# METHANE RECOVERY IN WASTEWATER TREATMENT PROJECT AMA07-W-01, PERAK, MALAYSIA

UNFCCC Clean Development Mechanism
Simplified Project Design Document
for
Small Scale Project Activity

AES AgriVerde™
An AES and AgCert joint venture

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**CLEAN DEVELOPMENT MECHANISM**
**PROJECT DESIGN DOCUMENT FORM (CDM-SSC-PDD)**
**Version 03 - in effect as of: 22 December 2006**

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**Annexes**

**Revision history of this document**

| Version Number | Date | Description and reason of revision |
|---|---|---|
| 01 | 21 January 2003 | Initial adoption |
| 02 | 8 July 2005 | • The Board agreed to revise the CDM SSC PDD to reflect guidance and clarifications provided by the Board since version 01 of this document.<br>• As a consequence, the guidelines for completing CDM SSC PDD have been revised accordingly to version 2. The latest version can be found at <http://cdm.unfccc.int/Reference/Documents>. |
| 03 | 22 December 2006 | • The Board agreed to revise the CDM project design document for small-scale activities (CDM-SSC-PDD), taking into account CDM-PDD and CDM-NM. |

## SECTION A. General description of small-scale project activity

### A.1 Title of the small-scale project activity:

Methane Recovery in Wastewater Treatment, Project AMA07-W-01, Perak, Malaysia, Ver. 7, 28 May 2008 (28/05/2008).

### A.2. Description of the small-scale project activity:

**Purpose:** This project will recover methane caused by the decay of biogenic matter in the effluent stream of an existing oil palm processing mill by introducing methane recovery and combustion to the existing anaerobic effluent treatment system (lagoons).

**Explanation of GHG emission reductions:** The proposed project activities will reduce GHG emissions in an economically sustainable manner, and will result in other environmental benefits, such as improved water quality and reduced odour. In simple terms, the project proposes to move from a high-GHG-emitting open air lagoon, to a lower-GHG-emitting anaerobic digester with capture and combustion of the resulting biogas.

**Contribution to sustainable development:** Worldwide, agricultural operations are becoming progressively more intensive to realize the economies of production and scale. The pressure to become more efficient drives significant operational similarities between facilities of a "type," as inputs, outputs, practices, and technology have become similar around the world.

This is especially true in palm oil operations. Because Palm Oil Mill Effluent (POME) is quite concentrated[1], its handling and disposal can create profound environmental consequences, such as greenhouse gas emissions, odour, and water/land contamination (including seepage, runoff, and over application).

The project will have positive effects on the local environment by improving air quality through the reduction of odor and cleaner emissions. The project will be installed with an extensive monitoring system, and is designed to comply with all the local environmental regulations. In a later project phase, the mill has agreed to contribute to the 9$^{th}$ Malaysian Plan 2006-2010 under the Sustainable Energy Development by agreeing to use at least 10% of the biogas output to create renewable energy for use on the site.

This proposed project activity is to be implemented at Foong Lee Sawiminyak Sdn Bhd which processes 310,052 tonnes of fresh fruit bunch (FFB) per year, generating approximately 170,529 cubic meters of wastewater per year. The wastewater from the mill is treated through a ponding system consisting of cooling, anaerobic, and facultative lagoons. The depth of each anaerobic lagoon is approximately 7m, although sludge can reduce lagoon depth and volume. The lagoons are de-sludged as needed to comply with effluent discharge requirements, which are monitored monthly. The average temperature in the region is about 27.6$^{o}$C. These factors create anaerobic conditions within the lagoons, resulting in methane generation from the biodegradation of the organic content in the wastewater.

[1] Untreated POME from an average sized mill, i.e., processing capacity of about 30 tonnes FFB per hour, has an organic content equivalent to the raw domestic sewage from a population of 300,000 persons. POME has an industry mean standard Chemical Oxygen Demand rating of 50,000 mg/l. (Industrial Processes & the Environment (Handbook #3) Crude Palm Oil Industry, pp. 23 & 27.)

**A.3. Project participants:**

**Table 1. 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) |
|---|---|---|
| Malaysia (host) | • AES AgriVerde Services (Malaysia) Sdn Bhd | No |
| Netherlands | • AES AgriVerde Ltd. | 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.

**A.4. Technical description of the small-scale project activity:**

**A.4.1. Location of the small-scale project activity:**

**A.4.1.1. Host Party(ies):**

The host party for this project activity is **Malaysia.**

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

The project will be located in **Perak.**

**A.4.1.3. City/Town/Community etc:**

The project sites are shown in Figure 1 with specifics detailed in Table 2 (Section A.4.1.4).

**A.4.1.4. Details of physical location, including information allowing the unique identification of this small-scale project activity :**

The physical location of the project activity site is shown in Figure 1 and listed in Table 2.

**Foong Lee Sawiminyak Sdn Bhd** has one facility in Perak:

- Foong Lee Sawiminyak Sdn Bhd (0007) is a 60T per hour palm oil mill located in Perak, Malaysia. This facility processes approximately 310,052 tonnes of Fresh Fruit Bunches (FFBs) per year. The mill is in operation approximately 16 hours per day, 6 days per week, 26 days per month, and 312 days per year and is in regulatory compliance. The mill uses a system of open lagoons to process POME effluent, including two anaerobic lagoons, a facultative lagoon and aerobic lagoons.

The anaerobic lagoons measure approximately 100m x 35m x 7m and 100m x 35m x 7m, and the facultative lagoon measures 130m x 33m x 4.5m. Note that while the lagoons were originally dug to a depth of 7m, the depth in some locations may have been reduced due to sludge build-up.



**Figure 1. Project Activity Site in Perak, Malaysia**

**Table 2. Detailed physical location and identification of project sites**

| Site Name | Address | Town/State | Contact | Phone | GPS | AES AgriVerde Site ID |
|---|---|---|---|---|---|---|
| Foong Lee Sawiminyak Sdn Bhd | Batu 9, Jalan, 31110 | Sungai Siput, Perak, Malaysia | Ng Kok Hoong | 05 5911713 | N4 55.500 E101 06.238 | 0007 |

### A.4.2. Type and category(ies) and technology/measure of the small-scale project activity:

The project activity described in this document is classified as a Type III, Other Project Activities, Category III H/Version 5, option *iv*, *Methane recovery in wastewater treatment*. The project activity will capture and combust methane gas produced from the anaerobic portion of an existing wastewater treatment system in Perak, Malaysia.

The project activity utilizes a simple, effective and reliable technology to capture lagoon-produced biogas: installing sealed covers over existing anaerobic POME lagoons to create an anaerobic digester system. Each cover will consist of a synthetic high-density polyethylene (HDPE) geo-membrane which is sealed by means of strip-to-strip welding and a peripheral anchor trench dug around the perimeter of the existing lagoon. The welded seams will be tested to ensure air-tight coupling between all HDPE pieces. In addition, lagoon berms will be upgraded, as necessary, to ensure secure anchoring. HDPE is an excellent product for large applications requiring UV, ozone, and chemical resistance and because of these attributes is one of the most commonly used geo-membranes worldwide. This covering approach effectively enables capture/combustion of 100% of the biogas produced in these lagoons.

The digester will incorporate other features to enhance long-term reliability including multiple agitators to gently turn over the POME, and a sludge handling system that enables sludge removal without breaking the digester's air-tight seal.

POME will continue to flow from the anaerobic treatment section to facultative and algae treatment lagoons so that the effluent discharge requirements can be met. The captured biogas will be routed to one or more high temperature, enclosed flares to destroy methane gas as it is produced. Digester sludge will continue to be handled as in the past: it is occasionally pumped into drying beds and is used as fertilizer for oil palm trees.

Biogas will be accurately metered using a thermal mass flow meter that has two sensing elements: a velocity sensor and a temperature sensor that automatically corrects for changes in gas temperature. The transducer electronics heats the velocity sensor to a constant temperature differential above the gas temperature and measures the cooling effect of the gas flow. The meter runs on DC power and includes a UPS back-up system to provide for the possibility of power outages. This meter type offers distinct advantages over standard flow meters including direct mass flow sensing that eliminates the need for temperature and pressure compensation, high accuracy and repeatability for low-pressure gas flow measurement applications, outstanding rangeability, lower flow blockage and pressure drop than conventional meters, and no moving parts. The meter measures the mass flow and automatically converts to normalized volumetric output (NCMH).

The flaring combustion system is automated to ensure that all biogas that exits the digester and passes through a meter and flare is combusted. A continuous flare ignition system with redundant electrodes ensures methane is combusted whenever biogas is present at the flare. This continuous ignition system is powered by a solar module (solar-charged battery system) that does not require external power. With a fully charged battery, the module will provide power to the igniter for up to two weeks without sunlight. The flare includes thermocouples to monitor flare temperature, a parameter that is checked more often than hourly. The component parts are verified functional on a periodic basis in accordance with manufacturer and other technical specifications.

The mill has agreed to enter a second project phase, using some of the biogas to create renewable energy, once they better understand the characteristics of biogas generation (including consistency of output) and issues associated with filtering the gas to prepare it for use. Their commitment is to contribute to the 9th Malaysian Plan 2006-2010 under the Sustainable Energy Development, i.e., to use at least 10% of the biogas output to create either heat (through a boiler or by modifying the existing biomass burner) or electricity via cogeneration. The renewable energy generation (and biogas usage) will be monitored to ensure biogas combustion, but no effort will be made to claim additional CERs for the possibility of slightly reduced diesel fuel usage used in the startup and supplemental generators.

Sludge disposition will be monitored to ensure final disposition is the same (as pre-project) or that the appropriate allowance is made for project leakage.

Technology and know-how transfer:

Expertise and equipment will be integrated from several countries including the USA, Mexico, Italy, India, Brazil, S. Korea, New Zealand, and Malaysia. A multi-faceted approach will be taken to ensure that technology transfer proceeds smoothly, including a methodical process for identifying and qualifying appropriate technology/services providers, transferring the manufacture and maintenance of certain subassemblies to local manufacturers, supervision of the complete installation, staff training, ongoing monitoring (by both site and project developer personnel) and development/implementation of a Monitoring Plan (by the project developer). The materials and labour used in this project are sourced from the host country whenever possible.

By working closely with the project on a day-to-day basis, the project developer will ensure that all installed equipment is properly operated and maintained, and will carefully monitor the data collection and recording process. Moreover, by working with the mill site's staff over many years, the project developer will ensure that site personnel acquire appropriate expertise and resources to operate the system on an ongoing/continuous basis (even after CDM status retires).

### A.4.3 Estimated amount of emission reductions over the chosen crediting period:

**Table 3. Estimated Emission Reductions over the chosen Crediting Period (7-year Renewable)**

| Years | Estimation of annual emission reductions in tonnes of $CO_2$e |
|---|---|
| 2007 – 2008 | 57,094 |
| 2008 – 2009 | 57,094 |
| 2009 – 2010 | 57,094 |
| 2010 – 2011 | 57,094 |
| 2011 – 2012 | 57,094 |
| 2012 – 2013 | 57,094 |
| 2013 – 2014 | 57,094 |
| **Total estimated reductions** (tonnes of $CO_2$e) | *399,655 |
| **Total number of crediting years** | 7 |
| **Annual average of the estimated reductions over the crediting period** (tonnes of $CO_2$e) | 57,094 |

*Small discrepancy due to rounding.

### A.4.4. Public funding of the small-scale project activity:

There is no official development assistance or public funding being provided for this project.

**A.4.5. Confirmation that the small-scale project activity is not a debundled component of a large scale project activity:**

A proposed small-scale project activity shall be deemed to be a de-bundled component of a large project activity if there is a registered small-scale CDM project activity or an application to register another small-scale CDM project activity:

- With the same project participants,
- In the same project category and technology/measure; and
- Registered within the previous two years; and
- Whose project boundary is within 1 km of the project boundary of the proposed small-scale activity at the closest point.

At this site, there are no other SSC CDM project activities registered, or applied for registration, with the same project participants.

## SECTION B. Application of a baseline and monitoring methodology

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

The project follows the AMS III H small scale methodology for Methane Recovery in Wastewater Treatment, Version 5, Scope 13, applicable as of the $31^{st}$ meeting of the CDM Executive Board.

The project qualifies as a small scale project because total annual project emission reductions will not exceed 60 Kt $CO_2$e.

### B.2. Justification of the choice of the project category:

The project proposes to introduce methane recovery and combustion to an existing wastewater treatment system, in this case, a system of anaerobic and facultative lagoons at an oil palm processing facility. This fits the methodology's applicability criterion option *iv*:

*iv.* Introduction of methane recovery and combustion to an existing anaerobic wastewater treatment system such as anaerobic reactor, lagoon, septic tank or an on site industrial plant.

The CDM project will add sealed lagoon covers to the two anaerobic lagoons, gas distribution, flaring and measurement systems, and equipment (if necessary) to maintain the third lagoon in a facultative state. Absent the proposed project activity, methane from the existing system of lagoons would continue to be emitted into the atmosphere.

GHG emissions calculations can be determined using a combination of internationally accepted IPCC guidance and direct measurements. Based on historical oil palm Fresh Fruit Bunch (FFB) processing rates and baseline calculations, the estimated emission reductions of the project activity will not exceed 60 Kt $CO_2$e in any year of the crediting period as shown in Table 3 of Section A.4.3.

## B.3. Description of the project boundary:

The project boundary is schematically illustrated in Figure 2, and includes (1) the two anaerobic lagoons (which are covered using HDPE to enable the (project's) capture and combustion of lagoon generated methane), (2) the facultative lagoon (which has to be maintained in a facultative state), (3) nearby land that accommodates the gas handling, metering system(s) and combustion equipment (including flares and future renewable energy equipment), and (4) monitoring for de-sludging and sludge disposition.

The spatial extent of the boundary is described by AMS III H, and is located at the GPS coordinates listed in Table 2.

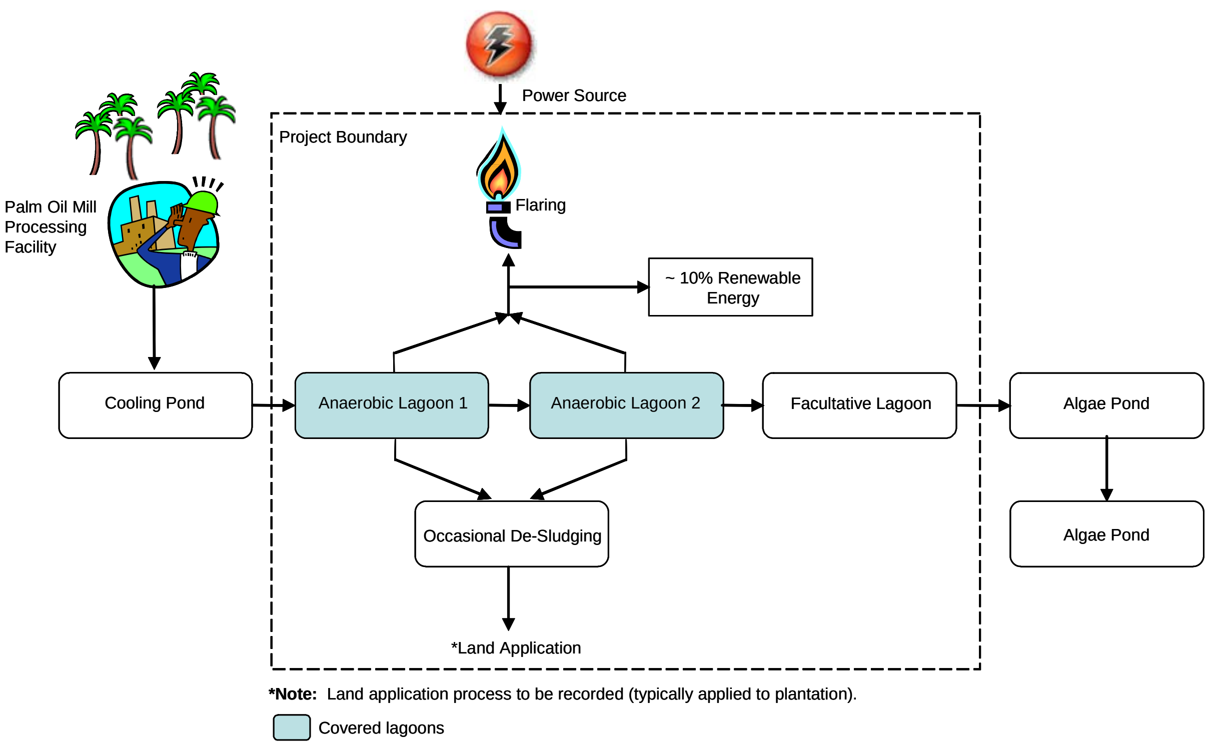



**Figure 2. Project Boundary**

## B.4. Description of baseline and its development:

A data assessment team visited the Foong Lee oil palm facility and found it uses a system of open lagoons, which combine cooling, sedimentation, anaerobic, facultative and aerobic processes to treat Palm Oil Mill Effluent (POME). This condition corresponds well with the methodology baseline section [6.] scenario *iv*:

> *(iv)* The existing anaerobic wastewater treatment system without methane recovery and combustion

and this scenario was determined to be the baseline (see section B.5 for a discussion of barriers).

Foong Lee's POME treatment system complies with current effluent discharge standards and is exemplary of the most common practice in Malaysia palm oil mills[2]. In fact, approximately 85% of the palm oil mills use open ponds; 5-10% use open tanks; the rest use composting and others[3]. Subsequent to treatment in the system of lagoons, the treated POME can be either:

– Applied to land (with a BOD limit of 5,000 mg/L), or
– Directed to waterways (with a BOD limit of 100 mg/L)[4].

Foong Lee uses land application.

The following data and parameters are used to determine baseline emissions:

**Table 4. Annual FFB production**

| Parameters | Variables | Value | Unit | Source |
|---|---|---|---|---|
| Annual FFB production | | 310,052 | tonnes | Mill records |
| Effluent Conversion Factor | | 0.55 | $m^3$/tonne | *Industrial Processes & the Environment*, Malaysia Dept. of Environment |
| Volume of wastewater | $Q_{y,ww}$ | 170,529 | $m^3$ | Estimated |
| COD untreated wastewater | $COD_{y,ww,untreated}$ | 0.111842 | Tonnes/$m^3$ | Site measurement |
| Methane correction factor to be treated in the digester | $MCF_{ww,\ treatment}$ | 0.8 | | MCF lower value in Table III H 1 |
| Methane generation capacity of treated wastewater | $B_{o,ww}$ | 0.21 | kg $CH_4$ / kg COD | IPCC |
| Global Warming Potential, methane | GWP_$CH_4$ | 21 | — | IPCC |

The total of baseline emission is calculated to be 67,287 $tCO_2$/year for this project.

**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 small-scale CDM project activity:**

Anthropogenic GHGs, including methane, are released into the atmosphere via decomposition of POME. Currently, this biogas is not collected or destroyed.

The proposed project activity intends to improve current wastewater management practices. These changes will result in the mitigation of anthropogenic GHG emissions, specifically the recovery of methane, by controlling the lagoon's decomposition processes and collecting and combusting the biogas.

[2] Abdul Latif *et al* 2003; Eco-Ideal 2004; Shirai *et al* 2003; Yeoh 2004b.

[3] Eco-Ideal 2004; Yeoh 2004a; Yeoh 2004b; Industrial Processes & the Environment, p. 40.

[4] ILBS 2004; Shamsudin 2006.

For this project, the total estimated emission reduction is estimated to be 399,655 $tCO_2e$ over the entire crediting period. The actual amount of emission reductions will be calculated ex post based on actual production.

The mill has committed to using at least 10% of the biogas to create renewable energy once they fully understand both the biogas generation characteristics and the filtering needed to prepare the biogas for use. This usage is likely to make an additional modest contribution to reduced anthropogenic emissions by slightly reducing diesel fuel usage (associated with the two onsite diesel generators) at the mill.

There are no existing, pending, or planned national regulatory requirements that govern GHG emissions from agro-industry operations (specifically, palm oil mill processing activities) as outlined in this PDD. The project participants have solicited information regarding this issue during numerous conversations with local and state government officials and through legal representation and have determined there is no regulatory impetus for producers to upgrade current wastewater treatment systems beyond the recommended open air anaerobic lagoon. The following paragraphs discuss the Malaysian palm oil industry and how conditions hinder changes in current practices.

According to the *Non-binding best practice examples to demonstrate addtionality for SSC project activities (EB35, Annex 34),*[5] "project participants shall provide an explanation to show that the project activity would not have occurred anyway due to at least one of the following barriers":

- *Investment barrier:* a financially more viable alternative to the project activity would have led to higher emissions;
- *Access-to-finance barrier*: the project activity could not access appropriate capital without consideration of the CDM revenues;
- *Technological barrier:* a less technologically advanced alternative to the project activity involves lower risks due to the performance uncertainty or low market share of the new technology adopted for the project activity and so would have led to higher emissions;
- *Barrier due to prevailing practice*: prevailing practice or existing regulatory or policy requirements would have led to implementation of a technology with higher emissions;
- *Other barriers* such as institutional barriers or limited information, managerial resources, organizational capacity, or capacity to absorb new technologies.

The most relevant barrier(s) which have prevented this project activity from being implemented without the assistance of CDM are as follows:

- ***Investment barriers** (most significant barrier)***:** This wastewater treatment approach is considered one of the more advanced systems in the world. In only a few countries have producers implemented such technology on a widespread basis because of high associated materials and ongoing maintenance costs compared to other types of systems. Though costs vary according to required lagoon size and other factors, initial costs to install an HDPE anaerobic digester system can run in the tens of thousands of US dollars[6]. The Malaysian palm oil industry views the installation of waste treatment systems as a means to satisfy statutory effluent discharge requirements, not a potential revenue source. Although "anaerobic digestion is a versatile biological treatment technology yielding methane as a useful bioenergy", the majority of mills continue to use pond or lagoon systems. These existing waste treatment systems adhere to Malaysian government requirements and are significantly lower in capital and operating costs

[5] http://cdm.unfccc.int/Reference/Guidclarif/methSSC_guid15_v01.pdf

[6] http://www.mrec.org/pubs/25145.pdf

than anaerobic digestion technology.[7] Implementing this project without the assistance of CDM does not provide the positive economic returns to justify or even partially offset the expenses. Even the use of biogas produced as a source of renewable energy does not provide a sufficient savings to justify its implementation.

In addition, AES AgriVerde is not only a project participant but is also the owner of all project activity equipment. Any renewable energy activity, such as heat or electricity generation, does not benefit or provide any revenue to AES AgriVerde. Therefore, this has no impact on any IRR estimates for this project. All cost estimates are provided in a separate attachment to the DOE. As demonstrated in the following table, implementing the project without the assistance of CDM is not sufficient to justify an investment in the improved waste treatment system.

| Project IRR | Percentage Value |
|---|---|
| IRR without CDM | Less than 0% |
| IRR with CDM | 22% |

- ***Technological barriers***: Operations and maintenance requirements involved with this technology, including the means to maintain pond circulation (once they are covered), maintaining biochemical equilibrium within the digester(s) and a detailed monitoring (including equipment and material maintenance) program to maintain system performance levels must also be considered[8]. There is a need for skilled and experienced operators and the availability of such personnel locally is limited as such biogas systems are still relatively rare.[9]

- ***Barriers due to prevailing practice*:** The current lagoon-based treatment system is considered the standard operating practice in palm oil mills in Malaysia[10]. Despite numerous changes to maximum discharge standards over the years, the combination of anaerobic lagoons and aerobic/facultative lagoons remains able to meet the current permitted discharge levels for land application or waterway discharge. The primary wastewater management priority for most palm oil mills is to simply maintain compliance with local effluent discharge regulations.

  While past practices cannot predict future events, it is worth noting that the site included in this project activity has been in existence for a number of years, during which time the prevailing wastewater management practice has been a system of open lagoons. As a result, there is no regulatory requirement for facilities to alter their current practices.

- *Other barriers:* Other common barriers include legal, social and business culture.

  *Legal:* Legal barriers are considered 'absolute' - because illegal options can not be the baseline. For instance, direct release of wastewater into the nearby water bodies is not permitted and is illegal; therefore this option cannot be considered.

[7] http://www.cogen3.net/doc/countryinfo/malaysia/TechnicalEconomicAnalysisCHPPalmEffluent_BG.pdf

[8] http://www.mrec.org/biogas/adgpg.pdf p.39-42.

[9] http://www.cogen3.net/doc/countryinfo/malaysia/TechnicalEconomicAnalysisCHPPalmEffluent_BG.pdf

[10] http://www.setatwork.eu/downloads/cp_malaysia.pdf

There is no legal barrier to this project, as it does not adversely affect any of the environmental regulations, either existing or pending.

*Social:* There are no general social barriers for this kind of project. The proposed project creates no socially unacceptable products and working with the system challenges no cultural or religious views.

*Business Culture:* The Foong Lee owners have applied their own stringent business view to the overall project and have determined not to presently use the biogas for other purposes (such as energy generation or offset) until they have seen the system operate (and gain comfort with the supply/ reliability of the biogas). They are supportive of the CDM project goals, however, and agreed to be a host site for such a project. Moreover, they have agreed to eventually use ≥10% of the biogas in some form of renewable energy, such as creating heat/steam, or to modify the existing biomass burner(s) to use both site produced biomass (such as kernels) and biogas.

Table 5 summarizes the barriers for their potential to impact the proposed project activity:

**Table 5. Barriers and their Potential to block project activity**

| Barriers | Potential |
|---|---|
| Financial/Investment | Most Significant |
| Technology | Significant |
| Prevailing Practice | Significant |
| Legal | No Barrier |
| Social | No Barrier |
| Business Culture | Moderate |

Each barrier and its potential impact were addressed using the questions in Table 6:

**Table 6. Barrier Test Framework**

| Barrier | *Potential baseline options* | *Direct release* | *Aerobic system* | *Business as usual* | *Biogas* | *Compost* |
|---|---|---|---|---|---|---|
| *** Y: Barrier exists N: Barrier does not exist NA: Question is not relevant (Y): Changing* | | | | | | |
| **Financial/Investment** | | | | | | |
| Is the technology intervention financially less attractive in comparison to other technologies (taking into account potentially available subsidies, soft loans or tax windows)? | | NA | Y | N | Y | Y |
| Is local equity participation difficult to find? | | NA | Y | N | Y | Y |
| Is international equity participation difficult to find? | | NA | NA | NA | NA | NA |
| Are site owners/project beneficiaries carrying any risk? | | NA | Y | N | Y | Y |
| **Technology** | | | | | | |
| Is technology option currently difficult to purchase through local equipment suppliers? | | NA | Y | N | Y | N |
| Are local skills and labor to operationalize and maintain this technology insufficient? | | NA | Y | N | (Y) | (Y) |
| Is this technology outside common practice in similar industries in the country? | | NA | Y | N | Y | Y |
| Is performance certainty not guaranteed with tolerance limits | | NA | N | N | N | N |
| Is there real or perceived risk associated with the technology? | | NA | Y | N | Y | Y |

| **Barrier** | ***Potential baseline options*** | ***Direct release*** | ***Aerobic system*** | ***Business as usual*** | ***Biogas*** | ***Compost*** |
|---|---|---|---|---|---|---|
| *** Y: Barrier exists N: Barrier does not exist NA: Question is not relevant (Y): Changing* | | | | | | |
| **Legal** | | | | | | |
| Does the practice violate host country laws or regulations or is it in non-compliance? | | Y | N | N | N | N |
| **Social** | | | | | | |
| Is the understanding of the technology low in the host country/industry considered? | | NA | Y | N | Y | Y |
| **Business Culture** | | | | | | |
| Is there a reluctance to change to alternative management practices in the absence of regulation? | | NA | Y | N | Y | Y |
| **Others** | | | | | | |
| Is there lack of experience in applying the technologies? | | NA | Y | N | Y | Y |

## B.6. Emission reductions:

### B.6.1. Explanation of methodological choices:

**Baseline Emissions**

The project follows the AMS III H small scale methodology for Methane Recovery in Wastewater Treatment, Version 5, Scope 13, applicable as of EB 31.

The baseline was found to correspond to methodology section 6 option *iv*:

*(iv)* The existing anaerobic wastewater treatment system without methane recovery and combustion

and Total Baseline Emissions are calculated as follows:

$$BE_y = (MEP_{y,ww,treatment} + MEP_{y,s,treatment}) * GWP\_CH_4$$

*Equation B1*

Where:

$MEP_{y,ww,treatment}$ = Methane emission potential of the wastewater treatment system in the year *y* (measured in tonnes)

$MEP_{y,s,treatment}$ = Methane emission potential of the untreated sludge in the year y (tonnes)

$GWP\_CH_4$ = Global Warming Potential of methane (value of 21 is used)

**Step 1 – Calculate open lagoon baseline emissions**

The baseline emissions from the lagoons are estimated based on the Chemical Oxygen Demand (COD) of the POME that would enter the lagoons in the absence of the project activity, the maximum methane producing capacity of wastewater ($B_o$) and a Methane Conversion Factor (MCF) that expresses what proportion of the effluent would be anaerobically digested in the open lagoons.

$$MEP_{y,ww,treatment} = Q_{y,ww} * COD_{y,ww,untreated} * B_{o,ww} * MCF_{ww,treatment}$$

*Equation B2*

Where:

| | | |
|---|---|---|
| $MEP_{y,ww,treatment}$ | = | Methane emission potential of the wastewater treatment system in the year *y*, (tonnes) |
| $Q_{y,ww}$ | = | Volume of wastewater treated in the year *y* ($m^3$) |
| $COD_{y,ww,untreated}$ | = | Chemical Oxygen Demand of the wastewater entering the anaerobic treatment system in the year *y* (tonnes/$m^3$) |
| $B_{o,ww}$ | = | Methane generation capacity of the treated wastewater (0.21 kg $CH_4$ / kg COD)[11] |
| $MCF_{ww, treatment}$ | = | Methane correction factor for the existing wastewater treatment system to which the sequential anaerobic treatment step is being introduced (MCF lower value in Table III H 1; value of 0.8 used) |

**Step 2 – Calculate emissions from sludge**

$$MEP_{y,s,treatment} = S_{y,untreated} * DOC_{y,s,untreated} * DOC_F * F * 16/12 * MCF_{s,treatment}$$

*Equation B3*

Where:

| | | |
|---|---|---|
| $MEP_{y,s,treatment}$ | = | Methane emission potential of the sludge treatment system in the year *y* (tonnes) |
| $S_{y,untreated}$ | = | Amount of untreated sludge generated in the year *y* ( tonnes) |
| $DOC_{y,s, untreated}$ | = | Degradable organic content of untreated sludge generated in the year *y* (fraction) |
| $DOC_F$ | = | Fraction of DOC dissimulated to biogas (fraction) (IPCC default is 0.5) |
| *F* | = | Fraction of $CH_4$ in landfill gas (IPCC default is 0.5) |
| *16/12* | = | Molar ratio of methane to carbon |
| $MCF_{s,treatment}$ | = | Methane correction factor for the sludge treatment system that will be equipped with methane recovery and combustion (MCF lower value in Table III H 1; value of 0 used) |

**Note**: As shown in Methodology III H, Section 13, "if the sludge is controlled combusted, disposed in a landfill with methane recovery, or used in soil applications, the emissions from sludge can be neglected, and the destiny of the final sludge will be monitored during the crediting period."

The existing Foong Lee practice is to de-sludge lagoons every few years on an "as needed" basis to ensure the overall POME treatment system complies with regulated effluent discharge levels. Sludge is dried in special purpose ponds and is subsequently land applied as fertilizer.  Since the baseline practice

[11] The IPCC default value of 0.25 Kg $CH_4$/Kg COD was corrected to take uncertainties into account.

of de-sludging and land applying as fertilizer will *not* be changed by the project, their sludge disposal process will be monitored **and $MEP_{y,s,treatment}$ taken as zero**.

**Step 3 – Determine Baseline Emissions**

Adding the results from Steps 1 and 2, determine the Baseline Emissions from:

$$BE_y = (MEP_{y,ww,treatment} + MEP_{y,s,treatment}) * GWP\_CH_4$$

*Equation B4*

**Project Emissions**

The amount of methane that would be emitted to the atmosphere due to the project activity and within the project boundaries can be estimated by referring to Volume 5, Chapter 3 of the 2006 IPCC Guidelines for National GHG Inventories.

The project emissions for this project activity are defined as the amount of methane that would be emitted to the atmosphere during the crediting period due to the project activity. In this case an anaerobic digester is considered the project activity and estimated emissions are determined as follows:

$$PE_y = PE_{y,power} + PE_{y,ww,treated} + PE_{y,s,final} + PE_{y,fugitive} + PE_{y,dissolved}$$

*Equation B5*

Where:

| | | |
|---|---|---|
| $PE_y$ | = | Project emissions in the year *y*, (tonnes $CO_2$e) |
| $PE_{y,power}$ | = | Emissions through electricity or diesel consumption in the year *y* (tonnes $CO_2$e) |
| $PE_{y,ww,treated}$ | = | Emissions through degradable organic carbon in treated wastewater in the year *y* (tonnes $CO_2$e) |
| $PE_{y,s,final}$ | = | Emissions through anaerobic decay of the final sludge produced in the year *y* (tonnes $CO_2$e) |
| $PE_{y,fugitive}$ | = | Emissions through methane release in capture and flare systems in the year *y* (tonnes $CO_2$e) |
| $PE_{y,dissolved}$ | = | Emissions through dissolved methane in treated wastewater in the year *y*, (tonnes $CO_2$e) |

**The following steps derive values for each of these parameters, summing them in Step 10.**

**Note: The term $PE_{y,power}$ will typically be zero as project does not utilize grid-based electricity, in continuance of pre-project activities. As the major part of the electricity comes from biomass based boiler for electricity generation and the negligible amount of emission from the diesel consumption of the other genset, it is deemed acceptable to assume that the project emissions due to electricity consumption is negligible.**

**Step 4 – Calculate emissions from treated wastewater for project**

$$PE_{y,ww,treated} = Q_{y,ww} * COD_{y,ww,treated} * B_{o,ww} * MCF_{ww,final} * GWP\_CH_4$$

*Equation B6*

Where:

| | | |
|---|---|---|
| $PE_{y,ww,treated}$ | = | Emissions through degradable organic carbon in treated wastewater in the year *y*, (tonnes $CO_2$e) |
| $Q_{y,ww}$ | = | Volume of wastewater treated in the year *y* ($m^3$) |
| $COD_{y, ww, treated}$ | = | Chemical oxygen demand of the treated wastewater in the year (tonnes/$m^3$) |
| $B_{o,ww}$ | = | Methane generation capacity of the treated wastewater (IPCC adjusted default of 0.21 Kg $CH_4$ / Kg COD) |
| $MCF_{ww, final}$ | = | Methane correction factor based on type of treatment and discharge pathway of the wastewater, fraction (MCF higher value in Table III H 1 for aerobic treatment, well managed; i.e., 0.1) |
| $GWP\_CH_4$ | = | Global warming potential of methane (value of 21 is used) |

**Step 5 – Calculate total amount of organic material removed in lagoon system**

$$PE_{y,s,final} = S_{y,final} * DOC_{y,s,final} * MCF_{s,final} * DOC_F * F * 16/12 * GWP\_CH_4$$

*Equation B7*

Where:

| | | |
|---|---|---|
| $PE_{y,s,final}$ | = | Methane emissions from the anaerobic decay of the final sludge generated in wastewater system in year *y* (tonnes $CO_2$e) |
| $S_{y,final}$ | = | Amount of final sludge generated by the wastewater system in the year *y* (tonnes) |
| $DOC_{y,s,final}$ | = | Degradable organic content of the final sludge generated by wastewater treatment in the year *y* (fraction) |
| $MCF_{s, final}$ | = | Methane correction factor of the landfill that receives the final sludge, estimated as described in category AMS III G. |
| $DOC_F$ | = | Fraction of DOC dissimulated to biogas (IPCC default value is 0.5) |
| *F* | = | Fraction of $CH_4$ in landfill gas (IPCC default value is 0.5) |
| *16/12* | = | Molar ratio of methane to carbon |
| $GWP\_CH_4$ | = | Global warming potential of methane (value of 21 is used) |

**Note:** Similar to Step 3, above, the value for $PE_{y,s,final}$ will be taken as zero because the existing practices for sludge disposition will continue unchanged in the project. During the project, sludge disposition will be verified.

**Step 6 – Calculate fugitive emissions from capture and flare inefficiencies**

$$PE_{y,fugitive,ww} = (1-CFE_{ww}) * MEP_{y,ww,treatment} * GWP\_CH_4$$

*Equation B8*

Where:

$PE_{y,fugitive,ww}$ = Fugitive emissions through capture and flare inefficiencies in the anaerobic wastewater treatment in year *y* (tonnes $CO_2$e)

$CFE_{ww}$ = Capture and flare efficiency of the methane recovery and combustion equipment in the wastewater treatment

$MEP_{y,ww,treatment}$ = Methane emission potential of the wastewater treatment plant in the year *y* (tonnes)

$GWP\_CH_4$ = Global warming potential of methane (value of 21 is used)

**Step 7 – Calculate fugitive emissions from capture and flare inefficiencies in sludge treatment**

$$PE_{y,fugitive,s} = (1-CFE_{s}) * MEP_{y,s,treatment} * GWP\_CH_4$$

*Equation B9*

Where:

$PE_{y,fugitive,s}$ = Fugitive emissions through capture and flare inefficiencies in the sludge treatment in the year *y* (tonnes $CO_2$e)

$CFE_{s}$ = Capture and flare efficiency of the methane recovery and combustion equipment in the sludge treatment system

$MEP_{y,s,treatment}$ = Methane emission potential of the sludge treatment system in the year *y* (tonnes)

$GWP\_CH_4$ = Global warming potential of methane (value of 21 is used)

**Step 8 – Calculate total fugitive emissions**

$$PE_{y,fugitive} = PE_{y,fugitive,ww} + PE_{y,fugitive,s}$$

*Equation B10*

Where:

$PE_{y,fugitive}$ = Emissions through methane release in capture and flare systems in the year *y* (tonnes $CO_2$e)

$PE_{y,fugitive,ww}$ = Fugitive emissions through capture and flare inefficiencies in the anaerobic wastewater treatment in year *y* (tonnes $CO_2$e)

$PE_{y,fugitive,s}$ = Fugitive emissions through capture and flare inefficiencies in the anaerobic sludge treatment in year *y* (tonnes $CO_2$e)

**Note:** Similar to Step 3, above, the value for $PE_{y,fugitive,s}$ will be taken as zero because the existing practices for sludge disposition will continue unchanged in the project. During the project, sludge disposition will be verified.

**Step 9 – Calculate emissions from methane dissolved in treated wastewater**

$$PE_{y,dissolved} = Q_{y,ww} * [CH_4]_{y,ww,treated} * GWP\_CH_4$$

*Equation B11*

Where:

| | | |
|---|---|---|
| $PE_{y,dissolved}$ | = | Emissions through dissolved methane in treated wastewater in the year *y* (tonnes $CO_2$e) |
| $Q_{y,ww}$ | = | Volume of wastewater treated in the year *y*, ($m^3$) |
| $[CH_4]_{y,ww,treated}$ | = | Dissolved methane content in the treated wastewater (tonnes/$m^3$) |
| | | Aerobic wastewater default = 0; in anaerobic wastewater the value can be measured or a default value = 0.0001 can be used |
| $GWP\_CH_4$ | = | Global warming potential of methane (value of 21 is used) |

**Step 10 – Calculate total project emissions**

$$PE_y = PE_{y,power} + PE_{y,ww,treated} + PE_{y,s,final} + PE_{y,fugitive} + PE_{y,dissolved}$$

*Equation B5*

The terms used in this equation are defined following Equation B5 in Step 3.

**Step 11 – Calculate emission reductions**

$$ER_y = BE_y - (PE_y + Leakage_y)$$

*Equation B12*

Where:

| | | |
|---|---|---|
| $ER_y$ | = | Emission reductions in the year *y*, tonnes $CO_2$e |
| $BE_y$ | = | Baseline emissions in the year *y*, tonnes $CO_2$e |
| $PE_y$ | = | Project emissions in the year *y*, tonnes $CO_2$e |
| $Leakage_y$ | = | Emission reductions in the year *y*, tonnes $CO_2$e |

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

Accurate data collection is essential. The subject palm oil processing facility maintains extensive FFB production and processing records to manage operations and to maximize both productivity and profitability. AES AgriVerde uses some data collected from this system. AES AgriVerde has a rigorous QA/QC system that ensures data security and data integrity. Spot audits of data collection activities will be conducted on a regular basis.

AES AgriVerde has a data management system capable of interfacing with producer systems to serve as a secure data repository. Project activity data related uncertainties will be reduced by applying sound data collection quality assurance and quality control procedures. Table 7 lists data and parameters available at the time of validation.

**Table 7. Data / Parameter Values and References**

| **Data / Parameter:** | **GWP $CH_4$** |
|---|---|
| Data unit: | |
| Description: | Global Warming Potential of Methane |
| Source of data used: | Intergovernmental Panel on Climate Change, *Climate Change 1995: The Science of Climate Change* (Cambridge, UK: Cambridge University Press, 1996) |
| Value applied: | 21 |
| Justification of the choice of data or description of measurement methods and procedures actually applied: | |
| Comments: | |

| **Data / Parameter:** | **$B_{o,ww}$** |
|---|---|
| Data unit: | Kg $CH_4$ / kg COD |
| Description: | Methane producing capacity of the treated wastewater |
| Source of data used: | IPCC default value for domestic wastewater as cited in UNFCCC AMS III H, V.5 methodology |
| Value applied: | 0.21 |
| Justification of the choice of data or description of measurement methods and procedures actually applied: | |
| Comments: | |

| **Data / Parameter:** | **$MCF_{ww,treatment}$** |
|---|---|
| Data unit: | Fraction |
| Description: | Methane correction factor |
| Source of data used: | IPCC default value as cited in UNFCCC AMS III H, V.5 methodology |
| Value applied: | 0.8 for anaerobic deep lagoon (baseline) |
| Justification of the choice of data or description of measurement methods and procedures actually applied: | |
| Comments: | |

| **Data / Parameter:** | **$MCF_{ww,final}$** |
|---|---|
| Data unit: | Fraction |
| Description: | Methane correction factor |
| Source of data used: | IPCC default value as cited in UNFCCC AMS III H, V.5 methodology |
| Value applied: | 1.0 for anaerobic digester with methane recovery (project) |
| Justification of the choice of data or description of measurement methods and | |

| | |
|---|---|
| procedures actually applied: | |
| Comments: | |

| **Data / Parameter:** | **$MCF_{s,treatment}$** |
|---|---|
| Data unit: | Fraction |
| Description: | Methane correction factor |
| Source of data used: | IPCC default value as cited in UNFCCC AMS III H, V.5 methodology |
| Value applied: | 0 for aerobic treatment, well managed (project and baseline) |
| Justification of the choice of data or description of measurement methods and procedures actually applied: | |
| Comments: | |

| **Data / Parameter:** | **$CFE_{ww}$** |
|---|---|
| Data unit: | |
| Description: | Capture and flare efficiency of the methane recovery and combustion equipment |
| Source of data used: | Default value specified in UNFCCC AMS III H., V.5 methodology, p.4 |
| Value applied: | 0.9 in wastewater treatment |
| Justification of the choice of data or description of measurement methods and procedures actually applied: | |
| Comments: | |

| **Data / Parameter:** | **$Q_{y,ww}$** |
|---|---|
| Data unit: | $m^3$ |
| Description: | Volume of wastewater treated in the year *y* |
| Source of data used: | Calculated |
| Value applied: | 170,529 |
| Justification of the choice of data or description of measurement methods and procedures actually applied: | Determined from FFB production data and site verified effluent conversion factor |
| Comments: | |

| **Data / Parameter:** | **$COD_{y,ww,\ untreated}$** |
|---|---|
| Data unit: | Tonnes/$m^3$ |
| Description: | Chemical oxygen demand of the wastewater entering the anaerobic treatment reactor / system with methane capture in the year *y* |
| Source of data used: | Site Data |
| Value applied: | 0.111842 |
| Justification of the choice of data or description of measurement methods and procedures actually applied: | |
| Comments: | |

| Data / Parameter: | $COD_{y,ww,treated}$ |
|---|---|
| Data unit: | Tonnes/$m^3$ |
| Description: | Chemical Oxygen Demand of the treated wastewater in the year *y* |
| Source of data used: | Site Data |
| Value applied: | 0.041305 |
| Justification of the choice of data or description of measurement methods and procedures actually applied: | |
| Comments: | |

| Data / Parameter: | $CH_{4,y,ww,treated}$ |
|---|---|
| Data unit: | Tonnes/$m^3$ |
| Description: | Dissolved methane content in the treated wastewater |
| Source of data used: | Refer to UNFCCC AMS III H, V.5 methodology |
| Value applied: | 0.0001 |
| Justification of the choice of data or description of measurement methods and procedures actually applied: | |
| Comments: | |

| Data / Parameter: | $\rho_{CH4,n}$ |
|---|---|
| Data unit: | kg/$m^3$ |
| Description: | Density of Methane at normal conditions |
| Source of data used: | Refer to UNFCCC Annex 13 |
| Value applied: | (0.716) |
| Justification of the choice of data or description of measurement methods and procedures actually applied: | |
| Comments: | |

### B.6.3 Ex-ante calculation of emission reductions:

Emission factors for the baseline are calculated as described in Section B.4. To estimate total yearly baseline methane emissions, the selected emission factors are calculated by determining the methane emission potential of untreated wastewater and untreated sludge.

**Table 8. Baseline Emissions (Methane shown in metric tonnes of $CO_2e$)**

| Foong Lee Sawiminyak Sdn Bhd (0007) | |
|---|---|
| Methane emission potential of untreated wastewater in tonnes $CH_4$/yr ($MEP_{y,ww,treatment}$) | 3,204 |
| Methane emission potential of untreated sludge in tonnes $CH_4$/yr ($MEP_{y,s,treatment}$) | 0 |
| Global warming potential of methane (GWP_CH4) | 21 |
| **Total annual baseline emissions in tonnes of $CO_2e$ (BEy)** | **67,287** |

| Foong Lee Sawiminyak Sdn Bhd (0007) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Year** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | **Total** |
| ***Expected Growth %*** | *0%* | *0%* | *0%* | *0%* | *0%* | *0%* | *0%* | |
| **Baseline Emissions ($tCO_2e$)** | 67,287 | 67,287 | 67,287 | 67,287 | 67,287 | 67,287 | 67,287 | *471,006 |

*Small discrepancy due to rounding.

Emission factors for the project activity are calculated as described in Section B.6.1. To estimate total yearly project methane emissions, the types of emissions listed in Table 9 are summed.

**Table 9. Project Activity Emissions (Methane shown in metric tonnes of $CO_2e$)**

| Foong Lee Sawiminyak Sdn Bhd (0007) | |
|---|---|
| Emissions through electricity or diesel consumption ($PE_{y,power}$) | 0 |
| Emissions through degradable organic carbon in treated wastewater ($PE_{y,ww,treated}$) | 3,106 |
| Emissions through anaerobic decay of the final sludge produced ($PE_{y,s,final}$) | 0 |
| Emissions through methane release in capture and flare systems ($PE_{y,fugitive,ww}$) | 6,729 |
| Emissions through dissolved methane in treated wastewater ($PE_{y,dissolved}$) | 358 |
| **Total annual project emissions (PEy)** | **10,193** |

| Foong Lee Sawiminyak Sdn Bhd (0007) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Year** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | **Total** |
| ***Expected Growth %*** | *0%* | *0%* | *0%* | *0%* | *0%* | *0%* | *0%* | |
| **Project Emissions ($tCO_2e$)** | 10,193 | 10,193 | 10,193 | 10,193 | 10,193 | 10,193 | 10,193 | 71,351 |

Since the technology used does not consist of equipment from another activity nor is the existing equipment transferred to another activity, leakage does not need to be considered according to the methodology.

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

**Table 10. Total Emission Reductions**

| **Table 10. Total Emission Reductions (tonnes $CO_2e$)** | | | | |
|---|---|---|---|---|
| ***Year*** | Estimation of project activity emissions ($tCO_2e$) | Estimation of baseline emissions ($tCO_2e$) | Estimation of leakage ($tCO_2e$) | Estimation of overall emission reductions ($tCO_2e$) |
| *1* | 10,193 | 67,287 | 0 | 57,094 |
| *2* | 10,193 | 67,287 | 0 | 57,094 |
| *3* | 10,193 | 67,287 | 0 | 57,094 |
| *4* | 10,193 | 67,287 | 0 | 57,094 |
| *5* | 10,193 | 67,287 | 0 | 57,094 |
| *6* | 10,193 | 67,287 | 0 | 57,094 |
| *7* | 10,193 | 67,287 | 0 | 57,094 |
| **Total** (tonnes $CO_2e$) | 71,351 | *471,006 | 0 | *399,655 |

*Small discrepancy due to rounding.

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

### B.7.1 Data and parameters monitored:

AES AgriVerde has developed a unique set of data management tools to efficiently capture and report data throughout the project lifecycle. On-site assessment, supplier production data exchange, task tracking, and post-implementation auditing tools have been developed to ensure accurate, consistent, and complete data gathering and project implementation. Sophisticated tools have also been created to estimate/monitor the creation of high quality, permanent ERs using IPCC formulae.

By coupling these capabilities with a quality and environmental management system, AES AgriVerde enables transparent data collection and verification.

Project metering devices are designed to continuously and accurately measure biogas flow and are specially designed for corrosive environments. Meters are received from the factory fully-calibrated and will be calibrated annually (meter accuracy = 1% of reading + 0.5% full scale accuracy). The meters are temperature and gas pressure corrected. Periodic maintenance will be performed based on manufacturer specifications.

Quarterly, an industry standard gas analyser will be used to measure both biogas and flare exhaust methane content to verify the efficiency of the flaring process. The process is described in the Monitoring Plan. The measuring equipment is calibrated in accordance with the manufacturer specifications. The equipment is accurate to within ±3% with 0.18 resolution.

See Table 11 for specific parameters to be monitored.

**Table 11. Data to be monitored**

| **Data / Parameter:** | $Q_{y,ww}$ |
|---|---|
| Unit: | $m^3$ |
| Description: | Volume of wastewater treated in the year *y* |
| Source of data to be used: | Site Specific FFB production Data |
| Value of data: | |
| Description of measurement methods and procedures to be applied: | Determined through mill records and site verified effluent conversion factor. To be field verified by a third party on an annual basis. |
| QA/QC procedures to be applied: | Mill FFB production data used in the calculation of yearly volume of wastewater treated will be checked against mill records. |
| Any comment: | Data will be archived electronically and kept for the duration of the project + 2 years. |

| **Data / Parameter:** | $COD_{y,ww,untreated}$ |
|---|---|
| Unit: | $Tonnes/m^3$ |
| Description: | Chemical oxygen demand of the wastewater entering the anaerobic treatment system in the year *y* |
| Source of data to be used: | Data collected on the AES AgriVerde Monitoring Form. |
| Value of data: | |
| Description of measurement methods and procedures to be applied: | Measured and recorded semi-annually |
| QA/QC procedures to be applied: | COD analysis of wastewater samples will be conducted in accordance to analysis equipment manufacturer's specifications and will include blank and calibration standards. |
| Any comment: | Data will be archived electronically and kept for the duration of the project + 2 years. |

| **Data / Parameter:** | $COD_{y,ww,treated}$ |
|---|---|
| Unit: | $Tonnes/m^3$ |
| Description: | Chemical oxygen demand of the treated wastewater in the year *y* |
| Source of data to be used: | Data collected on the AES AgriVerde Monitoring Form. |
| Value of data: | |
| Description of measurement methods and procedures to be applied: | Measured and recorded semi-annually |
| QA/QC procedures to be applied: | COD analysis of wastewater samples will be conducted in accordance to analysis equipment manufacturer's specifications and will include blank and calibration standards. |
| Any comment: | Data will be archived electronically and kept for the duration of the project + 2 years. |

| **Data / Parameter:** | **$MC_{biogas}$** |
|---|---|
| Unit: | Percentage (volume) |
| Description: | Methane content of biogas |
| Source of data to be used: | Gas analyzer |
| Value of data: | |
| Description of measurement methods and procedures to be applied: | Measured more often than hourly and recorded quarterly. The measuring equipment is calibrated in accordance with the manufacturer specifications. Sufficient measurements will be made to meet a 95% confidence level. |
| QA/QC procedures to be applied: | Use and calibration of the methane analyzer will be conducted in accordance with manufacturer's standards. A calibration/service log will be maintained for each methane analyzer. |
| Any comment: | Data will be archived electronically or on paper and kept for the duration of the project + 2 years. |

| **Data / Parameter:** | **$CFE_{ww}$** |
|---|---|
| Unit: | Percentage |
| Description: | Efficiency of flaring process |
| Source of data to be used: | Refer to UNFCCC AMS III H, V.5 methodology |
| Value of data: | 0.90 |
| Description of measurement methods and procedures to be applied: | Flares shall be operated in accordance with manufacturer specifications. Flare combustion temperature and biogas flow rate data will be recorded more frequently than hourly. If in any specific hour either of these parameters is out of specification, a flare efficiency of 50% will be used for this specific hour.<br><br>If at any given time the temperature of the flare is below 500$^{o}$C, 0% efficiency will be used for this period.<br><br>Provided these parameters are within specification, a value of 0.9 shall be used. |
| QA/QC procedures to be applied: | All flare monitoring equipment will be operated and calibrated according to manufacturer's specifications. Flare temperature and biogas flow data will be compiled and analyzed using software. Electronic flare monitoring data will be stored for the duration of the project + years. |
| Any comment: | Data will be archived electronically or on paper and kept for the duration of the project + 2 years. |

| **Data / Parameter:** | **$BGP_{Flare}$** |
|---|---|
| Unit: | NCMH |
| Description: | Amount of biogas recovered and directed to flare for combustion |
| Source of data to be used: | Continuous flow meter |
| Value of data: | |
| Description of measurement methods and procedures to be applied: | Measured and recorded more often than hourly. |
| QA/QC procedures to be applied: | AES AgriVerde employs an internal QA audit process that ensures monitoring activities are conducted in accordance with the monitoring plan and verifies the accuracy of data reported. |
| Any comment: | Data will be archived electronically or on paper and kept for the duration of the project + 2 years. |

| **Data / Parameter:** | **$BGP_{RE}$** |
|---|---|
| Unit: | NCMH |
| Description: | Amount of biogas recovered and directed to Renewable Energy Unit |
| Source of data to be used: | Continuous flow meter |
| Value of data: | |
| Description of measurement methods and procedures to be applied: | Measured and recorded more often than hourly. |
| QA/QC procedures to be applied: | AES AgriVerde employs an internal QA audit process that ensures monitoring activities are conducted in accordance with the monitoring plan and verifies the accuracy of data reported. |
| Any comment: | Data will be archived electronically or on paper and kept for the duration of the project + 2 years. |

| **Data / Parameter:** | **$RE_{ON}$** |
|---|---|
| Unit: | ºC |
| Description: | Signal to prove the Renewable Energy Unit is combusting the biogas |
| Source of data to be used: | Renewable Energy Unit mounted thermocouple |
| Value of data: | |
| Description of measurement methods and procedures to be applied: | Measured and recorded more often than hourly. |
| QA/QC procedures to be applied: | AES AgriVerde employs an internal QA audit process that ensures monitoring activities are conducted in accordance with the monitoring plan and verifies the accuracy of data reported. |
| Any comment: | Data will be archived electronically or on paper and kept for the duration of the project + 2 years. |

| **Data / Parameter:** | $S_{f, end use}$ |
|---|---|
| Unit: | |
| Description: | End use of final sludge |
| Source of data to be used: | Data collected on the AES AgriVerde Monitoring Form. |
| Value of data: | |
| Brief description of measurement methods and procedures to be applied: | Verified and recorded quarterly |
| QA/QC procedures to be applied: | End use of sludge will be monitored and inspected on-site (visually) with verification by the mill manager. |
| Any comment: | Data will be archived electronically or on paper and kept for the duration of the project + 2 years. |

### B.7.2 Description of the monitoring plan:

A complete set of procedures and a Monitoring Plan (see Annex 4) has been developed to ensure that accurate and relevant measurements and observations are made to document palm oil mill production metrics, project biogas production and equipment operation, including possible sources of sludge, emissions and leakage. This plan meets the requirements outlined in the approved methodology as shown in Appendix B of the simplified modalities and procedures for small-scale CDM project activities as it applies to the proposed project activity.

AES AgriVerde has established a dedicated O&M staff in the host nation to perform activities including but not limited to monitoring and collection of parameters, quality audits, personnel training, palm oil mill staff training and equipment inspections. The associated Monitoring Plan has been developed to provide guidance (work instructions) to individuals that collect and/or process data. AES AgriVerde staff will perform audits of Operations personnel on a regular basis to ensure integrity in the data collection and handling process.

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

The final draft of the application of the methodology was completed on 12 February 2008 (12/02/2008).

The entity determining the baseline and monitoring methodology is AES AgriVerde who is the project developer as well as a project participant. Contact information is 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:

The starting date for this activity is 25 March 2007 (25/03/2007).

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

The expected life of this project is 22y–8m.

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

The project activity will use a **renewable** crediting period

### C.2.1. Renewable crediting period

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

15 March 2008, or the actual date of registration by the CDM Executive Board

#### C.2.1.2. Length of the first crediting period:

The length of the crediting period is **7y-0m**.

### C.2.2. Fixed crediting period:

#### C.2.2.1. Starting date:

#### C.2.2.2. Length:

## SECTION D. Environmental impacts

### D.1. If required by the host Party, documentation on the analysis of the environmental impacts of the project activity:

In Malaysia, all mills processing oil palm fresh fruit bunches into crude palm oil, whether to intermediate or final products, are licensed as prescribed premises under the Malaysian Environmental Quality (Prescribed Premises) (Crude Palm Oil) Regulations, 1977 (ILBS 2004). The POME, as an extremely polluting effluent with high organic content, is legally regulated to ensure the discharge will not pollute the receiving environment. No discharge of effluent from the mills shall be allowed without license from the Regulations. Where such discharge is licensed, the effluents shall not exceed the level of parameters governed into a watercourse or onto land. The Regulations, however, do not specify the treatment technologies or requirement.

While an environmental impact analysis is not required for this type of GHG project activity, state-level approval by the Department of the Environment is required. This is accomplished via periodic renewal of the mill's business license. Additionally, the gas handling system must be approved by the Department of Safety and Health.

Environment:

There are no negative environmental impacts resulting from the proposed project activity.

Beyond the principal benefit of mitigating GHG emissions (the primary focus of the proposed project), the proposed activity will also result in positive environmental co-benefits. They include a reduction in atmospheric emissions of Volatile Organics Compounds (VOCs) that cause odour and acid rain, and promotion of an improved, modernized image of the palm oil production industry.

The combination of these factors will make the proposed project site more "neighbour friendly" and environmentally responsible.

**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:**

No action required.

## SECTION E. Stakeholders' comments

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

AES AgriVerde invited stakeholders to a meeting near the Foong Lee site to explain both the UNFCCC CDM process and proposed project activity. This meeting was held on 28 February 2007 (28/02/2007) at the Convention Centre, Taman Tun Sambanthan, Sg. Siput (U), Perak, Malaysia.

AES AgriVerde issued invitations to government officials at the federal, state, and local levels. Furthermore, AES AgriVerde published announcements of the meetings in the newspaper, which cover the states of: Selangor, Perak, and Negeri Sembilan.

These public announcements appeared in:

1. *New Straits Times* on 14 February 2007 (14/02/2007).

All invitations were in the English language. The meeting was attended by project participants, various members from the local community, and producer representatives. A full list of attendees and the meeting minutes are available on request.

John McMorris of AES AgriVerde gave a presentation addressing the following topics: the purpose of the meeting, global warming and the Kyoto Protocol, UNFCCC CDM processes, project processes and responsibilities, project participants, equipment used for evaluation and audits, and the information management system. Other topics included a project example, benefits of the project (environmental and economic), and where to get further information.

Encik Adinan Azizi, the Deputy Director for the Perak Department of Environment, expressed his appreciation for participating in the days events, and briefly expressed support for the project and the Malaysian government's role in project development.

Mark Leslie of AES AgriVerde also participated as a speaker and described the company's business role in Malaysia for reducing carbon emissions, and AES AgriVerde's on-going partnership with AgCert which has achieved significant regulatory experience through project work performed at over 1,000 sites.


**Figure 3. AES AgriVerde speakers at the Foong Lee Stakeholder's Meeting.**

**Figure 4. Audience participation at the Foong Lee Stakeholder's Meeting.**

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

After the presentations, attendees were afforded the opportunity to ask questions regarding the proposed project activities.

Overall, the comments from the attendees at the stakeholders’ meeting were positive and supportive of the project.  Additional comments are available in the Stakeholder’s Meeting Minutes document.

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

No action required.

## Annex 1

### CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

| Project Participant: | |
|---|---|
| Organization: | AES AgriVerde Ltd. |
| Street/P.O. Box: | 10 Queen Street, Suite 105 |
| Building: | Gibbons Building |
| City: | Hamilton |
| State/Region: | |
| Postfix/ZIP: | HM11 |
| Country: | Bermuda |
| Telephone: | +1 (321) 549-4253 |
| FAX: | +1 (321) 722-9008 |
| E-Mail: | registry@aes.com |
| URL: | www.aesagriverde.com |
| Represented by: | |
| Title: | Quality Assurance Director |
| Salutation: | Mr. |
| Last Name: | Miller |
| Middle Name: | A. |
| First Name: | Mark |
| Department: | Regulatory |
| Mobile: | |
| Direct FAX: | +1 (321) 722-9008 |
| Direct tel: | +1 (321) 549-4255 |
| Personal E-Mail: | registry@aes.com |

| Project Developer and Participant: | |
|---|---|
| Organization: | AES AgriVerde Services (Malaysia) Sdn Bhd |
| Street/P.O. Box: | Lingkaran Syed Putra |
| Building: | Suite 23.01, Level 23, Centrepoint South, Mid Valley City |
| City: | Kuala Lumpur |
| State/Region: | Selangor |
| Postfix/ZIP: | 59200 |
| Country: | Malaysia |
| Telephone: | +60 3 2287 9868 |
| FAX: | +60 3 2287 6998 |
| E-Mail: | |
| URL: | www.aesagriverde.com |
| Represented by: | |
| Title: | CDM Services/Logistics Manager |
| Salutation: | Ms. |
| Last Name: | Foo |
| Middle Name: | |
| First Name: | Siew Theng |
| Department: | Regulatory Affairs |
| Mobile: | |
| Direct FAX: | +60 3 2287 6998 |
| Direct tel: | +60 3 2287 9868 ext. 119 |
| Personal E-Mail: | SiewTheng.Foo@aes.com |

## Annex 2

## INFORMATION REGARDING PUBLIC FUNDING

There is no official development assistance or public funding being provided for this project.

## Annex 3

## BASELINE INFORMATION

The following parameters are used in the application of the baseline methodology:

**Baseline Input**

| Parameters | Variables | Value | Unit | Source |
|---|---|---|---|---|
| Annual FFB production | | 310,052 | tonnes | Mill Data Records |
| Volume of wastewater | $Q_{y,ww}$ | 170,529 | $m^3$/yr | Determined from mill FFB production records |
| COD untreated wastewater | $COD_{y,ww,untreated}$ | 0.111842 | Tonnes/ $m^3$ | Average of successive monthly readings; independent test laboratory results |
| Methane correction factor to be treated in the digester | $MCF_{ww, treatment}$ | 0.8 | - | MCF lower value in Table III.H.1 |
| Methane generation capacity of treated wastewater | $B_{o,ww}$ | 0.21 | Kg $CH_4$ / Kg COD | IPCC |
| Global Warming Potential, methane | GWP_$CH_4$ | 21 | - | IPCC |
| Sludge Disposition | $S_{f, end use}$ | | | Mill records. If sludge is land applied, $PE_{y,s,final} = 0$ & $MEP_{y,s,treatment} = 0$ |

**Project Input**

| Parameters | Variables | Value | Unit | Source |
|---|---|---|---|---|
| Annual FFB production | | 310,052 | tonnes | Mill Data Records |
| Volume of wastewater | $Q_{y,ww}$ | 170,529 | $m^3$/yr | Determined from mill FFB production records |
| COD treated wastewater | $COD_{y,ww,treated}$ | 0.041305 | Tonnes/$m^3$ | Average of semi-annual measurement; independent test laboratory results |
| Methane correction factor treated water | $MCF_{ww, final}$ | 0.1 | - | MCF higher value in Table III.H.1 |
| Methane generation capacity of treated wastewater | $B_{o,ww}$ | 0.21 | Kg $CH_4$ / Kg COD | IPCC |
| Global Warming Potential, methane | GWP_$CH_4$ | 21 | - | IPCC |
| Sludge Disposition | $S_{f, end use}$ | | | Mill records. If sludge is land applied, $PE_{y,s,final} = 0$ & $MEP_{y,s,treatment} = 0$ |
| Capture & Flare Efficiency | $CFE_{ww}$ | 0.9 | - | Provided flare stays |

| Parameters | Variables | Value | Unit | Source |
|---|---|---|---|---|
| of $CH_4$ recovery & combustion equipment | | | | within manufacturer specifications for flare temperature and biogas flow rate (checked more often than hourly). |

## Annex 4

## MONITORING INFORMATION

**Monitoring Plan**

**PURPOSE**

The purpose of this method specification is to describe the criteria for maintaining equipment, reporting equipment outages, and to provide detailed guidance for collection and processing of data that is used in the determination of Green House Gas (GHG) emissions and emission reductions.

**SCOPE**

This document applies to GHG Mitigation Project activities. It applies to all personnel that operate and/or maintain project activity equipment and/or have an active role in data collection and processing.

**ASSOCIATED DOCUMENTS**

- UNFCCC approved monitoring methodology: AMS III H, Methane recovery in wastewater treatment, Version 5: http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_UOWMJU5ZNUE0SGBGAZZNVFU9HVOV99
- Jody Zall Kusek, and Ray C. Rist, June 2004. Ten Steps to a Results-based Monitoring and Evaluation System: A Handbook for Development Practitioners, World Bank. http://www.worldbankinfoshop.org/ecommerce/catalog/product?item_id=3688663
- As-built documentation for:
    - Anaerobic digester
    - Biogas transfer system including a biogas flow-meter
    - Combustion system (Flare)
- O & M Weekly Monitoring Checklist
- O & M Quarterly Monitoring Form
- O & M Maintenance Log
- Data Collection Procedure
- Inventory Control
- Quarterly Inventory Reporting
- Control of Nonconforming Product/Service
- Control of Monitoring & Measurement Devices
- Equipment Calibration & Verification
- Competence, Training, and Awareness

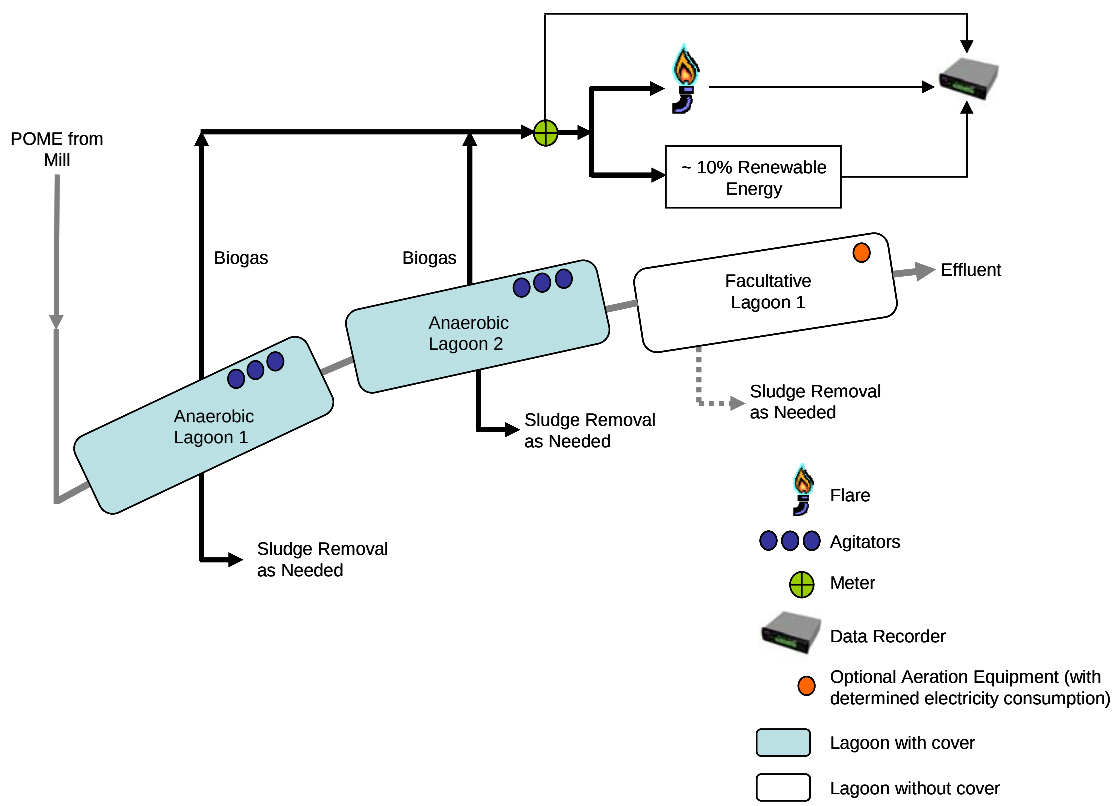
- Form B – Palm Oil Mills
- Operations Manual, $CH_4$ Analyzer
- EnviroCert Operations Management System (OMS)

**OPERATION AND MAINTENANCE ACTIVITIES**

**System Overview**

The equipment used to mitigate palm oil mill effluent GHG emissions in this project is shown in Figure 4.1. The system is made up of four (4) major subsystems:

- Anaerobic digester cell(s)
- Biogas transfer system including biogas flow-meters
- Combustion systems (flares)
- Renewable energy




**Note:**
- Electrical usage will be conservatively estimated by assuming 24-hour/day, full-time operation at manufacturers specifications. Optionally, may meter to reduce impact.
- Incoming power is from existing on-site power source.
- Number and size of agitators chosen at installation.
- Lagoon bypass available as needed for system maintenance.

**Figure 4.1. Typical Project GHG Mitigation System**

**SYSTEM COMPONENTS OPERATION REQUIREMENTS**

System familiarization and training will be divided into five sections:

- Training
- Normal Operation
- Safety Issues and Emergency Preparedness
- Inspections, and
- Alternative Operating Procedures

**Training**

All operations personnel will be trained on the system components and sub-assemblies. Training shall include: system components, normal operation, emergency operations, maintenance, and request for warranty service. Training on reporting procedures shall be provided by AES AgriVerde to the mill's site manager or another mill-designated employee.

**Normal Operation**

The project activity utilizes a simple, effective and reliable technology to capture lagoon-produced biogas: installing sealed covers over existing POME lagoons to create an anaerobic digester. The cover will consist of a synthetic high-density polyethylene (HDPE) geo-membrane, which is sealed by means of strip-to-strip welding and a peripheral anchor trench dug around the perimeter of the existing lagoon.

Because the project activity modifies existing POME treatment lagoons, the system will continue to treat POME in a manner consistent with normal lagoon operations. The digester will incorporate additional features to enhance long-term reliability including mechanical agitation to gently turn over the POME, and a sludge handling system that enables sludge removal without breaking the digester's air-tight seal.

POME will continue to flow from the anaerobic lagoons to aerobic treatment lagoons so that final effluent discharge requirements can be met. The captured biogas will be routed through a biogas handling piping system to an enclosed flare to destroy methane gas as it is produced. Digester sludge will continue to be handled as in the past: it will be pumped into drying beds and used as fertilizer for oil palm trees.

Biogas, to the flare and/or the renewable energy unit, will be accurately metered using a thermal mass flow meter that uses two sensing elements: a velocity sensor and a temperature sensor that automatically corrects for changes in gas temperature and pressure. The flow meter is equipped with a battery backup and will store and transmit total gas flow data to a data recorder.

The flaring combustion system is automated to ensure that all biogas that exits the digester and passes through the meter and flare is combusted. A continuous ignition system with redundant electrodes ensures methane is combusted whenever biogas is present at the flare. This continuous ignition system is powered by a solar module (solar-charged battery system) that does not require external power. With a fully charged battery, the module will provide power to the igniter for up to two weeks without sunlight. Temperature data from a thermocouple will be recorded in a data logger to ensure that biogas is properly combusted.

**Safety Issues and Emergency Preparedness**

Care should be exercised when working around project equipment as trapped biogas can be highly flammable.

**WARNING**

**The gas contained in the digester cell is EXTREMELY flammable.**

**Sources of ignition and smoking are not permitted within 10 meters of the cell and gas handling system.**

**Death or serious injury may result.**

Gas to the metering system should be disconnected prior to performing maintenance on the flow-meter or gas handling equipment. Care should be exercised when digging in the area where biogas pipes are buried (when applicable).

Prior to performing maintenance on the flare (or other combustion) system, the gas flow **must** be turned off. Care should be exercised when working near the flare system as flare system components can be extremely hot.

**Weekly Inspection**

A periodic inspection shall include the following:

- Influent piping:
  - check for pipeline obstructions, leaks, or corrosion at exposed joints
- Cover material: check for cracks, tears or points of distress (or wear) around the perimeter of the digester cell
- Check for excessive ballooning of cover (indicating excess biogas build-up) or presence of odour (indicating the possibility of a leak)
- Check for signs of gas or POME leakage through the cover
- Verify Agitator operation
- Biogas piping: check for leaks and/or cracks in piping
- Check for proper operation of the data recorder
- Check for proper operation of the flow meter (compare meter reading to previous reading. Meter reading should have changed since last reading)
- Check for proper operation of the flare thermocouples
- Visually inspect flare to determine if flare is combusting biogas. This system will typically be quite hot when operating

**Alternative Operating Procedures**

The site manager or operations employee should IMMEDIATELY notify AES AgriVerde in accordance with the Emergency Maintenance section of this annex if any project equipment or subsystems appear to be inoperative or operating abnormally. The mill's site manager and AES AgriVerde's Regional Maintenance Technician (RMT) shall work together to identify a mutually satisfactory approach to repairing affected equipment and to ensure that mill operations can continue unaffected. If at all possible, biogas should continue to be captured and combusted. If maintenance or warranty service is required, AES AgriVerde shall contact the appropriate service provider. The RMT and site manager will stay in close communications until the problem(s) are satisfactorily resolved.

**Maintenance, Trouble Reporting and Documentation**

**Emergency Maintenance:**

Situations requiring immediate attention due to failure of components in the digester or combustion system that may cause significant damage to the physical structure, or could result in the release of GHG or failure to capture GHG, should be immediately reported to the Regional Maintenance Technician. If unavailable, contact the National or International Monitoring Manager of the country where the project is located.

**Table 4.1. Contacts**

| Title | Phone | e-mail |
|---|---|---|
| Regional Maintenance Technician (RMT) | Supplied during training | Supplied during training |
| Malaysian National Monitoring Manager | +60 (0)3 2117 5070 | siewkhim.lee@aes.com |
| International Monitoring Manager | +1 321 544 1705 | richard.low@aesagriverde.com |

**Unscheduled Maintenance:**

Situations requiring maintenance (not resulting in the release or failure to capture GHG) should be reported to the Regional Maintenance Technician, normally within 1 to 24 hours of discovery.

**Records Keeping**

Maintenance and servicing of equipment shall be recorded.

**MONITORING ACTIVITES**

The following table summarizes key parameters monitored:

**Table 4.2. Key parameters monitored**

| ID | Item | Applies to Project | Monitored | | ER Calculation Data | | Performed by | Comments |
|---|---|---|---|---|---|---|---|---|
| | | | Ex-ante | Ex-post | Primary | Secondary | | |
| 1 | Sludge Removal (SLR) | ✓ | | ✓ | | ✓ | RMT, ME | Verifies proper disposition of sludge |
| 2 | Biogas Produced ($BGP_{Flare}$ ) | ✓ | | ✓ | ✓ | | ME, RMT | QA |
| 3 | Biogas Methane Content (MC) | ✓ | | ✓ | ✓ | | RMT | QA |
| 4 | Efficiency of Flaring Process (CFE) | ✓ | | ✓ | ✓ | | DP, RMT | Flare temperature and biogas flow total recorded more often than hourly |
| 5 | Renewable Energy System Combustion Confirmation ($RE_{ON}$) | ✓ | | ✓ | ✓ | | DP, RMT | Temperature measured when renewable energy (RE) device is installed. |
| 6 | Biogas Produced ($BGP_{RE}$) | ✓ | | ✓ | ✓ | | ME, RMT | Measure (separately from $BGP_{Flare}$) when RE device is installed. |
| Farm: ME – Mill Employee; DP – Data Processor; AES AgriVerde: RMT – Regional Maintenance Technician, QA – Quality Assurance; OP – Operations, EN – Engineer | | | | | | | | |

**MONITORING WORK INSTRUCTIONS**

Work instructions for the monitoring of key parameters can be found on the following pages.

**Work Instruction for monitoring ID 1, Sludge Removal**

**Summary**

Due to the physical characteristics of POME, it is sometimes necessary to remove accumulated sludge from the inside of a biodigester. This helps ensure the digester system operates properly. It is important to verify how the removed sludge is disposed.

This ID monitors the number of times sludge is removed from the digester and verifies the sludge is disposed of properly.

**References**

- AES AgriVerde Preventive Maintenance Instruction, Biodigester Sludge, Removal and Disposal Instruction
- UNFCCC approved monitoring methodology: AMS III H, Methane Recovery in wastewater treatment, Version 5.

**Training of Monitoring Personnel**

- Regional Monitoring Technicians shall be trained on data collection and transfer processes.
- Operations personnel shall be trained on proper disposition practices.

**Equipment, Materials and Tools**

- Biodigester Sludge Removal and Disposal Instruction
- Sludge removal record

**Calibration**

- None

**Process**

<table>
<tr><th>Step</th><th>Operator</th><th>Activity</th><th>Documentation</th><th>Comments</th></tr>
<tr><td>1</td><td>RMT</td><td>Determine need to remove sludge</td><td></td><td rowspan="4">Sludge is disposed in same manner as pre-project implementation</td></tr>
<tr><td>2</td><td>RMT</td><td>Coordinate with Mill and perform sludge removal in accordance with the PMI</td><td>Paper/Electronic</td></tr>
<tr><td>3</td><td>ME</td><td>Properly dispose of sludge</td><td></td></tr>
<tr><td>4</td><td>RMT</td><td>Document disposal method on maintenance form</td><td>Paper/electronic</td></tr>
<tr><td colspan="5">Farm: ME – Mill Employee; DP – Data Processor; AES AgriVerde: RMT – Regional Maintenance Technician, QA – Quality Assurance; OP – Operations, EN – Engineer, M – Maintenance</td></tr>
</table>

**Record Control**

| RECORD ID | RECORD LOCATION | RETENTION TIME | DISPOSITION |
|---|---|---|---|
| Sludge Disposal Form | Document Control Center | Duration of project +2 years | Destroy |

**Work Instruction for monitoring ID 2, Biogas Produced (Flare)**

**Summary**

This ID monitors the volume of biogas sent to the flare combustion system on a quarterly basis. It is a quality control check to ensure proper operation of the anaerobic digester.

**References**

- UNFCCC approved monitoring methodology: AMS III H, Methane Recovery in wastewater treatment, Version 5.
- Data collection forms (provided by site manager)
- Control of Monitoring and Measuring Device (MMD)
- O & M Quarterly Monitoring Form

**Training of Monitoring Personnel**

- Regional Maintenance Technicians and operations personnel shall be trained on data collection transfer processes.

**Equipment, Materials and Tools**

- Biogas Flow Meter

**Calibration**

- Prior to using a measuring device, ensure it is calibrated.

**Process**

| Step | Operator | Activity | Documentation | Comments |
|---|---|---|---|---|
| 1 | RMT | Record reading in appropriate area of the Quarterly Monitoring Form | Quarterly Monitoring Form | |
| 2 | RMT | Transmit data to operations | Fax, Electronic, etc | Enter data into EnviroCert |
| 3 | QA | Perform Quality Control Check for format, integrity, etc. | | |
| 4 | OP | Confirm reading within expected limits IAW manufacturer guidelines. | | |
| 5 | OP | Store Data | | |
| Farm: ME – Mill Employee; DP – Data Processor; AES AgriVerde: RMT – Regional Monitoring Technician, QA – Quality Assurance; OP – Operations, EN – Engineer | | | | |

**Record Control**

| RECORD ID | RECORD LOCATION | RETENTION TIME | DISPOSITION |
|---|---|---|---|
| Quarterly Monitoring Form | Document Control Center | Duration of project + 2 years | Destroy |

**Work Instruction for monitoring ID 3, Biogas Methane Content**

**Summary**

This ID determines the methane content of the biogas. It is a snapshot view of digestor operation. Methane concentration is determined with a gas analyzer. A range of ± 3% points is sufficient to determine uncertainties. For example, the nominal percentage of $CH_4$ in biogas is approximately 65%. Readings between 55% and 75% indicate proper operation of the digester prior to sampling and analysis. The measuring equipment is field calibrated in accordance with the manufacturer specifications.

**References**

- UNFCCC approved monitoring methodology: AMS III H, Methane Recovery in wastewater treatment, Version 5.
- Control of Monitoring and Measuring Device (MMD)
- Operations Manual $CH_4$ Analyzer
- Quarterly Monitoring Form
- O & M Maintenance Log

**Training of Monitoring Personnel**

- Operating the $CH_4$ Analyzer
- Regional Maintenance Technicians shall be trained on data collection transfer processes.
- Operations personnel shall be trained on data processing and storage

**Equipment, Materials and Tools**

- $CH_4$ Analyzer

**Calibration**

- As required by the manufacturer.

**Process**

| Step | Operator | Activity | Documentation | Comments |
|---|---|---|---|---|
| 1 | RMT | Prepare the gas analyzer as directed in the operator manual. | $CH_4$ Analyzer Operations Manual | |
| 2 | RMT | Connect the $CH_4$ analyzer to the system test port. | | |
| 3 | RMT | Open valve on test port | | |
| 4 | RMT | Take gas reading in accordance with Operations Manual | | Take 5 readings and average the results. |
| 5 | RMT | Record $CH_4$ readings in appropriate spaces of the Quarterly Monitoring Form | Quarterly Monitoring Form | If there is greater than 10% points difference from previous reading, initiate appropriate maintenance actions. |
| 6 | RMT | Close valve on test port | | |
| 7 | RMT | Disconnect hose in reverse order of connection | | |

| Step | Operator | Activity | Documentation | Comments |
|---|---|---|---|---|
| 8 | RMT | Double check that biogas test port valve is closed prior to leaving area | | |
| 9 | RMT | Transmit data to MLB operations | Fax, Electronic, etc | Enter into EnviroCert |
| 10 | QA | Perform Quality Control Check for format, integrity, etc. | | |
| 11 | OP | Confirm reading within expected limits IAW manufacturer guidelines. | | |
| 12 | OP | Store Data | | |
| Farm: ME – Mill Employee; DP – Data Processor; AES AgriVerde: RMT – Regional Monitoring Technician, QA – Quality Assurance; OP – Operations, EN – Engineer | | | | |

**Record Control**

| RECORD ID | RECORD LOCATION | RETENTION TIME | DISPOSITION |
|---|---|---|---|
| Quarterly Monitoring Form | Document Control Center | Duration of project + 2 years | Destroy |

**Work Instruction for monitoring ID 4, Flare Combustion System Operation**

**Summary**

This parameter is used to determine the efficiency of biogas combustion by the flare system(s). The total flow and flare temperature will be recorded on a more often than hourly basis by a battery-backed data recorder. The percent of biogas that is combusted will be determined from an analysis of the hourly flow and flame temperature data in accordance with the flare monitoring tool.

**References**

- UNFCCC approved monitoring methodology: AMS III H, Methane Recovery in wastewater treatment, Version 5.
- O & M Quarterly Monitoring Form
- Control of Monitoring and Measuring Device (MMD)

**Training of Monitoring Personnel**

- Regional Maintenance Technicians and operations personnel shall be trained on data collection transfer processes.

**Equipment, Materials and Tools**

- Data recorder, thermocouple, flow totalizer

**Calibration**

- Prior to using a measuring device, ensure it is calibrated.

**Process**

| Step | Operator | Activity | Documentation | Comments |
|---|---|---|---|---|
| 1 | RMT | Read meter and record reading in appropriate area of the Quarterly Monitoring Form | Quarterly Monitoring Form | |
| 2 | RMT | Transmit data to MLB operations | Fax, Electronic, etc | Enter data into EnviroCert |
| 3 | QA | Perform Quality Control Check for format, integrity, etc. | | |
| 4 | OP | Confirm reading within expected limits IAW manufacturer guidelines. | | |
| 5 | OP | Store Data | | |
| Farm: ME – Mill Employee; DP – Data Processor; AES AgriVerde: RMT – Regional Maintenance Technician; QA – Quality Assurance; OP – Operations, EN – Engineer | | | | |

**Record Control**

| RECORD ID | RECORD LOCATION | RETENTION TIME | DISPOSITION |
|---|---|---|---|
| Quarterly Monitoring Form | Document Control Center | Duration of project + 2 years | Destroy |

This parameter is used to determine the efficiency of biogas combustion by the flare system(s). The total flow and flare temperature will be recorded on a more often than hourly basis by a battery-backed data recorder. The percent of biogas that is combusted will be determined from an analysis of the hourly flow and flame temperature data in accordance with the flare monitoring tool.

**Work Instruction for monitoring ID 5, Renewable Energy System Operation**

**Summary**

This parameter is used to determine whether the Renewable Energy combustion system (when present) is operating and combusting biogas. A thermocouple will be used to indicate device operation; this signal will be recorded more often than hourly by a battery-backed data recorder. This information will be used in conjunction with ID 6 to document Renewable Energy System combustion of biogas.

**References**

- UNFCCC approved monitoring methodology: AMS III H, Methane Recovery in wastewater treatment, Version 5.
- O & M Quarterly Monitoring Form
- Control of Monitoring and Measuring Device (MMD)

**Training of Monitoring Personnel**

- Regional Maintenance Technicians and operations personnel shall be trained on data collection transfer processes.

**Equipment, Materials and Tools**

- Data recorder, thermocouple

**Calibration**

- Prior to using a measuring device, ensure it is calibrated.

**Process**

| Step | Operator | Activity | Documentation | Comments |
|---|---|---|---|---|
| 1 | RMT | Read meter and record reading in appropriate area of the Quarterly Monitoring Form | Quarterly Monitoring Form | |
| 2 | RMT | Transmit data to MLB operations | Fax, Electronic, etc | Enter data into EnviroCert |
| 3 | QA | Perform Quality Control Check for format, integrity, etc. | | |
| 4 | OP | Confirm reading within expected limits IAW manufacturer guidelines. | | |
| 5 | OP | Store Data | | |
| Farm: ME – Mill Employee; DP – Data Processor; AES AgriVerde: RMT – Regional Maintenance Technician; QA – Quality Assurance; OP – Operations, EN – Engineer | | | | |

**Record Control**

| RECORD ID | RECORD LOCATION | RETENTION TIME | DISPOSITION |
|---|---|---|---|
| Quarterly Monitoring Form | Document Control Center | Duration of project + 2 years | Destroy |

**Work Instruction for monitoring ID 6, Biogas Produced (Renewable Energy)**

**Summary**

This ID monitors the volume of biogas sent to the Renewable Energy combustion system. The total flow will be recorded on a more often than hourly basis by a battery-backed data recorder. This information will be used in conjunction with ID 5 to document Renewable Energy System combustion of biogas.

**References**

- UNFCCC approved monitoring methodology: AMS III H, Methane Recovery in wastewater treatment, Version 5.
- Data collection forms (provided by site manager)
- Control of Monitoring and Measuring Device (MMD)
- O & M Quarterly Monitoring Form

**Training of Monitoring Personnel**

- Regional Maintenance Technicians and operations personnel shall be trained on data collection transfer processes.

**Equipment, Materials and Tools**

- Biogas Flow Meter, totalizer

**Calibration**

- Prior to using a measuring device, ensure it is calibrated.

**Process**

| Step | Operator | Activity | Documentation | Comments |
|---|---|---|---|---|
| 1 | RMT | Record reading in appropriate area of the Quarterly Monitoring Form | Quarterly Monitoring Form | |
| 2 | RMT | Transmit data to operations | Fax, Electronic, etc | Enter data into EnviroCert |
| 3 | QA | Perform Quality Control Check for format, integrity, etc. | | |
| 4 | OP | Confirm reading within expected limits IAW manufacturer guidelines. | | |
| 5 | OP | Store Data | | |
| Farm: ME – Mill Employee; DP – Data Processor; AES AgriVerde: RMT – Regional Monitoring Technician, QA – Quality Assurance; OP – Operations, EN – Engineer | | | | |

**Record Control**

| RECORD ID | RECORD LOCATION | RETENTION TIME | DISPOSITION |
|---|---|---|---|
| Quarterly Monitoring Form | Document Control Center | Duration of project + 2 years | Destroy |

**Control of Measuring & Monitoring Devices (MMD)**

**PURPOSE**

The purpose of this document is to ensure that all MMD’s used to demonstrate product conformity with specified requirements is identified, controlled and gauged at prescribed frequencies and that records for these activities are kept.

**SCOPE**

This document applies to all MMD’s as well as software used to verify product conformity with specified requirements. It applies to all individuals responsible for the selection, maintenance, and use of MMD’s.

**ASSOCIATED DOCUMENTS**

A: O & M Manual
B: Corrective and Preventative Action

**DEFINITIONS**

| | |
|---|---|
| OM: | Operations and Maintenance |
| OPS: | Operations |
| QA: | Quality Assurance |
| RMT: | Regional Maintenance Technician |
| SUP: | MMD Supplier |

**PROCEDURE**

| Step | Responsibilities | Associated Documents |
|---|---|---|
| **1** Identify the need for measuring and/or monitoring devices/software | OM, OPS, QA, SUP | A |
| ↓ | | |
| **2** Determine type of equipment based on required accuracy | OM, QA, SUP | A |
| ↓ | | |
| **3** Upon purchase and/or installation, initiate record for equipment. | OM, OPS, RMT, SUP | A |
| ↓ | | |
| **4** Establish frequency and calibration method or verification activity | OM, QA, SUP | A |
| ↓ | | |
| **5** Correct any "Out of Tolerance" conditions. | OM, RMT, SUP | A, B |

**Note:**

BOX 1. OM, OPS, and QA, together with SUP shall identify MMD's/Software that will be used to monitor equipment performance.

BOX 2. MMD's/Software will be selected/designed as best suited to ensure proper performance. Determination of MMD's/Software required shall be based on the measurements to be taken and the accuracy required.

BOX 3. Calibrated Devices will be labeled at a minimum with a unique identification number, status of calibration and date next calibration due. Records will be maintained that show the actual state of each piece of equipment, physical conditions of calibrating equipment and actual readings obtained from calibration and/or verification. Records will be maintained in accordance with section 7.0 Record Control.

BOX 4. Off-the-shelf equipment will be calibrated in accordance with the SUP recommended calibration cycle.

Custom-gauged equipment calibration intervals shall be defined by OM & SUP.
The calibration intervals can be adjusted based on the analysis of previous calibration results and at the discretion of OM & SUP.
Third Party Calibration Service will be managed as if activity was performed by company personnel. This will include requirement that all Qualifying Certifications and references to the National Institute of Standards and Technology (NIST) be submitted/maintained.

BOX 5. Devices found to be out of tolerance will be adjusted/repaired. An investigation will be conducted to determine the effect that the out of tolerance condition may have had on the ability to verify conformance of product to customer requirements and to determine what action, if any, should be taken.

**RECORD CONTROL**

| RECORD ID | FILE LOCATION | RETENTION TIME | DISPOSITION |
|---|---|---|---|
| Equipment calibration records | Site of use | 1 year after equipment has been removed from service | Destroyed |

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