fuel oil to fuel a steam cycle makes little sense; less imported fossil fuel would be consumed if the steam plant did not operate in the off-crop period once the bagasse was consumed. Like Scenario 2, this scenario assumes increasing export demand and cane supply.

Scenario 4 assumes steam generation on bagasse only with diesel generation during the off-crop periods. This scenario is the same as Scenario 3, except that the cogeneration plant will include additional diesel generating capacity to enable year-round firm power supply. This entails the installation of a further 5 MW of medium speed diesel generation plant which will be operated whenever either the export demand exceeds the base load supplied by bagasse firing or bagasse firing is not available at all.

The feasibility study demonstrated that Scenario 4 has the strongest financial performance and economic benefits. Its internal rate of return after taxes and interest expenses was estimated at 12.7%.

The project activity is based on Scenario 4. The cogeneration plant would have 15 MW of bagasse-based steam turbine capacity. In addition, it would include an additional 5 MW diesel generator for peaking purposes and for use during off-crop periods when supply of bagasse runs out. (Plant design in all four scenarios includes a 2.5 MW diesel capacity for black-start and standby capability and another 2.5 MW diesel set dedicated to the grid.) This would eliminate the burning of fuel oil in the mill's boilers for electricity production during the off-crop periods. It was determined that less fuel could be used to produce more electricity, if during the off-crop periods the fuel oil would be processed through diesel units rather than through boilers. For example, under Scenario 4, the heavy fuel oil requirement to meet the 10 MW firm power obligations to GPL would be about 14% lower compared to Scenario 2.

Why emissions in the baseline scenario would likely exceed emissions the project activity scenario:

The Project will be connected to the regional grid, the Berbice Interconnected System, which has only diesel generation based on light fuel oil. In the absence of the proposed project, any incremental generation capacity to be connected to the BIS grid in the coming years is likely to be generated by new diesel sets to run on fuel oil. Since the new SSMP factory without the proposed cogeneration project will not generate surplus electricity for export to the grid, the displacement of fossil-fuel based electricity by bagasse-generated power will not take place. Based on detailed analysis shown in Section B.6.3 below, the CO_2 emission factor of the baseline grid amounts to 948 tons/GWh.

In contrast, CO_2 emissions associated with bagasse-based electricity are excluded from the emissions analysis because the combustion of bagasse does not lead to changes of carbon pools in the LULUCF sector.

CO_2 emission leakage of the proposed project activity will be zero. The project activity will not entail the purchase from or sale of bagasse to a market and thus, will not affect fossil fuel consumption elsewhere. (There is currently no market for bagasse in the country.) The project activity will use bagasse generated as by-product from the new SSMP factory and surplus bagasse from another sugar mill owned by GUYSUCO. In the absence of the proposed project, this surplus bagasse which amounts to 50,000 tonnes yearly will be dumped and left to decay as the prevailing practice in the region.

Sub-step 1b: Enforcement of applicable laws and regulations

2. The energy sector laws in existence in Guyana are the following: Electricity Reform Act 1999; Hydro-Electric Power Act Ch.56:03; Public Utilities Commission Act 1999; Guyana Energy Agency Act 1997; Energy Sector

(Harmonization of Laws) Act 2002; and Environmental Protection Act 1996.[5] While the potential for the use of renewable energy sources (including biomass) is widely recognized in the country, only hydropower investments are explicitly covered in the present energy legislations. Nonetheless, Guyana has a regime of fiscal incentives for the industrial development of the country, which includes free taxation and duties of all renewable energy equipment and materials in order to attract foreign investment into the country.[6] [7]

The Government of Guyana is committed to the exploration and utilization of domestic renewable energy sources and the reduction in the country's dependence on imported petroleum products. The *System Development Plan* prepared by GPL in 2000 reflects the official government policy of utilizing Guyana's renewable energy resources such as biomass and hydropower. In a 2000 Press Release, the Prime Minister Samuel Hinds cited bagasse-cogeneration in the GUYSUCO sugar mills as a viable national option to pursue and one that could attract global climate change benefit support. In recent years, there have been a number of studies and workshops commissioned in Guyana to review the utilization of bagasse, wood wastes and rice husks for the production of electrical power[8], but none of the sugar mills, saw mills and rice mills have engaged in generating power beyond their internal requirements.

All mentioned above show that current policies and regulations in Guyana are indeed encouraging in promoting renewable power projects.[9] The proposed project is the first of its kind in the country, intended to generate surplus bagasse-based electricity for sale to the grid. Earlier projects are focused on hydropower development and, as in the case of a UNDP-funded project, on photovoltaic systems. Hydropower projects in particular are seen to be the solution to the country's long-term power needs. One of the factors that make bagasse power generation less attractive is the lack of year-round cane supplies.[10]

3. Not applicable.

4. Both the project activity and the alternative scenario are in compliance with all regulations.

Step 3. Barrier analysis

This step is used to determine whether the proposed project activity faces barriers that:

(a) Prevent the implementation of this type of proposed project activity; and
(b) Do not prevent the implementation of at least one of the alternatives.

Sub-step 3a: Identify barriers that would prevent the implementation of type of the proposed project activity

Establish that there are barriers that would prevent the implementation of the type of proposed project activity from being carried out if the proposed project activity was not registered as a CDM activity. These barriers include:

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[5] Office of the Prime Minister (Guyana), "Electricity & Energy Sectors". www.electricity.gov.gy/article.php?id=6

[6] Guyana Energy Agency, "Energy 2000". www.sovereign-publications.com/guyana.htm

[7] Based on the letter, "Import Duty and Consumption Tax Exemption for the Skeldon Sugar Modernization Project," sent by Project Manager to Chairman of GUYSUCO on August 8, 2005 it was evident that the implementation of exemption procedure was requested on May 3, 2005 and thus these incentives had no influence on the decision to invest in the cogeneration project itself. (Copy of letter was provided to Validator.)

[8] National Development Strategy (Guyana) – Chapter 7.

[9] Also in Chapter 39 of the National Development Strategy (Guyana) it was addressed that "Active encouragement of private sector participation in the energy sector, in particular in electricity generation based on both imported and indigenous resources (bagasse and hydropower being priorities for the latter) and in transmission as well." www.guyana.org/NDS/chap39.htm

[10] Chapter 7, National Development Strategy (Guyana).

Technological barriers

Technological barriers represent a very important issue for increasing bagasse cogeneration in Guyana. Despite the fact that Rankine-cycle is a well known technology, the existing cogeneration units in the country operate with relatively low efficiency and the sugar mills are mostly obsolescent. It has been argued that there is a "tricky issue about technology and economic value for such technology."[11] Thus although this technology is well developed, the economic value for its application is not for the small-scale cogeneration plants similar to those in existing mills in Guyana.

The project activity is an addition to the new modern SSMP factory. The new sugar mill is modernized and much more efficient than those which have been in operation. The project activity faces the risk of lack of technical skills needed for operating and maintaining the new plant. A bagasse-based cogeneration facility for grid supply has not been in existence in Guyana. Training will be needed in cogeneration. For example, it has been identified that boiler operators will require computer skills to operate the boilers in the new mill.[12] Existing GUYSUCO power station managers and engineering staff will be re-trained to acquire skills to operate and maintain the new plant at the high level of efficiency required for commercial success.

Specifically, the new boilers will operate on steam at 54 bar pressure and 485^{0}C temperature which is significantly higher than GUYSUCO's existing boilers which operate around 15 bar pressure and 250^{0}C. This will require a more advanced regime of water chemistry to prevent corrosion of the boiler steam and water circuit internals and a higher level of maintenance to ensure integrity of the pressurized systems. The expertise to implement and manage these systems does not exist currently in GUYSUCO and will be introduced by training of existing staff and recruitment of expertise from outside Guyana. Manager and operator training will be carried out in Guyana by trainers from outside Guyana and key managers and operators will be seconded to similar operations in other countries where they will become familiar with the new type of equipment and will then be better equipped to manage and operate the new plant in Guyana.

Furthermore, the new steam and power plant will be a stand-alone facility within the confines of the new sugar factory and will operate in the same mode as an Independent Power Producer. This is a new concept within the sugar industry in Guyana and will require energy dispatch procedures that are integrated with the grid utility's own dispatch procedures. Penalties for supply shortfall and interruption will be imposed by a Power Purchase Agreement (PPA) that will be executed between GUYSUCO and the grid utility. The terms of the PPA will require an operating philosophy that is very different to that of the existing sugar factories and in the new plant it will, for much of the year, be more important to maintain energy flow to the grid than to maintain continuous sugar production. This will require retraining of managers and operators and the writing and implementation of new standard operating procedures. This aspect of the operation will require a level of expertise that is not present currently in Guyana.

These technological barriers require a significant degree of organizational change and manpower development that will increase both the capital investment cost and the operational costs of the project. This complicates the fact that cogeneration projects are inherently capital-intensive and affects the extent to which such projects can be implemented.

Investment barriers

(i) The project activity is intended to substitute a renewable biomass fuel (bagasse) for imported liquid fossil fuels (mainly No.2 Oil and No.6 Oil) used for electricity generation in the grid. Guyana is totally dependent on liquid

[11] The significance of this technology barrier is still evident even in an industrialized country as Brazil. Cited in Moema Bagasse Cogeneration Project (MBCP), PDD. December 2005.

[12] World Bank, "Draft Aide Memoire: Community Development Carbon Fund Project Appraisal Mission – Guyana." March 14-18, 2005.

fuels for electricity generation and because the bulk of the power generation comes from relatively inexpensive No.6 Oil processed in GPL's relatively efficient diesel engine-generators, it is difficult to design a biomass power system that will produce a lower **all-in** cost per kWh. Although bagasse cogeneration projects are "no or low" fuel cost systems, they are also higher capital cost systems compared to liquid fuel burning systems.[13]

Biomass power projects are generally very front-end capital intensive, and securing long-term loans from commercial banks for implementing these projects is usually difficult. The huge capital investment requirements for large biomass projects, especially with the scale and level of technology such as of the project activity, make it even more difficult to secure the financing necessary for project implementation.

(ii) The project activity is located in a country of high-perceived financial and political risk. It is understood that foreign commercial investors would typically require at least 20-25% return on investment to assume the risks.[14] It was this expectation of a high return that proved to be one of the key constraints when the concept of a cogeneration scheme for grid supply was first proposed by GUYSUCO (and disapproved) in year 2000.[15]

Without the commercial opportunity for sales of electrical energy to GPL, and the access to inter-governmental loans on preferential terms, it would have been very difficult to implement the project. Financing of the project activity includes concessionary finance from the People's Republic of China (via the Exim Bank of China) at terms that meet borrowing criteria set by the IMF.

Barriers due to prevailing practice

The project activity is the "first of its kind" in the country: The Guyana Bagasse Cogeneration Project is the first bagasse cogeneration project in Guyana that will generate surplus electricity for supply to the grid.[16] No project activity of this type is currently operational in the country. The energy produced from Guyana's sugar mills is used solely for meeting internal needs.

Sub-step 3b: Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity)

The alternative to the project activity is the SSMP factory without the proposed cogeneration project; i.e., another cogeneration facility in a smaller scale with lower efficiency boilers and one that will generate energy for internal needs only. The identified barriers of the project activity would not prevent the implementation of this alternative since it reflects what has been the prevailing practice in the country.

Step 4. Common practice analysis

Sub-step 4a: Analyze other activities similar to the proposed project activity

No sugar factory in Guyana is interconnected to the grid. As pointed out earlier, the eight sugar mills in the country consumed bagasse as fuel to generate energy for meeting internal requirements, and no surplus electricity is produced for export to the grid. The project activity is the first of its kind in the country.

Sub-step 4b: Discuss any similar options that are occurring

This project activity type does not exist in the country. None of the eight existing sugar mills that are operating in

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[13] RAC/AED, Annex 2 – Cogeneration, August 2000. CFU files, World Bank.

[14] Guyana Sugar Corporation, Skeldon Sugar Modernization Project: Cogeneration Feasibility Study Final Report, March 2004, p. 32.

[15] Ibid.

[16] Ibid.

the country produce electricity for purposes of selling to the grid.

Step 5. Impact of CDM registration

The approval and registration of the proposed project as a CDM activity will contribute to overcoming the barriers described above. Apart from being the first of its kind in the country thus making the removal of these barriers of particular importance, the project activity will achieve the aim of anthropogenic GHG reductions. If the project is registered and approved by the Executive Board, a CER purchase contract will improve the cash flow and debt service cover ratio of the project (which is high for capital intensive projects). Since funds from CERs are in hard (foreign) currency, this will lower the foreign exchange risks associated with servicing loans from abroad. The project activity will also bring about reduction in hard currency requirements as bagasse cogeneration replaces part of grid generation based on imported oil.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

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As discussed in Section B.4 of this document, Scenario 3 in the consolidated baseline methodology ACM0006 is applicable to the project activity. The definition of the project boundary related to the baseline methodology is applied to the project activity in the following way:

- *Baseline energy grid*: the Berbice Interconnected System (BIS) of the national grid is considered as a boundary, since it is the system to which the cogeneration project will be connected and therefore will receive all the surplus bagasse-based produced electricity.

- *Bagasse cogeneration plant*: the bagasse cogeneration plant considered as boundary comprises the whole site where the cogeneration facility is located. Also located in this site are the diesel sets that will run on heavy fuel oil during the off-crop periods.

- *Means for transportation (e.g., vehicles) of bagasse to the project site*: boundary includes the trucks used in hauling bagasse from production or storage site to cogeneration facility.

The project activity follows the steps provided by the methodology taking into account as project emissions during the year (PE_y) the following: (a) CO_2 emissions from combustion of fossil fuels for off-site transportation of bagasse to the project plant (PET_y); (b) CO_2 emissions from on-site consumption of fossil fuels being co-fired in the project plant ($PEFF_y$); (c) CO_2 emissions due to on-site consumption of electricity that is attributable to the project activity ($PE_{EC,y}$); and (d) CH_4 emissions from the combustion of bagasse to produce heat and electricity ($PE_{Biomass,CH4,y}$). Equations (2), (5), (6), (6a) and (7) specified in ACM0006 are used in calculating project emissions. Equation (5) is chosen because the fuel type and the actual quantity of fuel to be consumed for transportation of biomass residues are known; equations (6) and (6a) are chosen because they apply to Scenario 3; and equation (7) is included because methane emissions from combustion of biomass residues is part of the project boundary.

(5) $PET_y = \sum_i FC_{TR,i,y} \cdot NCV_i \cdot EF_{CO2,FC,i}$ (6) $PEFF_y = \sum_i (FF_{project\ plant,i,y} + FF_{project\ site,i,y}) \cdot NCV_i \cdot EF_{CO2,FF,i}$	Where: PE_y Project emissions during the year y in tons of CO_2 PET_y CO_2 emissions during the year y due to transport of the biomass residues to the project plant in tons of CO_2 $PEFF_y$ CO_2 emissions during the year y due to fossil fuels co-fired by the project plant or other fossil fuel consumption at the project site that is attributable to the project activity in tons of CO_2 $PE_{EC,y}$ CO_2 emissions during the year y due to electricity consumption at the project site that is attributable to the

(6a) $PE_{EC,y} = EC_{PJ,y} \cdot EF_{grid,y}$ (7) $PE_{Biomass,CH4,y} = EF_{CH4,BF} \cdot \sum_k BF_{k,y} \cdot NCV_k$ (2) $PE_y = PET_y + PEFF_y + PE_{EC,y} + GWP_{CH4} \cdot PE_{Biomass,CH4,y}$	project activity in tons of CO_2 $PE_{Biomass,CH4,y}$ CH_4 emissions from the combustion of biomass residues during the year *y* in tCH4 GWP_{CH4} Global Warming Potential for methane (21 t CO_2/t CH_4) $FC_{TR,i,y}$ Fuel consumption of fuel type *i* in trucks for transportation of biomass residues during the year *y* $FF_{project\ plant,i,y}$ Quantity of fossil fuel type *i* combusted in the project plant during the year *y* $FF_{project\ site,i,y}$ Quantity of fossil fuel type *i* combusted at the project site for other purposes that are attributable to the project activity during the year *y* NCV_i Net calorific value of fossil fuel type *i* in GJ/mass or volume unit $EF_{CO2,FF,i}$ CO_2 emission factor for fossil fuel type *i* in tCO_2/GJ $EC_{PJ,y}$ On-site electricity consumption attributable to the project activity in MWh/year $EF_{grid,y}$ CO_2 emission factor for grid electricity during the year *y* in tCO_2/MWh $BF_{k,y}$ Quantity of biomass residue type *k* used as fuel in the project plant during the year *y* in tons of dry matter $EF_{CH4,BF}$ Methane emission factor for combustion of biomass residues in the project plant in tCH_4/GJ NCV_k Net calorific value of biomass residue type *k* in GJ/ton of dry matter

By dispatching renewable electricity to the grid, the project activity will displace electricity that would otherwise be produced using fossil fuel. This electricity displacement will occur at the system's margin, i.e. this CDM project activity will displace electricity that is produced by marginal sources (mainly small, high speed diesel units being rented by GPL) which have higher electricity dispatching costs and are run only for peak generation.

Equation (8) is used to calculate emission reductions due to displacement of fossil fuel-based electricity during the year ($ER_{electricity,y}$) by the project activity. The calculation procedure is as follows:

(8) $ER_{electricity,y} = EG_y \cdot EF_{electricity,y}$ Following the conditions set by ACM0006/Version 04 for scenarios including Scenario 3, the emission factor for the displacement of electricity should correspond to the grid emission factor; that is $EF_{electricity,y} = EF_{grid,y}$ $EF_{grid,y}$ shall be determined according to ACM0002/Version 06: "Consolidated baseline methodology for grid-connected electricity generation from renewable sources". ACM0006 (p.24-25) specifies the following conditions for determining $EF_{grid,y}$:	Where: $ER_{electricity,y}$ Emission reductions due to displacement of electricity during the year *y* in tons CO_2 $EF_{electricity,y}$ CO_2 emission factor for the electricity displaced due to the project activity during the year *y* in tons CO_2 /MWh $EF_{grid,y}$ CO_2 emission factor for electricity displaced in the grid during the year *y* in tons CO_2 /MWh NCV_i Net calorific value (energy content) per mass or volume unit of fuel *i* $OXID_i$ Oxidation factor of the fuel *i* (see p. 1.29, 1996

[17] According to ACM0002, "Low operating cost and must run resources typically include hydro, geothermal, wind, low-cost biomass, nuclear and solar generation. If coal is obviously used as must-run, it should also be included in this list, i.e. excluded from the set of plants." Guyana's national grid runs only on heavy fuel oil and light fuel oil. BIS uses only light fuel oil.

• If the power generation capacity of the project plant is of more than 15 MW, $EF_{grid,y}$ should be calculated as a combined margin (CM), following the guidance in the section "Baselines" in the ACM0002. • If the power generation capacity of the project plant is less than or equal to 15MW, project participants may alternatively use the average CO_2 emission factor of the electricity system, as referred to in option (d) in step 1 of the baseline determination in ACM0002. In reference to the second condition cited above, since the power generation capacity of the proposed plant is equal to 15 MW, then following ACM0002 $EF_{grid,y} = EF_{OMaverage,,y}$ which is calculated as the generation-weighted average emissions per electricity unit (tCO_2 /MWh) of all generating sources serving the BIS, including low-operating cost and must-run power plants.[17] $\boldsymbol{EF_{OM,\,average,y} = \sum_{i,j} F_{i,j,y} \,.\, COEF_{i,j} \;/\; \sum_{j} GEN_{j,y}}$ $COEF_i = NCV_i \,.\, EF_{CO2,i} \,.\, OXID_i$ Based on ACM0006 (p.27), for scenarios including Scenario 3, EG_y shall be estimated as follows: $\boldsymbol{EG_y = EG_{project\ plant,y}}$	Revised IPCC Guidelines for default values) $\boldsymbol{EF_{CO2,i}}$ CO_2 emission factor per unit of energy of the fuel *i* $\boldsymbol{EG_{project\ plant,y}}$ Net quantity of electricity generated in the project plant during the year *y* in MWh $\boldsymbol{EF_{OM\ average,y}}$ CO_2 average Operating Margin emission factor of the grid $\boldsymbol{F_{i,j,y}}$ Amount of fuel *i* consumed by relevant power source or plant *j* in year *y* $\boldsymbol{GEN_{j,y}}$ Electricity delivered to the grid by each power source or plant *j* in MWh

For scenarios including Scenario 3, ACM0006 (p.32) specifies that emission reductions or increases due to displacement of heat ($ER_{heat,y}$) is equal to zero.

$$\boldsymbol{ER_{heat,y} = 0}$$

Baseline emissions due to natural decay or uncontrolled burning of anthropogenic sources of biomass residues ($BE_{Biomass,y}$) are determined in two steps according to the procedures described in ACM0006, p. 37. Equations (22b) and (22f) are used as shown below.

Step 1: Determination of the quantity of biomass residues used as a result of the project activity ($BF_{PJ,k,y}$) In the case of Scenario 3, ACM0006 specifies that the biomass would in the absence of the project activity (a) be used for heat generation in boilers at the project site and (b) be dumped or left to decay or burnt in an uncontrolled manner without utilizing it for energy purposes. The incremental use of biomass residues as a result of the project activity is calculated as the difference between the total quantity used in the project plant and the quantity that would have been used to generate the heat in boilers. That is, **(22b)** $\boldsymbol{BF_{PJ,k,y} = BF_{k,y} - [Q_{project\ plant,y} / (\varepsilon_{boiler}\ .}$	Where: $\boldsymbol{BF_{PJ,k,y}}$ Incremental quantity of biomass residue type *k* used as a result of the project activity in the project plant during the year *y* (tons of dry matter) $\boldsymbol{BF_{k,y}}$ Quantity of biomass residue type *k* combusted in the project plant during the year *y* (tons of dry matter) $\boldsymbol{Q_{project\ plant,y}}$ Net quantity of heat generated in the cogeneration project plant from firing biomass residues during the year *y* (GJ) $\boldsymbol{\varepsilon_{boiler}}$ Energy efficiency of the boiler that would be used in the absence of the project activity

NCV_k)] Step 2: Estimation of methane emissions, consistent with the baseline scenario for the use of biomass residues, i.e. Baseline emissions are calculated by multiplying the quantity of biomass residues that would not be used in the absence of the project activity with the net calorific value and an appropriated emission factor, as follows: (22f) $BE_{biomass,y} = GWP_{CH4} \cdot \sum_k BF_{PJ,k,y} \cdot NCV_k \cdot EF_{burning,CH4,k,y}$	NCV_k Net calorific value of the biomass residue type *k* (GJ/ton of dry matter) $EF_{burning,CH4,k,y}$ Methane emission factor for uncontrolled burning of the biomass residue type *k* during the year *y* (tCH_4/GJ) GWP_{CH4} Global Warming Potential of methane valid for the commitment period (tCO_2/tCH_4) $BE_{biomass,y}$ Baseline emissions due to natural decay or burning of anthropogenic sources of biomass residues during the year *y* (tCO_2/yr)

Based on option L1 specified in ACM0006 (p.42), it is argued here that the bagasse to be used in the project plant will not increase fossil fuel consumption elsewhere and, therefore, the project activity will have zero leakage emissions.

The project activity will use only bagasse produced as by-product from the new SSMP sugar factory and surplus bagasse, which would otherwise be disposed to decay, from another sugar mill owned by GUYSUCO. The project activity will not involve the purchase from or sell of bagasse to a market; let alone the fact that no market for bagasse currently exists in Guyana. All excess bagasse is dumped to decay or burnt in open heaps. Thus presently it is clear that the project activity will not result in increased fossil fuel consumption elsewhere. (Nonetheless, monitoring may be carried out to ensure that no market for bagasse to be generated from the new factory will emerge in the area.) For these reasons, the project activity will have zero leakage emissions (L_y).

$L_y = 0$

Based on Equation (1) emission reductions for the project activity (ER_y) will be calculated as follows:

(1) $ER_y = ER_{heat,y} + ER_{electricity,y} + BE_{Biomass,y} - PE_y - L_y$	Where: ER_y Emission reductions of the project activity during the year *y* in tons of CO_2 $ER_{heat,y}$ Emission reductions due to displacement of heat during the year *y* in tons of CO_2 $ER_{electricity,y}$ Emission reductions due to displacement of electricity during the year *y* in tons of CO_2 $BE_{Biomass,y}$ Baseline emissions due to natural decay or burning of anthropogenic sources of biomass residues during the year *y* in tons of CO_2 equivalents PE_y Project emissions during the year *y* in tons of CO_2 L_y Leakage emissions during the year *y* in tons of CO_2 $ER_{heat,y}$ and L_y are both equal to zero.

B.6.2. Data and parameters that are available at validation:

(Copy this table for each data and parameter)

Data / Parameter:	**GWP_{CH4}**
Data unit:	$t CO_2/t CH_4$
Description:	Global Warming Potential of methane
Source of data used:	IPCC default value
Value applied:	21 $t CO_2/t CH_4$
Justification of the choice of data or description of measurement methods and procedures actually applied :	IPCC default value
Any comment:	

B.6.3 Ex-ante calculation of emission reductions:

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Project emissions are estimated as follows:

a) Carbon dioxide emissions from combustion of fossil fuels for transportation of biomass residues to the project plant (PET_y)

Using Option 2, ACM0006, emissions are calculated based on the actual quantity of diesel fuel consumed for transportation of bagasse: each year, 50,000 tons surplus bagasse would be moved from another GUYSUCO-owned sugar mill to the project plant.

$$PET_y = \sum_i FC_{TR,i,y} \cdot NCV_i \cdot EF_{CO2,FC,i}$$

= 282,088.82 liters diesel/yr * 36.4 MJ/liter diesel * 0.0741 $t CO_2/GJ$

= **760.86 $t CO_2/yr$**

b) Carbon dioxide emissions from on-site consumption of fossil fuels ($PEFF_y$)

$$PEFF_y = \sum_i (FF_{project\ plant,i,y} + FF_{project\ site,i,y}) \cdot NCV_i \cdot EF_{CO2,FF,i}$$

= [(5,444,460 liters HFO/yr * 40.5 MJ/liter HFO * 77.4 tCO_2/TJ) +

(111,111 liters LFO/yr * 38.68 MJ/liter LFO * 74.1 tCO_2/TJ)]

= **17,385.21 tCO_2/yr**

c) CO_2 emissions during the year y due to electricity consumption at the project site that is attributable to the project activity ($PE_{EC,y}$)

$$PE_{EC,y} = EC_{PJ,y} \cdot EF_{grid,y}$$

= **0 tCO_2/yr**

Because electricity consumed at the project site, including the sugar mill and power plant, is power generated internally by the project plant, $PE_{EC,y}$ is equal to zero. Relevant emissions are already taken into account in the estimation of project emissions associated with the combustion of bagasse and coal in the generation of energy.

d) Methane emissions from combustion of biomass residues ($PE_{Biomass,CH4,y}$)

$$PE_{Biomass,CH4,y} = EF_{CH4,BF} \cdot \sum_k BF_{k,y} \cdot NCV_k$$

$= 41.1 \text{ kg } CH_4/TJ \ * \ [(347,822.85 \text{ tons bagasse} \ * \ 7.038 \text{ GJ/ton}) \ +$

$(55,000 \text{ tons bagasse} \ * \ 6.728 \text{ GJ/ton})] \ * \ 1/1000.$

= **115.82 t CH_4/yr**

The project emissions are therefore:

$$PE_y = PET_y + PEFF_y + PE_{EC,y} + GWP_{CH4} \cdot PE_{Biomass,CH4,y}$$

$= (760.86 + 17,385.21) \text{ t } CO_2/yr + 21 \text{ t } CO_2/t\ CH_4 \ * \ 115.82 \text{ t } CH_4/yr$

= **20,578.29 tCO_2/yr**

Baseline emissions are estimated as follows:

The baseline methodology considers the (a) emission reductions due to displacement of fossil fuel-based grid electricity by the bagasse-based electricity generated by the project activity and (b) determination of the emissions due to natural decay or uncontrolled burning of anthropogenic sources of biomass, as the core data to be determined in the baseline scenario.

The Guyana electricity system is divided into two regional systems: the Demerara Interconnected System (DIS) and the Berbice Interconnected System (BIS). Although DIS and BIS are linked, the energy flow between them is severely constrained by poor transmission lines capacity and does not account for any significant amount of each regional system's electricity demand. The project activity will be connected to the BIS and therefore is the relevant one for this project.

The method that is chosen to calculate the Operating Margin (OM) for the electricity baseline emission factor is the Option (d) *Average OM* in ACM0002 since the power generation capacity of the project plant is equal to 15MW. $EF_{OM,averge,y}$ is the same as the *Simple OM* method ($EF_{OM,y}$) in the case of the BIS because the system does not include any low-cost or must-run resources as defined in ACM0002. The BIS grid runs only on light fuel oil (LFO).

Average OM Emission Factor Calculation

According to the methodology, the project is to determine the Average OM Emission Factor ($EF_{OM,average,y}$). Therefore, the following equations are to be solved:

$$EF_{OM,\ average,y} = \sum_{i,j} F_{i,j,y} \cdot COEF_{i,j} \ / \ \sum_j GEN_{j,y}$$

$$COEF_i = NCV_i \cdot EF_{CO2,i} \cdot OXID_i$$

= 38.68 MJ/liter LFO * 20.2 tC/TJ * 0.99

= 0.0007735 tC/liter LFO

The Average OM emission factor is calculated using a 3-year average based on the most recent statistics available at the time of writing this PDD. The table below presents the data used in the calculation.

BIS Power Station	LFO Consumption (kWh/liter)				Electricity Generated (MWh)			
	Year 2003	2004	2005	3-year Average	2003	2004	2005	3-year Average
Onverwag t	3.6	3.6	3.6	3.60	18,299	20,686	24,331	21,105.33
Canefield	3.8	3.7	3.6	3.70	46,452	50,132	46,425	47,669.67
Village 53	3.9	3.9	3.7	3.83	10,505	13,418	12,842	12,255.00

Source: GPL

The table below shows the estimated average consumption of LFO in liters and quantity of electricity delivered to the grid. GPL's technical and transmission losses amount to about 19% of energy generated.

BIS Power Station	LFO Consumption (liters)	Electricity Delivered (MWh)
Onverwagt	5,862,592.5	17,095.32
Canefield	12,883,694.0	38,612.43
Village 53	3,199,738.9	9,926.55
Total	21,946,025.4	65,634.30

Therefore,

$EF_{OM,average,y}$ = [(21,946,025.4 liters LFO * 0.0007735 tC/liter LFO * 44/12 t CO_2/tC)

/ 65,634.30 MWh]

= 0.9483 t CO_2/MWh

Emission Reductions due to Displacement of Electricity ($ER_{electricity,y}$)

Baseline emissions due to displacement of fossil fuel-based grid electricity are calculated by multiplying the electricity baseline emission factor ($EF_{OM,average,y}$) by the amount of bagasse-based electricity generated by the project activity that is exported to the grid.

$ER_{electricity,y} = EG_y \cdot EF_{OM,average,y}$

= 67,449.86 MWh/yr * 0.9483 t $C0_2$/MWh

= **<u>63,962.70 tCO_2/yr</u>**

Baseline Emissions due to Natural Decay or Uncontrolled Burning of Anthropogenic Sources of Biomass ($BE_{Biomass,y}$)

$BE_{Biomass,y}$ is determined in the following two steps:

Step 1: In the case of Scenario 3 (ACM0006, p. 37), the incremental quantity of biomass residues used as a result of the project activity ($BF_{PJ,k,y}$) is determined according to Equation (22b), i.e.

$$BF_{PJ,k,y} = BF_{k,y} - [Q_{project\ plant,y} / (\varepsilon_{boiler} \cdot NCV_k)]$$

$= 402{,}822.85\ t_{bagasse}/yr - [1{,}823{,}986\ GJ\ /\ (0.7 * 7.038\ GJ/t_{bagasse})]$

$= 32{,}590.65\ t_{bagasse}/yr$

Step 2: Baseline emissions from the emission of methane due to uncontrolled burning or aerobic decay of the biomass residues (ACM0006, p. 39) are determined according to Equation (22f). The value of 0.001971 $tCH_4/t_{bagasse}$ is based on the default value of 0.0027 $tCH_4/t_{biomass}$ for the **product** of NCV_k and $EF_{burning,CH4,k,y}$, adjusted using a conservativeness factor of 0.73 (ACM0006, p.40).

$$BE_{biomass,y} = GWP_{CH4} \cdot \sum_k BF_{PJ,k,y} \cdot NCV_k \cdot EF_{burning,\ CH4,k,y}$$

$= 21\ tCO_2/tCH_4 * 32{,}590.65\ t_{bagasse}/yr * 0.001971\ tCH_4/t_{bagasse}$

$=$ **<u>1,348.96 tCO_2/yr</u>**

<u>Leakage emissions are zero:</u>

$$L_y = 0$$

The emission reductions on average of this project activity are:

$$ER_y = ER_{electricity,y} + BE_{Biomass,y} - PE_y - L_y$$

$= (63{,}962.70 + 1{,}348.96 - 20{,}578.29)\ t\ CO_2/yr$

$=$ **<u>44,733.37 t CO_2/yr</u>**

B.6.4 Summary of the ex-ante estimation of emission reductions:

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Year	Estimation of project activity emissions (tonnes of CO_2e)	Estimation of baseline emissions (tonnes of CO_2 e)	Estimation of leakage (tonnes of CO_2e)	Estimation of overall emission reductions (tonnes of CO_2 e)
2008	16,562.81	43,309.33	0	26,746.52
2009	15,874.60	60,713.45	0	44,838.84
2010	16,515.99	68,867.93	0	52,351.94
2011	20,549.69	70,156.67	0	49,606.98
2012	22,599.41	70,765.48	0	48,166.07
2013	24,899.46	71,406.53	0	46,507.07
2014	27,046.18	71,962.23	0	44,916.05
Total (t CO_2e)	144,048.15	457,181.62	0	313,133.50

B.7 Application of the monitoring methodology and description of the monitoring plan:

B.7.1 Data and parameters monitored:	
(Copy this table for each data and parameter)	
Data / Parameter:	**$BF_{i,y}$**
Data unit:	Tons of dry matter/yr (i.e., at 50% moisture content)
Description:	Quantity of bagasse combusted in the project plant during the year *y*
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Average of 402,822.85 tonnes bagasse/yr, of which 55,000 tonnes to be recovered from storage and used during off-crop periods. Yearly data: 307,720 tonnes bagasse in 2008; 388,640 in 2009; 424,680 from 2010 onwards.
Description of measurement methods and procedures to be applied:	Actual amount of bagasse combusted will be measured on a weekly basis and will be recorded continuously.
QA/QC procedures to be applied:	A system will be established to monitor the amount of bagasse combusted in the project site by measuring the quantity combusted on a weekly basis. Such on-site measurements will be crosschecked with an annual energy balance based on bagasse in-flows (from the SSMP and another GUYSUCO-owned sugar mill) and stock changes. Uncertainty level of data: Low.
Any comment:	100% of data will be monitored.

Data / Parameter:	**Moisture content of the biomass residues**
Data unit:	% water content
Description:	Moisture content of bagasse used as fuel in the project plant
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Bagasse with 50% moisture content is considered as dry matter.
Description of measurement methods and procedures to be applied:	On-site measurements will be done routinely.
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	**$EF_{CH4,BF}$**
Data unit:	$kgCH_4/TJ$
Description:	Methane emission factor for combustion of bagasse in the project plant
Source of data to be	2006 IPCC Guidelines, Volume 2, Chapter 2, Tables 2.2 to 2.6 (cited in

used:	ACM0006, p. 23).
Value of data applied for the purpose of calculating expected emission reductions in section B.5	41.1 kgCH_4/TJ
Description of measurement methods and procedures to be applied:	The value shown here is the IPCC default CH_4 emission factor for 'Other solid biomass residues' of 30 kg/TJ, adjusted for 300% assumed uncertainty by using a conservativeness factor of 1.37 (from Table 3, p.23 of the approved ACM0006).
QA/QC procedures to be applied:	Measurements may be conducted in the plant site or use IPCC default values, to be adjusted according to the conservativeness factors shown in Table 3 of ACM0006.
Any comment:	Monitoring of this parameter for project emissions should be done since methane emissions from bagasse combustion is included in the project boundary.

Data / Parameter:	**$FC_{TR,i,y}$**
Data unit:	Liters/yr
Description:	Consumption of diesel fuel to be used for transportation of bagasse during the year *y*
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	62,000 imperial gallon diesel/yr; converted to 282,088.82 liters diesel.
Description of measurement methods and procedures to be applied:	Actual consumption of diesel fuel will be measured and recorded.
QA/QC procedures to be applied:	On-site measurements to be based on fuel purchase receipts or fuel consumption meters in trucks
Any comment:	Bagasse will come from only two sources, thus the distance to be traveled is fixed. Uncertainty level of data: low.

Data / Parameter:	**$EF_{CO2,FC,i}$**
Data unit:	tCO_2/GJ
Description:	CO_2 emission factor for fossil fuel i consumed in trucks
Source of data to be used:	Table 1.4, 2006 IPCC Guidelines, p.1.23
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.0741 tCO_2/GJ
Description of measurement methods and procedures to be applied:	Use local or national data if available; otherwise to use IPCC default values.
QA/QC procedures to be applied:	Appropriateness of data will be checked annually.
Any comment:	

Data / Parameter:	$EF_{CO2,FF,i}$
Data unit:	tCO_2/TJ
Description:	CO_2 emission factors for heavy fuel oil (HFO) and light fuel oil (LFO) combusted in project plant and/or project site
Source of data to be used:	Table 1.4, 2006 IPCC Guidelines, p.1.23
Value of data applied for the purpose of calculating expected emission reductions in section B.5	77.4 tCO_2/TJ for HFO; 74.1 tCO_2/TJ for LFO.
Description of measurement methods and procedures to be applied:	Use local or national data if available; otherwise to use IPCC default values.
QA/QC procedures to be applied:	Appropriateness of data will be checked annually.
Any comment:	

Data / Parameter:	$FF_{project\ plant,i,y}$
Data unit:	m^3/yr
Description:	On-site consumption of heavy and light fuel oil for co-firing in the project plant
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	HFO: average of 5,444.46 m^3/yr (2008-2014) LFO: average of 111.11 m^3/yr (2008-2014) Yearly data: 4,457 m^3 in 2008; 4,080 in 2009; 4,215 in 2010; 5,504 in 2011; 6,159 in 2012; 6,894 in 2013; 7,580 in 2014; 8,222 in 2015; 8,824 in 2016; 9,390 in 2017. About 98% is HFO and 2% is LFO.
Description of measurement methods and procedures to be applied:	Actual consumption will be measured and recorded.
QA/QC procedures to be applied:	Flow meters to measure on-site fuel oil consumption for the operation of the project plant will be subject to a regular maintenance regime to ensure accuracy. Fuel purchase receipts may also be used to check consistency. Uncertainty level of data: Low.
Any comment:	

Data / Parameter:	$EG_{project\ plant,y}$
Data unit:	MWh/yr
Description:	Net quantity of (bagasse-based) electricity generated in the project plant during the year *y* exported to the grid
Source of data to be used:	On-site measurements and electricity sales receipts
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Average is 67,449.86 MWh/yr (2008-2014) Yearly power export from bagasse: 48,399 MWh in 2008; 63,220 in 2009; 70,246 in 2010; 71,605 in 2011; 72,247 in 2012; 72,923 in 2013; 73,509 in 2014; 74,014 in 2015; 74,445 in 2016; and 74,811 in 2017.

Description of measurement methods and procedures to be applied:	Readings of the energy metering connected to the grid will be done regularly and will be supported with Receipt of Sales.
QA/QC procedures to be applied:	Meters will be subject to a regular maintenance regime to ensure accuracy. Sales record and other records will be used to check consistency.
Any comment:	100% of data will be monitored.

Data / Parameter:	$\mathbf{Q_{project\ plant,y}}$
Data unit:	GJ
Description:	Net quantity of heat generated from firing bagasse in the project plant
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	1,823,986 GJ (This value is used in order to estimate correctly the incremental use of biomass residues based on Equation 22b in p. 37 of the approved methodology. For source of this value, see Annex 4.)
Description of measurement methods and procedures to be applied:	See Annex 4.
QA/QC procedures to be applied:	Consistency of metered net heat generation will be assessed annually based on sales receipts (if applicable) and quantity of fuels used.
Any comment:	100% of data will be monitored. (Please verify the use of $\mathbf{Q_{project\ plant,y}}$ in Equation 22b; an error is indicated in its definition in p.38 of ACM0006/Version 04.)

Data / Parameter:	$\mathbf{NCV_k}$
Data unit:	kJ/kg
Description:	Net calorific value of bagasse (@ 50% moisture content)
Source of data to be used:	Provided by the Project Developer; calculated using the current formula of the Sugar Milling Research Institute of South Africa.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	7,038 kJ/kg bagasse used during crop periods; 6,728 kJ/kg bagasse recovered from storage and used during off-crop periods
Description of measurement methods and procedures to be applied:	Based on the current formula of the Sugar Milling Research Institute of South Africa.
QA/QC procedures to be applied:	Local data available; shall be calculated by the current formula of the Sugar Milling Research Institute of South Africa. Consistency of local data will be checked with default values by the IPCC. Uncertainty level of data: Low.
Any comment:	

Data / Parameter:	$\mathbf{NCV_i}$
Data unit:	MJ/liter
Description:	Energy content of heavy fuel oil (HFO) and light fuel oil (LFO); petro-diesel

Source of data to be used:	**Source** (energy content of HFO & LFO): Various studies. Examples are: a. Dyer, J.A. and R.L. Desjardins, "The Impact of Farm Machinery Management on the Greenhouse Gas Emissions from Canadian Agriculture", *Journal of Sustainable Agriculture*, Vol. 22(3), 2003, The Haworth Press, Inc. b. Krajnc, Damjan and Peter Glavic, "Indicators of Sustainable Production", Journal of Clean Technologies and Environmental Policy, Vol. 5(3-4), October 2003, Springer Berlin/Heidelberg. c. www.ghgregistries.ca/registry/out/C0442-COMBINED-PDF.PDF For heating value of petro-diesel: Bioenergy Feedstock Development Programs, ORNL, TN USA
Value of data applied for the purpose of calculating expected emission reductions in section B.5	38.68 MJ/liter for LFO; 40.5 MJ/liter for HFO; 36.4 MJ/liter petro-diesel
Description of measurement methods and procedures to be applied:	For LFO, the value shown above is the energy content for No. 2 Oil; for HFO, it is the energy content of No. 6 Oil.
QA/QC procedures to be applied:	Appropriateness of data will be reviewed every year.
Any comment:	

Data / Parameter:	$\mathbf{EF_{burning,CH4,k,y}}$
Data unit:	tCH_4/GJ
Description:	Methane emission factor for uncontrolled burning of bagasse during the year
Source of data to be used:	2006 IPCC Guidelines, Volume 4, Table 2.5, default value for agricultural residues (cited in ACM0006, p.40).
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.001971 $tCH_4/t_{bagasse}$
Description of measurement methods and procedures to be applied:	In the absence of more accurate information, ACM0006 (p. 40) recommends to use 0.0027 $tCH_4/t_{biomass}$ as default value for the **product** of NCV_k and $EF_{burning,CH4,k,y}$. The value shown here is based on 0.0027 $tCH_4/t_{biomass}$, adjusted for greater than 100% estimated uncertainty by using a conservativeness factor of 0.73 (from Table 5, p.40).
QA/QC procedures to be applied:	Measurements may be conducted in the plant site or use IPCC default values, to be adjusted according to the conservativeness factors shown in Table 5 of ACM0006.
Any comment:	Monitoring of this parameter for project emissions should be done since methane emissions from bagasse combustion is included in the project boundary.

Data / Parameter:	$\mathbf{\varepsilon_{boiler}}$
Data unit:	-
Description:	Average net energy efficiency of heat generation in the boiler that would generate heat in the absence of the project activity
Source of data to be used:	Provided by project developer
Value of data applied	0.70

for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Manufacturer's information on the efficiency
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	$\mathbf{EF_{grid,y}}$ (which is equal to $\mathbf{EF_{OM\ average,y}}$)
Data unit:	t CO_2/MWh
Description:	CO_2 average Operating Margin emission factor of the grid
Source of data to be used:	Factor calculated based on data from GPL (the power utility in Guyana) provided by the Project Developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	The Average OM emission factor is calculated using a 3-year average based on the most recent statistics (i.e., the years 2003 to 2005) available at the time of writing this PDD. $EF_{OM\ average,y}$ = 0.9483 tCO_2/MWh
Description of measurement methods and procedures to be applied:	The Average OM emission factor will be calculated using a 3-year average based on the most recent statistics.
QA/QC procedures to be applied:	Level of uncertainty of data will depend on accuracy of annual GPL reporting.
Any comment:	Baseline emission parameter included in ACM0002.

Data / Parameter:	$\mathbf{F_{i,y}}$
Data unit:	liters
Description:	Amount of each fossil fuel i consumed by each power source/ plant during the year *y* (For the project boundary, the fossil fuel consumed by GPL's BIS power plants is only LFO.)
Source of data to be used:	From GPL
Value of data applied for the purpose of calculating expected emission reductions in section B.5	21,946,024.4 liters LFO Power station average data: Onverwagt – 5,862,592.5 liters; Canefield – 12,883,694.0; Village 53 – 3,199,738.9
Description of measurement methods and procedures to be applied:	Estimated as a 3-year average (2003-2005) based on GPL's data on LFO consumption (kWh/liter) and electricity generation (MWh) during the year.
QA/QC procedures to be applied:	Level of uncertainty of data will depend on accuracy of annual GPL reporting.
Any comment:	Baseline emission parameter included in ACM0002.

Data / Parameter:	$\mathbf{GEN_{j,y}}$

Data unit:	MWh/yr
Description:	Electricity delivered to the grid by each power plant *i* in BIS grid
Source of data to be used:	From GPL
Value of data applied for the purpose of calculating expected emission reductions in section B.5	65,634.30 MWh/yr
Description of measurement methods and procedures to be applied:	Calculated based on GPL's data on electricity generated by each power station of BIS adjusted by T&D losses (presently, 19% of energy generated).
QA/QC procedures to be applied:	Level of uncertainty of data will depend on accuracy of annual GPL reporting.
Any comment:	Baseline emission parameter included in ACM0002.

Data / Parameter:	**$COEF_i$**
Data unit:	tC/liter LFO
Description:	Carbon emission coefficient of LFO consumed in the grid
Source of data to be used:	Table 1-1, Revised 1996 IPCC Guidelines Reference Manual; Used in various studies: a. Dyer, J.A. and R.L. Desjardins, "The Impact of Farm Machinery Management on the Greenhouse Gas Emissions from Canadian Agriculture", *Journal of Sustainable Agriculture*, Vol. 22(3), 2003, The Haworth Press, Inc. b. Krajnc, Damjan and Peter Glavic, "Indicators of Sustainable Production", Journal of Clean Technologies and Environmental Policy, Vol. 5(3-4), October 2003, Springer Berlin/Heidelberg. c. www.ghgregistries.ca/registry/out/C0442-COMBINED-PDF.PDF
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.0007735 tC/liter LFO
Description of measurement methods and procedures to be applied:	38.68 MJ/liter LFO for energy content of LFO used in grid; 20.2 tC/TJ for carbon emission factor of LFO; and 0.99 for oxidation factor of LFO. Following the formulation given in ACM0002, then $COEF_i$ = 38.68 MJ/liter LFO * 20.2 tC/TJ * 0.99 = 0.0007735 tC/liter LFO
QA/QC procedures to be applied:	IPCC default values will be used if national or local data are unavailable.
Any comment:	Baseline emission parameter included in ACM0002. Data does not need to be monitored.

B.7.2 Description of the monitoring plan:

>> See Annex 4 for a description of the monitoring plan. In a related issue, detailed project management planning is shown in Annex 5.

B.8 Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies)

>>

1. Date of completing the final draft of this baseline section: 25/2/07

2. Name of person/entity determining the baseline: Adelaida Schwab, Noreen Beg and Johannes Heister of the World Bank. They are not a project participant as listed in Annex 1.

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

>> 30/09/05 This is the start of construction of project.

C.1.2. Expected operational lifetime of the project activity:

>> 20 years and 0 months

C.2 Choice of the crediting period and related information:

C.2.1. Renewable crediting period

7 years x 3

C.2.1.1. Starting date of the first crediting period:

>> 01/02/2008

C.2.1.2. Length of the first crediting period:

>> 7 years

C.2.2. Fixed crediting period:

Not applicable.

C.2.2.1. Starting date:

>> Not applicable.

C.2.2.2. Length:

>> Not applicable.

SECTION D. Environmental impacts

>>
See below.

D.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

>>An Environmental Impact Assessment (EIA) of the Skeldon Sugar Modernization Project (SSMP) was completed by the Ground Structures Engineering Consultants Inc. in March 2003 and the Environmental Protection Agency of Guyana (EPA) then issued a permit (Permit No.19990204-GSEPO dated 15 July 2003) for the SSMP to proceed.[18] The land for expansion of sugarcane cultivation was gained using old cane areas left

[18] The Environmental Permit authorizing the construction and expansion of the GUYSUCO Skeldon Sugar Estate was issued under the Environmental Protection Act No.11 of 1996 and the Environmental Protection Regulations 2000. The Environmental Permit covered specific terms and conditions that should be complied with in the implementation of the SSMP. These terms and conditions were made pertaining to the construction and operation stages of the project – to ensure that the potential impacts identified in the EIA were adequately addressed. Thus as required under the Environmental

around 20 years ago, and also independent cooperative lands. Trees (secondary forest) in parts of those areas were cleared for cane cultivation.[19]

The environmental consequences of the SSMP were detailed in the EIA report completed for the project. The report identified potential environmental and social impacts associated with the construction and operation of the SSMP including: landscape disturbance/vegetation loss; air emissions; noise pollution; impacts of agricultural practices on surface water quality; etc. All potential impacts were manageable through proper project design and implementation. Mitigating measures were incorporated in the design of the project and, together with monitoring plans, were included in the SSMP's Environmental Management Plan (EMP). The EMP was prepared by GUYSUCO and reviewed by the World Bank in accordance with its environmental safeguards policies.[20]

The EIA took into consideration a cogeneration facility to be integrated with the SSMP and identified two impacts of the cogeneration component:

- Increased open bagasse storage, and
- Increased storage capacity for heavy fuel oil.

Both of these impacts will be mitigated by operational procedures and monitoring protocols in accordance with World Bank and EPA guidelines.

There will be no transboundary impacts resulting from the proposed cogeneration project. All the relevant impacts will occur within Guyana's borders.

D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

>>

The impacts of the project activity itself are not considered significant. They will arise from activities (cane crushing, bagasse burning, and co-firing with fuel oil when bagasse supply runs out) that are already taking place in sugar mills in the region, except in the case of the project activity it will be in a larger scale. As the project activity will (a) displace fossil fuel-based electricity generation by bagasse-based electrical power, and (b) avoid methane emissions by utilizing as fuel an extra 50,000 tonnes of bagasse that would otherwise be dumped and left to decay, it will result in a positive net environmental impact.

GUYSUCO assumes the responsibility of ensuring that the new SSMP factory and the proposed cogeneration plant are efficiently managed and that conditions of the EPA Permit are complied with.

SECTION E. Stakeholders' comments

>>

See below.

E.1. Brief description how comments by local stakeholders have been invited and compiled:

>>

Participation of local stakeholders was invited through a series of public meetings held. Since the conception of the SSMP in 1999, there had been joint consultative meetings with the local community to discuss in detail the

Protection Act of 1996, the Guyana EPA will conduct a regular inspection and monitoring to review the enforcement of the Permit. EPA reserves the right to cancel or suspend the Permit if any of the terms or conditions of the Environmental Permit is breached.

[19] Interview with Dr. H.B. Davis, Agricultural Division of GUYSUCO.

[20] World Bank, Integrated Safeguards Data Sheet (ISDS) – SSMP, September 16, 2005.

environmental and social impacts of the factory project and the role that private farmers and cooperatives would play.

Initial public consultation was held on the following dates:
13 July 1999 - inter-agency experts meeting in Georgetown
15 July 1999 - public meeting at Skeldon
16 July 1999 - local farmer meeting at Skeldon
19 July 1999 - public meeting in Georgetown
21 August 1999 - union & workers meeting at Skeldon

The above meetings were advertised and the Environmental Impact Assessment process explained through the following media:
National press
National and local TV
National and local radio
Flyers
Public announcement
Notice boards

The issues raised in the above consultation are recorded in the Environmental Impact Assessment report.

Prior to publication of the final draft of the Environmental Impact Assessment report, a public hearing was held on 28 Nov 2002 at Skeldon. This was arranged and chaired by the EPA and was publicised by the EPA through the media as indicated above. At the meeting the project sponsor (GUYSUCO) explained the background to the project and the benefits that would be derived by GUYSUCO and the community. The EPA invited public comment and responded accordingly.

In late 2004, GUYSUCO again held consultations on the EIA with local business groups, private farmers and cooperatives, union representatives and government authorities. The discussion emphasized the construction of the SSMP factory to manufacture VHP sugar and the accompanying expansion of existing cane cultivation at the Skeldon Estate as well as in holdings owned by private farmers and cooperatives. The integration of the proposed cogeneration facility in the new sugar factory was also elaborated making it clear that the facility would be operated to generate electrical power both for internal use and for sale to the national grid.

GUYSUCO has a record of the outcome of the public consultations mentioned above.

E.2. Summary of the comments received:

>>

The project activity received no negative comment or opposition during the public consultations. Instead it gathered stakeholders' support with the understanding that it would contribute to a more stable electricity supply in the region.

This positive stakeholders' response to the project activity was further demonstrated in March 2005, when a World Bank mission was conducted to undertake environmental and social due diligence of the bagasse cogeneration project as an integral part of the SSMP in the Berbice region.[21] The mission team met with the Corriverton Chamber of Commerce who described how local businesses have been adversely affected by the historical unreliability of the local power supply. Many business operators have invested on diesel generators to produce their own electricity because of the unreliability of GPL's power supply. They were enthusiastic about the prospect of improved service (fewer outages and stable voltage) in their area and said that they would likely resume consumption of GPL power once it has been demonstrated that service has improved. They also said that an

[21] World Bank, "Draft Aide Memoire: Community Development Carbon Fund Project Appraisal Mission – Guyana," March 14-18, 2005.

improved power supply would enable existing rice millers and sawmill operators to expand output and increase employment.

Other stakeholder consultations attended by the team during the mission are as follows:

- Meeting with GUYSUCO management and union representatives, as well as members of cooperative societies and private farmers who were interested to provide sugar cane to SSMP.
- Meetings in Georgetown held by social development experts.

In these occasions the bagasse cogeneration project and the community benefits the project would provide were discussed. The following are the main responses:

(i) Mr. Trevor Thomas, Permanent Secretary, Ministry of Labour, Human and Social Services – In support to the project, the Ministry would monitor its effect on local employment and social stability in the area. The importance of having a consultative process early on in project implementation was emphasized so that workers and area residents would be kept informed and any issues could be raised and resolved.
(ii) Mr. Clive Nurse, Chief Cooperative Development Officer, Ministry of Labour – A request was made that the Cooperative Division be involved when the cooperative societies negotiate their contracts with GUYSUCO to ensure that the requirements of the Cooperative Societies Act are fulfilled.
(iii) Mr. Kenneth Joseph, General President, National Association of Agricultural, Commercial and Industrial Workers; and Mr. Komal Chand, President, Guyana Agricultural and General Workers' Union – They indicated that their unions fully support the proposed project as a necessary effort to improve the overall efficiency of the sugar industry. They said that GUYSUCO has kept them well informed about the project. Concern raised was about finding sufficient skilled labor locally.
(iv) Major General (retd) J.G. Singh, Executive Director, Conservation International Guyana – He expressed his support for the development of a conservation area at the Halcrow Conservancy (part of the environmental safeguards component of the SSMP).

E.3. Report on how due account was taken of any comments received:

>>

The local community is supportive of the project activity and there has been no need to modify the cogeneration project due to comments received.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

1.1 Project Developer Responsible for the CDM Project Activity

Organization:	Guyana Sugar Corporation Inc. (GUYSUCO)
Street/P.O.Box:	-
Building:	Head Office, Ogle Estate
City:	-
State/Region:	East Coast Demerara
Postfix/ZIP:	-
Country:	Guyana
Telephone:	(592) 222-6030/41
FAX:	(592) 222-6048
E-Mail:	-
URL:	http://www.GuySuCo.com
Represented by:	Nick Jackson (Booker Tate Ltd. as Corporate Manager of GUYSUCO)
Title:	Chief Executive
Salutation:	Mr.
Last Name:	Jackson
Middle Name:	-
First Name:	Nick
Department:	-
Mobile:	-
Direct FAX:	-
Direct tel:	(592) 222-6042
Personal E-Mail:	NickJ@guysuco.com
Organization:	World Bank Carbon Finance Unit
Street/P.O.Box	1818 H Street NW
Building:	MC
City:	Washington
State/Region:	DC
Postfix/ZIP:	20433
Country:	USA
Telephone:	1202 473 9189
FAX:	1202 522 7432
E-Mail:	IBRD-carbonfinance@worldbank.org
URL:	www.carbonfinance.org
Represented by:	Joelle Chassard
Title:	Manager, Carbon Finance
Salutation:	Ms.
Last Name:	Chassard
Middle Name:	
First Name:	Joelle
Department:	ENVCF
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	

Annex 2

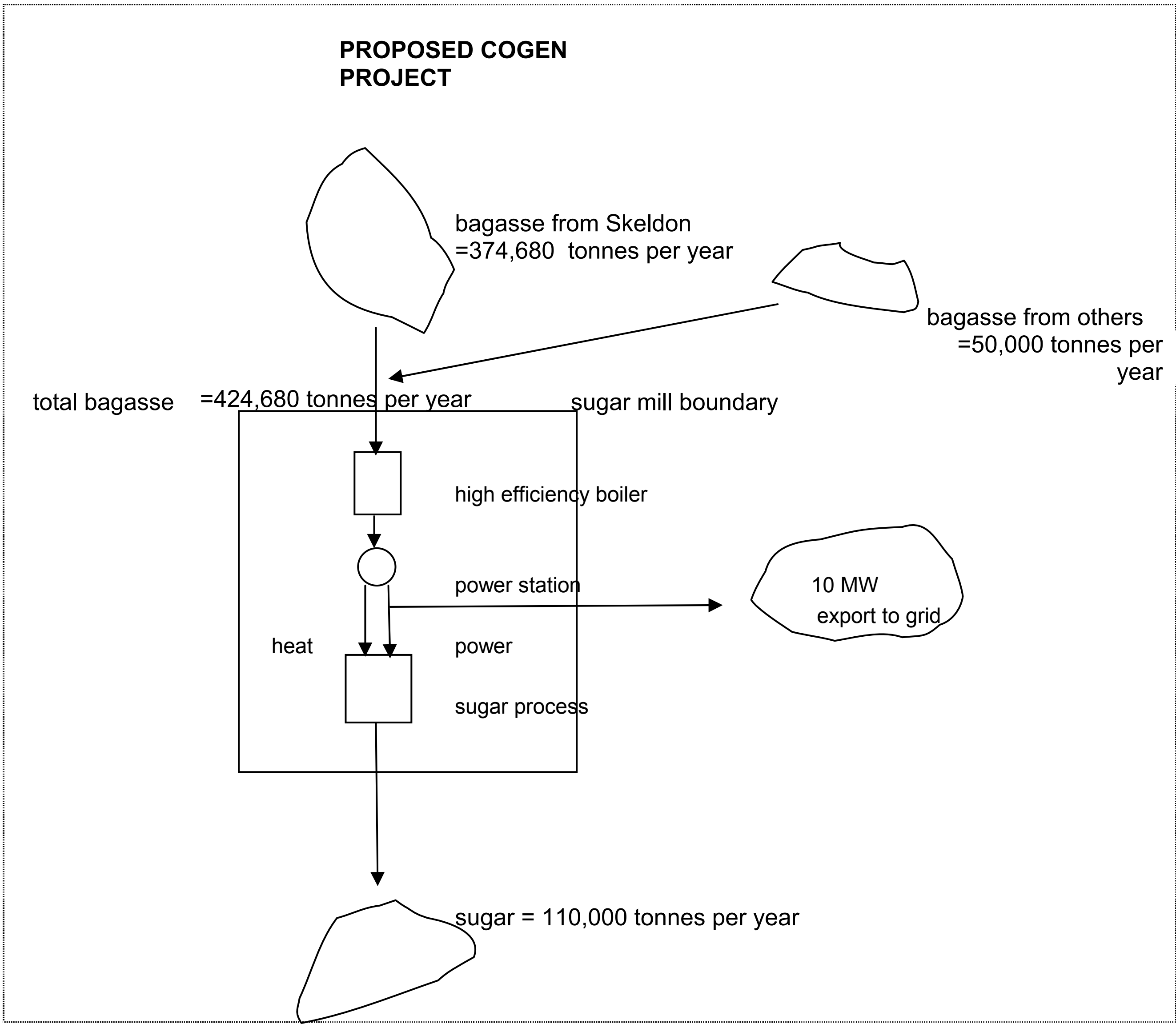
INFORMATION REGARDING PUBLIC FUNDING

There is no Annex I public funding involved in Guyana Bagasse Cogeneration project activity. The project will not make use of Official Development Assistance (ODA), nor result in the diversion of such ODA.

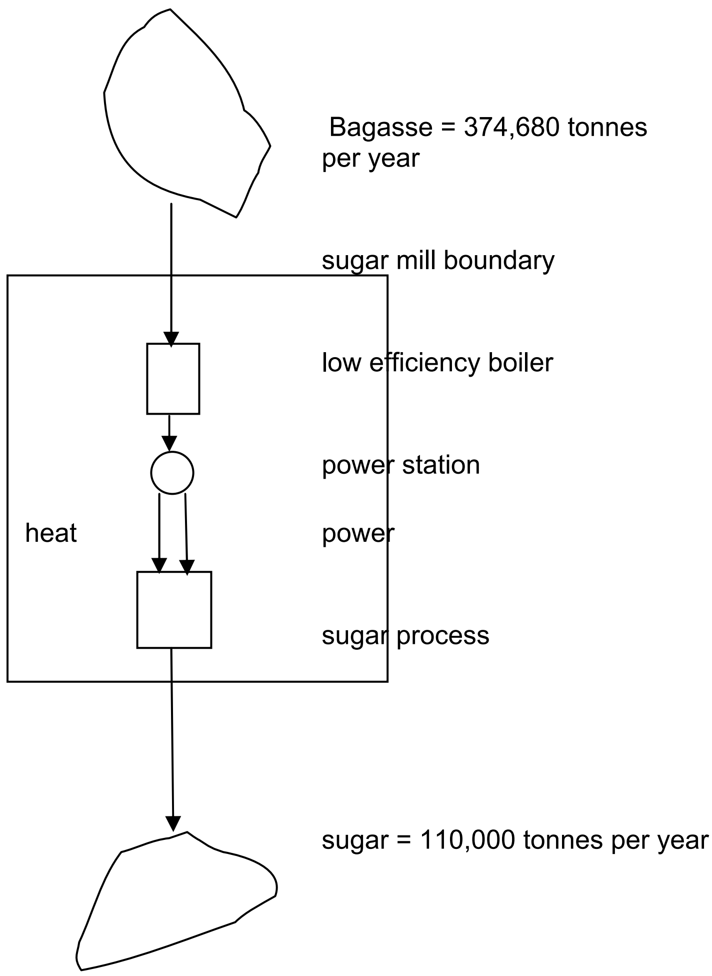
Annex 3

BASELINE INFORMATION

The baseline for the project activity is the SSMP sugar factory without the proposed cogeneration plant capable of producing surplus bagasse-based electricity for export to the grid. In the absence of the project activity, a smaller cogeneration facility with low efficiency boilers will be added to the SSMP factory, and a smaller quantity of bagasse will be combusted annually. Because of its small scale, the cogeneration facility will generate energy for on-site uses only and surplus bagasse will be discarded and left to decay. The diagrams below illustrate the baseline situation in contrast with the project activity.



WITHOUT PROPOSED COGEN PROJECT



The baseline grid:

The Guyana electricity system is divided into two regional systems: the Demerara Interconnected System (DIS) and the Berbice Interconnected System (BIS). The project activity will be connected with the BIS, which therefore will receive all the bagasse-based produced electricity. Only the BIS becomes part of the project boundary.

While the BIS is part of the national grid system, it is linked to the DIS by an underrated 13.8 kV connector between Onverwagt power station and Sophia distribution point. Because of this transmission and distribution constraint, the supply of power to the Berbice region comes primarily from the three diesel power plants situated within Berbice.[22] Consequently, while the energy flow between BIS and DIS is heavily limited by the transmission lines capacity, it does not account for any significant amount of each regional system's electricity demand.

[22] The three plants are located at Onverwagt in West Berbice; at Canefield Canje (near New Amsterdam in East Berbice); and Village 53 located close to the coastal highway between Good Hope and Corriverton (the town nearest to Skeldon site) and approximately 18 km from Corriverton.

The present power supply in the country is generated from diesel fuel using a mixture of distillate (light fuel oil) or heavy fuel oil. GPL's generating capacity in Berbice comprises a mix of high and medium speed diesel generators operating exclusively on light fuel oil (LFO). GPL has a total installed capacity of 21.8 MW in Berbice, with only 14 MW of available capacity. The poor condition of its permanent capacity has forced GPL to supplement it with both its own and rented packaged units. Of the 21.8 MW installed capacity, about 4.8 MW is rented by GPL. These small, high speed units are better suited for stand-by or peak generation and hence are expensive to operate.

The assumptions and data used in determining the baseline for the project activity, including variables, parameters and data sources are discussed and tabulated in the text of this document.

Annex 4

MONITORING INFORMATION

The data and parameters that will be monitored in this project activity are detailed in Section B.7.1. Monitoring will take place from year 2008 up to the end of the last crediting period. Since neither leakage emissions nor emissions change due to displacement of heat were identified in this project activity, there will be no need to monitor the variables for these cases. The monitoring will occur as follows:

- The quantity of bagasse combusted in the project plant will be determined on a weekly basis by using published sugar industry standard calculations to deduce the amount of bagasse produced from known quantities of sugar cane and water (both measured inputs). The additional bagasse fuel brought from an external source will be weighed.

- On-site consumption of fuel oil will be monitored by fuel meters installed in the fuel supply to each generator.

- The quantity of electricity exported to the grid will be metered by GUYSUCO and by GPL and will be confirmed through the energy invoice emitted by GUYSUCO to GPL each month. (See Attachment 1 below.)

- Net calorific value of bagasse will be based on local data and will be calculated by the current formula of the Sugar Milling Research Institute of South Africa. Consistency of local data will be monitored by comparing it with IPCC default values.

- Methane emission factor for combustion of bagasse in the project plant may be monitored if on-site measurements are conducted. Consistency of data will be checked with IPCC default values, to be adjusted according to the conservativeness factors shown in Table 4 of ACM0006.

- On-site consumption of heavy and light fuel oil for co-firing in the project will be measured using flow meters, which will be subject to routine maintenance to ensure accuracy. Fuel purchase receipts may also be used to check consistency. (See Attachment 1 below.)

- Net quantity of electricity generated in the project plant during the year will be monitored. Readings of the energy metering connected to the grid will be done regularly and will be supported with Receipt of Sales. Meters will be subject to a regular maintenance regime to ensure accuracy.

- Net quantity of heat generated in the project plant from firing bagasse will be monitored continuously during the year. Net heat generation will be determined according to the measurement procedures cited in ACM0006, p.56 (see below):

NCV bagasse (kJ/kg)	useage ratio	weighted average
7083	76.00%	6997.8
6728	24.00%	

bagasse used without project activity =371,627 tonnes

bagasse used with project activity =424,680 tonnes

incremental use= 53,053 tonnes

Heat balance for PDD		03-Feb-07
without cogen		
cane	tonnes	1,102,000
bagasse from Skeldon	tonnes	374,680
bagasse from Albion	tonnes	0
bagasse available	tonnes	374,680
bagasse loss before boilers	%	1.00%
net bagasse available to boilers	tonnes	370,933
steam/cane ratio	%	52.00%
steam required	tonnes	573,040
bagasse NCV	kJ/kg	7,083
steam pressure	Mpa (a)	3.10
steam temperature	deg C	380
enthalpy	kJ/kg	3,183
boiler efficiency	%	70.00%
heat generated	GJ	1,823,986
bagasse required	tonnes	367,880
bagasse surplus	tonnes	3,053
with cogen		
cane	tonnes	1,102,000
bagasse from Skeldon	tonnes	374,680
bagasse from Albion	tonnes	50,000
bagasse available	tonnes	424,680
bagasse loss before boilers	%	1.00%
net bagasse available to boilers	tonnes	420,433
steam/cane ratio	%	69.15%
steam required	tonnes	761,979
bagasse NCV	kJ/kg	6,998
steam pressure	Mpa (a)	5.40
steam temperature	deg C	485
enthalpy	kJ/kg	3,394
boiler efficiency	%	86.00%
heat generated	GJ	2,586,157
bagasse required	tonnes	429,729
bagasse surplus	tonnes	-9,296

= 1,504 tonnes HFO

- CO_2 average Operating Margin emission factor of the grid will be estimated based on GPL data on the amount of LFO consumed by each power plant in the BIS grid and electricity delivered to the grid by each plant. Accuracy of annual GPL reporting shall be monitored.

With regard to leakage, presently it is clear that the project activity will not result in increased fossil fuel consumption elsewhere. This is because no market for bagasse currently exists in the entire country and excess bagasse is dumped to decay or burnt in open heaps. Hence, the project activity will not involve the purchase from or sell of bagasse to a market. The project activity will use only bagasse generated as by-product from the new SSMP sugar factory and from another sugar mill owned by GUYSUCO. Bagasse from the second source constitutes surplus bagasse that the sugar mill does not need and would otherwise be disposed to decay. For these reasons, leakage would be zero. Nonetheless, monitoring may be carried out to ensure that no market for bagasse from the new factory will emerge in the project area and, therefore, $L_y = 0$ will hold during the crediting period. The parameter to be monitored will be the quantity of bagasse for which leakage could be ruled out, and for this project activity it will be alternative B_1 in the baseline methodology.

The archiving of these data will occur up to two years after the end of the crediting period or the last issuance of CERs for this project activity, whatever occurs later.

Attachment 1

Guyana Bagasse Project

The project will have two boilers for co-firing of Heavy Fuel Oil (HFO) and three diesel generators that are fuelled by HFO or light fuel oil. These represent sources of backup power generation to be used as follows:

- Start up and shutdown;
- During fuel supply interruptions and breakdowns to maintain firm power supply to the grid and to avoid sugar processing interruption;
- During the off-season when bagasse fuel reserves are exhausted and it is necessary to maintain firm power supply to the grid.

The quantity of energy dispatched to the grid and sourced from bagasse will be determined as follows:

A) It will be assumed that all energy for the sugar factory and the cogeneration parasitic loads is generated from the available bagasse; this may be supplemented by energy generated from fossil fuel in the boilers or in the diesel generators;

B) The energy exported to the grid will be the aggregate of :

    i) Energy generated from the bagasse that remains after the sugar factory and the cogeneration parasitic loads have been satisfied; and

    ii) Energy generated from fossil fuel;

C) Metering of electrical energy and HFO to the boilers and the use of equations based on the above assumptions will allow the amount of energy exported to the grid from bagasse generation to be calculated; totalising meters will be provided for this purpose;

D) It will be necessary to establish a conversion factor for MWh energy generated per tonne of HFO consumed in the boilers; this can be derived from the manufacturers' certified performance data and confirmed in the factory performance trials; this factor can be verified and updated at regular intervals.

The attached flow diagrams illustrate the principles described above:

Flow Diagram 1

This represents normal in-crop operations in which there is no supplementary use of fossil fuel and the 10 MW dispatched to the grid is totally generated from bagasse. This displaces a similar amount of fossil fuel generation at the grid utility.

Flow Diagram 2

This represents a situation where 2 MW is being generated from the use of HFO in the boilers. This results in the same amount of energy from the boilers but with reduced bagasse consumption and a reduced bagasse power component. The amount of energy generated from bagasse and dispatched to the grid reduces to 8 MW.

Flow Diagram 3

This represents a situation where 2 MW is being generated from the use of HFO in the diesel generators. This is added to the total amount of energy dispatched to the grid but is not counted as bagasse generated power and does not displace any fossil fuel generation at the grid utility. The amount of energy generated from bagasse and dispatched to the grid remains at 10 MW.

In the above scenarios the amount of energy generated from bagasse and dispatched to the grid is determined by periodic measurement of the following quantities:

Quantity	**Unit**	**Flow Diagram ref**
Energy from turbine generator 1	MWh	E1
Energy from turbine generator 2	MWh	E2
Energy to cogen parasitic load	MWh	E3
Energy to sugar factory load	MWh	E4
Energy from HFO to boiler 1	MWh	E6
Energy from HFO to boiler 2	MWh	E7
Energy from diesel generator 1	MWh	E8
Energy from diesel generator 2	MWh	E9
Energy from diesel generator 3	MWh	E10

Thus, the energy generated from bagasse and dispatched to the grid is defined as :

E5B = E1+E2-E3-E4-E6-E7

Diagram 1

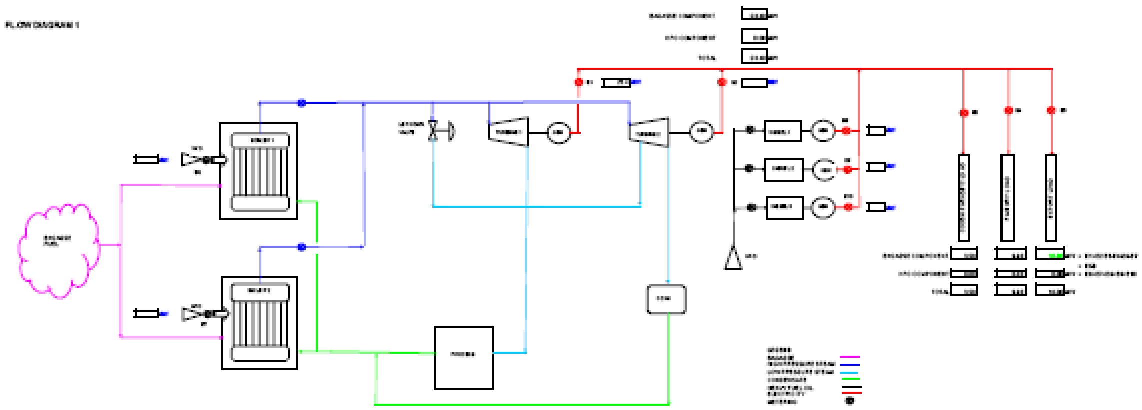


Diagram 2

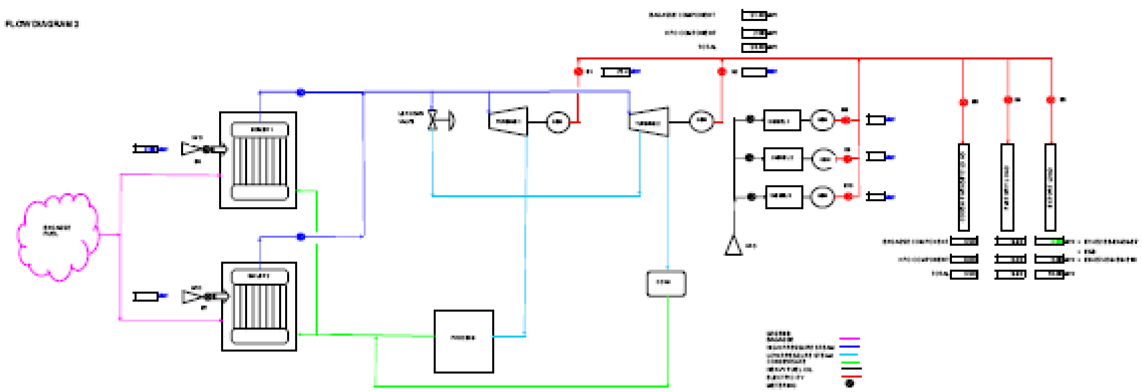
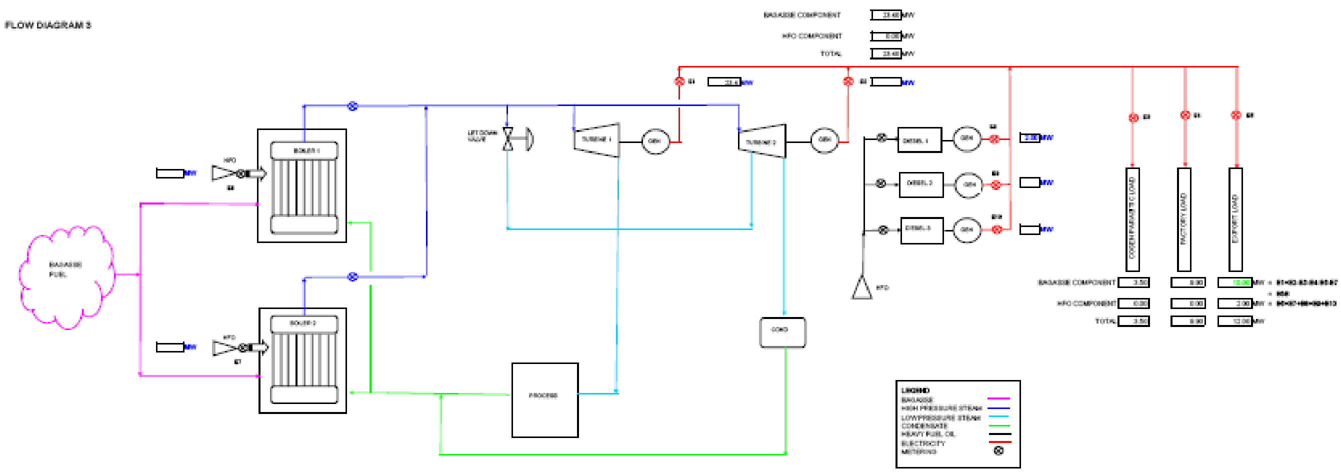


Diagram 3


FLOW DIAGRAM 3
BAGASSE FUEL
BOILER 1
BOILER 2
HFO
LET DOWN VALVE
TURBINE 1
TURBINE 2
GEN
DIESEL 1
DIESEL 2
DIESEL 3
PROCESS
COND
BAGASSE COMPONENT
HFO COMPONENT
TOTAL
FACTORY LOAD
EXPORT LOAD
LEGEND
BAGASSE
HIGH PRESSURE STEAM
LOWPRESSURE STEAM
CONDENSATE
HEAVY FUEL OIL
ELECTRICITY
METERING

Annex 5

PROJECT MANAGEMENT PLANNING

The authority and responsibility for registration, monitoring, measurement and reporting is detailed in the chart below.

Skeldon Cogeneration Project

ER validation

Authority and responsibility for project management, registration, monitoring, measurement and reporting

Activity	Responsibility
Project management Project implementation Operational training Plant performance testing Plant take over and delivery to Guysuco	Project Director
Registration	Chief Executive
Plant operation	General Manager, Skeldon Factory Manager
Monitoring & Reporting	Production Manager Head Laboratory Technician
Measurement	Engineering Manager Control & Instrument Engineer

Procedures for training of monitoring personnel
Training of monitoring personnel will be under two categories:
a) For simple recording of totalising meter readings this will be done by laboratory staff who are carrying out similar routine tasks on a daily basis. They will be trained by the Head Laboratory Technician who reports to the Production Manager.

b) For any qualitative measurements that are required these will also be carried out by the laboratory staff but if there is a need for specialised analysis that is outside of the scope of normal factory operations the training for this will be provided by GUYSUCO's internal Central Analytical and Environmental Monitoring Services which operates a well equipped laboratory at Head Office in Georgetown.

Procedures identified for calibration of monitoring equipment
Calibration of monitoring equipment will be carried out by the factory's own Control and Instrumentation Department (under the C&I Engineer) which will be equipped with all test and reference equipment required to calibrate the monitoring equipment and reports to the Engineering Manager. If any third party verification is required this will be provided by the Guyana National Bureau of Standards.

Procedures identified for maintenance of monitoring equipment and installations
Maintenance of monitoring equipment will be carried out by GUYSUCO's own Control & Instrumentation Department.

Procedures identified for monitoring, measurements and reporting
Monitoring will be by manual recording of data displayed on totalizing measurement devices on energy and fuel flows. Routine analytical data from the sugar factory mass and chemical balance will also be used.

Procedures identified for day-to-day records handling (including what records to keep, storage area of records and how to process performance documentation
Recording of data will be integrated into the factory mass and chemical balance reporting system which is an essential and integral part of routine sugar factory operations. Data will be entered into the computer based system which processes this data and the computer system will record and present this data in the required format. The data will be made available on GUYSUCO's company-wide information management system over a computer network. Two levels of back up are available and a data recovery procedure is in place in the event of a catastrophic failure.

Procedures identified for dealing with possible monitoring data adjustments and uncertainties
Monitoring data adjustments are not allowed after data entry into the computer system. Data is verified by a senior manager before entry and any uncertainties will be referred to the Factory Manager before entry.

Procedures identified for review of reported results/data
Reported data is reviewed by the Factory Manager, General Manager, Skeldon and General Manager, Technical Services.

Procedures identified for internal audits of GHG project compliance with operational requirements
An internal quality audit group is available within GUYSUCO and this will be tasked to include the audit of the GHG project compliance. GUYSUCO has ISO 9001 certification and will be extending this to include the new Skeldon factory and cogeneration project.

Procedures identified for project performance reviews before data is submitted for verification, internally or externally
The GUYSUCO internal quality audit group will be tasked with the review of data before submission for verification.

Procedures identified for corrective actions in order to provide for more accurate future monitoring and reporting
Any requirement for more accurate reporting will be identified by the quality audit group and auctioned by the management team.

Annex 6

SPREADSHEETS

GUYANA BAGASSE COGENERATION PROJECT

Project Emissions: data/parameters; equations used

FC(TR,i,y)	Consumption of diesel fuel for transporting bagasse to project site (liters/yr)	282088.82
NCV (i)	Net calorific value of diesel oil (GJ/liter)	0.0364
EF(CO2,FC,i)	CO2 emission factor for diesel oil (tCO2/GJ)	0.0741
FF(project plant,i,y)	Quantity of HFO & LFO combusted in project plant (liters/yr)	
FF(project site,i,y)	Quantity of other fossil fuels combusted at project site for other purposes (liters/yr)	0
NCV(i)	Net calorific value of HFO (GJ/liter)	0.0405
	Net calorific value of LFO (GJ/liter)	0.03868
EF(CO2,FF,i)	CO2 emission factor for HFO (tCO2/GJ)	0.0774
	CO2 emission factor for LFO (tCO2/GJ)	0.0741
EC(PJ,y)	On-site electricity consumption attributable to project activity (MWh)	0
BF(k,y)	Quantity of bagasse used as fuel in project plant (tons of dry matter)	
NCV(k)	Net calorific value of bagasse used during crop periods (GJ/ton of dry matter)	7.038
	Net calorific value of bagasse used during off-crop (GJ/ton of dry matter)	6.728
EF(CH4,BF)	Methane emission factor for combustion of bagasse in project plant (tCH4/GJ)	0.0000411

Year	FF(project plant,i,y)		BF(k,y)	
	HFO (li/yr)	LFO (li/yr)	crop (tons)	off-crop (t)
2008	4367860	89140	252720	55000
2009	3998400	81600	333640	55000
2010	4130700	84300	369680	55000
2011	5393920	110080	369680	55000
2012	6035820	123180	369680	55000
2013	6756120	137880	369680	55000
2014	7428400	151600	369680	55000

PET(y)	CO2emissions due to transport of bagasse to project plant (tCO2/yr)
PEFF(y)	CO2emissions due to co-firing HFO & LFO in project plant, or other fossil fuel consumption in project site (tCO2/yr)
PE(EC,y)	CO2 emissions due to electricity consumption in project site attributable to project (tCO2/yr)
PE(biomass,CH4,y)	CH4 emissions due to combustion of bagasse in project plant (tCH4/yr)
PE(y)	Project emissions (tCO2/yr)

Year	PET(y)	PEFF(y)	PE(EC,y)	PE(biomass,CH4,y)	PE(y)
2008	760.8612489	13947.42274	0	88.3108861	16562.8126
2009	760.8612489	12767.66542	0	111.717951	15874.60364
2010	760.8612489	13190.12494	0	122.1429462	16515.98806
2011	760.8612489	17223.831	0	122.1429462	20549.69412
2012	760.8612489	19273.54199	0	122.1429462	22599.40511
2013	760.8612489	21573.59937	0	122.1429462	24899.46249

2014	760.8612489	23720.31958	0	122.1429462	27046.1827
					144048.1487

GUYANA BAGASSE COGENERATION PROJECT

Baseline Emissions: data/parameters; equations used

EG(y)	Net quantity of electricity generated in the project plant (MWh/yr)	
EF(grid,y)	CO2 emission factor for electricity displaced in the grid due to project activity (tCO2/MWh)	0.9483
BF(k,y)	Quantity of bagasse used as fuel in the project plant (tons dry matter/yr)	
Q(project plant,y)	Net quantity of heat generated from firing bagasse in project plant (GJ/yr)	1823986
E(boiler)	Energy efficiency of the boiler that would be used in absence of project activity	0.7
NCV(k)	Net calorific value of bagasse (GJ/ton)	7.038
EF(burning,CH4,k,y)	CH4 emission factor for uncontrolled burning of bagasse or left to decay; Default value given in ACM0006 as product of NCV(k) and EF(burning,CH4,k,y)in tCH4/ton bagasse	0.001971

Year	EG(y)	BF(k,y)
	MWh/yr	tons
2008	48399	307720
2009	63220	388640
2010	70246	424680
2011	71605	424680
2012	72247	424680
2013	72923	424680
2014	73509	424680

ER(electricity,y)	Emission reductions due to displacement of electricity (tCO2/yr)
ER(heat,y)	Emission reductions due to displacement of heat (tCO2/yr)
BE(biomass,y)	Baseline emissions due to natural decay or uncontrolled burning of bagasse (tCO2/yr)
L(y)	Leakage emissions (tCO2/yr)
ER(y)	Emission reductions due to project activity (tCO2/yr)

Year	ER(elec.,y)	ER(heat,y)	BE (biomass,y)		L(y)	PE(y)	ER(y)
			Step1	Step2			
2008	45896.7717	0	-62512.20883	-2587.442835	0	16562.813	26746.51586
2009	59951.526	0	18407.79117	761.9168845	0	15874.604	44838.83888
2010	66614.2818	0	54447.79117	2253.648525	0	16515.988	52351.94232
2011	67903.0215	0	54447.79117	2253.648525	0	20549.694	49606.97602
2012	68511.8301	0	54447.79117	2253.648525	0	22599.405	48166.07362
2013	69152.8809	0	54447.79117	2253.648525	0	24899.462	46507.06742
2014	69708.5847	0	54447.79117	2253.648525	0	27046.183	44916.05022
							313133.4644

GUYANA BAGASSE COGENERATION PROJECT

Estimation of grid emission factor (EF (electricity,y) = EF(grid,y)

EF(grid,y) = EF(OM,average,y)

F(i,j,y)	Amount of fuel i (LFO) consumed by relevant power sources j (liters/yr)	
NCV(i)	Net calorific value of fuel i (LFO) in GJ/liter	0.03868
EF(CO2,i)	CO2 emission factor for LFO (tC/TJ)	20.2
OXID(i)	Oxidation factor of LFO	0.99
GEN(j,y)	Electricity delivered to the grid by each power source (MWh/yr)	
COEF(i) = NCV(i) * EF(CO2,i) * OXID(i) * 44/12 tCO2/tC		0.002836

Power Station	LFO consumption (liters)	Electricity delivered (MWh)
	3-yr average: 2003-05	3-yr average: 2003-05
Onverwagt	5862592.5	17095.32
Canefield	12883694	38612.43
Village 53	3199738.9	9926.55
Total	**21946025.4**	**65634.3**

EF(OM,average,y) 0.948351815 tCO2/MWh

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