



**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:**

PT. BUDI ACID JAYA Tapioca Starch Production Facilities Effluent Methane Extraction And On-site Power Generation Project in Lampung Province, Republic of Indonesia (“The Project” or “the Project activity”)

Version 01

26 December 2006

A.2. Description of the project activity:

The Project activity involves the installation of a closed anaerobic wastewater treatment and biogas extraction system at an existing tapioca starch manufacturing plant and its auxiliary facilities for treatment of organic wastewater, which is currently treated at an open lagoon based system. The collected biogas will be utilized for electricity generation which will be used on-site. By extracting and utilizing biogas, the Project activity will reduce the CH₄ emissions that would have otherwise been emitted from the existing open lagoons. The electricity generated with biogas by the Project activity will displace carbon intensive electricity of the South Sumatran grid as well as the diesel based captive generation and will additionally reduce GHG emissions.

The project developer PT. BUDI ACID JAYA (hereafter referred to as BAJ) is the largest tapioca starch producer in Indonesia. BAJ plans to install a number of Upflow Anaerobic Sludge Blanket (UASB) digesters, a high rate anaerobic digestion technology for wastewater treatment, at WAY ABUNG, which is one of its sixteen tapioca starch facilities located in Lampung Province in the southern part of the Sumatra Island in Indonesia. WAY ABUNG plant produces tapioca starch and associated products (i.e. glucose and acetic acid) from tapioca residues. The facilities are currently capable of producing 450 tons of tapioca starch, 60 tons of glucose, and 30 tons of citric acid daily. The operation of these facilities results in approximately 16,900 m³/day of wastewater with high organic content. All wastewater from the production processes is currently treated at an open anaerobic lagoon system prior to its release into the adjacent river system. The existing system meets the effluent regulatory standards for the tapioca industry in Indonesia.

In the Project activity, the organic wastewater from WAY ABUNG plant is sent to anaerobic digesters prior to being discharged into the existing open anaerobic lagoon treatment system. Anaerobic digestion consistently generates methane-rich biogas. Generated biogas is collected and utilized as fuel for electricity generation and surplus biogas is flared in the Project. The generated electricity will supply WAY ABUNG plant’s electricity demand, replacing carbon intensive electricity imported from the grid¹ as well as the diesel based captive power generation. The Project initially plans to install five biogas engine generators with capacity of 1.0 MW each or total generation capacity of 5.0 MW. Depending on the actual biogas generation, the project developer may expand the generation capacity up to 8.0 MW by installing three additional 1.0 MW generators.

¹ The project activity replaces electricity imported from South Sumatra, West Sumatra and Riau electricity grid (SSWSR grid).



The amount of greenhouse gases (GHGs) emission reductions resulting from the Project activity is expected to be approximately 280,000 tCO₂e per annum.

The Project activity will directly contribute to sustainable development of Indonesia in several ways as shown below.

Environmental benefits

- Mitigation of uncontrolled GHG emission from the lagoons.
- Mitigation of unpleasant odor caused by treatment of high strength organic wastewater at open lagoons.

Economical benefits

- Utilization of biogas as a new indigenous fuel source in Indonesia.
- Access to foreign expertise and training to facilitate smooth technology transfer.
- Access to overseas capital through the sale of CERs.

Social benefits

- Creation of new jobs for local population.
- Staff training to improve their technical skills.

A.3. 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)
Party/country: Indonesia (host)	PT. BUDI ACID JAYA (BAJ)	No
Party/country: Japan	SUMITOMO Corp.	No

(* 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.

SUMITOMO Corp, who is a project participant, is the contact for this Project activity (See Annex 1 for contact details).

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

Republic of Indonesia

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

Lampung Province, Sumatra Island

A.4.1.3. City/Town/Community etc:

Desa Gunung Batin, Terusan Nunyai, Lampung Tengah

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

The Project activity will be located on the premises of BAJ Way Abung factories, located in the village of Desa Gunung Batin in the central part of Lampung Province in the southern part of Sumatra, Indonesia.

**Figure 1: Location map of proposed project activity****A.4.2. Category(ies) of project activity:**

Sectoral scope 13: Waste handling and disposal

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

The technology to be implemented by the Project activity is an Upflow Anaerobic Sludge Blanket (UASB) system. Developed in the late 1970's, it is an internationally recognized "high rate" anaerobic treatment technology known for its effectiveness in the treatment of high strength organic wastewater



from such operations as food processing and distillery. In the UASB process, wastewater flows upward through a sludge blanket composed of microorganisms that naturally form granules or particles of 0.5 to 2 mm in diameter (“sludge granules”). When wastewater comes in contact with the granules, anaerobic decomposition of the organic material contained in the wastewater takes place, resulting in the generation of methane-rich biogas. The hydraulic turbulence caused by produced biogas bubbles provides mixing to the digester. The high sedimentation velocity of biological granules formed in the digester prevents washout of the sludge granules, leading to longer sludge retention time in the digester.

Through the utilization of this advanced technology, the Project will be able to achieve approximately 90% removal of COD, significantly reducing the COD load to the open lagoons, which subsequently receive effluent from the UASB digester.

Extracted biogas will be forwarded from a gasholder to biogas engine generators for electricity generation. The project developer plans to install of a set of gas engines supplied by a widely recognized technology supplier for biogas applications.

The planned treatment system is illustrated in the flow chart shown in Figure 2 below.

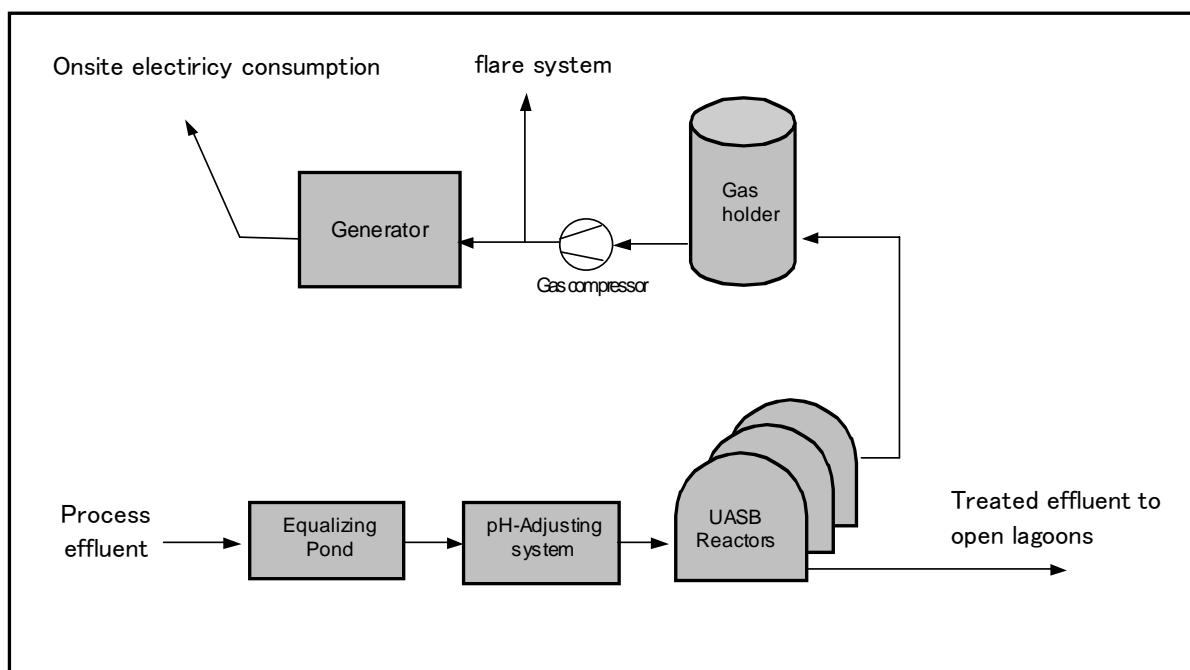


Figure 2: Process Flow Diagram

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

Years	Annual estimation of emission reductions in tonnes of CO ₂ e
Year 1 (July 2007 – June 2008)	280,306
Year 2 (July 2008 – June 2009)	280,306



Year 3 (July 2009 – June 2010)	280,306
Year 4 (July 2010 – June 2011)	280,306
Year 5 (July 2011 – June 2012)	280,306
Year 6 (July 2012 – June 2013)	280,306
Year 7 (July 2013 – June 2014)	280,306
Total estimated reductions (tonnes of CO ₂ e)	1,962,142
Total number of crediting years	7
Annual average over the crediting period of estimated reductions (tonnes of CO ₂ e)	280,306

A.4.5. Public funding of the project activity:

The Project will receive partial capital cost funding from New Energy and Industrial Technology Development Organization (NEDO), an administrative agency incorporated under Japan's Ministry of Economy, Trade and Industry. Funding from NEDO, though public, is not counted as part of Japan's official development assistance.

SECTION B. Application of a baseline methodology

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

Avoided wastewater and on-site energy use emissions in the industrial sector – version04 (AM0022 version 04)

It is hereafter referred to as the baseline methodology.

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

AM0022 version 04 has been chosen because the Project activity involves the installation of an anaerobic treatment system in an existing open lagoon-based wastewater treatment facility and meets all the applicability conditions stated in the baseline methodology as follows:

- Project is implemented in existing lagoon-based industrial wastewater treatment facilities for wastewater with high organic loading;

The Project is implemented in an existing lagoon-based industrial wastewater treatment facility in a tapioca starch manufacturing plant. The wastewater in the Project plant treats high organic loading materials (compounds).

- The organic wastewater contains simple organic compounds (mono-saccharides). If the methodology is used for wastewater containing materials not akin to simple sugars a CH₄ emissions factor different from 0.21 kgCH₄/kgCOD has to be estimated and applied;

The primary organic compound contained in the cassava processing wastewater is starch, which is a poly-saccharide, a more complex organic compound compared to mono-saccharides. As the baseline methodology stipulates, an alternative CH₄ emission factor is estimated and applied for the project



activity. The maximum CH₄ producing capacity (B₀), 0.21 kg CH₄/kg COD, stated in approved baseline methodology AM0013 “Avoided methane emissions from organic waste-water treatment” is selected for the Project. As discussed in AM0013, this value is based on the default IPCC value for B₀, 0.25 kg CH₄/kg COD, taking account of the 50 – 100% uncertainty range, and it is applicable to all organic wastewater types. Considering the fact that this value has been established as the result of comprehensive discussions among the methodology panel as well as the CDM Executive Board, it is a conservative and transparent approach for the project participant to adopt this value for the methane emission factor.

- The methodology is applicable only to the improvement of existing wastewater treatment facilities. It is not applicable for new facilities to be built or newly build to extend current site capacity;

The Project is implemented in existing wastewater treatment facilities, not in new facilities to be built or newly build to extend the current site capacity of the tapioca starch manufacturing plant.

- It can be shown that the baseline is the continuation of a current lagoon system for managing wastewater. In particular, the current lagoon based system is in full compliance with existing rules and regulations;

As described in section B. 4 below, the baseline is the utilization of the current lagoon system for managing wastewater. Also, the current lagoon based system is in full compliance with existing rules and regulations of the Republic of Indonesia².

- The depth of the anaerobic lagoons should be at least 1m;

The depth of the anaerobic lagoons is approximately 6m.

- The temperature of the wastewater in the anaerobic lagoons is always at least 15°C;

Annual minimum temperature of the wastewater in the anaerobic lagoon is approximately 30 °C.

- In the project, the biogas recovered from the anaerobic treatment system is flared and/or used on-site for heat and/or power generation, surplus biogas is flared;

The Project utilizes the biogas recovered from the UASB system for power generation and surplus biogas is flared.

- Heat and electricity needs per unit input of the water treatment facility remain largely unchanged before and after the project;

Before and after the Project implementation, heat and electricity needs per unit input of the water treatment facility remain largely unchanged.

- Data requirements as laid out in the related Monitoring Methodology are fulfilled. In particular, organic materials flow into and out of the considered lagoon based treatment system and the contribution of different removal processes can be quantified (measured or estimated)

² Ministerial Decree No. KEP-51/MENLH/10/1995: Liquid Waste Quality Standards for Industrial Activities



As described in section B.7 below, data requirements will be fulfilled. Organic materials flow into and out of the considered lagoon based treatment system and the contribution of different removal processes will be measured and quantified.

The baseline methodology will be used in conjunction with the approved monitoring methodology AM0022 version04.

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

	Source	Gas	Included?	Justification / Explanation
Baseline	CH ₄ emissions from the open lagoon	CO ₂	Excluded	Originating from a biogenic source, considered carbon neutral
		CH ₄	Included	Main GHG emission source
		N ₂ O	Excluded	Negligible
	On site CO ₂ emissions from fossil fuel displaced by biogas	CO ₂	Included	Main GHG emission source
		CH ₄	Excluded	Negligible
		N ₂ O	Excluded	Negligible
	Grid CO ₂ emissions from fossil fuel displaced by biogas	CO ₂	Included	Main GHG emission source
		CH ₄	Excluded	Negligible
		N ₂ O	Excluded	Negligible
Project Activity	CH ₄ emissions from the open lagoon	CO ₂	Excluded	Originating from a biogenic source, considered carbon neutral
		CH ₄	Included	Main GHG emission source
		N ₂ O	Excluded	Negligible
	CH ₄ emissions from the new wastewater treatment facility	CO ₂	Excluded	Originating from a biogenic source, considered carbon neutral
		CH ₄	Included	Main GHG emission source
		N ₂ O	Excluded	Negligible
	CH ₄ emissions from inefficient combustion and leaks	CO ₂	Excluded	Originating from a biogenic source, considered carbon neutral
		CH ₄	Included	Main GHG emission source
		N ₂ O	Excluded	Negligible

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

As per the baseline methodology, the baseline determination follows a six-step process below.

- Step 1: List a range of potential baseline options
- Step 2: Select the barriers from the range of potential barriers
- Step 3: Score the barriers
- Step 4: Compare which is the most plausible baseline option
- Step 5: Investment Analysis



Step 6: Conclusion

Step 1: List a range of potential baseline options

Following alternatives are considered as potential baseline scenarios.

Alternative 1: Continuation of the current situation

Alternative 2: The Project is undertaken without CDM assistance. (Anaerobic digestion system)

Alternative 3: Aerobic wastewater treatment system (activated sludge or filter bed treatment)

Alternative 4: Direct release of wastewater to a nearby water body

Step 2: Select the barriers from the range of potential barriers

The following barriers that may prevent the implementation of the considered alternatives are selected.

1. Legal barriers
2. Technical barriers
3. Financial barriers
4. Social barriers
5. Business culture barriers

Step 3: Score the barriers

Each barrier selected in Step 2 is scored by addressing a range of potential questions.

1. Legal barrier

- Does the practice violate any host country laws or regulations or is it not in compliance with them?

At present in Indonesia there are no regulatory or contractual requirements which enforce implementation of a specific wastewater treatment technology such as anaerobic digester or aerobic treatment system to cassava processing plants for effluent treatment. Current Indonesian law allows utilization of open lagoon systems for wastewater treatment in tapioca industry. BAJ currently meets the industrial effluent discharge standards for the tapioca industry by utilizing the existing open lagoon based wastewater treatment system. Therefore, alternative 1 does not face any legal barriers.

Since alternative 2 and 3 improve the wastewater treatment system and do not violate any laws or regulations in Indonesia, they also do not face legal barriers.

Direct release of starch processing wastewater to water bodies without further treatment will result in violation of the effluent discharge standards set by the laws and regulations of Indonesia. Therefore, Alternative 4 cannot be considered the baseline and is excluded from further assessment.

2. Technical barrier

- Is this technology option currently difficult to purchase through local equipment suppliers?
- Are skills and labor to operationalize and maintain this technology in country insufficient?
- Is this technology outside common practice in similar industries in the country?
- Is performance certainty not guaranteed within tolerance limits?



- Is there real, or perceived, technology risk associated with the technology?

Alternative 1 has been a common way of handling wastewater from tapioca starch production in Indonesia. In Lampung province, most of the tapioca starch production facilities utilize open lagoon based systems for treating wastewater. The related technology, skills and labor are readily available in Indonesia and there are few risks associated with this technology. Therefore, Alternative 1 does not face technical barriers.

At present in Lampung province, only a few tapioca starch processing facilities adopt anaerobic bioreactor technology for wastewater treatment. Though the related technology may be available domestically, skills and labor to operate and maintain the facility properly may be acquired only after extensive training which is not available at the moment. Furthermore, anaerobic digestion technology is not a common practice in tapioca starch industry or other similar industries in Indonesia, thus entailing significant performance and technology risks in effluent treatment. Therefore, Alternative 2 faces strong technical barriers.

Although aerobic wastewater treatment is well established and commonly used for both domestic and industrial wastewater treatment in many parts of the world, there is limited experience with this type of technology in the tapioca starch industry in Indonesia. There is strong performance uncertainty in applying an aerobic treatment system in effluent treatment. Therefore, Alternative 3 also faces strong technical barriers.

3. Financial barrier

- Is the technology intervention financially less attractive in comparison to other technologies (taking into account potential subsidies, soft loans or tax windows available)?
- Is equity participation difficult to find locally?
- Is equity participation difficult to find internationally?
- Are site owners/ project beneficiaries carrying any risk?
- Is technology currency (country) denomination a risk?
- Is the proposed project exposed to commercial risk?

At present, BAJ is utilizing open lagoon based system. Therefore, Alternative 1 does not face any financial barriers.

Compared with the current practice, both anaerobic digesters and aerobic treatment systems entail high initial and O&M costs. BAJ does not plan to install anaerobic digesters or an aerobic treatment system at its own capital because the existing wastewater treatment system fulfills all regulatory requirements for industrial wastewater discharge in Indonesia. Therefore, the Project is not deemed attractive to local investors.

The interest shown by Sumitomo Corporation (Japan) and partial capital cost funding from NEDO are contingent on the Project being implemented as a CDM activity. The Project site owner and the Project beneficiaries will face the risk of introducing a completely new technology. Based on the above arguments, it is concluded that Alternatives 2 and 3 face a significant financial barrier.

4. Social barrier

- Is the understanding of the technology low in the host country/ industry considered?



Since Alternative 1 is currently used at the Project site and is common practice in Indonesia, no social barriers are identified.

Alternative 2 and 3 face certain social barriers associated with the low understanding of the technology. However, it is expected that these barriers can be overcome through the public meetings and public awareness promotion campaigns.

5. Business Culture barrier

- Is there reluctance to change to alternative management practices in the absence of regulations?

As mentioned above, Alternative 1 is currently used for wastewater treatment and meets all regulatory requirements of Indonesia. Therefore there is no barrier caused by the change of the management practice.

As for Alternatives 2 and 3, in the absence of regulations that require installation of anaerobic digesters or aerobic treatment systems, BAJ would not have any incentive to change the effluent treatment system due to the technology and financial barriers mentioned above. Furthermore, BAJ has no experience in managing anaerobic digestion or aerobic treatment system. Therefore there are significant business culture barriers associated with the change of the management practices.

Summary of Barrier Analysis

The table below summarizes the results of the barrier analysis conducted above.

Table 1: Summary of Barrier Analysis

Barrier Tested	Plausible Baseline Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Legal		N	N	N	Y
<ul style="list-style-type: none"> • Does the practice violate any host country laws or regulations or is it not in compliance with them? 		N	N	N	Y
Technical		N	Y	Y	-
<ul style="list-style-type: none"> • Is this technology option currently difficult to purchase through local equipment suppliers? 		N	Y	Y	-
<ul style="list-style-type: none"> • Are skills and labour to operationalize and maintain this technology in country insufficient? 		N	Y	Y	-
<ul style="list-style-type: none"> • Is this technology outside common practice in similar industries in the country? 		N	Y	Y	-
<ul style="list-style-type: none"> • Is performance certainty not guaranteed within tolerance limits? 		N	Y	Y	-
<ul style="list-style-type: none"> • Is there real, or perceived, technology risk associated with the technology? 		N	Y	Y	-
Financial		N	Y	Y	-
<ul style="list-style-type: none"> • Is the technology intervention financially less attractive in 		N	Y	Y	-



comparison to other technologies (taking into account potential subsidies, soft loans or tax window available)?				
• It equity participation difficult to find locally?	N	Y	Y	-
• Is equity participation difficult to find internationally?	N	Y	Y	-
• Are site owners/ project beneficiaries carrying any risk?	N	Y	Y	-
• Is technology currency (country) denomination risk?	N	N	N	-
• Is the proposed project exposed to commercial risk?	N	N	N	-
Social	N	N	N	-
• Is the understanding of the technology low in the host country/ industry considered?	N	N	N	-
Business Culture	N	Y	Y	-
• Is there a reluctance to change to alternative management practices in the absence of regulation?	N	Y	Y	-

Step 4: Compare which is the most plausible baseline option

As discussed above, Alternative 1, continuation of the current situation, does not have any significant barriers while Alternative 2, anaerobic digestion system, and Alternative 3, aerobic treatment system, face insurmountable technical, financial and business culture barriers, which prevent the implementation of these alternatives. Therefore, Alternative 1, continuation of the current situation, is considered to be the most plausible baseline scenario.

Step 5: Investment analysis

Since there is only one baseline option, this step is not required by the baseline methodology.

Step 6: Conclusion

Based on the above arguments, continuation of the current open lagoon based wastewater treatment system is the baseline scenario in the absence of the CDM project activity.

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): >>

As per AM0022, the Project is additional because the baseline scenario is different from the proposed Project activity. In the absence of the project activity, effluent from the plant will continue to be treated by the existing open lagoon system, emitting a large amount of methane into the atmosphere.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:



In order to quantify emission reductions achieved by the project activity, procedures to calculate project emissions, baseline emissions, leakage and emission reductions set out in the methodology are applied as follows.

Project emissions

Total estimated project emissions are the sum of fugitive methane emissions from the existing lagoon based wastewater treatment system, possible methane emissions from the new anaerobic wastewater treatment facility, from incomplete biogas combustion and biogas leaks.

As per the procedures set out in AM0022 ver.03, total project emissions are estimated using the following equations.

$$E_{project} = E_{CH4_lagoons} + E_{CH4_NAWTF} + E_{CH4_IC+Leaks} \quad (1)$$

where:

$E_{project}$ is the Total Project Emissions (tCO₂e)

$E_{CH4_lagoons}$ is the fugitive methane emissions from lagoons (tCO₂e)

E_{CH4_NAWTF} is the fugitive methane emissions from the new anaerobic wastewater treatment facility (tCO₂e)

$E_{CH4_IC+Leaks}$ is the methane emissions from inefficient combustion and leaks (tCO₂e)

The calculations for each component of equation (1) are provided below.

1) Fugitive Methane Emissions from Lagoons ($E_{CH4_lagoons}$)

The digester effluent is discharged into lagoons where it is further treated prior to its release into the adjacent river system. While the removal of residual COD in lagoons is expected to occur under aerobic conditions, Fugitive Methane Emissions from Lagoons are calculated as follows:

$$E_{CH4_lagoons} = M_{lagoon_anaerobic} \cdot EF_{CH4} \cdot GWP_{CH4} / 1000 \quad (2)$$

where:

$M_{lagoon_anaerobic}$ is the amount of organic material removed by anaerobic processes in the lagoon system (kgCOD)

EF_{CH4} is the methane emission factor (kgCH₄/kgCOD). A default COD to Methane conversion factor of 0.21kg CH₄/kgCOD is used.

GWP_{CH4} is the Global Warming Potential of methane ($GWP_{CH4}= 21$)

Amount of organic material removed by anaerobic processes in the lagoon system ($M_{lagoon_anaerobic}$)

$$M_{lagoon_anaerobic} = M_{lagoon_total} - M_{lagoon_aerobic} - M_{lagoon_chemical_ox} - M_{lagoon_deposition} \quad (3)$$



where:

M_{lagoon_total} is the total amount of organic material removed in the lagoon system from equation (5) (kg COD)

$M_{lagoon_aerobic}$ is the amount of organic material degraded aerobically in the lagoon system (kg COD). Surface aerobic losses of organic material in pond-based systems equal to 254kg COD per hectare of pond surface area and per day is assumed to be lost through aerobic processes.

$M_{lagoon_chemical_ox}$ is the amount of organic material lost through chemical oxidation in the lagoon system (kg COD).

$M_{lagoon_deposition}$ is the amount of organic material lost through deposition in the lagoon system from equation (6) (kg COD)

Amount of organic material removed in the lagoon system (M_{lagoon_total})

$$M_{lagoon_total} = M_{lagoon_input} \cdot R_{lagoon} \quad (5)$$

$$\text{with } M_{lagoon_input} = M_{input_total} \cdot (1 - R_{NAWTF}) \quad (4)$$

where:

M_{lagoon_input} is the input of organic material from the new project anaerobic wastewater treatment facility into the lagoon system (kg COD)

R_{lagoon} is the total organic material removal ratio of the lagoon. It is a project specific factor, and is equal to the proportion of organic material removed (through all route) within the boundaries of the lagoon system under consideration.

M_{input_total} is the total amount of organic material fed into the new project wastewater treatment facility (kg COD)

R_{NAWTF} is the total organic material removal efficiency of the new project wastewater treatment facility.

Amount of organic material degraded aerobically in the lagoon system ($M_{lagoon_aerobic}$)

The amount of organic material degraded aerobically in the lagoon system is calculated as the product of default value of surface aerobic losses of organic material in pond (254 kg COD/ha/day), total surface area of the lagoons (21.303 ha) and number of days in a year (365 days).

As per the methodology, sensitivity analysis was conducted as follows in order to determine the effect of change in the surface aerobic loss of COD to the emission reductions:

Table 2: A sensitivity analysis for the surface aerobic losses of organic material

Surface aerobic losses	Error factor applied	Project emissions from lagoons	Sensitivity	Baseline emissions from lagoons	Sensitivity	Emission reductions	Sensitivity



	%	(tCO ₂ e)	%	(tCO ₂ e)	%	(tCO ₂ e)	%
254	-	36,003	-	316,309	-	280,306	-
280	10%	35,112	2.4	315,417	0.3	280,305	0
330	30%	33,397	7.2	313,703	0.8	280,306	0
381	50%	31,648	7.0	311,954	1.4	280,306	0
508	100%	27,293	12.1	307,599	2.8	280,306	0
762	200%	19,818	44.9	300,124	5.1	280,306	0
1270	500%	1,165	96.8	281,470	11.0	280,305	0

This analysis clearly shows that the emissions reduction calculated are independent of the surface oxidative removal of COD in this project, and thus the 254 kg COD/ha/day is appropriate for this project.

Amount of organic material lost through chemical oxidation in the lagoon system ($M_{\text{lagoon_chemical_ox}}$)

At present, no oxidative chemical compounds are used in the production process. Approximately 5 kg of calcium hypochlorite is used daily for cleaning and disinfecting the production lines. This amount is diluted with the total daily effluent of 16,900 m³/day, resulting in a concentration of less than 0.0003 kg/m³. Oxidation of chlorite mostly occurs during the washing and disinfection of the production lines and it is mostly consumed by the time when the effluent reaches to the lagoons. Therefore there will be no organic material lost through chemical oxidation in the lagoon system. Actual consumption of calcium hypochlorite will be monitored during the crediting period.

Amount of organic material lost through deposition in the lagoon system ($M_{\text{lagoon_deposition}}$)

$$M_{\text{lagoon_deposition}} = M_{\text{lagoon_input}} \cdot R_{\text{deposition}} \quad (6)$$

where:

$R_{\text{deposition}}$ is the organic material deposition ratio of the lagoon.

Feasibility study shows that there is no organic material lost through deposition in the lagoon system. Therefore, the organic material deposition ratio of the lagoon for the project activity is set to zero.

2) Methane emissions from new anaerobic wastewater treatment facility ($E_{\text{CH}_4 \text{ NAWTF}}$)

Methane emissions from the specific anaerobic wastewater treatment facilities that are installed by the Project, are assessed and estimated based on monitoring measurements, technology supplier data and expert estimates. They may be disregarded if documented evidence for their insignificance is given.

The technology provider, PAPOP CO., LTD., has estimated based on their experience that the physical leakage from UASB system is less than 3% for systems with size similar to the project activity. To ensure conservativeness, physical leakage factor of 5% of total biogas production is used for the Project activity.

3) Methane emissions from inefficient combustion emissions ($E_{\text{CH}_4 \text{ IC+Leaks}}$)

Methane emissions from inefficient combustion from biogas flaring and biogas use for on site electricity generation are quantified through the following equation.



$$E_{CH4_IC+Leaks} = \left(\sum_r V_r \cdot C_{CH4_r} \cdot (1 - f_r) \cdot GWP_{CH4} \right) + PE_{flare} \quad (7)$$

where:

the emissions are summed over two routes r for methane destruction (heating and power generation). Of which only power generation is relevant to the project activity.

$E_{CH4_IC+Leaks}$	is the methane emissions from inefficient combustion (t CO ₂ e)
V_r	is the biogas combustion process volume in route r (Nm ³)
C_{CH4}	is the methane concentration in biogas (tCH ₄ /Nm ³) ³ .
f_r	is the proportion of biogas destroyed by combustion
PE_{flare}	is the project emissions from flaring of the residual gas stream (tCO ₂ e) calculated following the procedures described in the “ <i>Tool to determine project emissions from flaring gases containing Methane</i> ”. PE_{flare} can be calculated on an annual basis or for the required period of time using this tool. For the purpose of ex-ante calculation, the project emission from flaring of the residual gas stream (PE_{flare}) is estimated as 885 tCO ₂ e.

4) Methane emissions from leaks in biogas system

Leaks in the biogas system include leaks from any anaerobic digester and leaks from the biogas pipeline delivery system. The project developer must provide, justify and take to account specific data required to calculate related emissions when applying this methodology.

Leaks in the biogas system (i.e. pipeline leakage) are anticipated to be negligible compared to the baseline emissions due to the short distance covered by the pipeline from UASB reactors to gas holders and then to the generator. The pipeline will undergo regular maintenance and monitoring to ensure the leakage remains negligible.

Baseline Emissions

Total estimated baseline emissions are the sum of fugitive methane emissions from the existing lagoon based wastewater treatment system and CO₂ emissions from the generation of power on site or off site.

$$E_{BL} = E_{CH4_lagoon_BL} + E_{CO2_power_BL} \quad (8)$$

where:

E_{BL}	is the total baseline emissions (tCO ₂ e)
$E_{CH4_lagoon_BL}$	is the fugitive methane emissions from lagoons in the baseline case (tCO ₂ e). It is calculated with baseline data based on equation (2) in the section on project emissions.

³ Though not specified in the baseline methodology, it is calculated using CH₄ density of 0.7168 kg CH₄/Nm³ CH₄ at standard temperature and pressure (0 degree Celsius and 1,013 bar) as per ACM0001 ver.04 and biogas methane concentration monitored during the project activity.



$E_{CO2_power_BL}$ is the CO₂ emissions from on site or off site fossil power generation in the baseline case (tCO₂) that is displaced by generation based on biogas collected in the anaerobic treatment facility.

1) Fugitive methane emissions from lagoons ($E_{CH4_lagoon_BL}$)

Methane emissions from lagoons are calculated using equations (2), (3), (5) and (6). In the baseline case, without the new anaerobic treatment facility, no wastewater material degrades before entering the lagoon system and all the organic material to be treated enters the lagoons system. Therefore, equation (4) has to be changed for the baseline calculations as shown below:

$$M_{lagoon_input_BL} = M_{input_total} \quad (11)$$

where:

$M_{lagoon_input_BL}$ is the input of organic material from the new project anaerobic wastewater treatment facility into the lagoon system (kg COD)

M_{input_total} is the total amount of organic material fed into the baseline wastewater treatment facility (kg COD) It is the same amount as fed into the project wastewater treatment facility.

All emission factors for surface aerobic losses of organic material, aerobic degradation, deposition or removal as well as chemical oxidation are determined in the same way as described for project emissions calculations.

2) On site and off site grid power generation emissions displaced by generation based on biogas collected in the anaerobic treatment facility ($E_{CO2_power_BL}$)

Displaced electricity CO₂ emissions are:

$$E_{CO2_power} = EL \cdot CEF \quad (10)$$

where:

EL is the amount of electricity displaced by the electricity generation from the biogas collected from the anaerobic treatment facility. This is estimated as product of: (1) average specific electricity consumption for the output of the facility, estimated using 3 years historical data: and (2) the annual production.

CEF is the carbon emission factor for the electricity displaced by the electricity generated from the biogas. (tCO₂e/MWh).

For the purpose of ex-ante calculation, EL was determined from the expected electricity generation from the gen set installed as the part of the Project activity because the EL determined by the procedure provided in the baseline methodology appear to be beyond the maximum generation capacity of the Project activity. For the ex-post calculations, the appropriateness of the EL value will be evaluated by comparing the actual power generation and the value of EL estimated as per the methodology.



For the project activity, two sources of electricity (grid and captive generation) are used in the baseline situation. As specifically directed in the methodology, the lowest among following two values is applied for the calculations;

- (i) CEF of the grid which is calculated based on ACM0002 (tCO₂e/MWh)
- (ii) CEF of the on site electricity generation equipment displaced (tCO₂e/MWh)

CEF of the grid (0.81 tCO₂e/MWh) is utilized in the Project calculations because it was smaller than the CEF of the on site electricity (0.91 tCO₂e/MWh). Details of the CEF calculations are included in Annex 3.

Leakage

As per the methodology, leakage is considered to be negligible.

Emission Reductions

Emission reductions, ER (tCO₂e) are calculated as the difference between the total baseline emissions (equation (8)) and the total project emissions (equation (1)). Leakage is considered to be negligible.

$$ER = E_{BL} - E_{project} \quad (12)$$

It has to be verified that the emissions of CH₄ from the lagoons in the baseline scenario are not higher than the total emissions of biogas from the digester and the lagoons in the project scenario. Therefore calculate:

$$E_{CH4_lagoon_BL} - (E_{CH4_lagoon} + E_{CH4_NAWTF} + E_{CH4_coll}) \quad (13)$$

where:

E_{CH4_coll} is the amount of methane expressed in (tCO₂e) contained in the biogas collected from the anaerobic treatment facility (i.e. the sum of the biogas sent to generation sets and biogas sent to the flare)

If the result of the equation (13) is positive, it will be deducted from the result obtained through the equation (12) in order to obtain the final estimation of the emission reductions.

For the purpose of ex-ante calculation, it is assumed that the emissions of CH₄ from the lagoons in the baseline scenario are equal to the total emissions of biogas from the digester and the lagoons in the Project. Therefore, equation (13) sums up to zero and is disregarded in the emission calculations.

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

Data / Parameter:	EF_{CH4}
Data unit:	kg CH ₄ / kg COD
Description:	Methane emission factor



Source of data used:	Estimated by project developer as a part of feasibility study
Value applied:	0.21
Justification of the choice of data or description of measurement methods and procedures actually applied :	The primary organic compound contained in the cassava processing wastewater is starch, which is a poly-saccharide, a more complex organic compound compared to mono-saccharides. As the baseline methodology stipulates, an alternative CH ₄ emission factor is estimated and applied for the project activity. The maximum CH ₄ producing capacity (B ₀), 0.21 kg CH ₄ /kg COD, stated in approved baseline methodology AM0013 “Avoided methane emissions from organic waste-water treatment” is selected for the Project. As discussed in AM0013, this value is based on the default IPCC value for B ₀ , 0.25 kg CH ₄ /kg COD, taking account of the 50 – 100% uncertainty range, and it is applicable to all organic wastewater types. Considering the fact that this value has been established as the result of comprehensive discussions among the methodology panel as well as the CDM Executive Board, it is a conservative and transparent approach for the project participant to adopt this value for the methane emission factor.
Any comment:	

Data / Parameter:	R_{lagoon}
Data unit:	%
Description:	Organic material removal ratio
Source of data used:	Estimated by project developer as a part of feasibility study
Value applied:	98.76
Justification of the choice of data or description of measurement methods and procedures actually applied :	Estimated by project developer using historical COD data of wastewater entering open lagoon treatment system and of wastewater leaving open lagoon treatment system. Data in more detail
Any comment:	Data provided in Annex 3

Data / Parameter:	R_{deposition}
Data unit:	%
Description:	Organic material deposition ratio
Source of data used:	Estimated by project developer as a part of feasibility study
Value applied:	0 (Project scenario), 0 (Baseline scenario)
Justification of the choice of data or description of measurement methods and procedures actually applied :	Estimated by project developer as follows: <u>Project scenario</u> All solid material that could sediment is assumed to be removed by the UASB system implemented by the project activity. This is a conservative assumption. <u>Baseline scenario</u> The initial project feasibility analysis determined that there is little or no sedimentation occurring in the anaerobic pond as the anaerobic activity effectively keeps all solid COD material in suspension.
Any comment:	



Data / Parameter:	Proportion of methane emitted from UASB digesters
Data unit:	%
Description:	Proportion of methane emitted from UASB digesters
Source of data used:	IPCC default value
Value applied:	5
Justification of the choice of data or description of measurement methods and procedures actually applied :	To ensure the conservativeness, IPCC default value is used. The technology provider, PAPOP CO., LTD., has estimated based on their experience that the physical leakage from UASB system is less than 3% for systems with size similar to the project activity. To ensure conservativeness, physical leakage factor of 5% of total biogas production is used for the Project activity.
Any comment:	

Data / Parameter:	CEF
Data unit:	tCO ₂ /MWh
Description:	Carbon emission factor for the electricity displaced by the electricity generated from the biogas
Source of data used:	
Value applied:	0.81
Justification of the choice of data or description of measurement methods and procedures actually applied :	The project activity involves displacement of both grid electricity and captive generated electricity. As per the methodology, the smaller of the following two values was chosen as the CEF; (i) CEF of the grid which is calculated based on ACM0002 (tCO ₂ e/MWh) (ii) CEF of the on site electricity generation equipment displaced (tCO ₂ e/MWh) CEF of the grid is chosen for the project calculations because it was smaller than the CEF of the on site electricity.
Any comment:	Data provided in Annex 3.

Data / Parameter:	Density of CH₄
Data unit:	kg CH ₄ /Nm ³ CH ₄
Description:	Density of methane at standard condition (0 degree Celsius, 1,013 bar)
Source of data used:	ACM0001 ver.04
Value applied:	0.7168
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	

B.6.3 Ex-ante calculation of emission reductions:

Project emissions



$$\begin{aligned}
 E_{\text{project}} &= E_{CH_4_lagoons} + E_{CH_4_NAWTF} + E_{CH_4_IC+Leaks} \\
 &= 20,410(tCO_2e / yr) + 13,104(tCO_2e / yr) + 2,490(tCO_2e / yr) \\
 &= 36,003(tCO_2e / yr)
 \end{aligned}$$

1) Fugitive methane emissions from lagoons ($E_{CH_4_lagoons}$)

$$\begin{aligned}
 E_{CH_4_lagoons} &= M_{\text{lagoon_anaerobic}} \cdot EF_{CH_4} \cdot GWP_{CH_4} / 1000 \\
 &= 4,628,041(kg\ COD) \times 0.21(kg\ CH_4 / kg\ COD) \times 21(tCO_2e / tCH_4) / 1000(kg / t) \\
 &= 20,410(tCO_2e)
 \end{aligned}$$

Total amount of organic material removed by anaerobic processes in the lagoons system ($M_{\text{lagoon_anaerobic}}$)

$$\begin{aligned}
 M_{\text{lagoon_anaerobic}} &= M_{\text{lagoon_total}} - M_{\text{lagoon_aerobic}} - M_{\text{lagoon_chemical_ox}} - M_{\text{lagoon_deposition}} \\
 &= 6,603,014(kg\ COD) - 1,974,973(kg\ COD) - 0(kg\ COD) - 0(kg\ COD) \\
 &= 4,628,041(kg\ COD)
 \end{aligned}$$

Total amount of organic material removed in the lagoon system ($M_{\text{lagoon_total}}$)

$$\begin{aligned}
 M_{\text{lagoon_total}} &= M_{\text{lagoon_input}} \cdot R_{\text{lagoon}} \\
 &= 6,685,936(kg\ COD) \times 0.9876 \\
 &= 6,603,014(kg\ COD)
 \end{aligned}$$

Input of organic material from the new project anaerobic wastewater treatment facility ($M_{\text{lagoon_input}}$)

$$\begin{aligned}
 M_{\text{lagoon_input}} &= M_{\text{input_total}} \cdot (1 - R_{NAWTF}) \\
 &= 66,859,357(kg\ COD) \times (1 - 0.9) \\
 &= 6,685,936(kg\ COD)
 \end{aligned}$$

Amount of organic material degraded aerobically in the lagoon system ($M_{\text{lagoon_aerobic}}$)

$$M_{\text{lagoon_aerobic}} = 254(kg\ COD / ha / day) \times 21.303(ha) \times 365(day) = 1,974,973(kg\ COD)$$

Amount of organic material lost through chemical oxidation in the lagoon system ($M_{\text{lagoon_chemical_ox}}$)

$$M_{\text{lagoon_chemical_ox}} = 0\ kg\ COD$$

Amount of organic material lost through deposition in the lagoon system ($M_{\text{lagoon_deposition}}$)

$$\begin{aligned}
 M_{\text{lagoon_deposition}} &= M_{\text{lagoon_input}} \cdot R_{\text{deposition}} \\
 &= 6,685,936(kg\ COD) \times 0 \\
 &= 0(kg\ COD)
 \end{aligned}$$

**2) Methane missions from new anaerobic wastewater treatment facility (E_{CH4_NAWTF})**

$$\begin{aligned}
 E_{CH4_NAWTF} &= (E_{CH4_lagoon_BL} - E_{CH4_lagoon}) \times 0.05 \\
 &= [282,483(tCO_2e) - 20,410(tCO_2e)] \times 0.05 \\
 &= 13,104(tCO_2e)
 \end{aligned}$$

3) Methane emissions from inefficient combustion emissions and leaks in biogas system ($E_{CH4_IC+Leak}$)

$$\begin{aligned}
 E_{CH4_IC+Leaks} &= \left(\sum_r V_r \cdot C_{CH4_r} \cdot (1 - f_r) \cdot GWP_{CH4} \right) + PE_{flare} \\
 &= 16,401,061(Nm^3 biogas) \times 0.000466(tCH_4 / Nm^3 biogas) \times (1 - 0.99) \times 21(tCO_{2e} / tCH_4) + 885(tCO_{2e}) \\
 &= 2,490(tCO_2e)
 \end{aligned}$$

Baseline emissions

Total estimated baseline emissions are the sum of fugitive methane emissions from the existing lagoon based wastewater treatment system and CO₂ emission from the generation of power on site and off site

$$\begin{aligned}
 E_{BL} &= E_{CH4_lagoons_BL} + E_{CO2_power_BL} \\
 &= 282,483(tCO_2e / yr) + 33,826(tCO_2e / yr) \\
 &= 316,309(tCO_2e / yr)
 \end{aligned}$$

1) Fugitive methane emissions from lagoons ($E_{CH4_lagoon_BL}$)

$$\begin{aligned}
 E_{CH4_lagoons_BL} &= M_{lagoon_anaerobic_BL} \cdot EF_{CH4} \cdot GWP_{CH4} / 1000 \\
 &= 64,055,171(kg COD) \times 0.21(tCH_4 / kg COD) \times 21 / 1000(kg / t) \\
 &= 282,483(tCO_2e)
 \end{aligned}$$

Total amount of organic material removed by anaerobic processes in the lagoons system**($M_{lagoon_anaerobic_BL}$)**

$$\begin{aligned}
 M_{lagoon_anaerobic_BL} &= M_{lagoon_total_BL} - M_{lagoon_aerobic_BL} - M_{lagoon_chemical_ox_BL} - M_{lagoon_deposition_BL} \\
 &= 66,030,145(kg COD) - 1,974,973(kg COD) - 0(kg COD) - 0(kg COD) \\
 &= 64,055,171(kg COD)
 \end{aligned}$$

Total amount of organic material removed in the lagoon system ($M_{lagoon_total_BL}$)



$$\begin{aligned}
 M_{\text{lagoon_total_BL}} &= M_{\text{lagoon_input_BL}} \times R_{\text{lagoon}} \\
 &= M_{\text{input_total}} \times R_{\text{lagoon}} \\
 &= 66,859,357 \text{ (kg COD)} \times 0.9876 \\
 &= 66,030,145 \text{ (kg COD)}
 \end{aligned}$$

Amount of organic material degraded aerobically in the lagoon system ($M_{\text{lagoon_aerobic_BL}}$)

$$M_{\text{lagoon_aerobic_BL}} = 254 \text{ (kg COD / ha / day)} \times 21.303 \text{ (ha)} \times 365 \text{ (day)} = 1,974,973 \text{ (kg COD)}$$

Amount of organic material lost through chemical oxidation in the lagoon system ($M_{\text{lagoon_chemical_ox_BL}}$)

$$M_{\text{lagoon_chemical_ox_BL}} = 0 \text{ (kg COD)}$$

Amount of organic material lost through deposition in the lagoon system ($M_{\text{lagoon_deposition_BL}}$)

$$\begin{aligned}
 M_{\text{lagoon_deposition_BL}} &= M_{\text{lagoon_input_BL}} \cdot R_{\text{deposition}} \\
 &= 66,859,357 \text{ (kg COD)} \times 0 \\
 &= 0 \text{ (kg COD)}
 \end{aligned}$$

2) On site and off site grid power generation emissions displaced by generation based on biogas collected in the anaerobic treatment facility ($E_{\text{CO}_2_power_BL}$)⁴

$$\begin{aligned}
 E_{\text{CO}_2_power_BL} &= EL \cdot CEF \\
 &= 41,760 \text{ (MWh)} \times 0.81 \text{ (tCO}_2\text{ / MWh)} \\
 &= 33,826 \text{ (tCO}_2\text{)}
 \end{aligned}$$

Leakage

As per the methodology, leakage is considered to be negligible.

$$\text{Leakage} = 0 \text{ (tCO}_2\text{e)}$$

Emission Reductions

$$\begin{aligned}
 ER &= E_{\text{BL}} - E_{\text{project}} \\
 &= 316,309 \text{ (tCO}_2\text{e / yr)} - 36,003 \text{ (tCO}_2\text{e / yr)} \\
 &= 280,306 \text{ (tCO}_2\text{e / yr)}
 \end{aligned}$$

⁴ The above calculations are performed for the case of 5 MW total generation capacity. However, if developer decides to increase total generation capacity up to 8 MW, baseline emissions reduction from power generation will increase accordingly.



$$E_{CH_4_lagoon_BL} - (E_{CH_4_lagoon} + E_{CH_4_NAWTF} + E_{CH_4_coll}) = 0 (tCO_2e / yr)$$

$$ER = 280,306 (tCO_2e / yr)$$

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

Year	Estimation of project activity emissions (tonnes of CO ₂ e)	Estimation of baseline emissions (tonnes of CO ₂ e)	Estimation of leakage (tonnes of CO ₂ e)	Estimation of overall emission reductions (tonnes of CO ₂ e)
Year 1 (July 2007 – June 2008)	36,003	316,309	0	280,306
Year 2 (July 2008 – June 2009)	36,003	316,309	0	280,306
Year 3 (July 2009 – June 2010)	36,003	316,309	0	280,306
Year 4 (July 2010 – June 2011)	36,003	316,309	0	280,306
Year 5 (July 2011 – June 2012)	36,003	316,309	0	280,306
Year 6 (July 2012 – June 2013)	36,003	316,309	0	280,306
Year 7 (July 2013 – June 2014)	36,003	316,309	0	280,306
Total (tonnes of CO₂e)	252,021	2,214,163	0	1,962,142

B.7 Application of the monitoring methodology and description of the monitoring plan:
B.7.1 Data and parameters monitored:

Data / Parameter:	Wastewater flows entering the project treatment facility
Data unit:	m ³ / year
Description:	The volume of wastewater flows entering into the new anaerobic digestion system
Source of data to be used:	Measured by project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	5,918,850
Description of measurement methods and procedures to be	Measured continuously by flow meters.



applied:	
QA/QC procedures to be applied:	Flow meters will undergo maintenance / calibration subject to appropriate industry standards.
Any comment:	Used for project emissions and baseline emissions calculation. The value applied for the purpose of ex-ante estimation was calculated using the daily flow rate of wastewater (16,911 m ³ / day) measured on-site as a part of feasibility study and annual operating days of the plant (350days).

Data / Parameter:	Wastewater flows leaving project treatment facility
Data unit:	m ³ / year
Description:	The volume of wastewater flows leaving the new anaerobic digestion system
Source of data to be used:	Measured by project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	5,918,850
Description of measurement methods and procedures to be applied:	Measured continuously by flow meters.
QA/QC procedures to be applied:	Flow meters will undergo maintenance / calibration subject to appropriate industry standards.
Any comment:	Used for project emissions calculation. The value applied for the purpose of ex-ante estimation was calculated using the daily flow rate of wastewater (16,911 m ³ / day) measured on-site as a part of feasibility study and annual operating days of the plant (350days).

Data / Parameter:	Wastewater organic material concentration entering the project treatment facility
Data unit:	kg COD/ m ³
Description:	COD concentration of the wastewater entering the new anaerobic digestion system
Source of data to be used:	Measured by project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	11.296
Description of measurement methods and procedures to be applied:	Daily sampling of the untreated process effluent will be conducted. COD concentration will be analyzed daily at the Project site. To ensure accuracy, tests will be carried out under the supervision of an accredited laboratory each week.
QA/QC procedures to be applied:	Sampling and analysis will be carried out adhering to internationally recognized procedures
Any comment:	Used for project emissions and baseline emissions calculation



Data / Parameter:	Wastewater organic material concentration leaving the treatment facility
Data unit:	kg COD/ m ³
Description:	COD concentration of the wastewater leaving the new anaerobic digestion system
Source of data to be used:	Measured by project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	1.1296
Description of measurement methods and procedures to be applied:	Daily sampling of the UASB reactor effluent will be conducted. COD concentration will be analyzed daily at the Project site. To ensure accuracy, tests will be carried out under the supervision of an accredited laboratory each week.
QA/QC procedures to be applied:	Sampling and analysis will be carried out adhering to internationally recognized procedures
Any comment:	Used for project emissions calculation. The value used in section B.5 is calculated using COD concentration entering the project treatment facility (11.296 kg COD/ m ³) and the assumed total organic material removal efficiency of the new project wastewater facility (0.9).

Data / Parameter:	R_{NAWTF}
Data unit:	Fraction
Description:	Total organic material removal efficiency of the new project wastewater facility.
Source of data to be used:	Calculated using COD concentration entering the project treatment facility and COD concentration leaving the treatment facility.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.9
Description of measurement methods and procedures to be applied:	Calculated using COD concentration entering the project treatment facility and COD concentration leaving the treatment facility.
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	Electricity generated
Data unit:	MWh
Description:	Electricity generated from the biogas collected in the anaerobic treatment facility and consumed on site or sent the grid
Source of data to be used:	Measured by project developer
Value of data applied for the purpose of calculating expected emission reductions in	41,760



section B.5	
Description of measurement methods and procedures to be applied:	Measured continuously using electricity meters For the purpose of ex-ante calculation, electricity generated by the project activity was assumed as follows: $5\text{MW} \times 24\text{hours/year} \times 348\text{ days/year}$. As explained in Section A.2, the project developer plans to increase the generation capacity to 8.0 MW depending on the amount of biogas generated by the UASB reactors. This will influence in no way other aspects of the project. In this case expected annual power generation will increase up to 66,816 MWh ($= 8\text{ MW} \times 24\text{ hours/year} \times 348\text{ days/year}$).
QA/QC procedures to be applied:	Electricity meters will undergo maintenance / calibration subject to appropriate industry standards.
Any comment:	

Data / Parameter:	Biogas sent to flares (V₁)
Data unit:	Nm ³ biogas
Description:	Surplus biogas sent to flare system
Source of data to be used:	Measured by project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	6,365,900
Description of measurement methods and procedures to be applied:	Measured continuously by flow meters
QA/QC procedures to be applied:	Flow meters will undergo maintenance / calibration subject to appropriate industry standards
Any comment:	Used for project emissions and emissions reduction calculation

Data / Parameter:	Biogas sent to generation sets (V₂)
Data unit:	Nm ³ biogas
Description:	Biogas sent to generation facility and used for electricity generation
Source of data to be used:	Measured by project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	16,401,957
Description of measurement methods and procedures to be applied:	Measured continuously by flow meters
QA/QC procedures to be applied:	Flow meters will undergo maintenance / calibration subject to appropriate industry standards
Any comment:	Used for project emissions and emissions reduction calculation



Data / Parameter:	Biogas methane concentration
Data unit:	%
Description:	Percentage of methane in the biogas
Source of data to be used:	Measured by project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	65
Description of measurement methods and procedures to be applied:	Measured continuously by near infrared spectrometry
QA/QC procedures to be applied:	Near infrared spectrometry will undergo maintenance / calibration subject to appropriate industry standards
Any comment:	Used for project emissions and emissions reduction calculation

Data / Parameter:	C_{CH_4}
Data unit:	t CH ₄ / Nm ³ biogas
Description:	Methane concentration in biogas
Source of data to be used:	Measured by project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.000466
Description of measurement methods and procedures to be applied:	Calculated using biogas methane concentration (65%, volume/volume) and methane density at standard condition (0.7168 kgCH ₄ /Nm ³)
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	Project emissions from flaring of the residual gas stream (PE_{flare})
Data unit:	t CO _{2e}
Description:	Project emissions from flaring of the residual gas stream
Source of data to be used:	Measured/Calculated
Value of data applied for the purpose of calculating expected emission reductions in section B.5	885
Description of	Electronic



measurement methods and procedures to be applied:	
QA/QC procedures to be applied:	The parameters used for determining the project emissions from flaring of the residual gas stream in year y (PE_{flare}) should use the QA/QC procedures as per the “ <i>Tool to determine project emissions from flaring gases containing Methane</i> ”.
Any comment:	The parameters used for determining the project emissions from flaring of the residual gas stream (PE_{flare}) should be monitored as per the “ <i>Tool to determine project emissions from flaring gases containing Methane</i> ”.

Data / Parameter:	Gen set combustion efficiency (f)
Data unit:	%
Description:	Proportion of biogas combusted by generation facility
Source of data to be used:	Measured by project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	99
Description of measurement methods and procedures to be applied:	Generation set combustion efficiency will be determined annually during regular O&M down time and as part of the regular O&M schedule.
QA/QC procedures to be applied:	Generation set combustion efficiency will be calibrated annually.
Any comment:	Used for project emissions calculation

Data / Parameter:	Amount of chemical oxidising agents entering system boundary
Data unit:	tonnes/m ³
Description:	Amount of chemical oxidising agents entering system boundary
Source of data to be used:	Measured by project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0
Description of measurement methods and procedures to be applied:	Continuously monitored whether oxidative chemical species are utilized in the process.
QA/QC procedures to be applied:	Regular samples will test for concentration of oxidising agents where they are identified as being likely to be present in wastewater when they are part of the process
Any comment:	Used for project emissions and baseline emissions calculation



Data / Parameter:	Flow of wastewater directly to the current wastewater treatment system
Data unit:	m ³
Description:	Volume of flow of wastewater directly to the current wastewater treatment system and bypassing the new wastewater treatment facility
Source of data to be used:	Measured by project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0
Description of measurement methods and procedures to be applied:	Bypass flow is measured by an electromagnetic flow meter.
QA/QC procedures to be applied:	Monitoring equipment will undergo maintenance / calibration subject to appropriate industry standards
Any comment:	Used for project emissions calculation

Data / Parameter:	Loss of biogas from pipeline
Data unit:	%
Description:	Loss of biogas from pipeline
Source of data to be used:	Measured by project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0
Description of measurement methods and procedures to be applied:	Integrity of biogas pipeline for losses of biogas methane will be tested annually through pressurizing the system and establishing pressure drops through leakage.
QA/QC procedures to be applied:	Annual checks to be carried out to international standards
Any comment:	Used for project emissions calculation

Data / Parameter:	Organic material removed from wastewater facility
Data unit:	t COD
Description:	Organic material removed from wastewater facility
Source of data to be used:	Measured by project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	60,173
Description of measurement methods	Removal of COD after monitoring and prior to entry to the lagoon system should be recorded to ensure CH ₄ emissions are not overestimated. This may be material



and procedures to be applied:	screened out after the wastewater concentration is recorded
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	Biogas calorific value
Data unit:	J/Nm ³
Description:	Calorific value of biogas
Source of data to be used:	Measured by project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	24,128
Description of measurement methods and procedures to be applied:	Measured annually by accredited laboratory
QA/QC procedures to be applied:	Measured annually by accredited laboratory
Any comment:	

B.7.2 Description of the monitoring plan:

All monitoring equipment will be installed by experts and regularly calibrated to the highest standards by BAJ. BAJ staff at the site will be trained in the operation of all monitoring equipment. All reading will be taken under the supervision of management. BAJ will appoint an executive to be responsible for all data monitoring / acquisition and recording for CDM purposes.

MONITORING PLAN

1. Responsibility of the Project Management

BAJ will be responsible for the execution of the monitoring plan. It will collect and store relevant data in a systematic and reliable way, evaluate them regularly, and ensure the availability of pertinent information for verification. An electronic spreadsheet file will be kept to record and manage all monitored variables and will be regularly presented to the DOE for verification.

2. Quality Assurance and Quality Control

The quality assurance and quality control for recording, maintaining and archiving data shall be maintained by BAJ. BAJ will also make sure that it provides the staff in charge of data collection and monitoring with necessary training opportunities to enhance efficiency of their work.



3. On-site Procedures

Operation and Maintenance Logs

Daily O&M logs will be maintained by each shift leader on a real time basis. They will provide detailed on-the-spot information about the operation of the plant. Any event of significance will be reported and recorded in a special log.

Operation and Maintenance Report

This report will be developed each month and presented to BAJ management. The report will include the following topics:

- Summary
- Accidents, malfunctions and remedial measures taken
- Safety and environment
- Plant performance and availability
- Meter records
- Fuel report
- Personnel changes

Procedures for Calibration of Equipment

BAJ will carry out calibration according to international standards.

It is important to note that BAJ will be required to install and maintain all electricity metering equipment and associated transformers conforming to specifications.

4. Data Storage and Filing – Electric Workbook

All relevant data will be monitored and electronically stored.

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)

Clean Energy Finance Committee
Mitsubishi UFJ Securities Co., Ltd.
Tokyo, Japan

Phone: +81 3 6213 6860
Fax: +81 3 6213 6175



E-mail: hatano-junji@sc.mufg.jp

Mitsubishi UFJ Securities Co., Ltd. Is the CDM advisor to the Project (not a project participant).

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:**

03 April 2006

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

21 years

C.2 Choice of the crediting period and related information:**C.2.1. Renewable crediting period****C.2.1.1. Starting date of the first crediting period:**

01 July 2007

C.2.1.2. Length of the first crediting period:

7 years

C.2.2. Fixed crediting period:**C.2.2.1. Starting date:**

Not applicable

C.2.2.2. Length:

Not applicable

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

Under the current Indonesian Law, an Environmental Impact Assessment (EIA) is not required for the implementation of the Project activity. According to the Ministry of Environment, when the project participant applies for an Indonesian DNA approval, it is only required to submit the documents about EIA conducted prior to the construction/expansion of Way Abung Factory.

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

PT Budi Acid Jaya (BAJ) conducted a stakeholders' consultation meeting for the Project on November 10th, 2006. The meeting took place at BAJ's Way Abung facility in Gunung Batin in Terusan Nunyai, Lampung Tengah. The purpose of the stakeholders' meeting was to present to the community surrounding the project location an overview of the Project, its development as well as the benefits of the Project implementation.

Letters of invitation were sent out to government officials and local community leaders. The officials and the community leaders then further distributed the invitation to the surrounding communities. Nineteen people including members of the local community, government officials, and non-governmental organization attended the meeting.

The meeting was facilitated by BAJ and preceded according to the agenda attached below.

Program Agenda

1. Registration
2. Opening
3. Introduction of participants
4. Opening speech by PT BAJ Way Abung
5. Speech by an official from Mining and Energy Agency representing Middle Lampung Region
6. Introducing the company profile of BAJ
7. Introduction of Biogas project
8. Presentation on the Project with CDM scheme
9. Discussion
10. Signing of minute of meeting
11. Closing

The minutes of the meeting are available upon request.

**E.2. Summary of the comments received:**

The representatives of the local community acknowledged the direct and indirect benefits resulting from the Project and showed support to the implementation of the project by BAJ and Sumitomo Corporation.

The participants raised the following environmental concerns:

- Waste generated by the project and its handling.
- Handling of potential methane gas leakage.
- Impact of the introduction of additional microorganisms in the waste water treatment process.

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

Due account was taken of all comments and BAJ provided detailed explanation of all issues raised during the stakeholders' meeting.

- Waste generated by the project and its handling.
→ The effluent from the project will be utilized mainly for irrigation and washing purposes. The UASB process installed as part of the project activity provides an advanced treatment prior to the lagoon system, so it is anticipated that the effluent from the lagoon in the project case will contain a much lower organic load compared to the current situation (i.e. anaerobic lagoon system alone). There will be no direct disposal of the treated effluent into the community waterworks. The solid waste will be collected and managed for composting and/or fertilizer purpose.
- Handling of potential methane gas leakage.
→ The company is obliged to design an Environment Management Procedure (UKL) and Environment Monitoring Procedure (UPL). The periodic measurement and monitoring scheduled by the UKL and UPL will control for the occurrence of leakage.
- Impact of the introduction of additional microorganisms in the waste water treatment process and its handling.
→ No additional microorganisms from other sources will be introduced. Because all microorganisms required for anaerobic digestion are formed in UASB reactors, there will be no additional negative environmental impact.

**Annex 1****CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY**

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Represented by:	
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URL:	http://www.sumitomocorp.co.jp
Represented by:	
Title:	Manager
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

The Project will receive partial capital cost funding from New Energy and Industrial Technology Development Organization (NEDO), an administrative agency incorporated under Japan's Ministry of Economy, Trade and Industry. Funding from NEDO, though public, is not counted as part of Japan's official development assistance.

**Annex 3****BASELINE INFORMATION****Table 3 : Wastewater characteristics**

COD removal Efficiency of UASB system	0.9	
COD (before UASB system)	11,296	mg/liter
COD (after UASB system)	1,130	mg/liter
Effluent flow	16,911	m ³ /day
Annual COD load to lagoons before UASB system implementation	66,859,357	kg COD/yr
Annual COD load to lagoons after UASB system implementation	6,685,936	kg COD/yr
Plant operation	350	days/ yr

Data source: BAJ

Table 4 : Lagoon condition

Lagoon Depth	6	m
Area	21.3	hectares
Minimum Lagoon Temperature (2005)	30	°C
Minimum Ambient Temperature (2005)	32	°C

Data source: BAJ

Table 5: Organic material removal ratio for lagoons based on the historical Lagoon COD data

Average COD in to the lagoon	10,000	mg/l
Average COD out from the lagoon	124.0	mg/l
Average COD removal ratio	98.76	%

Data source: BAJ

Table 6 : Historical Specific Electricity consumption

	Tapioca (MWh/ton)	Glucose (MWh/ton)	Citric Acid (MWh/ton)
2003	0.1907	0.1164	1.7554
2004	0.2003	0.1325	1.4885
2005	0.2081	0.1464	1.5240
Average	0.1997	0.1318	1.5893

Data source: BAJ

**Table 7: Expected production and electricity consumption**

	Expected production (Tonnes/year)	Electricity usage (MWh/year)
Tapioca	157,500	31,456
Glucose	21,000	2,767
Citric Acid	10,500	16,688
Total		50,911

Data source: BAJ

(i) CEF of the grid which is calculated based on ACM0002 (tCO₂e/MWh)**Table 8: Fuel specification**

	(A)	(B)	(C)	(D)	(E)
Fuel Type	Density [kg/kl]	Net Calorific value [TJ/Nm ³]	Net Calorific value [TJ/kt]	Carbon Emission Factor [tC/TJ]	Oxidation Factor
Data Source	PERTAMINA	PERTAMINA	IPCC	IPCC	IPCC
Coal	-	-	25.75	25.80	0.980
Natural gas	-	4.278E-05	-	15.30	0.995
HSD	850	-	43.33	20.20	0.990
IDO	880	-	43.33	20.20	0.990
MFO	990	-	40.19	21.10	0.990

HSD: High speed diesel
 IDO: Industrial diesel oil
 MFO: Marine fuel oil

Operating margin calculation**Table 9: SSWSR grid generation by source [MWh]**

Fuel type	2001	2002	2003	2004	2005
Hydro	1,679,483	1,683,932	2,405,772	2,226,603	2,271,983
Coal	2,741,448	2,713,276	2,378,787	2,618,576	2,932,329
Natural gas	198,959	285,440	432,820	952,256	872,254
HSD	902,223	1,092,790	859,118	994,728	454,909
IDO	86,266	121,928	91,549	115,943	66,887
MFO	97,452	106,988	160,686	993	33,603
Total	5,705,831	6,004,354	6,328,732	6,909,099	6,631,965

Source: PLN publication, PLN hearing

**Table 10: Proportion of electricity generated from low-cost/must run resources in SSWSR grid**

Year	Total generation [MWh]	Low-cost/must run resources [MWh]	Proportion of low- cost/must run resources
2001	5,705,831	1,679,483	29%
2002	6,004,354	1,683,932	28%
2003	6,328,732	2,405,772	38%
2004	6,909,099	2,226,603	32%
2005	6,631,965	2,271,983	34%
5-year average	6,315,996	2,053,555	32%

Table 11: 2003 Operating margin for the SSWSR grid

Fuel type	(A) Electricity generated [MWh]	(B) Fuel consumption [kt]	(C) Fuel consumption [Nm3]	(D) Calorific value per mass [TJ/kt]	(E) Calorific value per volume [TJ/Nm3]	(F) Calorific value [TJ] (B) × (D) or (C) × (E)	(G) Carbon emission factor [tC/TJ]	(H) Oxidation factor	(I) CO ₂ emission [tCO ₂] (F) × (G) × (H) × 44/12	(J) CO ₂ emission factor [tCO ₂ /MWh] (I) / (A)
Data Source	PLN	PLN	PLN	IPCC	PERTAMINA		IPCC	IPCC		
Coal	2,378,787	1,383	-	25.75	-	35,605	25.80	0.98	3,300,884	1.39
Natural gas	432,820	-	253,382,687	-	4.278E-05	10,839	15.30	0.995	605,037	1.40
HSD	859,118	286	-	43.33	-	12,403	20.20	0.99	909,445	1.06
IDO	91,549	19.2	-	43.33	-	834	20.20	0.99	61,150	0.67
MFO	160,686	12.4	-	40.19	-	499	21.10	0.99	38,246	0.24
Total	3,922,960								4,914,763	1.25

Table 12: 2004 Operating margin for the SSWSR grid

Fuel type	(A) Electricity generated [MWh]	(B) Fuel consumption [kt]	(C) Fuel consumption [Nm3]	(D) Calorific value per mass [TJ/kt]	(E) Calorific value per volume [TJ/Nm3]	(F) Calorific value [TJ] (B) × (D) or (C) × (E)	(G) Carbon emission factor [tC/TJ]	(H) Oxidation factor	(I) CO ₂ emission [tCO ₂] (F) × (G) × (H) × 44/12	(J) CO ₂ emission factor [tCO ₂ /MWh] (I) / (A)
Data Source	PLN	PLN	PLN	IPCC	PERTAMINA		IPCC	IPCC		
Coal	2,618,576	1,469	-	25.75	-	37,838	25.80	0.98	3,507,917	1.34
Natural gas	952,256	-	384,624,620	-	4.278E-05	16,453	15.30	0.995	918,422	0.96
HSD	994,728	386	-	43.33	-	16,728	20.20	0.99	1,226,619	1.23
IDO	115,943	24.1	-	43.33	-	1,043	20.20	0.99	76,466	0.66
MFO	993	0.41	-	40.19	-	16	21.10	0.99	1,256	1.26
Total	4,682,496								5,730,680	1.22

Table 13: 2005 Operating margin for the SSWSR grid

Fuel type	(A) Electricity generated [MWh]	(B) Fuel consumption [kt]	(C) Fuel consumption [Nm3]	(D) Calorific value per mass [TJ/kt]	(E) Calorific value per volume [TJ/Nm3]	(F) Calorific value [TJ] (B) × (D) or (C) × (E)	(G) Carbon emission factor [tC/TJ]	(H) Oxidation factor	(I) CO ₂ emission [tCO ₂] (F) × (G) × (H) × 44/12	(J) CO ₂ emission factor [tCO ₂ /MWh] (I) / (A)
Data Source	PLN	PLN	PLN	IPCC	PERTAMINA		IPCC	IPCC		
Coal	2,932,329	1,595	-	25.75	-	41,063	25.80	0.98	3,806,875	1.30
Natural gas	872,254	-	354,849,211	-	4.278E-05	15,180	15.30	0.995	847,323	0.97
HSD	454,909	134	-	43.33	-	5,793	20.20	0.99	424,784	0.93
IDO	66,887	13.8	-	43.33	-	597	20.20	0.99	43,791	0.65
MFO	33,603	3.26	-	40.19	-	131	21.10	0.99	10,049	0.30
Total	4,359,982								5,132,823	1.18



Table 14: Operating margin emission factor

Year	(A) CO ₂ emission [tCO ₂]	(B) Total electricity generated [MWh]	(C) Low-cost/must run resources [MWh]	(D) OM emission factor [tCO ₂ /MWh] (A)/((B)-(C))
2003	4,914,763	6,328,732	2,405,772	1.25
2004	5,730,680	6,909,099	2,226,603	1.22
2005	5,132,823	6,631,965	2,271,983	1.18
3-year average				1.22

Build margin calculation

Table 15: Build margin emission factor

Power Plant name	(A) Commissioning year	(B) Net electricity generated [MWh]	(C) Fuel consumption [Nm ³]	(D) Fuel Type	(E) Calorific value [kJ/Nm ³]	(F) Calrific value (C)×(E) [TJ]	(G) Carbon Emission Factor [tC/TJ]	(H) Oxidation Factor	(I) CO ₂ Emission (F)×(G)×(H) ×44/12 [tCO ₂]	(J) CO ₂ Emission Factor (I) / (B) [tCO ₂ /MWh]
Data Source	PLN	PLN	PLN		PERTAMINA		IPCC	IPCC		
PLTG Truck Mounted 1	Dec-04	109,551	34,262,838	Gas	42,778	1,466	15.30	0.995	81,814	0.747
PLTG Truck Mounted 2	Dec-04	121,387	38,509,084	Gas	42,778	1,647	15.30	0.995	91,954	0.758
PLTG Inderalaya II	Aug-04	235,375	83,301,359	Gas	42,778	3,563	15.30	0.995	198,910	0.845
PLTG Rental TI. Duku #1	Jan-04	79,684	41,551,860	Gas	42,778	1,778	15.30	0.995	99,219	1.245
PLTG Apung	2004	81,776	25,020,604	Gas	42,778	1,070	15.30	0.995	59,745	0.731
PLTA BATUTEKI #1	2002	75,241	-	Hydro	-	-	-	-	-	-
PLTA BATUTEKI #2	2002	69,896	-	Hydro	-	-	-	-	-	-
PLTA BESAI #1	2001	154,075	-	Hydro	-	-	-	-	-	-
PLTA BESAI #2	2001	209,659	-	Hydro	-	-	-	-	-	-
PLTA SKRK #2 [VOEST ALPN]	1998	190,102	-	Hydro	-	-	-	-	-	-
Total		1,326,745				9,524			531,643	0.40

Combined margin calculation

$$\begin{aligned}
 EF_y &= w_{OM,y} \cdot EF_{OM,y} + w_{BM,y} \cdot EF_{BM,y} \\
 &= (0.5) \cdot (1.22) + (0.5) \cdot (0.40) \\
 &= 0.81
 \end{aligned}$$

(ii) CEF of the on site electricity generation equipment displaced (tCO₂e/MWh)

Table 16: CEF of the on site electricity generation equipment displaced

Year	(A) Electricity generated [MWh]	(B) Fuel type	(C) Fuel density [kg/kl]	(D) Fuel consumption [kl]	(E) Fuel consumption [kt] (C)×(D)×10 ⁻⁶	(F) Net calorific value per mass [TJ/kt]	(G) Calorific value [TJ] (E)×(F)	(H) Carbon emission factor [tC/TJ]	(I) Oxidation factor	(J) CO ₂ emission [tCO ₂] (G)×(H)×(I)× 44/12	(K) CO ₂ emission factor [tCO ₂ /MWh] (J) / (A)
Data Source	BAJ	BAJ	PERTAMINA	BAJ			IPCC		IPCC	IPCC	
2003	7,765	IDO	880	2,523	2.22	43.33	96.20	20.2	0.99	7,054	0.91
2004	7,960	IDO	880	2,587	2.28	43.33	98.64	20.2	0.99	7,233	0.91
2005	6,891	IDO	880	2,240	1.97	43.33	85.41	20.2	0.99	6,263	0.91
3-year average											0.91



Annex 4
MONITORING INFORMATION
