



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

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**SECTION A. General description of project activity****A.1 Title of the project activity:**

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Guyana Bagasse Cogeneration Project  
Version 03.1  
October 5, 2006

**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 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 one-fourth of Guyana's export earnings and plays an important role in achieving trade balance.

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.

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)	Yes
	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.

**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<sup>0</sup>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. 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 <sub>2</sub> e
2008	31,834.42
2009	46,822.85
2010	52,953.85
2011	50,210.47



2012	48,770.41
2013	47,112.36
2014	45,522.17
<b>Total estimated reductions</b> (tonnes of CO <sub>2</sub> e)	323,226.53
<b>Total number of crediting years</b>	7 (3x)
<b>Annual average over the crediting period of estimated reductions</b> (tonnes of CO <sub>2</sub> e)	46,175.22

**A.4.5. Public funding of the project activity:**

>> There is no Annex I public funding involved in the Guyana Bagasse Cogeneration project activity.



**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 03: “Consolidated baseline 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
<b>Baseline</b>	Grid electricity generation	CO <sub>2</sub>	Yes	Displacement of fuel oil-based grid electricity by the bagasse-based electricity generated by the project activity
		CH <sub>4</sub>	No	Excluded in the approved methodology ACM0006/Version 03 for simplification.
		N <sub>2</sub> O	No	Excluded in the approved methodology for simplification.
	Uncontrolled burning or decay of surplus biomass	CO <sub>2</sub>	No	Approved methodology assumed that CO <sub>2</sub> emissions from surplus biomass residues do not lead to changes of carbon pools in the LULUCF sector.
		CH <sub>4</sub>	Yes	There would be 50,000 tonnes of surplus bagasse that would be dumped and left to decay if the project cogeneration plant is not built.
		N <sub>2</sub> O	No	Excluded in the approved methodology for simplification.
	Heat generation	CO <sub>2</sub>	No	ER <sub>heat,y</sub> = 0 as specified in ACM0006/Version 03 for Scenario 3.
		CH <sub>4</sub>	No	
		N <sub>2</sub> O	No	





<b>Project Activity</b>	On-site fossil fuel consumption due to project activity	CO <sub>2</sub>	Yes	Fuel oil co-fired by the project cogeneration plant.
		CH <sub>4</sub>	No	Excluded for simplification. Approved methodology assumed that this emission source is very small.
		N <sub>2</sub> O	No	Excluded for simplification. Approved methodology assumed that this emission source is very small.
	Off-site transportation of biomass	CO <sub>2</sub>	Yes	Combustion of diesel fuel for transportation of bagasse to the project plant.
		CH <sub>4</sub>	No	Excluded for simplification. Approved methodology assumed that this emission source is very small.
		N <sub>2</sub> O	No	Excluded for simplification. Approved methodology assumed that this emission source is very small.
	Combustion of biomass for electricity and/or heat generation	CO <sub>2</sub>	No	Approved methodology assumed that CO <sub>2</sub> emissions from surplus biomass do not lead to changes of carbon pools in the LULUCF sector.
		CH <sub>4</sub>	Yes	Emissions from the use of bagasse as fuel in the project plant
		N <sub>2</sub> O	No	Excluded for simplification. Approved methodology assumed that this emission source is 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.

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 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.

**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, 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), GUYUSCO 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 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<sub>2</sub> emission factor of the baseline grid amounts to 948 tons/GWh.

In contrast, CO<sub>2</sub> 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<sub>2</sub> 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 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. 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.

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, 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. However, 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 (*National Development Strategy*, 1996).

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:

#### **Technological barriers**

Technological barriers represent a very important issue for increasing bagasse cogeneration in Guyana, as



– despite the fact that Rankine-cycle is a well known technology – the existing cogeneration units operate with relatively low efficiency using low-pressure boilers and the sugar mills are mostly obsolescent. Moreover, the small capacity of these mills does not permit the industry to benefit from the scale-economies that are inherent in modern mills. Thus although this technology is well developed, the economic value for its application is not present for the scale of operation currently taking place in existing mills.

The project activity is an addition to the new modern SSMP factory. The new sugar mill is much more efficient than those which have been in operation. Nonetheless, the project activity faces the risk of lack of technical skills needed for operating and maintaining the advanced technology. 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 (*World Bank Mission*, March 2005). 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.

### **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 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 cost per kWh. Biomass power projects are very front-end capital intensive, and the commercial finance situation is not conducive to the provision of the long-term loans necessary to enable biomass power plant projects to be implemented.

(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. 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 (and disapproved) in year 2000.

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. 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, rather another cogeneration facility in a smaller scale and one that will generate energy for internal needs only. Therefore, as the barriers mentioned above are directly related to entering into a new business



(electricity sale), there is no impediment for the factory to maintain its core business (production of sugar).

#### **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 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 all 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. The financial benefit of the revenue obtained by selling CERs will improve the project's financial situation and loan repayment ability; and it is also likely to attract new players and new technology. Furthermore, as the project activity will bring about reduction in hard currency requirements for the importation of fuel oil used by GPL and self-generators to some extent, it will contribute to reducing inflation and exchange rate risk.

#### **B.6. Emission reductions:**

<b>B.6.1. Explanation of methodological choices:</b>
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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 CO<sub>2</sub> emissions from off-site transportation of bagasse to the project plant ( $PET_y$ ) and from on-site consumption of fossil fuels being co-fired in the project plant ( $PEFF_y$ ), as well as CH<sub>4</sub> emissions from the combustion of bagasse to produce heat and electricity ( $PE_{Biomass,CH4,y}$ ). Equations (2), (5), (6) and (7) specified in ACM0006 will be 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 is known; equation (6) is chosen because it applies to Scenario 3; and equation (7) is included because methane emissions from combustion of biomass is part of the project boundary.

<p>(5) <math>PET_y = \sum_i F_{Trans,i,y} \cdot COEF_{CO2,i}</math></p> <p>(6) <math>PEFF_y = \sum_i FF_{project\ plant,i,y} \cdot COEF_{CO2,i}</math></p> <p>(7) <math>PE_{Biomass,CH4,y} = EF_{CH4} \cdot \sum_i BF_{i,y} \cdot NCV_i</math></p> <p>(2) <math>PE_y = PET_y + PEFF_y + GWP_{CH4} \cdot PE_{Biomass,CH4,y}</math></p>	<p>Where:</p> <p><math>PE_y</math> Project emissions during the year <math>y</math> in tons of CO<sub>2</sub></p> <p><math>PET_y</math> CO<sub>2</sub> emissions during the year <math>y</math> due to transport of the biomass to the project plant in tons of CO<sub>2</sub></p> <p><math>PEFF_y</math> CO<sub>2</sub> emissions during the year <math>y</math> due to fossil fuels co-fired by the project plant in tons of CO<sub>2</sub></p> <p><math>PE_{Biomass,CH4,y}</math> CH<sub>4</sub> emissions from the combustion of biomass during the year <math>y</math></p> <p><math>GWP_{CH4}</math> Global Warming Potential for methane (21 t CO<sub>2</sub>/t CH<sub>4</sub>)</p> <p><math>F_{Trans,i,y}</math> Fuel consumption of fuel type <math>i</math> used for transportation of biomass</p> <p><math>COEF_{CO2,i}</math> CO<sub>2</sub> emission factor for the fuel type <math>i</math></p> <p><math>FF_{project\ plant,i,y}</math> Quantity of fossil fuel type <math>i</math> combusted in the project plant during the year <math>y</math></p> <p><math>BF_{i,y}</math> Quantity of biomass type <math>i</math> used as fuel in the project plant during the year <math>y</math></p> <p><math>EF_{CH4}</math> Methane emission factor for combustion of biomass in the project plant</p> <p><math>NCV_i</math> Net calorific value of biomass type <math>i</math></p>
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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 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) will be 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 will be as follows:

<p><b>(8) <math>ER_{electricity,y} = EG_y \cdot EF_{electricity,y}</math></b></p> <p>Following the conditions set by ACM0006 for scenarios including Scenario 3, the emission factor for the displacement of electricity should correspond to the grid emission factor; that is</p> <p><math>EF_{electricity,y} = EF_{grid,y}</math></p> <p><math>EF_{grid,y}</math> shall be determined according to ACM0002: “Consolidated baseline methodology for grid-connected electricity generation from renewable sources”. ACM0006 (p.21) specifies the following conditions for determining <math>EF_{grid,y}</math>:</p> <ul style="list-style-type: none"> <li>• If the power generation capacity of the biomass power plant is of more than 15 MW, <math>EF_{grid,y}</math> should be calculated as a combined margin (CM), following the guidance in the section “Baselines” in the ACM0002.</li> <li>• If the power generation capacity of the biomass power plant is less than or equal to 15MW, project participants may alternatively use the average CO<sub>2</sub> emission factor of the electricity system, as referred to in option (d) in step 1 of the baseline determination in ACM0002.</li> </ul> <p>In reference to the second condition cited above, since the power generation capacity of the proposed bagasse plant is equal to 15 MW, then <math>EF_{grid,y} = EF_{OM,average,y}</math> which is calculated as the generation-weighted average emissions per electricity unit (tCO<sub>2</sub>/MWh) of all generating sources serving the BIS, including low-operating cost and must-run power plants.<sup>1</sup></p> <p><math>EF_{OM,average,y} = \frac{\sum_{ij} F_{ij,y} \cdot COEF_{ij}}{\sum_j GEN_{j,y}}</math></p> <p><math>COEF_i = NCV_i \cdot EF_{CO2,i} \cdot OXID_i</math></p> <p>Based on ACM0006 (p.24), for scenarios including</p>	<p>Where:</p> <p><math>ER_{electricity,y}</math> Emission reductions due to displacement of electricity during the year <math>y</math> in tons CO<sub>2</sub></p> <p><math>EF_{electricity,y}</math> CO<sub>2</sub> emission factor for the electricity displaced due to the project activity during the year <math>y</math> in tons CO<sub>2</sub>/MWh</p> <p><math>EF_{grid,y}</math> CO<sub>2</sub> emission factor for electricity displaced in the grid during the year <math>y</math> in tons CO<sub>2</sub>/MWh</p> <p><math>NCV_i</math> Net calorific value (energy content) per mass or volume unit of fuel <math>i</math></p> <p><math>OXID_i</math> Oxidation factor of the fuel <math>i</math> (see p. 1.29, 1996 Revised IPCC Guidelines for default values)</p> <p><math>EF_{CO2,i}</math> CO<sub>2</sub> emission factor per unit of energy of the fuel <math>i</math></p> <p><math>EG_{project\ plant,y}</math> Net quantity of electricity generated in the project plant during the year <math>y</math> in MWh</p> <p><math>EF_{OM,average,y}</math> CO<sub>2</sub> average Operating Margin emission factor of the grid</p> <p><math>F_{i,j,y}</math> Amount of each fossil fuel <math>i</math> consumed by each power source or plant <math>j</math></p> <p><math>GEN_{j,y}</math> Electricity delivered to the grid by each power source or plant <math>j</math></p>
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<sup>1</sup> 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.





Scenario 3,  $EG_y$  shall be estimated as follows:

$$EG_y = EG_{project\ plant,y}$$

For scenarios including Scenario 3, ACM0006 (p.29) specifies that emission reductions or increases due to displacement of heat ( $ER_{heat,y}$ ) is equal to zero.

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

Baseline emissions due to natural decay or uncontrolled burning of anthropogenic sources of biomass ( $BE_{Biomass,y}$ ) will be calculated using Equation (24a) in accordance with the description of the situation under Scenario 3 (ACM0006, p.7). In the absence of the project activity, the quantity of biomass that would not be needed for heat generation would be dumped and left to decay or burned in an uncontrolled manner as the general practice in the area.

<p>(24a) <math>BE_{Biomass,y} = GWP_{CH_4} \cdot \sum_i BF_{i,not\ used,y} \cdot NCV_i</math></p> <p style="text-align: center;"><math>\cdot EF_{burning,CH_4,i}</math></p>	<p>Where:</p> <p><math>BE_{Biomass,y}</math> Baseline emissions due to natural decay or uncontrolled burning of anthropogenic sources of biomass during the year <math>y</math> in tons CO<sub>2</sub>e</p> <p><math>BF_{i,not\ used,y}</math> Quantity of biomass type <math>i</math> used as fuel in the project plant during year <math>y</math>, which in the absence of the project activity would not be used and dumped to decay or burned in uncontrolled manner</p> <p><math>NCV_i</math> Net calorific value of the biomass type <math>i</math></p> <p><math>EF_{burning,CH_4,i}</math> CH<sub>4</sub> emission factor for uncontrolled burning of the biomass type <math>i</math></p> <p><math>GWP_{CH_4}</math> Global Warming Potential of methane</p>
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Based on option L1 specified in ACM0006 (p.36), 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:

$(1) ER_y = ER_{heat,y} + ER_{electricity,y} + BE_{Biomass,y} - PE_y - L_y$	<p>Where:</p> <p><math>ER_y</math> Emission reductions of the project activity during the year <math>y</math> in tons of <math>CO_2</math></p> <p><math>ER_{heat,y}</math> Emission reductions due to displacement of heat during the year <math>y</math> in tons of <math>CO_2</math></p> <p><math>ER_{electricity,y}</math> Emission reductions due to displacement of electricity during the year <math>y</math> in tons of <math>CO_2</math></p> <p><math>BE_{Biomass,y}</math> Baseline emissions due to natural decay or burning of anthropogenic sources of biomass during the year <math>y</math> in tons of <math>CO_2</math> equivalents</p> <p><math>PE_y</math> Project emissions during the year <math>y</math> in tons of <math>CO_2</math></p> <p><math>L_y</math> Leakage emissions during the year <math>y</math> in tons of <math>CO_2</math></p> <p><math>ER_{heat,y}</math> and <math>L_y</math> are both equal to zero.</p>
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#### B.6.2. Data and parameters that are available at validation:

(Copy this table for each data and parameter)

<b>Data / Parameter:</b>	<b>9. <math>COEF_{CO_2,i}</math></b> (for use in Equation 5)
Data unit:	t $CO_2$ / MJ
Description:	$CO_2$ emission factor for diesel fuel
Source of data used:	Table 1-32, Revised 1996 IPCC Guidelines Reference Manual: average $CO_2$ emission factor for light & heavy diesel trucks.
Value applied:	72.098 g $CO_2$ /MJ
Justification of the choice of data or description of measurement methods and procedures actually applied :	IPCC default values will be used if national or local data are unavailable. Data does not need to be monitored. Uncertainty level of data: Low.
Any comment:	

<b>Data / Parameter:</b>	<b>9a.</b> (for use in Equation 5)
Data unit:	MJ/liter diesel
Description:	Heating value of petro-diesel
Source of data used:	Bioenergy Feedstock Development Programs, ORNL, TN USA
Value applied:	36.4 MJ/liter petro-diesel
Justification of the choice of data or description of measurement methods and procedures actually applied :	To convert $COEF_{CO_2,i}$ to t $CO_2$ / liter of diesel fuel:  $COEF_{CO_2,i} = 0.0000721 \text{ t}CO_2/MJ * 36.4 \text{ MJ/liter} = 0.002624 \text{ t}CO_2/liter$



Any comment:	
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<b>Data / Parameter:</b>	<b>9. <math>COEF_{CO_2,i}</math></b> (for use in Equation 6)
Data unit:	tCO <sub>2</sub> /liter fuel oil
Description:	CO <sub>2</sub> emission factors for heavy fuel oil (HFO) and light fuel oil (LFO)
Source of data used:	Table 1-1, Revised 1996 IPCC Guidelines Reference Manual
Value applied:	20.2 tC/TJ for LFO; 21.1 tC/TJ for HFO
Justification of the choice of data or description of measurement methods and procedures actually applied :	IPCC default values will be used if national or local data are unavailable. Data does not need to be monitored.
Any comment:	

<b>Data / Parameter:</b>	<b>9a.</b> (for use in Equation 6)
Data unit:	MJ/liter
Description:	Energy content of heavy fuel oil (HFO) and light fuel oil (LFO)
Source of data used:	Used in various studies.
Value applied:	38.68 MJ/liter for LFO; 40.5 MJ/liter for HFO
Justification of the choice of data or description of measurement methods and procedures actually applied :	To convert $COEF_{CO_2,i}$ to tCO <sub>2</sub> /liter fuel oil:  $COEF_{CO_2,i}$ for LFO = 38.68 MJ/liter * 20.2 tC/TJ * 44/12 tCO <sub>2</sub> /tC = 0.002865 tCO <sub>2</sub> /liter  $COEF_{CO_2,i}$ for HFO = 40.5 MJ/liter * 21.1 tC/TJ * 44/12 tCO <sub>2</sub> /tC = 0.003133 tCO <sub>2</sub> /liter
Any comment:	

<b>Data / Parameter:</b>	<b><math>EF_{burning,CH_4,i}</math></b>
Data unit:	kg CH <sub>4</sub> /TJ
Description:	Methane emission factor for uncontrolled burning of bagasse
Source of data used:	Table 1-7, Revised 1996 IPCC Guidelines Reference Manual. No methane emission factor for bagasse is reported in the table. The value shown here is based on the default CH <sub>4</sub> emission factor of 300 kg/TJ for combustion of biomass in agriculture or forestry, and adjusted using a conservativeness factor of 0.73.
Value applied:	219 kg CH <sub>4</sub> /TJ
Justification of the choice of data or description of measurement methods and procedures actually applied :	IPCC default values will be used if national or local data are unavailable. Data does not need to be monitored.
Any comment:	



<b>Data / Parameter:</b>	<b><math>BF_{i,not\ used,y}</math></b>
Data unit:	Tons/yr
Description:	Quantity of bagasse that would be dumped to decay or burned in uncontrolled manner in the absence of project activity
Source of data used:	Project Developer
Value applied:	50,000 tonnes of surplus baggase
Justification of the choice of data or description of measurement methods and procedures actually applied :	This amount has been estimated by the Project Developer. In the absence of the project activity, 50,000 tonnes of excess bagasse will be discarded and left to decay (see Annex 3 on Baseline Information for details).
Any comment:	

<b>Data / Parameter:</b>	<b><math>GWP_{CH4}</math></b>
Data unit:	t CO <sub>2</sub> /t CH <sub>4</sub>
Description:	Global Warming Potential of methane
Source of data used:	IPCC default value
Value applied:	21 t CO <sub>2</sub> /t CH <sub>4</sub>
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:

>>

Project emissions are estimated as follows:

a) Carbon dioxide emissions from combustion of fossil fuels for transportation of biomass 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 GUYSUOCO-owned sugar mill to the project plant.

$$\begin{aligned}
 PET_y &= F_{Trans,i,y} \cdot COEF_{CO_2,i} \\
 &= 282,088.82 \text{ liters diesel/yr} * 36.4 \text{ MJ/liter diesel} * 0.0000721 \text{ t CO}_2/\text{MJ} \\
 &= \mathbf{740.33 \text{ t CO}_2/\text{yr}}
 \end{aligned}$$

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

$$PEFF_y = \sum FF_{project\ plant,i,y} \cdot COEF_{CO_2,i}$$



$$\begin{aligned}
&= [(5,444,460 \text{ liters HFO/yr} * 40.5 \text{ MJ/liter HFO} * 21.1 \text{ tC/TJ}) + \\
&(111,111 \text{ liters LFO/yr} * 38.68 \text{ MJ/liter LFO} * 20.2 \text{ tC/TJ})] * 44/12 \text{ t CO}_2/\text{tC} \\
&= \mathbf{17,378.29 \text{ tCO}_2/\text{yr}}
\end{aligned}$$

c) Methane emissions from combustion of biomass ( $PE_{Biomass,CH_4,y}$ )

$$\begin{aligned}
PE_{Biomass,CH_4,y} &= EF_{CH_4} \cdot \sum BF_{i,y} \cdot NCV_i \\
&= 20.55 \text{ kg CH}_4/\text{TJ} * [(347,822.85 \text{ tons bagasse} * 7.038 \text{ GJ/ton}) + \\
&(55,000 \text{ tons bagasse} * 6.728 \text{ GJ/ton})] * 1/1000. \\
&= \mathbf{57.90 \text{ t CH}_4/\text{yr}}
\end{aligned}$$

$$\begin{aligned}
PE_y &= PET_y + PEF_{CO_2,y} + GWP_{CH_4} \cdot PE_{Biomass,CH_4,y} \\
&= (740.33 + 17,378.29) \text{ t CO}_2/\text{yr} + 21 \text{ t CO}_2/\text{t CH}_4 * 57.90 \text{ t CH}_4 \\
&= \mathbf{19,334.52 \text{ tCO}_2/\text{yr}}
\end{aligned}$$

Baseline emissions are estimated as follows:

The baseline methodology considers the (a) 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 will be 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.  $EF_{OM,average,y}$  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:



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

$$\begin{aligned} COEF_i &= NCV_i \cdot EF_{CO_2,i} \cdot OXID_i \\ &= 38.68 \text{ MJ/liter LFO} * 20.2 \text{ tC/TJ} * 0.99 \\ &= 0.0007735 \text{ tC/liter LFO} \end{aligned}$$

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
Onverwagt	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,

$$\begin{aligned} EF_{OM, average, y} &= [(21,946,025.4 \text{ liters LFO} * 0.0007735 \text{ tC/liter LFO} * 44/12 \text{ t CO}_2/\text{tC}) \\ &\quad / 65,634.30 \text{ MWh}] \\ &= 0.9483 \text{ t CO}_2/\text{MWh} \end{aligned}$$

#### 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.

$$\begin{aligned} ER_{electricity,y} &= EG_y \cdot EF_{OM, average, y} \\ &= 67,449.86 \text{ MWh/yr} * 0.9483 \text{ t CO}_2/\text{MWh} \end{aligned}$$



$$= \underline{63,962.70 \text{ tCO}_2/\text{yr}}$$

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

In accordance with the baseline scenario describes under Scenario 3 in ACM0006, in the absence of the project activity, the bagasse would be used to generate heat in boilers of another cogeneration plant that would be established at the project site and excess bagasse would be dumped and left to decay (as the prevailing practice in the region). Since the other plant that would be considered in the absence of the project activity would be small and would generate energy for internal requirements only, it has been estimated that there would be 50,000 tonnes of bagasse that would be dumped and left to decay if the project cogeneration plant is not built. For these reasons,  $BE_{Biomass,y}$  is calculated below based on the 50,000 tonnes of bagasse that will be disposed in the absence of the project activity.<sup>2</sup> The value of 219 kg  $\text{CH}_4/\text{TJ}$  assumed for  $EF_{burning \text{ CH}_4,i}$  is based on the default  $\text{CH}_4$  emission factor of 300 kg/TJ for combustion of biomass in agriculture or forestry, as provided in Table 1-7 of the Revised 1996 IPCC Guidelines Reference Manual, and adjusted using a conservativeness factor of 0.73.

$$BE_{Biomass,y} = GWP_{CH_4} \cdot \sum_i BF_{i,not \text{ used},y} \cdot NCV_i \cdot EF_{burning,CH_4,i} \quad (24a)$$

$$= [21 \text{ t CO}_2/\text{t CH}_4 * (50,000 \text{ tons bagasse/yr} * 6.728 \text{ GJ/ton bagasse} * 219 \text{ kg CH}_4/\text{TJ})$$

$$/ 1000.]$$

$$= \underline{1,547.10 \text{ t CO}_2/\text{yr}}$$

Leakage emissions are zero:

$$L_y = 0$$

The emission reductions on average of this project activity are:

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

$$= (63,962.70 + 1,547.10 - 19,334.52) \text{ t CO}_2/\text{yr}$$

$$= \underline{46,175.28 \text{ t CO}_2/\text{yr}}$$

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

<sup>2</sup> Given the description of the baseline scenarios in ACM0006, it appears there is an error in p.34. Equation 24a would logically fit Scenario 3 while Equation 24 would be Scenario 16. (Please verify.)



&gt;&gt;

Year	Estimation of project activity emissions (tonnes of CO <sub>2</sub> e)	Estimation of baseline emissions (tonnes of CO <sub>2</sub> e)	Estimation of leakage (tonnes of CO <sub>2</sub> e)	Estimation of overall emission reductions (tonnes of CO <sub>2</sub> e)
2008	15,609.45	47,443.87	0	31,834.42
2009	14,675.78	61,498.63	0	46,822.85
2010	15,207.53	68,161.38	0	52,953.85
2011	19,239.65	69,450.12	0	50,210.47
2012	21,288.52	70,058.93	0	48,770.41
2013	23,587.62	70,699.98	0	47,112.36
2014	25,733.51	71,255.68	0	45,522.17
<b>Total (t CO<sub>2</sub>e)</b>	135,342.06	458,568.59	0	323,226.53

### 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)

<b>Data / Parameter:</b>	1. $BF_{i,y}$
Data unit:	tons/yr
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 cross-checked with an annual energy balance based on bagasse in-flows (from the SSMP and another GUYSSUCO-owned sugar mill) and stock changes. Uncertainty level of data: Low.
Any comment:	100% of data will be monitored.

<b>Data / Parameter:</b>	2. & 18. $NCV_i$
Data unit:	kJ/kg





Description:	Net calorific value of bagasse to be used as fuel in the project cogeneration plant (Equation 7) or bagasse to be dumped in the absence of the project activity (Equation 24a)
Source of data to be used:	Project Developer; calculated by 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 (Used also for excess bagasse to be discarded in the absence of project).
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:	

<b>Data / Parameter:</b>	<b>3. <math>EF_{CH_4}</math></b>
Data unit:	kg CH <sub>4</sub> /TJ
Description:	Methane emission factor for combustion of bagasse in the project plant
Source of data to be used:	Table 1-16, Revised 1996 IPCC Guidelines Reference Manual.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	20.55 kg CH <sub>4</sub> /TJ
Description of measurement methods and procedures to be applied:	Table 1-16, Revised 1996 IPCC Guidelines Reference Manual is used. No methane emission factor for bagasse is reported in the table. The value shown here is the IPCC default value for wood burned in stoker boilers of 15 kg/TJ, adjusted using conservativeness factor of 1.37 (from Table 3, p.20 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:	

<b>Data / Parameter:</b>	<b>8. <math>F_{Trans,i,y}</math></b>
Data unit:	liters/yr
Description:	Consumption of diesel fuel to be used for transportation of bagasse during the year <i>y</i>
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 fuel/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 in the plant site and recorded.
QA/QC procedures to be applied:	Bagasse will come from only two sources, thus the distance to be travelled is fixed. Uncertainty level of data: Low.
Any comment:	Data does not need to be monitored.

<b>Data / Parameter:</b>	<b>10. <math>FF_{project\ plant,y}</math></b>
Data unit:	m <sup>3</sup> /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 <sup>3</sup> /yr (2008-2014) LFO: average of 111.11 m <sup>3</sup> /yr (2008-2014)  Yearly data: 4,457 m <sup>3</sup> 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:	

<b>Data / Parameter:</b>	<b>11. <math>EG_{project\ plant,y}</math></b>
Data unit:	MWh
Description:	Net quantity of (bagasse-based) electricity generated in the project plant during the year <i>y</i> 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	Readings of the energy metering connected to the grid will be done regularly and



measurement methods and procedures to be applied:	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.

<b>Data / Parameter:</b>	$EF_{OM\ average,y}$
Data unit:	t CO <sub>2</sub> /MWh
Description:	CO <sub>2</sub> 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.

<b>Data / Parameter:</b>	$F_{i,y}$
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.

<b>Data / Parameter:</b>	$GEN_{i,y}$
--------------------------	-------------



Data unit:	MWh/yr
Description:	Electricity delivered to the grid by each power plant <i>i</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.

<b>Data / Parameter:</b>	<b><math>COEF_i</math></b>
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.
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 $COEF_i = 38.68 \text{ MJ/liter LFO} * 20.2 \text{ tC/TJ} * 0.99 = 0.0007735 \text{ tC/liter LFO}$
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

### 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: 5/10/06
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:**

>> 24 February 2004 (This was the date of the letter from the World Bank to GUYSUCO indicating approval of the project and suggesting to contact the CDCF for CDM support. Project Developer believes this is the valid date to use.)

**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. 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) which 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 which 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 environmental and social impacts of the factory project and the role that private farmers and cooperatives would play. In late 2004, the Project Sponsor (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. Many business operators have invested to produce their own electricity using diesel generators 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 improved power supply would enable existing rice millers and sawmill operators to expand output and increase employment.

**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:	<a href="http://www.GuySuCo.com">http://www.GuySuCo.com</a>
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:	<a href="mailto:NickJ@guysuco.com">NickJ@guysuco.com</a>
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:	<a href="mailto:IBRD-carbonfinance@worldbank.org">IBRD-carbonfinance@worldbank.org</a>
URL:	<a href="http://www.carbonfinance.org">www.carbonfinance.org</a>
Represented by:	Joelle Chassard
Title:	Manager, Carbon Finance
Salutation:	Ms.
Last Name:	Chassard
Middle Name:	
First Name:	Joelle
Department:	ENVCF





**CDM – Executive Board**

Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	



**Annex 2**

**INFORMATION REGARDING PUBLIC FUNDING**

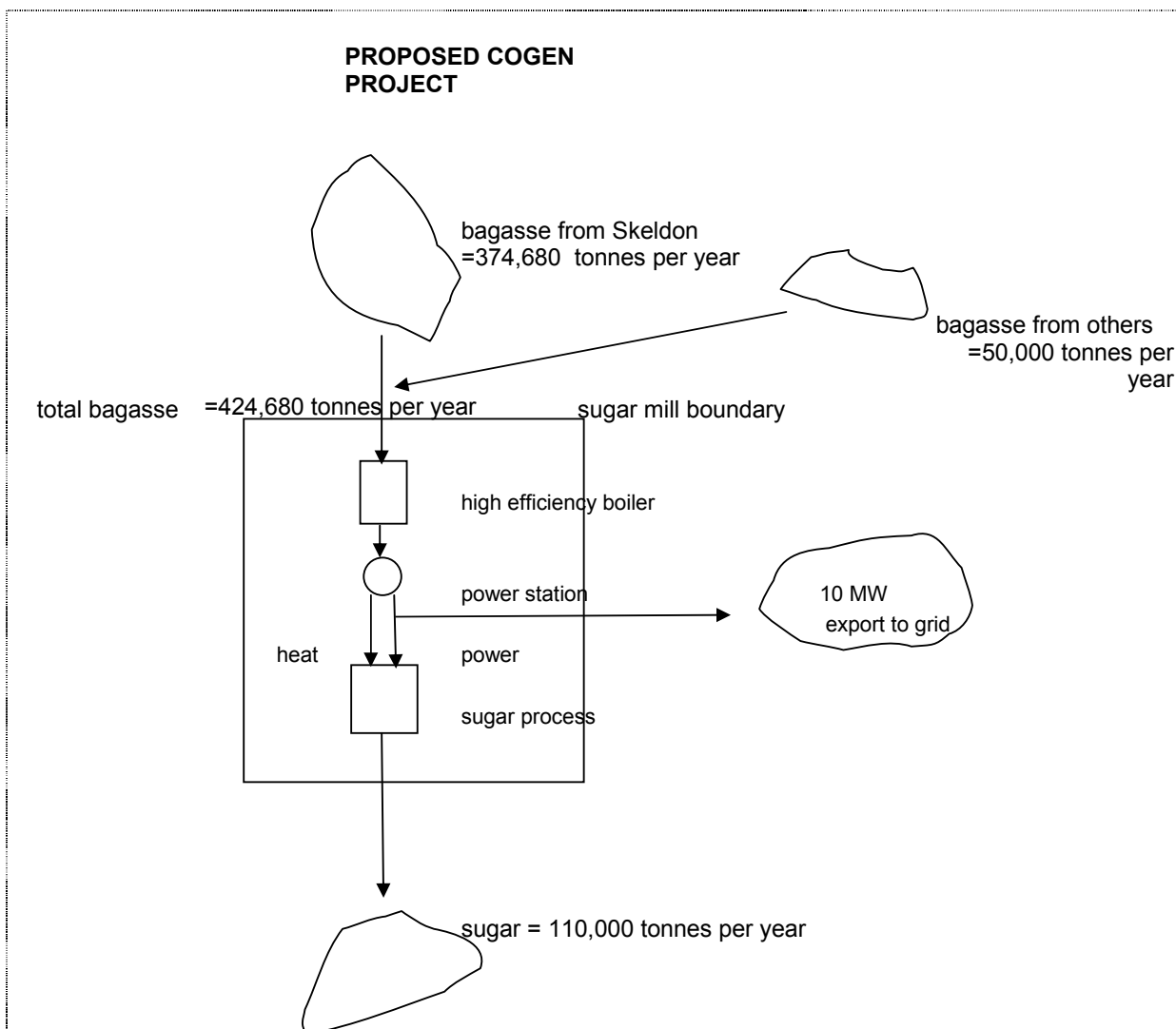
There is no Annex I public funding involved in Guyana Bagasse Cogeneration project activity.



**Annex 3**

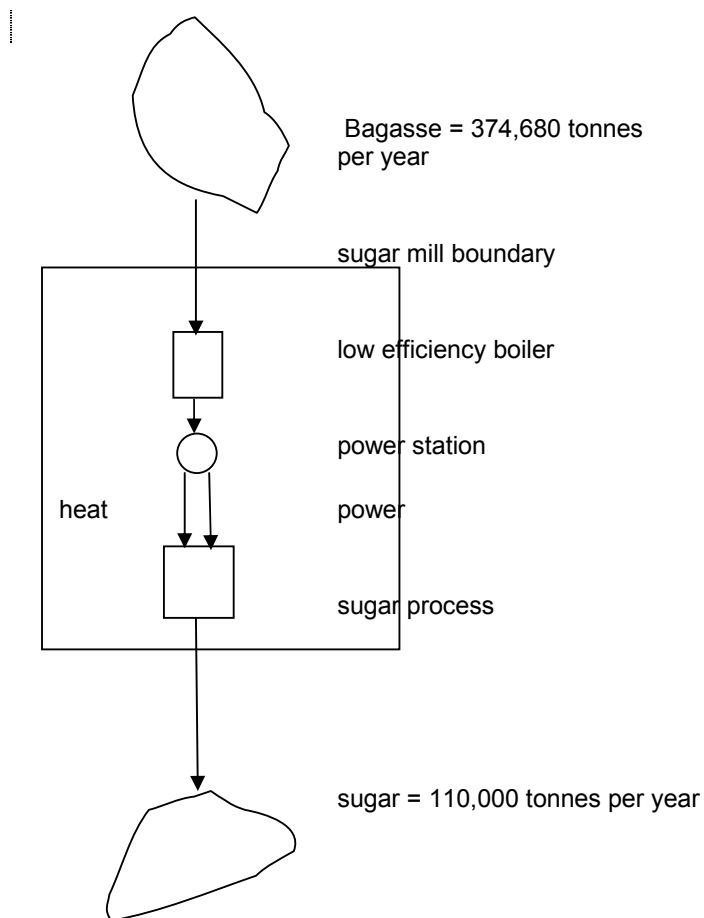
**BASELINE INFORMATION**

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.<sup>3</sup> 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.

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.

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<sup>3</sup> 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.



#### 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.
- 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 default values by the IPCC.
- 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 3 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.
- 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.
- CO<sub>2</sub> 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 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 approach B<sub>1</sub> 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.

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