

Validation Opinion on Post-Registration Changes of Registered CDM Project Activity

Chumporn applied biogas technology for
advanced waste water management

GLC Report No: 002, Rev. 09

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Details of the Registered Project Activity / Programme of Activities		
UNFCCC Ref.	2148	
Project Title:	Chumporn applied biogas technology for advanced waste water management	
Host Country:	Thailand	
Sectoral Scope, Technical Area	CDM Sectoral Scope 13 – Waste handling and disposal 13.1 – Waste handling and disposal	
Methodology / Version	AM0013, Version 04	
Name:	Avoided methane emissions from organic waste-water treatment	
Project Size:	<input checked="" type="checkbox"/> Large Scale <input type="checkbox"/> Small Scale	
Number of verification:	1 st	
Dates of monitoring period (including both days)	2009-02-09 to 2010-08-31	

Project assessed by:	Assessment reviewed by:	Work approved by:
Markus Weber Stephen P Etheridge Karunakar Avuram	Anu Chaudhary	Jose-Emilio Moreno
Date of this revision:	Revision No.	Number of pages
2014-11-24	09	30

Summary:	
Scope of the assessment of the Post-Registration Changes:	<input type="checkbox"/> Prior to commencement of a verification of the project activity <input checked="" type="checkbox"/> When performing a verification of the project activity <input type="checkbox"/> Independent assessment (independent from a verification of the project activity)
Category of the Post-Registration Changes:	<input type="checkbox"/> Changes that do not require prior approval by the CDM Executive Board (<i>in accordance with Appendix 1 of the CDM Project Standard changes to be submitted together with request for issuance</i>) <input checked="" type="checkbox"/> Changes that require prior approval by the CDM Executive Board (<i>changes to be submitted under "Post-registration change requests - prior approval"</i>)

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Type of Post-Registration Changes:	
Temporary Deviations from the monitoring plan or the monitoring methodology (TDEV)	<input checked="" type="checkbox"/> No revised PDD / PDD / PoA-DD + generic CPA-DD is/are submitted enclosed to this Assessment Report. All temporary deviations are of a type specified in Appendix 1 of the CDM PS. <input type="checkbox"/> yes <input checked="" type="checkbox"/> no Temporary deviation period: 2009-02-09 to 2010-08-31
Corrections that do not affect project design (CORR)	<input checked="" type="checkbox"/> ONE revised PDD / PoA-DD + generic CPA-DD is/are submitted together with this Assessment Report (in both clean and track change) All corrections are of a type specified in Appendix 1 of the CDM PS. <input type="checkbox"/> yes <input checked="" type="checkbox"/> no
Change to the Start Date of the Crediting Period (CGCP)	<input type="checkbox"/> ONE revised PDD / PoA-DD + generic CPA-DD is/are submitted together with this Assessment Report (in both clean and track change) The change to the start date of the crediting period requires prior approval as specified in the CDM PS. <input type="checkbox"/> yes <input type="checkbox"/> no Proposed start date of the crediting period: _____ <i>Note: Prior approval by the CDM EB is not required in case of (a) bringing forward the start date up to one year earlier or (b) postponing the start date by up to one year (or by up to two years for project activities in LDCs).</i>
Permanent Changes from the monitoring plan or the monitoring methodology (CGMPMETH)	<input checked="" type="checkbox"/> ONE revised PDD / PoA-DD + generic CPA-DD is/are submitted together with this Assessment Report (in both clean and track change) All changes are of a type specified in Appendix 1 of the CDM PS <input type="checkbox"/> yes <input checked="" type="checkbox"/> no
Changes to the Project or Programme Design (CGPD)	<input checked="" type="checkbox"/> (one revised PDD / PoA-DD + generic CPA-DD (incl. a version of that PDD / PoA-DD + generic CPA-DD with tracked changes) + revised investment analysis spreadsheet (if applicable) + revised emission reduction calculation spreadsheet (if applicable) is/are submitted enclosed to this Assessment Report. (a) In the case of a project activity, the changes have an impact on: <input type="checkbox"/> Scale <input type="checkbox"/> Additionality <input type="checkbox"/> Applicability and application of baseline Methodology <input checked="" type="checkbox"/> None of the above (b) In the particular case of a PoA, the changes relate to: <input type="checkbox"/> Expanding geographical coverage <input type="checkbox"/> Including additional host Parties

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History of report revisions:

Rev.	Date	Person	Function	Action
01	2014-09-11	Karunakar Avuram / Markus Weber / Stephen P Etheridge	Auditor / ATL / Technical Expert	Draft report
02	2014-09-26	Anu Chaudhary	Technical reviewer/ Technical expert	Review of project documents
03	2014-10-06	Karunakar Avuram	Auditor	Revision in report
04	2014-10-12	Anu Chaudhary	TE/TR	Review of revised documents
05	2014-10-12	Karunakar Avuram	Auditor	Addressing TR comment and preparation of final report
06	2014-10-13	Jose-Emilio Moreno	Final Reviewer and Approver	Final reviewed and approved
07	2014-11-21	Karunakar Avuram	Auditor	Revised in response to clarification request by UNFCCC
08	2014-11-24	Anu Chaudhary	Technical Reviewer	Review of revised documents
09	2014-11-24	Jose-Emilio Moreno	Final Reviewer and Approver	Final reviewed and approved

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Abbreviations

CDM	Clean Development Mechanism
CDM-EB	CDM Executive Board (the board)
CH ₄	Methane
CO ₂	Carbon dioxide
CO ₂ e	Carbon dioxide equivalent
COD	Chemical Oxygen Demand
CPO	Crude Palm Oil
CSTR	Completely Stirred Tank Reactor
DOE	Designated Operational Entity
ER	Emission Reduction
GHG	Greenhouse gas(es)
GLC	Germanischer Lloyd Certification GmbH
IRR	Internal rate of return
MP	Monitoring Plan
MR	Monitoring Report
PDD	Project Design Document
PP	Project Participant
PS	Project Standard
R&D	Research and development
QA/QC	Quality Assurance / Quality Control
UASB	Up-flow Anaerobic Sludge Blanket
UNFCCC	United Nations Framework Convention on Climate Change
VVS	Validation and Verification Standard

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1 BACKGROUND AND SUMMARY OF THE POST-REGISTRATION CHANGES

Germanischer Lloyd Certification GmbH (GLC) was contracted by the project participant Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH to perform the 1st verification for the registered CDM project activity “**Chumporn applied biogas technology for advanced waste water management**” (UNFCCC Project no. 2148) for the monitoring period from 2009-02-09 to 2010-08-31 (including both days). During the on-site visit to the project site (conducted from 2010-11-22 to 2010-11-24) and also based on interviews with the project participants GLC assessment team saw the need to request for approval from the board (via submission of a Post-Registration Changes) of the following changes:

- **Wastewater intake to the treatment system** – It was proposed, as per the registered Project Design Document (PDD), that the wastewater from Crude Palm Oil (CPO) section as well as Refinery section would be treated in the project treatment system. Nevertheless, as per the actual implementation, the wastewater only from CPO is treated in the project treatment system while the wastewater from Refinery is directly treated in existing open lagoon system as the Chemical Oxygen Demand (COD) of wastewater from Refinery section is very low and was causing difficulties due to unstable chemical and physical composition (e.g. pH value).
- **Utilization of biogas** – As per the registered PDD, it was proposed to utilize the biogas produced from the wastewater treatment in the boilers at CPO. However, as per the actual implementation, a part of biogas is also utilized in high pressure (HP) boilers at Refinery section.
- **Revision in IRR calculation** – In line with the changes in the project design and based on the actual investment cost, the IRR calculation has been revised.
- **Change in PP name** – There is a change in name of a project participant (PP) from Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH to Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.
- **Changes in monitoring plan** – There are changes in the monitoring plan with regards to ‘measurement methods and procedures’ for some of the monitoring parameters.
- **Corrections in the registered PDD** – Mistakes in the registered PDD with reference to ex-ante estimation of baseline and project emissions have been corrected.
- **Sludge treatment system** – A correction is made in the PDD in the technology description section with reference to sludge treatment system. Only ‘sand bed filter’ was mentioned in the registered PDD. It is made clear in the revised PDD in order to facilitate, if necessary, the use of other technical solutions such as ‘belt press’ in order to produce sludge dry enough for transportation and land application.

All the applicable post-registration changes have been addressed in a revised version of the PDD. This report includes an assessment and GLC’s validation opinion on the above mentioned changes to the

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registered CDM project activity as per the revised PDD (version 09, dated 2014-08-10) submitted with this report. In accordance with applicable guidance of the CDM Project Standard^{/15/}, the assessments and opinions on all applicable post-registration changes are presented in one validation opinion report which is submitted to UNFCCC for approval.

This assessment report presents GLC's opinion on the post-registration changes of the project activity as addressed in the context of the 1st verification for the project activity. The assessment was performed by GLC on the basis of applicable UNFCCC criteria, requirements and procedures for the assessment of post-registration changes for a registered CDM project activity. The assessment was performed based on the recommendations and guidance of the latest version of the CDM Validation and Verification Standard (VVS)^{/14/} and the CDM Project Standard (PS) ^{/15/}.

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2 ASSESSMENT AND TECHNICAL REVIEW TEAM

A competent assessment and technical review team with relevant knowledge and experience in the specific scopes and sectors was appointed by GLC. The appointment of the team takes into account the required scope, technical area and project activity knowledge requirements for assessing the post-registration changes.

Table 2-1: Assessment and technical review team members, summary of qualification and knowledge

Salutation	Name	Function ¹⁾	Sectoral scope specific knowledge	Technical area specific knowledge	Local/Regional knowledge	Type of involvement						
						Desk review	On-site visit / interviews	Reporting	Supervision of work	Technical review	Expert input	Approval
<input checked="" type="checkbox"/> Mr. <input type="checkbox"/> Ms.	Markus, Weber	ATL	X	X				X	X			
<input checked="" type="checkbox"/> Mr. <input type="checkbox"/> Ms.	Srikanth Meesa	A				X	X	X				
<input checked="" type="checkbox"/> Mr. <input type="checkbox"/> Ms.	Karunakar Avuram	A				X	X	X				
<input checked="" type="checkbox"/> Mr. <input type="checkbox"/> Ms.	Stephen P Etheridge	TE	X	X	X	X	X	X			X	
Technical Review and Approval												
<input type="checkbox"/> Mr. <input checked="" type="checkbox"/> Ms.	Anu Chaudhary	R	X	X	X					X	X	
<input checked="" type="checkbox"/> Mr. <input type="checkbox"/> Ms.	Jose-Emilio Moreno	FR / FA										X

1) ATL: Assessment Team Leader; TE: Technical Expert; R: Reviewer; FR: Final Reviewer; FA: Final Approval

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3 ASSESSMENT OF THE POST-REGISTRATION CHANGES

3.1 Temporary Deviations from the Registered Monitoring Plan and/or Monitoring Methodology

Following are the temporary deviations applied for the first monitoring period from 2009-02-09 to 2010-08-31.

3.1.1 Sampling frequency for COD analysis

For the COD related parameters ($COD_{c,baseline}$, $COD_{a,in}$, $COD_{a,out}$ and $COD_{c,dig,out}$), as per the registered monitoring plan, it was proposed that 4 samples per hour, 12 samples per day (weekly same day, same time) are collected for COD measurement. However, during the first monitoring period, 2 samples per time mixed together and 2 times a week were collected for COD measurement. Besides that COD samples were also sent to external laboratory once a month for COD analysis.

It is assessed during the course of the verification that PP wrongly understood the requirement of the registered monitoring plan (12 samples per day, weekly same day, were understood as 12 daily samples, every day, and this of all COD sampling points) and therefore the PP found it is not possible to comply with the registered monitoring plan completely. As a result samples were taken as mentioned above (2 samples are collected and mixed together and is done twice a week) and as a crosscheck with the internal laboratory data, samples were taken and analysed by an external laboratory additionally once a month.

PP adjusted the sampling procedure to the description in the registered monitoring plan after the onsite verification. Therefore, a temporary deviation is requested by the PP for the first monitoring period.

GLC's assessment team is of the opinion that the deviation can be accepted considering the fact that the COD was still analysed on weekly basis but with less number of samples. Besides, the COD was analysed by external laboratory on monthly basis and PP proposes to consider conservative value between monthly external laboratory data and weekly internal laboratory data for the respective months for emission reduction calculation. The approach is deemed appropriate as it results in conservative emission reductions.

3.1.2 Measuring frequency of depth of lagoons

It was mentioned in the registered monitoring plan, as part of the description of measurement methods, that monthly measurements and calculation of yearly average would be followed for the depth of the lagoon (D_{ing}). Nevertheless, as per the applied monitoring methodology, the parameter shall be measured daily. Therefore, PP revised the measuring frequency to be in line with the methodology. However, over the first monitoring period, the depth of the lagoon was only measured monthly. Therefore, PP proposes a temporary deviation for the first monitoring period since it was monitored as per the registered monitoring plan but not according to the monitoring methodology. For the calculation of emission reduction for the first monitoring period, PP

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proposes to apply the most conservative value for fraction due to depth (fd) as per Table 1 of the applied methodology, AM0013 Version 04. The assessment team is of the opinion that this can be accepted as it results in more conservative emission reductions. The parameter would be measured daily for future monitoring periods as stated in the revised monitoring plan which is in accordance with the applied monitoring methodology.

3.2 Corrections

The following corrections have been made in the revised PDD:

3.2.1 Change in PP's name from GTZ to GIZ

The name of one of the project participants has been changed i.e. the name of Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH has been changed to Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

It is assessed from publicly available information (<http://www.deutsche-kultur-international.de/en/org/organisations/german-organisation-for-technical-cooperation-gtz.html>) that The German Organisation for Technical Cooperation (Deutsche Gesellschaft für Technische Zusammenarbeit – GTZ) GmbH is now the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH since 1 January 2011.

It is also assessed and confirmed from the provided evidence document^{8/} that GIZ GmbH applied for authorisation of its participation in the project "Chumporn applied biogas technology for advanced waste water management" on 2013-11-13 and the Federal Environment Agency, German Emission Trading Authority authorised Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH as project participant for the above mentioned project on 2013-11-21. It has also been mentioned in its letter of authorisation by the Federal Environmental Agency, "On 01 January 2011 GIZ GmbH has been merged into the GTZ GmbH. The GIZ GmbH has taken over the business activities of the GTZ GmbH". It has also been further mentioned, "Because the merger became valid by 01 January 2011 the GIZ GmbH is authorised as a project participant from this date onwards."^{8/}

The PP has provided the revised MoC which is submitted along with the revised PDD. It is confirmed that the name of the PP has been updated in the respective sections of the revised PDD.

3.2.2 Improvements in technology description

The project description has been improved in the section 'Technologies and/or measures'. The wastewater is first treated in Completely Stirred Tank Reactor (CSTR) followed by Up-flow Anaerobic Sludge Blanket (UASB) system. However, there was no mentioning of UASB in the technology description of the registered PDD. From the interview with the project participants, it was understood that the technology of combination of CSTR and UASB was supplied as a single package by the technology supplier which is generally called as CSTR system.

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Nevertheless, the description has been improved by mentioning combination of CSTR and UASB in order to make it transparent.

GLC's verification team is of the opinion that this does not have any negative impact on the project as the project technology was not altered post-registration. The technology in place i.e. combination of CSTR and UASB is the same that has been planned and the biogas generation was estimated considering the technology in place now. This is also confirmed from the original technical drawings of the project obtained from the technology supplier^{17/}.

Besides, the description of sludge treatment system has been improved in the revised PDD. In the registered PDD only 'sand bed filter' was mentioned for sludge treatment. However, from the onsite interviews it was assessed that there were difficulties with the original treatment system, implemented as per registered PDD. Since the sand bed filter did not deliver the expected dry sludge, to be used for land application, a belt press was proposed to be implemented. Therefore, the additional information simply reflects the intention to introduce a new technical solution for the treatment of sludge if needed and should therefore give the project owner some flexibility in sludge treatment, without other changes to the project activity. Therefore, it has been improved by stating that the treatment system would consist of sand bed filters or other technical solution such as belt press in order to produce sludge dry enough for the transportation land use. The correction in the PDD is deemed appropriate as it describes the sludge treatment system more appropriately and it does not have any impact on the project design.

The corrections in the technology description can be clearly identified in section A.3 of the revised PDD.

3.2.3 Corrections in baseline and project emissions

Some mistakes in the ex-ante estimated values of baseline and project emissions were recognised by the PP and therefore corrected in section B.6.3 and B.6.4 of the revised PDD.

The following corrections have been made:

	Registered PDD (t CO ₂ e)	Revised PDD (t CO ₂ e)	Assessment
Baseline Emission			
(i) Lagoon	39,175	38,531	The decrease in baseline emission from the lagoon is caused by the exclusion of refinery waste water to the new waste water treatment plant as assessed in section 3.5 of the report. This refinery waste water has a small impact on lagoon baseline emissions due to the low COD load of this discharge.

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(ii) Power/Heat	905	854	It is assessed that the original calculation as per the registered PDD did not take into account a small amount of biogas going to the flare and therefore it resulted in slightly higher value. The calculation is now corrected by deducting the amount of biogas to flare. Further reduction is due to a correction: the registered PDD inconsistently states the amount of electricity consumed in the absence of the project activity (Egy). While the Egy was mentioned as 0 MWh/yr in B.6.2, a value of 78.2 MWh/yr was applied in the old calculations. This is now considered as zero for baseline emissions in order to be conservative.
Total	40,080	39,385	As assessed above
Project Emissions			
(i) Lagoon	7,836.50	5,111	<p>According to the applied methodology AM0013 (version 04) and the registered PDD, the lagoon project emissions are calculated as:</p> $\text{CH}_4 \text{ emissions from the lagoons (kg/yr)} = \text{COD}_{\text{dig_out}} \text{ (kg COD/yr)} \times \text{B}_0 \text{ (kg CH}_4\text{/kg COD)}$ <p>Where:</p> <p>$\text{COD}_{\text{dig_out}}$ Is Chemical Oxygen Demand of effluent</p> <p>B_0 Is maximum methane producing capacity</p> <p>$\text{MCF}_{\text{dig_out}}$ Is methane conversion factor (fraction) as above</p> <p>The methodology does not mention that carry over of COD in the lagoon has to be taken into account in this calculation. The carry over in the original calculation was therefore wrongly applied and has been removed now.</p> <p>The emission reduction calculation spreadsheet (ER sheet) submitted along with the registered PDD was checked. It was found that the COD was wrongly calculated in the ER sheet. COD</p>

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			available was calculated as the sum of COD at the outlet of digester and the leftover COD from the previous month. Leftover COD was calculated as $COD_{available} (1 - MCF)$. The emissions from lagoon are calculated based on COD available. Therefore, the leftover COD was accounted additionally which resulted in higher project emissions. The revised calculation is in accordance with the applied methodology.
(ii) Physical Leakage from biogas digesters	8,212.52	5,606	The calculation in the registered PDD had been based on the biogas production of 13,370 kg/day. This is not explained and is not in line with all other calculations which are based on an output of 12,700 m ³ /day (refer to table 12 in the revised PDD and parameter table FR_{Bio} at 300 days production per year). Since the proportion of methane in biogas is being expressed in ppm in the PDD, the calculation in the original ER calculation sheet, which is based on 65% of the 13,370 kg biogas/day is not correct. The new corrected calculation is based on volume percent.
(iii) Stack emission from flare emissions or energy generation	182.50	125	In line with the calculation of physical leakage from the digester above, the revised value is now based on the volume of biogas. It is confirmed from the ER sheet available at UNFCCC CDM web page that it was assumed as flare would be operated 2 days in a year. Though it was mentioned quantity of biogas flared per day as 12,700 m ³ /day, it was considered 13.37 tons per day in the calculation which is not correct. The revised calculation is correct
(iv) Power/Heat	315.80	324	Small diviaation due to conservative rounding. It is assessed and confirmed from the revised ER sheet that the project emissions due to electricity consumption per month has been calculated as 26.32 tCO _{2e} . If these values are summed up for 12 months, it results in 315.8 tCO _{2e} . Nevertheless, for the sake of conservativeness, every month values have been rounded-up to 27 tCO _{2e} which account to

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			324 tCO ₂ e per annum. This is considered to be appropriate.
(v) Emissions from land application of sludge	85.17	86	It is a small divagation due to conservative rounding of the numbers.
(vi) Dewatering of sludge		0.00	The component is added in the revised PDD but is considered as zero for the ex-ante calculation. This is deemed appropriate as the dewatering would be measured only when it takes place.
Total	16,632.49	11,252	As assessed above
Emission reductions	23,448	28,133	As assessed above

The assessment team confirms that the revised values of baseline emissions, project emissions and emission reductions presented in section B.6.3 and B.6.4 of the revised PDD are correct. It is to be noted that the revised ex-ante calculation of emission reductions are submitted in a separate excel spreadsheet. Therefore, the calculation tables provided in Annex 3 of the registered PDD have not been included in Appendix 4 of the revised PDD. This is deemed appropriate as the calculation tables are available in the excel sheets submitted along with the revised PDD.

Project emissions from wastewater removed in the dewatering process were mentioned as not relevant in the registered PDD. However, in the revised PDD, the formula specified in the applied methodology has been included in section B.6.1 to account for the project emissions. The inclusion is deemed appropriate as the project emissions due to dewatering may be relevant to the project activity at times when sludge treatment and dewatering take place. As per the applied methodology (AM0013, version 04), the wastewater removed from the dewatering process may contain some organic matter that has not been degraded/removed. The relevant monitoring parameters have also been included in section B.7.1 of the revised PDD which is assessed in below section. The changes are deemed appropriate and therefore accepted.

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3.2.4 Editorial corrections

Minor editorial corrections such as update of table numbers throughout the PDD, change in wording from "treated sludge" to "sludge from the open pond treatment" in section B.5, etc. have been done in the PDD which are deemed appropriate.

It shall also be noted that due to the use of latest PDD template, Annexes of the registered PDD have been referred to the corresponding Appendixes in the revised PDD.

(i) Changes to the Start Date of the Crediting Period

This section is not applicable to the project activity under assessment

(ii) Permanent Changes from the Registered Monitoring Plan or Monitoring Methodology

Permanent changes have been made to the registered monitoring plan with reference to the following monitoring parameters and the same have been incorporated in section B.7.1 of the revised PDD:

Parameter	Proposed change	GLC's Assessment
T2	Improved description against 'source of data'	There is no change in monitoring plan pertaining to the parameter. Additional information how the data would be obtained is presented. The proposed change in the PDD is deemed of editorial in nature.
F _{Dig}	Change in flow meter type from 'Vortex Flow Meter' to 'Magnetic Flow Meter'	<p>It was observed during the onsite assessment that magnetic flow meter was installed for measuring flow rate of organic wastewater into the digester. Though it was mentioned in the registered monitoring plan that 'vortex flow meter' or similar would be installed, the description has been revised indicating 'magnetic flow meter' for the sake of transparency. The verification team is of the opinion that magnetic flow meters are commonly used in the industry to measure wastewater quantity. Besides, there is no deviation in accuracy of the monitoring equipment and the monitoring frequency. In fact, the parameter is measured on a continuous basis (data is logged every minute) through magnetic flow meter. The corresponding change has also been made from 'hourly' to 'continuously' with reference to monitoring frequency.</p> <p>The change to the monitoring plan is deemed appropriate and therefore acceptable as it does not</p>

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		compromise the quality of monitoring.
	Data backup frequency	It was learnt from the onsite interviews that the data is backed up monthly into external data storage device. Though the data backup frequency increases from weekly to monthly, it can be accepted as it does not have any direct impact on emission reductions. It shall be noted that similar change was made to other parameters also where applicable and therefore the assessment is not repeated. The changes in the revised PDD are deemed appropriate.
F _{Dig_out}	The parameter is mentioned separately	A common description was provided for F _{Dig} and F _{Dig_out} in the registered PDD. However, the description was mentioned separately in the revised PDD. The change is considered appropriate as the flow rate of organic wastewater out of the digester (F _{Dig_out}) is measured separately on a continuous basis using magnetic flow meter. The assessment team confirms that the revised monitoring approach is in line with the applied monitoring methodology.
COD _{c,baseline} COD _{a,in} COD _{a,out} COD _{la} COD _{c,dig_out}	Change in COD analysis method from 'Potassium Dichromate Digestion' analysis to 'Close Reflux Method'	<p>'Potassium Dichromate Digestion' method was chosen initially and the same was mentioned in the registered PDD. The method is referred as "AWWA 5220B. P5-14,1998". However, during the verification site visit it was observed that COD analysis equipment at onsite laboratory were different. From the onsite interviews it was assessed that the described method in the registered PDD was chosen in the early project design stage, but did not reflect the common practice of COD analysis in the industry. Therefore, the Close Reflux Method has been followed from the beginning which delivers accurate and reliable COD values.</p> <p>GLC's technical and local expert is also of the opinion that Close Reflux Method is widely accepted method of COD analysis and is followed largely for COD analysis of wastewater in the host country. There is no change in monitoring frequency; the COD analysis is carried out weekly by collecting 4 samples per hour at different timings and total 12 samples per day (the samples are collected on the same day every week and at same times). Therefore, the change in COD</p>

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		<p>method is accepted by the GLC's assessment team.</p> <p>The description in the PDD has been revised accordingly. The new method is referred as "APHA 5220 D". Therefore, the source of data has also been updated accordingly from "Laboratory tests at CPI (monthly) – Method: AWWA 5220B.,P5-14,1998" to "Laboratory tests at CPI (monthly) – Method: APHA 5220 D". The changes in the revised PDD are deemed appropriate.</p>
T _{Ing}	No change in monitoring plan, but inclusion of additional comment for clarity	Temperature of the lagoons would be same as that of the ambient temperature. Therefore, the assessment team is of the opinion that the ambient temperature data obtained from the local weather station would be appropriate to use in the calculations.
D _{Ing}	<p>Change in measuring frequency in order to be in line with the methodology;</p> <p>Inclusion of QA/QC procedure in the revised PDD</p>	<p>As per the registered monitoring plan, monthly measurements and calculation of yearly average would be followed for the parameter. Nevertheless, as per the applied monitoring methodology, the parameter shall be measured daily. Therefore, PP revised the measuring frequency in order to be in line with the methodology. This correction is deemed appropriate. A temporary deviation as described above is proposed.</p> <p>Besides, for the sake of transparency, QA/QC procedures have been mentioned in the revised PDD stating, that the measurement is done by a mechanical measuring tape, which does not need recalibration and the accuracy is in the range of the scale: ± 1 cm. This is deemed appropriate and therefore the revision in the PDD is acceptable.</p>
EL _{P,y}	Editorial correction – additional information is provided	<p>Against the 'value (s) applied' it is mentioned that the ex-ante value was estimated by the technology provider and a reference to Appendix 4 is made. It was left blank in the registered PDD. Besides, the accuracy of the measuring instrument has been added as $\pm 1\%$ which is deemed appropriate. Since no specification is provided on the level of accuracy of the measuring instrument, the assessment team based on its sectoral expertise is of the opinion that the level of accuracy is appropriate.</p> <p>Therefore, the revision in the PDD can be</p>

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		accepted.
F _{la}	Inclusion of QA/QC procedures	<p>It has been added in the revised PDD that the calibration of the weighbridge would be carried out once in 2 years and the accuracy of the measuring equipment would be ± 10 kg.</p> <p>The monitoring methodology does not specify calibration frequency and accuracy of the monitoring equipment. The assessment team can confirm based on sectoral and local expertise that the calibration frequency and accuracy represent good practice.</p> <p>The specified QA/QC procedures deemed appropriate and therefore the revision is acceptable.</p>
F _{C,dw} COD _{C,dw}	Monitoring for these parameters is proposed as and when dewatering takes place	<p>As per the registered PDD, monitoring is not applicable for these parameters because a dewatering process was not expected. However, PP proposes to modify monitoring plan for these parameters as dewatering of sludge might be needed some times due to technical difficulties.</p> <p>A provision to calculate and account for project emissions from the wastewater removed in the dewatering process has been included for times when dewatering of sludge actually takes place. Therefore, in order to be flexible, a monitoring approach for the relevant parameters is proposed in the revised PDD. It is assessed from the onsite interviews that the monitoring system (such as flow meter and COD measurement) has been included in the project from the beginning but were not included in the PDD mistakenly, which has now been corrected.</p> <p>It shall be noted that when the wastewater treatment system does not function due to some technical or maintenance reasons, the sludge would be treated the same way as wastewater effluent in open ponds. In such case, the project emissions would be accounted accordingly by monitoring flow and COD. Therefore, sludge treatment will take place as and when it is produced. The proposed approach is deemed appropriate and therefore accepted.</p>
FR _{Bio}	Change in type of biogas monitoring equipment and its	As per the registered PDD, it was proposed to measure biogas flow rate at outlet of digester using

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	location	<p>Coriolis Mass Flow Meter or similar with a measuring range of 100 – 500 kg/hr at 0.717 kg/m³ and with an accuracy of the instrument $< \pm 1\%$ at 2 – 100%. Further it was proposed to measure at each digester outlet. However, during the verification site visit it was observed that all the biogas flow from the digesters is combined into one pipeline and a thermal Mass Flow Meter was installed to measure total biogas flow rate from the digesters.</p> <p>From the onsite interviews it was assessed that the Coriolis mass flow meter had been chosen at the early project design stage, not knowing of the limitations in availability for the pressure of biogas in the pipes. The thermal mass flow meter is one of the most common choices of flow meter for biogas monitoring in Thailand. The thermal mass flow meter was installed from the beginning. The sectoral expertise of the assessment team is of the opinion that thermal mass flow meter delivers similarly accurate and reliable measurements as the Coriolis mass flow meter. The accuracy of the thermal mass flow meter is $\pm 1\%$ of reading, $\pm 0.2\%$ of full scale. The biogas flow rate would be measured continuously and transferred online and recorded. The change in monitoring plan for the monitoring parameter does not compromise quality and accuracy of monitoring.</p> <p>Therefore, the change in monitoring plan is accepted. The corresponding changes have been incorporated in the revised PDD transparently.</p>
	Correction in ex-ante value	<p>The ex-ante value has been corrected by deducting 15% physical leakage as mentioned in other parts of the PDD and recommended by the applied methodology. The correction is considered as editorial in nature and therefore accepted.</p> <p>$300 \text{ day} \times 12,700 \text{ m}^3 = 3,810,000 \text{ m}^3$</p> <p>$3,810,000 - 15\% \text{ leakage} = 3,238,500 \text{ m}^3$</p>
P _{CH4,bio}	Correction in methane content measurement	<p>As per the registered PDD, the parameter would be measured at digester outlet (measurement at each digester line). Average of at least 5 control measurements at 1 hour frequency would be considered. However, the biogas pipelines from CSTRs and UASBs are combined into one header</p>

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		<p>and the methane content is measured at common header on hourly basis using portable analyzer. The approach is deemed appropriate as it is not possible to measure at each digester line in practice. Besides, the revised approach gives more accurate value of methane content. Therefore the correction in the revised PDD is deemed appropriate.</p> <p>Monitoring frequency has been included in the monitoring plan for the sake of transparency. The stated monitoring frequency i.e. 'continuous measurement with at least hourly recording or periodical measurement at 95% confidence level using portable analyser' is as stipulated in the applied methodology. Therefore, it is deemed appropriate.</p>
$FR_{f,inlet}$ $T_{comb,f}$ $FR_{e,inlet}$ $T_{comb,e}$	<p>The proposed revision is same for all these parameters i.e. installed biogas flow meter is of different type compared to the one mentioned in the registered PDD.</p>	<p>The registered PDD states, "Two gas flow meters of standard type are currently being considered for installation: Vortex Flow Meter, 4" meter size, Model VFM 7700 or Kobold DOG-1119L". Nevertheless, Thermal mass flow meters were installed for monitoring these parameters for the reasons mentioned under the assessment of FR_{Bio} above. Therefore, the monitoring plan has been revised accordingly.</p> <p>The accuracy of these instruments is $\pm 1\%$ of reading, $\pm 0.2\%$ of full scale, which represents food practice. Further the assessment team, based on sectoral expertise and the practice followed for other CDM projects in Thailand, confirms the proposed minimum re-calibration interval of 2 years is appropriate.</p> <p>All the corresponding changes made in the revised PDD are deemed appropriate.</p>
$FR_{e,inlet}$	<p>Correction in ex-ante value applied</p>	<p>The ex-ante value of $FR_{e,inlet}$ has been corrected in the revised PDD based on 15% leakage assumed and 25,400 m³ to the flare. The change is considered as editorial correction.</p> <p>The total biogas from digesters is 3,238,500 m³/yr Biogas flow rate to flare is 25,400 m³/yr Biogas flow rate to heat generating equipment is 3,213,100 m³/yr (3,238,500 – 25,400)</p>

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FR _{e,s}	Deviation in measurement method	<p>As per the registered PDD, the parameter should be measured using Coriolis mass flow meter or similar on hourly basis. As per the applied monitoring methodology also, it is required to monitor on a continuous basis. Nevertheless, PP proposes a deviation in the monitoring approach of the parameter.</p> <p>As it involves huge cost to install a flow meter in the stack, PP proposes to monitor “half-yearly” in the course of preparation of the environmental monitoring report for the Department of Industry. The assessment team is of the opinion that this is a case where project participants are unable to implement the registered monitoring plan and it will not be possible to monitor the parameter in accordance with the monitoring plan that would comply with the applied monitoring methodology (Para 277 – 278 of CDM Project Standard, Ver.07.0).</p> <p>The approach proposed by PP is that the parameter would be determined by measuring the instantaneous value of the flow rate of stack gases half-yearly under normal operating conditions of the boiler and multiplying with the operating time of the boiler which is logged continuously.</p> <p>The assessment team is of the opinion that the deviation can be accepted considering the below facts:</p> <ol style="list-style-type: none"> 1. The continuous measurement of stack gas emissions requires huge financial effort for the installation of flow meter with the radius of the stacks of the boilers 2. The combustion efficiency of boilers using gaseous fuel is close to 100%. (It was also clarified by small scale working group that combustion efficiency of heat / electricity generation equipment can be considered 100% for small scale projects. Though the project is not a small scale project, the technical reason is still valid) 3. The determination of project emissions from the stack gas of heat generation equipment is deemed conservative, because only a small percentage of
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		combusted material is biogas in the boilers and the remaining is baseline fuel (biomass). The chance of incomplete combustion of biomass is more compared to biogas. Therefore the methane content in the stack gas results in higher project emissions.
P _{CH4,e,s}	Deviation in monitoring frequency	<p>As per the applied monitoring methodology, the parameter is required to monitor at least quarterly. According to the registered PDD, the parameter would be monitored quarterly using portable analyzer. Nevertheless, for the same reasons mentioned for FR_{e,s}, PP proposes to measure the methane content in stack gases "half-yearly" together with the flow rate of stack gases for the purpose of environmental monitoring for Department of Industry. The same will be used for emission reduction calculation.</p> <p>The deviation can be accepted for the same reasons mentioned under the assessment of FR_{e,s}.</p>
Egy	Correction in historical value for calculation of baseline emissions	<p>The historical value of the parameter Egy (Amount of electricity in the year y that would be consumed at the project site in the absence of the project activity) was mentioned as 78.2 MWh in section B.7.1 while it was mentioned as 0 in section B.6.2 of the registered PDD. Therefore, the value has been corrected to 0 in section B.7.1 of the revised PDD and a clarification has been provided stating that though the historic consumption was 78.2 MWh, it is considered 0 for baseline emissions. The incorrect statement in Appendix 5 of the revised PDD has also been deleted.</p> <p>The correction is deemed appropriate as a conservative approach is taken.</p>
All	Due to up-gradation of the PDD form to the latest template, respective changes such as inclusion of 'monitoring frequency' and 'purpose of data' have been made in the monitoring parameter tables	<p>The changes are deemed appropriate as they fulfil the requirements of latest PDD template and the respective guidelines. It is confirmed that 'monitoring frequency' and 'purpose of data' have been mentioned appropriately for all the monitoring parameters. The monitoring frequencies mentioned in section B.7.1 of the revised PDD are in accordance with Annex 4 of the registered PDD (Appendix 5 of the revised PDD) apart from the parameters related to stack gases where a</p>

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		deviation is proposed as assessed above. The changes are considered to be editorial in nature and therefore accepted.
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In line with the above mentioned changes in the monitoring plan and the changes in the project design assessed in the below section, the monitoring plan diagram in section B.7.2 has also been revised. The assessment team confirms that the revised diagram appropriately represents the actual monitoring system implemented at onsite. It is also confirmed that the implemented monitoring system is in accordance with the methodological requirements. The main changes in the diagram are with references to the monitoring points. The changes are as below:

1. Flow rate and organic concentration of wastewater into digester (ID-1 and ID-2) are measured after the distribution tank instead of before the distribution tank as mentioned in the registered PDD. This is deemed appropriate considering the fact that the distribution tank is part of the project treatment system and there would be no COD loss across the distribution tank.
2. Inclusion of monitoring parameters related to sludge treatment
3. The diagram was simplified and therefore not all monitoring points, such as monitoring points related to land application, have been shown in the diagram. Nevertheless, the revised monitoring plan described in section B.7.1 of the PDD covers all the monitoring parameters to be monitored. The assessment team is of the opinion that the diagram represents only the overview of the measurement points and it does not conflict with the monitoring plan described in B.7.1 of the PDD. Therefore, the revised diagram is deemed appropriate.

The changes in the monitoring points are deemed appropriate. GLC's assessment team also confirms that Appendix 5 has been updated in line with the changes in the monitoring plan.

The permanent changes in the monitoring plan have been assessed in accordance with Para 308 – 311 of CDM VVS (version 07.0). The assessment team confirms that all the changes in the monitoring plan are appropriately reflected in the revised PDD. The proposed permanent changes in the monitoring plan are in accordance with Para 277 – 279 and/or Appendix 1 of CDM PS (Ver.07.0).

(iii) Changes to the project design of a registered project activity

3.5.1 Wastewater intake to the project system

The project activity was implemented at Chumporn Palm Oil Industry (CPI). Wastewater is produced in the factory from two sections called CPO (Crude Palm Oil) production and Refinery plant. Though it was not explicitly mentioned in the registered PDD, it was planned to treat the wastewater produced from CPO as well as Refinery in the project treatment system. Nevertheless, it was observed during the verification site visit that the wastewater from CPO only is treated in the project system while the wastewater from Refinery is directly treated in open lagoons. It is assessed from the onsite interviews that, during the early stage of project operation it became clear to the operating team that the treatment of refinery waste water was difficult due to strong fluctuation in waste water composition such as quick changes in COD and pH values. Moreover, the COD load from refinery wastewater accounts to only 1.6% of the total

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estimated COD load. Therefore, the PP decided to bypass the wastewater of refinery section from the project treatment system and treat directly in open lagoon system i.e. same as baseline scenario. The wastewater only from CPO is treated in the project treatment system.

This is deemed appropriate as it was not explicitly mentioned in the PDD that the wastewater from both CPO and Refinery are treated in the project treatment system. Moreover, the impact of wastewater from refinery in terms of emission reduction is very minimal as the COD accounts to only 1.6% of the total COD which is also evident from the revised ex-ante emission reduction calculation. The PDD has been revised now accordingly. The GLC's assessment team is of the opinion that this change does not have any negative impact on the project activity and therefore the change can be accepted.

3.5.2 Utilisation of biogas

During the project design stage, it was planned to utilize the biogas produced from the project treatment system in biomass boilers at CPO section and the same was described in the registered PDD. However, during the verification site visit it was observed that the biogas is also utilized in two high pressure boilers (HP boilers) at Refinery. From the onsite interviews it is assessed that in order to make the project activity financially more attractive it was decided post-registration, after proven reliable operation of the biogas system, to divert a part of the biogas to be utilized in two HP boilers at CPI's refinery plant although it required an additional investment to facilitate the use of biogas at refinery boilers.

The PDD has been revised to incorporate these changes. The HP boilers have been included under technology description in section A.4.3 (Combustion systems). The baseline information has been adjusted in section B.4. Further information on the impact on project additionality (IRR calculation) has been provided in section B.5 of the revised PDD.

The reasons for such changes in the project design were further assessed during the onsite verification. Below is the outcome of the assessment:

- The equity IRR which was initially estimated by a local biogas consultant, Natural Power Co. Ltd., in the feasibility study was based on a total investment of 40,800,000 Thai Baht (THB). This was also verified from the IRR sheet available at UNFCCC CDM web page ^{/3/}.
- After completion of the construction and project start-up, it was realised by the project owner that the initial investment was largely underestimated. The actual investment cost (for construction, installation and energy utilisation) was 76,556,047 THB. The actual investment was verified from the accounts department of CPI ^{/16/} since all the investment expenditure has already been paid out. The project under such circumstances was much less attractive than estimated (as it resulted an IRR of -5.8% without CDM benefits and 1.2% with CDM benefits).
- The project owner (also a project participant) after internal discussions decided to utilise part of biogas produced from the wastewater treatment in the two HP boilers at CPI's refinery plant in order to make the project financially attractive. Therefore,

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approximately 15% of the biogas is supplied to HP boilers at refinery and the equivalent amount is decreased to boilers at CPO. However, this required an additional investment of 6,304,197 THB ^{/16/} (for one new boiler and change of burner in another boiler) in order to facilitate the use of biogas in refinery section boilers. This change improves the IRR of the project activity.

- It is worth to note the reason to become financially more attractive when there is no change in total gas utilisation is that the boilers at CPO were using biomass fuel while the boilers at refinery were using bunker fuel oil. The cost of bunker fuel being much higher compared to cost of biomass, replacing bunker fuel oil would be more attractive financially. It is further assessed from the follow up interviews that there is a technical limitation for not using more than 15% of biogas at refinery boilers. Therefore any excess biogas, if available, will only be utilised at CPO boilers.
- Though an additional investment of 6,304,197 THB^{/16/} was needed to make necessary modifications in order to utilise biogas at refinery boilers, it reduced overall fuel expenditure. This adjustment leads to improved IRR of 10.5% without CDM benefits and 19.7% with CDM benefits. Although the IRR improves slightly, it still lies below the benchmark of 14.95%. It is clear that considering the CER revenues ensured the project to be financially attractive. It is worth to note that though the actual investment made was higher than the original estimated value, PP considered the original value only (40,800,000 THB) along with the additional investment incurred for the modification in order to facilitate the use of biogas in HP boilers (6,304,197 THB) for the demonstration of additionality. This is in accordance with Para 282 (a) of the Project Standard (version 07.0).
- A sensitivity analysis has also been carried out by varying the key parameters +/- 10% in accordance with Para 21 of EB 62, Annex 5. The IRR varies from 9% to 13% without CDM revenues which are lower than the benchmark. The information has been transparently provided in section B.5 of the revised PDD. The revised information is deemed appropriate. The corresponding calculations have been included in the IRR spreadsheet^{/4/} and a summary table of IRR values has also been presented in the PDD^{/2/} for the revised scenario.
- The assessment team confirms that there is no change in the technology of wastewater treatment system or its capacity from what it was initially planned and designed. This is also confirmed by the technology supplier.

GLC's assessment team confirms that the project is additional even under the revised circumstances. The emission reductions for fossil fuel replacement from HP boilers have not been included in the project activity for conservativeness.

Sections A.3 and B.5 of the PDD have been revised accordingly to incorporate the permanent changes in project design and the corresponding revisions in IRR calculations. The project flow diagram and the project boundary diagram have also been updated accordingly in sections A.3 and B.3 respectively of the PDD. The revised PDD describes the implemented project accurately and appropriately.

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GLC's assessment team confirms that the changes in project design have been described in the revised PDD in compliance with Para 280 – 282 of CDM Project Standard (version 07.0)^{/15/}. The assessment team further confirms based on onsite interviews that the project design was proposed to modify as assessed above towards the end of 2008 after implementation of the project described in the registered PDD and initial start-up of the project. Therefore, the assessment team is of the opinion that the changes were not known prior to registration of the project activity. The assessment team confirms that the changes would not impact the overall operation/ability of the project activity to deliver emission reductions as stated in the PDD. The ex-ante estimated emissions marginally changed due to corrections in the emission reduction calculation as assessed in section 3.2.3.

The assessment of the changes to the project design has been conducted in accordance with Para 315 – 319 of CDM VVS (version 07.0)^{/14/}. The GLC's assessment team confirms that the changes made to the project design would not adversely affect the conclusions of the validation report of the registered PDD with regard to:

- (a) Additionality of the project;
- (b) Scale of the project;
- (c) Applicability and application of the approved baseline methodology under which the project activity was registered;
- (d) The compliance of the monitoring plan with the applied monitoring methodology.

GLC confirms that PP prepared the revised PDD using latest PDD template (version 05.0) of UNFCCC available at the CDM web page and submitted to the assessment team. The revised PDD^{/2/} in clean and track change modes is submitted to CDM EB by GLC along with this report. The assessment team confirms that the text from the registered PDD has been correctly transferred to the new template and the changes have been made in track change in line with the PRC requirements. In the sections that are not applicable, it has been stated that 'the section is left blank intentionally'. It is confirmed that the revised PDD has been prepared in accordance with the respective guidelines of the new PDD template. The revised PDD is deemed appropriate and it correctly describes the project activity.

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4 VALIDATION OPINION / VALIDATION STATEMENT

Germanischer Lloyd Certification GmbH (GLC) was commissioned by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH to perform the 1st verification of the CDM project activity **“Chumporn applied biogas technology for advanced waste water management”** (UNFCCC Project no. 2148) for the monitoring period from 2009-02-09 to 2010-08-31 (including both days). During the on-site visit to the project site (from 2010-11-22 to 2010-11-24) and also based on interviews with the project participants GLC assessment team saw the need to request for approval from the board of Post-Registration Changes of the project activity as described in this report.

It is GLC opinion that the revised PDD (version 10)^{/2/} reflects, in an appropriate and transparent manner, all the Post-Registration Changes to the project activity.

GLC hereby confirms that the Post Registration Changes comply with the requirements established in the CDM Project Standard and that the revised version of the PDD addresses such changes in a correct and transparent manner. GLC therefore recommends the approval of the revised PDD by the Board.

Hamburg, 2014-11-24

José-Emilio Moreno

Germanischer Lloyd
Certification

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5 REFERENCES

Reference	Author: Title, version, date of issue
/1/	Registered PDD of "Chumporn applied biogas technology for advanced waste water management", Version 07; dated 2008-05-10
/2/	Revised PDD of "Chumporn applied biogas technology for advanced waste water management", Version 10; dated 2014-11-20
/3/	Registered version of IRR calculation spread sheet of "Chumporn applied biogas technology for advanced waste water management"
/4/	Revised IRR calculation spreadsheet of "Chumporn applied biogas technology for advanced waste water management"; dated 2014-11-20
/5/	Registered version of ex-ante emission reduction calculation spread sheet of the project activity
/6/	Revised ex-ante emission reduction calculation spreadsheet of the project activity; dated 2014-08-09
/7/	Revised Modalities of Communication Statement for the project "Chumporn applied biogas technology for advanced waste water management"; dated 2014-06-24
/8/	Federal Environment Agency; German Emission Trading Authority: Authorization of the participation of the Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH as project participant in the project "Chumporn applied biogas technology for advanced waste water management"; dated 2013-11-13
/9/	CDM-EB: Applied methodology AM0013, Version 04; "Avoided methane emissions from organic waste-water treatment"
/10/	CDM-EB: Guidelines on the Assessment of Investment Analysis, Version 05 (EB 62, Annex 5)
/11/	CPI: Contract for Installation of LPG Gas Burner and Auto Control, Contract number PU-BK 008 / 2551; dated 2008-10-24
/12/	CPI: Installation of LPG Piping System, Contract number PU-BK 009 / 2551; dated 2008-11-05

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Reference	Author: Title, version, date of issue
/13/	CPI: Automatic Biogas / LPG Supply, Contract number PU-BK 009 / 2553; dated 2010-05-19
/14/	CDM-EB: CDM Validation and Verification Standard, Version 07.0
/15/	CDM-EB: CDM Project Standard, Version 07.0
/16/	CPI: Statements from the accounts department, dated 2008-01-23
/17/	Natural Power Co., Ltd.: Technical drawings of the wastewater project at CPI, dated 2006-05-30