Validation opinion
Revision of the monitoring plan

<table>
<tr><td colspan="4">Title of project activity:</td></tr>
<tr><td colspan="4">Siam Quality Starch Wastewater Treatment and Energy Generation Project in Chaiyaphum, Thailand</td></tr>
<tr><td colspan="2">CDM reference number:</td><td colspan="2">DNV project No.:</td></tr>
<tr><td colspan="2">1993</td><td colspan="2">PRJC-201814-2009-CCS-MYS</td></tr>
<tr><td>Type of revision:</td><td colspan="3">☐ Proposed revision only includes the request by the CDM EB
☐ Proposed revision includes not only the request by the CDM EB but also additional revisions proposed by the PP/DOE
☒ Proposed Revision includes revisions proposed by the PP/DOE</td></tr>
<tr><td>Date</td><td>Work carried out by:</td><td>Work verified by:</td><td>Approved by:</td></tr>
<tr><td>5 January 2011</td><td>Simon Wong (GHG Auditor) /Ramesh Ramachandran (CDM verifier)</td><td>Felipe Lacerda Antunes</td><td>Hendrik W. Brinks</td></tr>
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1 Description of the changes to the monitoring plan

The project applies the approved consolidated methodologies AM0013 Version 04 - "*Avoided methane emissions from organic waste-water treatment*" and AMS-I.C version 12 "*Thermal energy for the user with or without electricity*".

The revision of the monitoring plan is related to: a) introduction of back-up calculation for the electricity consumed by the sludge decanter facility and biogas plant auxiliaries during the year (project emissions), b) calibration of the internal electricity meters, c) alternative measurement for the amount of burner stack gas (project emissions), d) use of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" version 1 for biogas flow (baseline and project emissions) and e) measurement of biogas flow and methane content in either dry or wet basis (baseline and project emissions). The revisions to the monitoring plan are described below.

Project emissions:

a) Amount of electricity consumed in the sludge decanter facility

The validated PDD and the underlying monitoring methodology AM0013 Version 04 for the project in question require the amount of grid electricity consumed during a period of monitoring to be measured (m). To determine the amount of electricity consumed by project activity, the electricity consumed in the project activity is measured by internal meters.

It was verified during the site visit that one electricity meter is already installed to measure electricity consumption of ancillary equipment located at the biogas facility. However, there has been a delay in installation of the electricity meter for the sludge decanter system

(ancillary equipment located away from the main biogas facility). It is noted that because this is a delay in installation in the first monitoring period of 15 April 2009 – 30 November 2009 (it is envisaged the meter will be installed in the second monitoring period), the nature of this request is a deviation, and in response to the clarification raised by the CDM Executive Board, this will be dealt in a separate request for deviation submission.

The proposed revision is to introduce an alternative procedure to calculate electricity consumed in the project activity (for the sludge decanter facility and biogas plant auxiliaries). A check procedure is necessary to confirm under all project operating conditions that all the installed electricity meters are reading correctly, and if it is not reading at all, or is not reading correctly, a back-up method of calculating the electricity consumption is required.

An alternative approach is introduced in line with the more recent versions of methodologies such as AMS-III.H, which allows for the calculation of the electricity consumption in the following manner:

"*Alternatively it shall be assumed that all relevant electrical equipment operate at full rated capacity, plus 10% to account for distribution losses, for 8760 hours per annum*".
Thus, in this proposed calculation it is assumed that all project activity equipment operate at full rated capacity, plus 10% to account for distribution losses, for 8 760 hours per annum.

$Q_{elec\_cons,y}$ (kWh) = [rated capacity of equipments (kW) x 24 (hr/day) x 365 (days/year)] x 1.10

b) Calibration of the electricity meters installed in the project activity
The validated PDD and the underlying monitoring methodology AM0013 Version 04 have both stated explicitly that the electricity is to be calibrated by appropriate industrial and/or international standards. However, the project participants and the verification team were not able to identify the industry standards for calibration of internal electricity meters. It was also confirmed through follow-up interviews that the Provincial Electricity Authority (PEA) of Thailand will use its own calibrated external meters for invoicing and no calibration requirements have been enforced to the internal electricity meters employed by the end-users.

The project participant therefore requests to revise the monitoring plan such that the electricity meters will either be calibrated by the PEA or replaced, at a frequency recommended by the PEA. In case a firm PEA opinion cannot be obtained regarding the recommended frequency during the course of the whole crediting period, the meters will be calibrated by the PEA or replaced, every 12 months, whichever occurs earlier.

c) Alternative measurement for the amount of burner stack gas
The validated PDD and the underlying monitoring methodology for the project in question require direct measurement of the flow rate of the burner stack gas. The project participant requests for a revision of monitoring plan to instead allow for the amount of stack gas to be indirectly monitored through the use of (a) monitored amount of biogas feed into the burners ($Q_{biogas\_burner,y}$), and (b) a $Q_{biogas\_burner,y}$: $Q_{burner\_stack,y}$ ratio (Nm^3 stack gas / Nm^3 feed biogas) obtained through periodical measurement campaigns.

Two main issues are present that has made direct monitoring impossible, they are:
(i) SQS has thus far been unable to find stack gas flow meters that will be suitable for monitoring, given the high temperatures (around 300^oC), large flows (up to 250 m^3/

min) and the particulates present[*].

(ii) As the burners are co-fired with fuel oil[†] and shares the same stack, even when the hurdle in (i) is overcome and the total stack gas flow is directly monitored, a further calculation step is involved to determine the stack gas amount that is due to the biogas (gas feed).

Thus, the approach to directly measure stack gas emissions for the biogas portion is not feasible in lieu of this. The project participants firstly conducted a measurement campaign by commissioning an independent laboratory using the U.S.EPA Method 18 (H/C Analyzer (HORIBA)) to measure stack gas flow, temperature and pressure for each of the four burners for 1 hour over 5 days (i.e. total of 20 hours worth of operation). The stack gas flow monitored as part of this measurement campaign was divided by the monitored amount of biogas feed flow into the burner during this 20-hour period to obtain 20 sets of Nm^3 stack gas / Nm^3 feed biogas ratio. Significantly, during this testing period, the fuel oil feed stream was shut off, thereby allowing for the derivation of a feed: stack ratio that is independent of the fuel oil feed stream, identified as a practical problem in (ii) above. The calculation method used to derive this ratio, including the application of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream", was cross checked and found appropriate by DNV.

In response to the clarification raised by the CDM Executive Board, two conservativeness measures have been adopted for the determination of the appropriate Nm^3 stack gas / Nm^3 feed biogas ratio.

The first conservativeness measure is to take the highest of the observed readings during a particular measurement campaign. During the first verification period, the maximum 29.2 Nm^3 stack gas / Nm^3 feed biogas figure was recorded. This is the most conservative monitored value that can be adopted. As this is a monitored parameter, the value will change annually and the highest measured value will be taken into account for each subsequent measurement campaign.

Furthermore, an additional conservativeness measure will be taken into account by applying the Subsidiary Body for Scientific and Technological Advice (SBSTA) conservativeness factory for uncertainty in the calculations, which is a measure adopted in some CDM methodologies such as AMS-III.H. Several uncertainty factors were adopted in the study[‡], it is proposed that the most conservative factor available in the study of 1.37 is applied. As this is a conservativeness factor, this value will be fixed throughout the crediting period.
The resultant stack gas: biogas ratio will therefore be the product of the maximum measured stack gas: biogas ratio obtained in the periodical measurement campaign and the conservativeness factor, which in the first verification period yields a ratio of 40 Nm^3 stack gas / Nm^3 feed biogas. Two other options were proposed to the DNV to calculate the final stack gas: biogas ratio, Option a) apply conservativeness factor of 1.02 as a result of the 4.0% uncertainty range (the uncertainty range for the stack gas: biogas activity level ratio is +/- 4.0%. This leads to a SBSTA default factor of 1.02, for the uncertainty range of less than or

[*] Monitoring of the stack gas flow rate and methane content of stack gas the burner stacks in two measurement campaigns at each burner stack gas (total 4 burners) by an external entity: Life & Environment Co., Ltd. using the U.S. EPA Method 18 (HORIBA) during the verification period.

[†] The fuel oil is a baseline fuel, hence stack gas emissions for the fuel oil portion is not to be counted as a project emission.

[‡] SBSTA uncertainty factor (http://unfccc.int/resource/docs/2003/sbsta/10a02.pdf, p24).

equal to 10%), and b) apply conservativeness factor of 1.02 to correspond to default value for fugitive emission activity levels. Both options were demonstrated in the spreadsheet calculation yielding a lower stack gas: biogas ratio [*], as compared to using the conservativeness factor of 1.37.

It is also suggested that the measurement campaign is to be conducted annually to determine the stack gas/feed biogas gas ratio. This annual testing, which involves the disruption of normal operations by shutting off of the fuel oil stream entirely, for a significant period for each test is considered an appropriate interval given that the stack gas emissions are a very minor source of emissions, at only 0.15% of total CERs. The project proponent and verification team however welcome any suggestions the Meth Panel and Executive Board may have.

Baseline emissions:

d) Use of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" version 1 for biogas flow

The validated PDD and the underlying monitoring methodology AM0013 Version 04 for the project in question require volumetric flow rate (m^3/year) measurement for the biogas flow. In the registered monitoring plan, no description is provided on how the biogas flows that are measured on volumetric basis will be converted to mass basis for the calculation of CERs.
The project participant has adopted the method given in the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" hereafter referred as "the Tool", in the first monitoring period and requests for the inclusion of this Tool in the monitoring plan to properly calculate the mass flow of the gaseous stream from volumetric measurement, which only came into effect after the project's registration.

e) Measurement of biogas flow and methane content in either dry or wet basis (baseline and project emissions)

The validated PDD and the underlying monitoring methodology AM0013 Version 04 for the project in question require the fraction of methane in biogas to be measured on wet basis. However the methodology was silent on whether the biogas measurements will be carried out on a wet or dry basis, but this was addressed in the validated PDD as to be monitored in dry basis.
In the project activity, the biogas flow rate is measured on wet basis (where flow measurement is not possible in dry basis for a wet stream), whereas the methane content in biogas is measured in dry basis which is shown in the table below. In addition, the project participant wishes to leave flexibility on whether the biogas measurements will be carried out on a wet or dry basis, as this may change if and when the meters and analyzers are replaced in future.

Data/Parameter	Description in registered monitoring plan	Actual practice (as at current)	Description in revised monitoring plan
$Q_{biogas\_total,y}$	Not specified	Wet basis	Wet or dry basis
$Q_{biogas\_burner,y}$	Dry basis	Wet basis	Wet or dry basis
$Q_{biogas\_flare,y}$	Dry basis	Wet basis	Wet or dry basis
w_{CH4}	Wet basis	Dry basis	Wet or dry basis

[*] Issue 2 (stack gas flow) - Uncertainty Range Calculation.xls

2 Assessment of the revision of the monitoring plan

The proposed revision of the monitoring plan ensures that the level of accuracy or completeness in the monitoring and verification process is not reduced as a result of the revisions

- ***Electricity consumed in the project activity:*** In addition to regular measurement of the electricity consumption in the project activity as per the monitoring plan, the proposed alternative electricity consumption calculation provides an additional Quality Control to confirm under all project operating conditions that the electricity meter is reading properly or as a back-up method when malfunction of the electricity meters. During the first monitoring period where the electricity meter measuring the electricity consumption at the sludge decanter facility was not installed, a request for deviation will be filed.
- ***Electricity meter calibration:*** This change does not adversely affect the level of accuracy of completeness in the monitoring and verification process, as the project participant has actively sought PEA guidance and has gone beyond industry standards (i.e. DNV has carried out a follow-up interview with the Director of the Supervision and Maintenance Division, PEA Region 3 and has confirmed that PEA does not require the end-users to carry out the calibration of its internal electricity meters). It is noted however that the electricity meters are considered accurate and in good condition, based on the calibration carried out on 15 March 2010 by PEA (beyond this particular monitoring period) that showed an error of approximately 0.3%.
- ***Stack gas flow rate:*** It appears that the measurement of stack gas attributable to the project activity is not possible as the burners are co-fired with fuel oil and shares the same stack. With the revision of the monitoring plan, the biogas flow rate into the burners will be monitored as per current practice and calculated according to the maximum measured ratio of the stack gas and feed biogas gas coupled with the 1.37 conservativeness factor adopted from the SBSTA study, which will further give better and more conservative representation of the stack gas due to the combustion of biogas. Reliable quantitative estimations to describe the impact of the revision were not available as the monitoring plan only works when the stack gas is derived purely from the biogas stream (project stream) and the methodology does not provide provision to estimate the stack gas flow on a stream where both baseline and project fuel are present. Whereas in actual practice, the stack gas flow is due to both biogas (project stream) and the fuel oil (baseline stream). Direct measurement of stack gas flow rate due to the methodology as required by the methodology is not possible and therefore there were no reference figure to compare against. It is considered that this change does not adversely affect the level of accuracy or completeness in the monitoring and verification process, as the feed stream itself is monitored, and the stack gas / Nm^3 feed biogas figure is a project-specific, that is derived in a sound manner for the first verification period and the same approach will be adopted in the subsequent verifications. As elaborated above, given that two feed streams are present and a calculation step using the maximum measured ratio is therefore necessary regardless of whether it is the total stack flow or biogas feed flow that is monitored, the use of the ratio does not reduce accuracy. It is also worth noting that $Q_{burner\_stack,y}$ is used for the calculation of $PE_{stack,y}$, which was verified in contributing to approximately 0.8% of total project emissions in this monitoring period, and approximately 0.15% of total CERs. This request is project specific due to the biogas being destructed in a co-fired burner, and does not require a change in the methodology.
- ***Introduction to the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" in the revised monitoring plan*** - This change is for the purpose of clarifying the

calculation procedure, and does not adversely affect the level of accuracy or completeness in the monitoring and verification process.

- ***Measurement of biogas flow and methane content in either dry or wet basis*** - This change is for the purpose of applying calculation procedure, and does not adversely affect the level of accuracy or completeness in the monitoring and verification process.

The proposed revision of the monitoring plan is in accordance with the approved monitoring methodology applicable to the project activity whilst ensuring the conservativeness of the emission reductions calculation

- ***Electricity consumed in the project activity:*** The proposed revision in the monitoring plan does not change any formulae or steps involved in the emission reduction calculation, but only provide an alternative electricity consumption calculation not explained or envisaged in the registered PDD and validation report.
- ***Electricity meter calibration:*** The proposed revision in the monitoring plan does not change the QA/QC level as the electricity meters will be replaced latest annually which is considered to be conservative, but only provide an alternative calibration method not explained or envisaged in the registered PDD and validation report when there are no actual industry or international standards enforced by the PEA.
- ***Stack gas flow rate:*** It appears that the measurement of stack gas attributable to the project activity is not possible as the burners are co-fired with fuel oil and shares the same stack. The proposed revision of the monitoring plan will allow the project participant to measure and calculate the stack gas flow rate, This request is project specific due to the biogas being destructed in a co-fired burner, and does not require a change in the methodology.
- ***Introduction to the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" in the revised monitoring plan*** - This change is for the purpose of clarifying the calculation procedure using the approved Tool to properly calculate the mass flow of the gaseous stream from volumetric measurement, which only came into effect after the project's registration and not included in the registered PDD.
- ***Measurement of biogas flow and methane content in either dry or wet basis*** - This change is for the purpose of clarifying the measurement procedure, which was ambiguous in the registered monitoring plan.

The findings of previous verification reports, if any, have been taken into account

As this is the first verification activity, the findings will be taken into account in the revised monitoring report and verification report.

3 Validation opinion

DNV recommends the approval of the revised monitoring plan submitted by the project participants.

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