



VERIFICATION/ CERTIFICATION REPORT

AWMS METHANE RECOVERY PROJECT BR07-S-34, BAHIA, ESPIRITO SANTO, MINAS GERAIS, AND SAO PAULO, BRAZIL

(UNFCCC Registration Ref. No. 1534)

Verification Period:
10 April 2008 to 31 May 2010

REPORT No. 2010-1169

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DET NORSKE VERITAS



VERIFICATION/ CERTIFICATION REPORT

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CERTIFICATION AS

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Summary:

Det Norske Veritas Certification AS (DNV) has performed the verification of the emission reductions reported for the “AWMS Methane Recovery Project BR07-S-34, Bahia, Espirito Santo, Minas Gerais, and Sao Paulo, Brazil” (UNFCCC Registration Ref. No. 1534) for the period 10 April 2008 to 31 May 2010.

In our opinion, the GHG emission reductions reported for the project in the monitoring report (Version 3) of 31 May 2011 are fairly stated.

The GHG emission reductions were calculated correctly on the basis of the monitoring methodology AMS-III.D (version 11) and the Project Design Document of 14 Nov 2007.

Det Norske Veritas Certification AS may certify that the emission reductions from the “AWMS Methane Recovery Project BR07-S-34, Bahia, Espirito Santo, Minas Gerais, and Sao Paulo, Brazil” during the period 10 April 2008 to 31 May 2010 amount to 8 320 tonnes of CO₂ equivalent.

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**Abbreviations**

AWMS	Animal Waste Management System
B ₀	Maximum methane potential
BGP	Biogas produced
CAFO	Confined Animal Feeding Operations
CAR	Corrective Action Request
CDM	Clean Development Mechanism
CEE	Combustion Equipment Efficiency
CEF	Carbon Emission Factor
CER	Certified Emission Reduction(s)
CH ₄	Methane
CO ₂	Carbon dioxide
CO ₂ e	Carbon dioxide equivalent
DNV	Det Norske Veritas
DNA	Designated National Authority
EFP	Efficiency of Flaring Process
FAR	Forward Action Request
GHG	Greenhouse gas(es)
GWP	Global Warming Potential
HRT	Hydraulic Retention Time
IPCC	Intergovernmental Panel on Climate Change
MC	Methane content of biogas
MCF	Methane conversion factor
MP	Monitoring Plan
O&M	Operation and Maintenance
PDD	Project Design Document
QA/QC	Quality Assurance/Quality Control
SIR	Sludge removal count
UNFCCC	United Nations Framework Convention for Climate Change
V _s	Volatile solids excreted in kg/day



1 INTRODUCTION

AgCert International (AgCert) has commissioned Det Norske Veritas Certification AS (DNV) to carry out the verification and certification of emission reductions reported for the “AWMS Methane Recovery Project BR07-S-34, Bahia, Espirito Santo, Minas Gerais, and Sao Paulo, Brazil” (the project) in the period 10 April 2008 to 31 May 2010. This report contains the findings from the verification and a certification statement for the certified emission reductions.

1.1 Objective

Verification is the periodic independent review and *ex post* determination by a Designated Operational Entity (DOE) of the monitored reductions in GHG emissions that have occurred as a result of the registered CDM project activity during a defined verification period.

Certification is the written assurance by a DOE that, during a specific period in time, a project activity achieved the emission reductions as verified.

The objective of this verification was to verify and certify emission reductions reported for the “AWMS Methane Recovery Project BR07-S-34, Bahia, Espirito Santo, Minas Gerais, and Sao Paulo, Brazil” for the period 10 April 2008 to 31 May 2010.

1.2 Scope

The scope of the verification is:

- To verify that actual monitoring systems and procedures are in compliance with the monitoring systems and procedures described in the monitoring plan.
- To evaluate the GHG emission reduction data and express a conclusion with a reasonable level of assurance about whether the reported GHG emission reduction data is free from material misstatement.
- To verify that reported GHG emission data is sufficiently supported by evidence.

The verification shall ensure that reported emission reductions are complete and accurate in order to be certified.

1.3 Description of the Project Activity

Participating Party(ies):	Brazil, Switzerland, United Kingdom of Great Britain and Northern Ireland.
Title of project activity:	AWMS Methane Recovery Project BR07-S-34, Bahia, Espirito Santo, Minas Gerais, and Sao Paulo, Brazil
UNFCCC Registration Ref. No.:	1534
Project's crediting period:	10 April 2008 to 9 April 2015 (renewable)
Period verified in this verification:	10 April 2008 to 31 May 2010



The project comprises reduction of methane (CH₄) emissions by means of installing ambient temperature anaerobic digesters for treatment of manure and by capturing and flaring the resulting biogas or utilizing it for energy generation.

The technology employed by the project activity includes installation of new covered lagoons creating an anaerobic digester. The covered and lined lagoon system creates a digester with sufficient capacity and hydraulic retention time (HRT) to nearly eliminate the volatile solids loading in the effluent. Processed effluent from the lagoon cells is routed to the clarification lagoon(s) and captured gas will be removed and combusted.

Prior to project implementation, the project farms used anaerobic lagoon systems to treat manure. Treatment of manure in anaerobic lagoons is thus the selected baseline scenario.

1.4 Methodology for Determining Emission Reductions

Project emissions are the CO₂ emissions as a result of the project's electricity consumption and methane emissions from methane captured but not destroyed in the flare due to incomplete combustion of biogas in the flare (i.e. flare efficiency). Each site's electricity consumption was estimated ex-ante in the validated PDD based on the power consumption of the equipment installed and the validated emission factor of 0.2677 kg CO₂ per kWh. The methane emissions from methane captured but not destroyed in the flare are determined ex-post based on measurements of the flare efficiency.

According to the validated project design, leakage effects are not required by AMS-III.D.

As required by AMS-III.D, the baseline emissions are the lower of i) the actual amount of methane generated by the digester, captured and sent to the flare and ii) the baseline methane emissions that were calculated ex-ante in the PDD based on livestock population data and IPCC default emission factors. The selection of the lower of these two values was done for each farm individually.

Emission reductions are determined as the difference between baseline emissions and project emissions ($ER_{net} = BE - PE$).

2 VERIFICATION METHODOLOGY

The verification of the emission reductions has assessed all factors and issues that constitute the basis for emission reductions from the project. These include:

- i) The determination of the baseline methane emissions which were calculated ex-ante in the PDD and that are thus derived from the registered PDD;
- ii) The determination of baseline emissions determined based on measurements of the biogas flow to the flares and the methane content of the biogas in order to determine the amount of methane that has been captured and sent to the flare;
- iii) The determination of project emissions due to the project's electricity consumption that were also calculated ex-ante in the PDD and that are thus derived from the registered PDD;
- iv) The determination of project emissions due to methane captured but not flared due to incomplete combustion of biogas in the flare (i.e. flare efficiency).

**Verification team**

Role	Last Name	First Name	Country	Type of involvement						
				Administrative	Desk review	Site visit / Interviews	Reporting	Supervision of work	Technical review	Sectoral competence
Project manager	Lehmann	Michael	Norway	✓						
Technical team leader / CDM Verifier	Antunes	Felipe	Brazil		✓	✓	✓	✓		✓
GHG Auditor	Philipi	Fabiana	Brazil			✓				
Auditor	Araújo	Anali	Brazil			✓				
Sector expert	Tavares	Luis Filipe	Brazil		✓		✓			✓
Technical reviewer	Lai	Chee Keong	China						✓	✓

Duration of verification

Preparations: 30 June 2010 to 16 July 2010

On-site verification: 19 July 2010 to 29 July 2010

Reporting, calculation checks,
resolution of verification findings & QA: 2 August 2010 to 10 Feb 2010

Correction of verification / certification report following completeness check
by UNFCCC Secretariat 15 March 2011

Inclusion of further clarifications in response to requests of review by
three CDM Executive Board members 6 June 2011

2.1 Review of Documentation

The monitoring report (version 1 dated 25 June 2010 and version 2 dated 7 Feb 2011 and version 3 dated 31 May 2011) /1/ for the period 10 April 2008 to 31 May 2010, the procedure for calculating emission reductions in AgCert's database EnviroCert /2/, supporting spreadsheets, consisting of biogas volume measurement data for each farm and associated emission reduction calculations /3/ and the instruction manuals for the applied flow meter type and the CO₂ content measurement instrument /4//5/ were assessed. In addition, the project's Project Design Document (PDD) /6/ and the project's validation report /8/ were reviewed.

The monitoring report of 25 June 2010 has been made publicly available on the CDM website (date of requesting publication was 30 June 2010).



2.2 On-Site Audits at Farm Offices and Inspection of Project Implementation

DNV visited all farms for which emission reductions have been reported (refer to Appendix A). For these farms DNV verified that the actual implementation of the project was as described in the PDD. The site visit comprised a check of the digester system, the flare and the biogas meter and included:

- Verifying the implementation and the effectiveness of operation and maintenance of the anaerobic digester and biogas handling system;
- Verifying that the volumes of biogas produced by the digester and sent to the flare are measured with a gas flow meter and that the methane content of biogas is analysed at least quarterly; and
- Verifying that monitoring equipment is calibrated and correctly operated and maintained.

AgCert's office in São Paulo was visited on 21 July 2010. DNV audited the processes for recording data collected by AgCert's employees in Brazil. DNV audited in particular the procedures for data recording, processing and reporting and associated QA/QC procedures.

The above assessments were guided by the checklists contained in Appendix C.

2.3 Assessment of Emission Reductions Calculations

The Excel spreadsheets with output of data from the AgCert's EnviroCert database and associated emission reduction calculations /3/ were assessed. The assessment was guided by the checklist contained in Appendix C.

2.4 Reporting of Findings

Findings established during the verification may be as follows:

A corrective action request (CAR) is issued, where:

- i. Non-conformities with the monitoring plan or methodology are found in monitoring and reporting, or if the evidence provided to prove conformity is insufficient;
- ii. Mistakes have been made in applying assumptions, data or calculations of emission reductions which will impair the estimate of emission reductions;
- iii. Issues identified in a FAR during validation to be verified during verification have not been resolved by the project participants.

A clarification request (CL) shall be raised if information is insufficient or not clear enough to determine whether the applicable CDM requirements have been met.

A forward action request (FAR) is issued for actions if the monitoring and reporting require attention and/or adjustment for the next verification period.

The verification was able to verify that the GHG emission reductions reported for the project in the monitoring report of 31 May 2011 are fairly stated. However, four corrective action requests (CAR) and three requests for clarification (CL) were identified (refer to Appendix B). No forward action requests were identified.

The monitoring report was corrected to address the CARs and CLs identified. Moreover, further information was included in the monitoring report to comply with the UNFCCC Secretariat's completeness and information and reporting checklist.



3 VERIFICATION FINDINGS

This section summarises the findings from the verification of the emission reductions reported for the “AWMS Methane Recovery Project BR07-S-34, Bahia, Espirito Santo, Minas Gerais, and Sao Paulo, Brazil” for the period 10 April 2008 to 31 May 2010.

3.1 Open Issues from Validation and/or Previous Verifications

As this is the first verification of emission reductions reported for the project, there are no FARs from previous verifications. There are also no remaining issues from the validation of the project.

3.2 Project Implementation

DNV inspected all farms for which emission reductions have been reported and was able to verify that anaerobic digesters and systems for capturing and flaring biogas have been implemented at all farms for which emission reductions have been reported. DNV was thus able to confirm that project implementation is in accordance with the project description contained in registered PDD of 14 Nov 2007.

The digesters performance is as planned and the captured biogas is flared at all sites and partly utilized at one site for energy generation. Visual checks of the digesters’ membrane integrity and the gas handling system are performed by AgCert and/or the farm owner, recorded and presented to the audit team.

The flares at all farms have a temperature and pressure measure device that assures the effective combustion of methane during the time the biogas is directed to the flare. If the temperature decreases, the electronic system closes the main valve and restarts after a few minutes with an electric spark. The flare design ensures that no gas is sent through the flare without the flare being ignited. The flares were inspected and maintained as required by the operation manual and these checks are reported in the “Record Book” of each farm according to inspections and maintenances procedure.

The project consists of four swine production sites owned and operated by different entities. Three of the sites are operational and in use and still contribute to the overall project activity. However, one site, 21522, which was implemented and operated according to the PDD, has ceased operation.

AgCert International, the project participant, designed, operated, and maintained the project equipment. However, this digester has not operated as expected, having captured very little biogas since February 2008. Multiple attempts to make the digester effective have been fruitless with only 51000 cubic meters of gas from 5 Oct 2006 to May 2009. Based on a mutual agreement between the site owner and AgCert International, the business contract was severed for the site in question, thus terminating continued operations and maintenance of the anaerobic digester and associated equipment by AgCert International, plc, as well as ending continued monitoring of the site’s contribution to project activity 1534.

It is thus DNV’s opinion that the project implementation complies with the description in the PDD and advanced waste management systems (AWMS), i.e. anaerobic digesters, were



implemented also at the site 21522. This was verified by DNV during the verification of previous monitoring periods.

The Guidelines on assessment of different types of changes from the project activity as described in the registered PDD state that changes to the project design to be considered may include “removal or addition of one (or more) site of a project activity registered with multiple-sites”. It is DNV’s understanding that “removal” would apply in case a site in the PDD was never implemented or the measure to reduce greenhouse gases (GHG) emissions is physically removed.

3.3 Compliance of Monitoring Plan with Monitoring Methodology

DNV is able to confirm that the monitoring plan contained in the registered PDD of 14 Nov 2007 is in accordance with the approved methodology applied by the project activity, i.e. AMS-III.D (version 11).

3.4 Compliance of Monitoring with Monitoring Plan

The monitoring has been carried out in accordance with the monitoring plan contained in the registered PDD of 14 Nov 2007.

All parameters to be monitored as stated in the monitoring plan and stipulated in the monitoring methodology AMS-III.D have been adequately monitored and the data have been reported as specified except for the following parameters:

- The **percentage of biogas that is methane** was only directly measured starting from Feb 2009 onward for site 10965, Jul 2008 for site 27512 and Nov 2008 for site 30412 while the CO₂ content of biogas was measured throughout the whole monitoring period. No emissions reductions are claimed for the site 21522, since this site will not be monitored according to a mutual contractual agreement.

No sludge removal was performed for the sites within this project. This was confirmed by reviewing the weekly and monthly reports and by reviewing the maintenance reports and records. In accordance with the monitoring instructions of the project participants, the project participants determine the need to remove sludge and coordinate as necessary with maintenance staff to schedule sludge removal, perform sludge removal, properly dispose sludge and document the disposal method.

	<i>Assessment/ Observation</i>
<i>Data / Parameter: (as in monitoring plan):</i>	Ambient temperature <i>Note: This parameter is not explicitly listed in the monitoring plan, but the monthly average ambient temperature is applied to adjust the density of methane applied in the calculation of baseline emissions</i>
<i>Measuring frequency:</i>	Information is taken from data published by the US National Oceanic and Atmospheric Administration http://www7.ncdc.noaa.gov
<i>Reporting frequency:</i>	Monthly



<i>Is measuring and reporting frequency in accordance with the monitoring plan and monitoring methodology? (Yes / No)</i>	Yes
<i>If applicable, has the reported data been cross-checked with other available data?</i>	Not applicable
<i>How were the values in the monitoring report verified?</i>	Cross check of a sample of reported data with the data published on www.inmet.gov.br . It must be noted that rainfall is not considered in the determination of emission reductions.
<i>Does the data management (from monitoring equipment to emission reduction calculation) ensure correct transfer of data and reporting of emission reductions and are necessary QA/QC processes in place?</i>	Yes

	Assessment/ Observation
<i>Data / Parameter: (as in monitoring plan):</i>	Biogas produced (BGP)
<i>Measuring frequency:</i>	Continuous measurement of the flow
<i>Reporting frequency:</i>	Biogas meters are read at least once a month by a local AgCert employee and the meter readings are reported and recorded in EnviroCert by AgCert's data processing unit in Melbourne.
<i>Is measuring and reporting frequency in accordance with the monitoring plan and monitoring methodology? (Yes / No)</i>	Yes
<i>Type of monitoring equipment:</i>	ROOTS® Rotary Meters
<i>Is accuracy of the monitoring equipment as stated in the PDD? If the PDD does not specify the accuracy of the monitoring equipment, does the monitoring equipment represent good monitoring practise?</i>	The PDD does not specify the accuracy. The equipment accuracy is 99.9 %. The type of flow meter applied represent good monitoring practise.
<i>Calibration frequency /interval:</i>	According to the installation, operation and maintenance manual /4/, no initial calibration after correct installation is required. Moreover, the flow meter type applied has a tendency to measure lower volumes if there are any operating problems, resulting in rather an underestimation of actual biogas flows.
<i>Is the calibration interval in line with the monitoring plan? If the monitoring plan does not specify the frequency of calibration, does the selected frequency represent good monitoring practise?</i>	The flow meter is maintained and operated according to a well defined Operations and Maintenance (O&M) Plan.
<i>If applicable, has the reported data been cross-checked with other available data?</i>	In line with AMS-III.D, the measured biogas flow is cross-checked with the theoretical amount of biogas generated, calculated based on livestock population data and IPCC default emission factors
<i>How were the values in the monitoring report</i>	The biogas volumes reported in the monitoring



verified?	report were assessed against the records on biogas flow meter readings recorded in EnviroCert. Moreover, the biogas volume meter reading at the farms at the time of the on-site audit was compared with the last biogas meter reading recorded by AgCert to cross-check the reported biogas meter readings.
Does the data management (from monitoring equipment to emission reduction calculation) ensure correct transfer of data and reporting of emission reductions and are necessary QA/QC processes in place?	AgCert's data processing unit in Melbourne, Florida, USA performs QA/QC of the reported data before the biogas flow data are recorded in AgCert's database EnviroCert.

	Assessment/ Observation
Data / Parameter: (as in monitoring plan):	Methane content of biogas (MC) <i>Note: Prior to Feb 2009 at site 10965, Jul 2008 at site 27512 and Nov 2008 at site 30412 the methane content of biogas was not directly measured, but was calculated from the measured CO₂ content.</i>
Measuring frequency:	At least quarterly, if measured more frequently a quarterly average is calculated.
Reporting frequency:	Quarterly
Is measuring and reporting frequency in accordance with the monitoring plan and monitoring methodology? (Yes / No)	Yes
Type of monitoring equipment:	Landtec BioGas Check portable gas analyser Prior to the use of the Landtec Biogas Check portable gas analyser, a Bacharach Fyrite gas analyzer was used.
Is accuracy of the monitoring equipment as stated in the PDD? If the PDD does not specify the accuracy of the monitoring equipment, does the monitoring equipment represent good monitoring practise?	The PDD does not specify the accuracy. The maximum error rate for methane with volume between 15 and 100% as per the operating manual of the LandTec Biogas Check portable gas analyser is 3%. The portable CO ₂ analyser and the Landtec BioGas Check portable gas analyser represent good monitoring practise.
Calibration frequency /interval:	The Landtec Biogas Check portable gas analyser performs a self-calibration (against bottled gas samples) prior to use at each site. Every 6 months the portable gas analysers are taken out of service and sent to the manufacturer for recalibration. All methane content measurements were measured with a Landtec Biogas Check portable gas analyser which was last calibrated less than six months prior to the measurement. The absorbing solution is changed monthly for the portable manual CO ₂ analyser. No calibrations are required per the manufacturer for the Bacharach Fyrite gas analyzer.
Is the calibration interval in line with the	The PDD does not specify the calibration frequency,



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<i>monitoring plan? If the monitoring plan does not specify the frequency of calibration, does the selected frequency represent good monitoring practise?</i>	but the calibration frequency represents good monitoring practise.
<i>Did calibration confirm proper functioning of monitoring equipment? (Yes / No):</i>	Yes
<i>Is(are) calibration(s) valid for the whole reporting period?</i>	Yes
<i>If applicable, has the reported data been cross-checked with other available data?</i>	Reported methane and CO ₂ concentrations are cross-checked with methane and CO ₂ concentration reported for other similar sites.
<i>How were the values in the monitoring report verified?</i>	The methane and CO ₂ concentrations reported in the monitoring report were assessed against the records on methane and CO ₂ concentration recorded in EnviroCert (output spreadsheets). Moreover, at selected sites DNV observed the measurements of the methane and CO ₂ concentration.
<i>Does the data management (from monitoring equipment to emission reduction calculation) ensure correct transfer of data and reporting of emission reductions and are necessary QA/QC processes in place?</i>	AgCert's data processing unit in Melbourne, Florida, USA performs QA/QC of the reported data before the biogas flow data are recorded in AgCert's database EnviroCert.

	Assessment/ Observation
<i>Data / Parameter: (as in monitoring plan):</i>	Combustion equipment efficiency (CEE) / (%), i.e. 100% less any time the flare is out of service and gas is flowing
<i>Observation frequency:</i>	Weekly
<i>Reporting frequency:</i>	Weekly / Monthly
<i>Is measuring and reporting frequency in accordance with the monitoring plan and monitoring methodology? (Yes / No)</i>	The PDD states measured and recorded quarterly. The weekly measurement is conservative.
<i>Type of monitoring equipment:</i>	Not applicable
<i>If applicable, has the reported data been cross-checked with other available data?</i>	Not applicable
<i>How were the values in the monitoring report verified?</i>	Sample of records from weekly assessments on operational status were reviewed. The operation of the flare was confirmed and recorded using weekly observations. The operations and Maintenance (O&M) Plan foresees that if the flare is observed to be non-operational at any time, immediate action is taken to restore operation of the flare. In order to be conservative, the volume of biogas metered from the last observed date of operation until the restoration of the flare operation is deducted from the total biogas metered for the monitoring period and no emission reductions are claimed for that period. During the monitoring period in question, the flare



	was observed to be operational at all weekly observations.
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	<i>Assessment/ Observation</i>
<i>Data / Parameter: (as in monitoring plan of PDD):</i>	Flare efficiency (EFP)
<i>Measuring frequency:</i>	Yearly
<i>Reporting frequency:</i>	Yearly
<i>Is measuring and reporting frequency in accordance with the monitoring plan and monitoring methodology? (Yes / No)</i>	<p>The monitoring methodology and monitoring plan do not stipulate the frequency for performing flare efficiency measurements. However, the general guidance for SSC CDM Methodologies states in paragraph 12b, "Data elements that are generally constant and indirectly related to the emission reductions (e.g. Emission Factors, Calorific Value, System Efficiencies) should be measured or calculated at least once in a year, unless detailed specifications are provided as part of the indicated methodology".</p> <p>At the farm with site ID 10965 the frequency of flare efficiency measurements was for some instances less than annually. Hence, in accordance with the accepted request for deviation (I-DEV0342), a default flare efficiency of 50% as stipulated by the "Tool to determine project emissions from flaring gases containing methane" was applied for the periods from when the one year validity of the previous flare efficiency test expired until the next flare efficiency test (refer to CAR 2 in Appendix B).</p>
<i>Type of monitoring equipment:</i>	Landtec BioGas Check portable gas analyser
<i>Is accuracy of the monitoring equipment as stated in the PDD? If the PDD does not specify the accuracy of the monitoring equipment, does the monitoring equipment represent good monitoring practise?</i>	The PDD does not specify the accuracy. The Landtec BioGas Check portable gas analyser represent good monitoring practise.
<i>Calibration frequency /interval:</i>	The Landtec Biogas Check portable gas analyser performs a self-calibration (against bottled gas samples) prior to use at each site. Every 6 months the portable gas analysers are taken out of service and sent to the manufacturer for recalibration.
<i>Is the calibration interval in line with the monitoring plan? If the monitoring plan does not specify the frequency of calibration, does the selected frequency represent good monitoring practise?</i>	The PDD does not specify the calibration frequency, but the calibration frequency represents good monitoring practise.
<i>Did calibration confirm proper functioning of monitoring equipment? (Yes / No):</i>	Yes
<i>Is(are) calibration(s) valid for the whole</i>	Yes



<i>reporting period?</i>	
<i>If applicable, has the reported data been cross-checked with other available data?</i>	Not applicable
<i>How were the values in the monitoring report verified?</i>	The flare efficiency values were cross-check with the flare efficiency measurement records.
<i>Does the data management (from monitoring equipment to emission reduction calculation) ensure correct transfer of data and reporting of emission reductions and are necessary QA/QC processes in place?</i>	AgCert's data processing unit in Melbourne, Florida, USA performs QA/QC of the reported data before the biogas flow data are recorded in AgCert's database EnviroCert.

3.5 Accuracy of Emission Reduction Calculations

Project and baseline emissions during the reporting period were correctly calculated. Baseline emissions are the lower of i) the actual amount of methane generated by the digester, captured and sent to the flare and ii) the amount of baseline methane emissions that were calculated ex-ante in the PDD based on livestock population data and IPCC default emission factors. The selection of the lower of these two values was done for each farm individually.

The amount of baseline methane emissions that were calculated ex-ante in the PDD as well as the project emissions due to the project's electricity consumption that were calculated ex-ante in the PDD have been correctly applied to the monitoring period in question.

The biogas meter readings are recorded once a month by a local AgCert employee. For practical reasons (long distances from one farm to another), it is not always feasible to read the biogas meters at all farms included in the project on exactly the starting date and the end date of the reporting period. Hence, meter reading dates do not necessarily fall on the exact date of the reporting period start and end dates. As a consequence, average daily biogas volumes for each site and for a specific month are determined in accordance with a well defined procedure /2/ using the last biogas meter reading in the month prior to that month, the reading(s) in the month itself and the first reading in the month after that month.

For site 21522 which has discontinued a contractual arrangement with the Project Participant, AgCert International, and which is no longer monitored, it is assumed that emission reductions are zero and that there is no leakage. At the time of the contract termination, the site was not operational therefore no electricity would be consumed, and hence no leakage applied.

Even in case the farmer again operated the AWMS to treat manure being produced by the swine farm connected to the AWMS, it would be appropriate to assume zero emission reductions for this site. Due to safety reasons, the farmer would in that case also continue to operate the flare. As shown in the monitoring report, leakage due to the site's electricity consumption for sites in operation is less than 1% of the measured emission reductions from these sites, i.e. the amount of methane being captured and flared. Hence, in case the AWMS is operated and consumes electricity, the operation of the AWMS will result in emission reductions which will exceed project emissions associated with the electricity consumption due to operating the AWMS. Considering zero emission reductions from this site would thus be in accordance with paragraph 208 (a) of the VVM (version 01.2), which states that the DOE may opt to make the most conservative assumption theoretically possible in finalizing the verification report in case only



partial data are available because activity levels or non-activity parameters have not been monitored in accordance with the registered monitoring plan.

3.6 Data Management System and Quality Assurance

Data is collected and processed by AgCert according to well defined data collection and processing procedures:

- i) A local AgCert employee visits the farms at least once a month to read the biogas flow meters and perform measurements of the methane and CO₂ content of biogas;
- ii) Data is checked by employees of AgCert's São Paulo office before being reported to AgCert's data processing unit at Melbourne, Florida, USA;
- iii) Reported data is thoroughly checked prior to being entered into AgCert's EnviroCert database;
- iv) Data is processed using well-established procedures and automated processes.

QA/QC for reported data and calculations is generally adequate.



4 CERTIFICATION STATEMENT

Det Norske Veritas Certification AS (DNV) has performed the verification of the emission reductions that have been reported for the “AWMS Methane Recovery Project BR07-S-34, Bahia, Espirito Santo, Minas Gerais, and Sao Paulo, Brazil” (UNFCCC Registration Reference No. 1534) for the period 10 April 2008 to 31 May 2010.

AgCert International is responsible for the collection of data in accordance with the validated monitoring plan and the reporting of GHG emissions reductions from the project.

It is DNV’s responsibility to express an independent verification statement on the reported GHG emission reductions from the project. DNV does not express any opinion on the selected baseline scenario or on the validated and registered PDD.

DNV conducted the verification on the basis of the monitoring methodology AMS-III.D (version 11), the Project Design Document of 14 Nov 2007 and the monitoring report (Version 3) dated 31 May 2011. The verification included i) checking whether the provisions of the monitoring methodology AMS-III.D and the monitoring plan were consistently and appropriately applied and ii) the collection of evidence supporting the reported data.

DNV’s verification approach draws on an understanding of the risks associated with reporting of GHG emission data and the controls in place to mitigate these. DNV planned and performed the verification by obtaining evidence and other information and explanations that DNV considers necessary to give reasonable assurance that reported GHG emission reductions are fairly stated.

In our opinion the GHG emissions reductions reported for the “AWMS Methane Recovery Project BR07-S-34, Bahia, Espirito Santo, Minas Gerais, and Sao Paulo, Brazil” (UNFCCC Registration Ref. No. 1534) for the period 10 April 2008 to 31 May 2010 are fairly stated in the monitoring report (Version 3) dated 31 May 2011.

The GHG emission reductions were calculated correctly on the basis of the approved baseline and monitoring methodology AMS-III.D (version 11) and the validated PDD of 14 Nov 2007.

Det Norske Veritas Certification AS is able to certify that the emission reductions from the “AWMS Methane Recovery Project BR07-S-34, Bahia, Espirito Santo, Minas Gerais, and Sao Paulo, Brazil” during the period 10 April 2008 to 31 May 2010 amount to 8 320 tonnes of CO₂ equivalent.

Rio de Janeiro and Oslo, 6 June 2011

Felipe Lacerda Antunes
CDM Verifier
DNV Rio de Janeiro, Brazil

Michael Lehmann
Director of Services and Technologies
Det Norske Veritas Certification AS



REFERENCES

Documents provided by the Project Participants that relate directly to the reporting of emission reductions.

- /1/ AgCert: *Monitoring Report for “AWMS Methane Recovery Project BR07-S-34, Bahia, Espirito Santo, Minas Gerais, and Sao Paulo, Brazil” for period 10 April 2008 to 31 May 2010.* Version 1 dated 25 June 2010, version 2 dated 7 Feb 2011 and version 3 dated 31 May 2011.
- /2/ AgCert: *How to Calculate Metered ERs (This document describes how the EnviroCert System calculates a month’s Metered ER from Biogas (based on meter readings), CO₂ (based on CO₂ readings), and Methane Density (based on monthly temperature).* Version of 20 October 2007
- /3/ AgCert: *Excel sheets documenting the emission reduction calculations:*
 - MR01-BR07-S-34 envirocert output 062510.xls
 - MR01-BR07-S-34 calculation tables (swine).xls
 - 1534 - MR01-BR07-S-34 Envirocert Calculations.xls
- /4/ Dresser ROOTS Meter and Instruments: *Installation, Operation & Maintenance – Series B3 ROOTS Meters Models and Differential Testing of ROOTS® Rotary Meters*
- /5/ Bacharach: *Instruction 11-9026 FYRITE Gas Analyzer - CO₂ and O₂ Indicators.* Landtec: *LandTec Biogas Check gas analyser manual*
- /6/ AgCert: *Project Design Document of “AWMS Methane Recovery Project BR07-S-34, Bahia, Espirito Santo, Minas Gerais, and Sao Paulo, Brazil”.* Version 5 of 14 November 2007.
- /7/ AgCert: *Flare efficiency measurement reports:*
 - Site ID 10965: reports dated 17 September 2007, 15 April 2008 and 5 November 2009
 - Site ID 27512: reports dated 21 September 2007, 21 July 2008, 15 May 2009 and 8 February 2010
 - Site ID 30412: reports dated 13 December 2007, 17 July 2008, 18 May 2009 and 22 April 2010

Background documents:

- /8/ TÜV Industries Service GmbH TÜV SÜD Group: *Validation Report for “AWMS Methane Recovery Project BR07-S-34, Bahia, Espirito Santo, Minas Gerais, and Sao Paulo, Brazil”.* Report No 949525 of 23 November 2007
- /9/ CDM EB: *Simplified baseline and monitoring methodology AMS-III.D – Methane recovery in agricultural and agro industrial activities.* Version 11.
- /10/ CDM Executive Board: *Validation and Verification Manual.* Version 01.2



Persons interviewed during the verification, or persons who contributed with other information that are not included in the documents listed above. Please refer also to Protocol 4 in Appendix A for a list of persons who were interviewed during the farm office audits and farm visits.

/11/ Daniela Kurosaki Figueiredo , Monitoring Manager, AgCert Brazil

/12/ David Lawrence, Project Coordinator, AgCert Brazil

/13/ Michael Mosley, Director of Quality, AgCert Melbourne, USA

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APPENDIX A

LIST OF AUDITED AWMS

List of audited AWMS

Name of farm owner	Name of farm	Site identification	Date of audit/ Auditor AA: Anali Araujo FA: Felipe Antunes FP: Fabiana Philipi	Conformity of audited AWMS with AMWS characteristics indicated in PDD	Destruction method
Leila Maria Souza Vicente Araujo	Fazenda Pimenta	10965	29 July 2010 / AA	✓	Flare
Granja Courotex	Granja Courotex Ltda.	21522	<i>No ERs are reported</i> (*)	N/A	N/A
Saulo de Deus Vieira	Granja Esperança	27512	23 July 2010 / FP	✓	Flare/Heating
João Gilberto Mário Van Den Broek	Fazenda Esmeralda Lote 38	30412	19 July 2010 / FA	✓	Flare

(*) Per mutual contractual agreement between farm owner and the project participant, emission reductions from site 21522 are no longer monitor.

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APPENDIX B

CORRECTIVE ACTION REQUESTS AND FORWARD ACTION REQUESTS

Corrective action requests

CAR ID	Corrective action request	Response by Project Participants	DNV's assessment of response by Project Participants
CAR 1	<p>AMS-III.D (version 11) requires analysing the methane content of the combusted gases either online, or with samples taken at least quarterly, while the PDD states that this parameter is measured quarterly. However, the methane content was not directly measured throughout the whole monitoring period and instead the methane content was for some months calculated from the measured CO₂ content of biogas. This represents a deviation from AMS-III.D, version 11.</p> <p>The monitoring report refers to an approved deviation for this. However, while this deviation was approved by the CDM EB for other similar project activities by the same project participants, a request for deviation must be submitted for this project activity.</p>	<p>All quarterly methane contents reported in the monitoring report from March 2009 onwards are based on direct methane readings with Landtec gas analyzers. Prior to this, Bacharach Fyrite gas analyzers were used to take CO₂ readings. The wording was changed in the Monitoring Report to reflect that a Request for Deviation will be requested.</p>	<p>A request for deviation was submitted for this project, and the CDM Executive Board accepted the request for deviation (I-DEV0342).</p> <p>The percentage of biogas that is methane was directly measured starting from Feb 2009 onward for site 10965, Jul 2008 for site 27512 and Nov 2008 for site 30412 while the CO₂ content of biogas was measured throughout the whole monitoring period. Prior to this the methane content was calculated in accordance with the accepted request for deviation (I-DEV0342) as 94% minus the measured content of CO₂.</p> <p>The emission reduction calculations are in accordance with the accepted deviation and the monitoring report was eventually revised to refer to the approved deviation.</p> <p>This CAR is closed.</p>
CAR 2	<p>At the farm "Fazenda Pimenta", site ID 10965, the frequency of flare efficiency measurements was less than annually. The flare efficiency measurements following the one on 15 April 2008 was on 5 November 2009 and thus with more than one year in between two measurements. This represents a deviation from the monitoring plan.</p> <p>While the monitoring plan applies a conservative flare efficiency of 50% from 15 April 2009 to 5 November</p>	<p>A request for deviation will be requested for the application of 50% for flare efficiency for the period 15 April 2008 through 5 November 2009.</p>	<p>In accordance with the accepted request for deviation (I-DEV0342), a default flare efficiency of 50% as stipulated by the "Tool to determine project emissions from flaring gases containing methane" was applied at the farm with site ID 10965 for the periods from when the one year validity of the previous flare efficiency test expired until the next</p>

CAR ID	Corrective action request	Response by Project Participants	DNV's assessment of response by Project Participants
	2009, a request for deviation must be submitted to seek acceptance by the CDM EB for applying 50% in this period.		<p>flare efficiency test.</p> <p>The emission reduction calculations are in accordance with the accepted deviation and the monitoring report was eventually revised to refer to the approved deviation.</p> <p>This CAR is closed.</p>
CAR 3	The monitoring report, version 1, does not indicate any utilization of biogas at the farm "Granja Esperança", site ID 27512. However, during the site visit it was observed that there is a grain dryer installed. It must be demonstrated how the use of biogas in a grain dryer complies with the project design as described in the registered PDD and how complete combustion of biogas in the grain dryer is ensured.	<p>Per Figure B.1 of the PDD, Project Boundary, the biogas is occasionally used to ignite a heater; two months of the year when the coffee harvest is complete. When the heater is used, a manual valve shuts off the biogas in the pipe to the flare, and instead directs it to the heater where it is ignited by a manual ignition button and combusted.</p> <p>The valve stays closed and every time that the equipment is used, there is a person there that is controlling and operating the dryer. The system is started manually; there is a person that turns the valve on. The system works as the flare system; it uses a blower and a solenoid valve.</p> <p>An efficiency test of the burners was conducted, and the results are attached. The efficiency is 100%.</p>	<p>DNV was able to confirm that the description of the project design in the registered PDD provides for utilizing of biogas.</p> <p>The information provided by the project participants, including the test of the combustion efficiency of the dryer performed on 10 November 2011 demonstrate that biogas directed to the dryer during manual operation of the dryer is destroyed. While the combustion efficiency test of dryer showed 100% combustion efficiency, the flare efficiencies measured at site 27512 is conservatively applied also for the biogas combusted in the dryer.</p> <p>This CAR is closed.</p>
CAR 4	The flare efficiency test result for the farm "Fazenda Esmeralda Lote 38" (site ID 30412) was 99.8% on 22 April 2010. However, in the monitoring report version 1 and in the ER calculation spreadsheet the applied value was 100%.	This was corrected in the Monitoring Report version 2 and in the ER calculation spreadsheet.	<p>The monitoring report was corrected and the calculation of emission reductions now correctly considers the flare efficiency of 99.8% at site 30412 from 22 April 2010 onwards.</p> <p>This CAR is closed.</p>

Clarification requests

CAR ID	Corrective action request	Response by Project Participants	DNV's assessment of response by Project Participants
CL 1	The monitoring report indicates that the start date for monitoring at sites 10965 and 30412 are 24 July 2007 and 3 April 2006, respectively. However, the EnviroCert calculation spreadsheet indicates 3 April 2006 and 24 July 2007, respectively.	This was corrected in the new version of the Monitoring Report.	The revised monitoring report was corrected to indicate the correct start dates for monitoring at sites 10965 and 30412. This CL is closed.
CL 2	The emission reduction estimate stated in section E.1 of the PDD also appears to consider emission reductions from site 21522. It needs to be clarified how this provides for an adequate comparison with the actual emission reductions reported for the monitoring period as no emission reductions are reported for site 21522.	The emission reductions comparison considered emission reductions from site 21522. Another section was added in the revision to the Monitoring Report to compare emissions reductions without these sites.	The revised monitoring report demonstrates that even when excluding site 21522 actual emission reductions are lower than the emission reductions estimated in the registered PDD. This CL is closed.
CL 3	The monitoring report does not describe the equipment applied for measuring the CO ₂ content of biogas prior to measuring both methane and CO ₂ content with the BioGas Check portable gas analyser.	The equipment used for measuring the CO ₂ content of biogas was the Bacharach Fyrite gas analyzer. These units do not require re-calibration, per the manufacture. This has been added to the revised Monitoring Report.	The revised monitoring report correctly describes the use of the Bacharach Fyrite gas analyzer to measure the CO ₂ content of biogas. This CL is closed.

Forward action requests from previous verification

FAR ID	Forward action request	Summary of how FAR has been addressed in this reporting period	Assessment of how FAR has been addressed
	<i>Not applicable. This is the first verification.</i>		

Forward action requests from this verification

FAR ID	Forward action request	Response by Project Participants	DNV's assessment of response by Project Participants
	<i>No FAR was identified</i>		

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APPENDIX C

CHECKLISTS

Checklist 1: Management system/controls for data collection and recording

The data management system/controls are assessed to identify reporting risks and to assess the data management system's/control's ability to mitigate reporting risks. The GHG data management system/controls are assessed against expectations for best practise. A score is assigned as follows:

F: Full - all best practice expectations are implemented.

P: Partial - a proportion of the best practice expectations is implemented

L: Limited - this should be given if little or none of the system component is in place.

A Forward Action Request (FAR) is issued where the management system/controls need to be improved in order to assure that data is adequately collected and recorded during the subsequent monitoring and reporting period.

1) Data on biogas volume and CH₄ content of biogas

Is there a clear allocation of responsibility and authority for data collection and recording and have persons assigned to specific tasks received sufficient training?

Is data collected and recorded in a consistent manner in terms of data collection frequency, data collection and recording practise, etc.?

Is there any QA/QC performed with regard to data collection and recording?

Is there any QA/QC performed by local employees of AgCert with regard to data collection and recording?

2) Data on electricity generation (if applicable)

Is there a clear allocation of responsibility and authority for data collection and recording and have persons assigned to specific tasks received sufficient training?

Is data collected and recorded in a consistent manner in terms of data collection frequency, data collection and recording practise, etc.?

Is there any QA/QC performed with regard to data collection and recording?

3) Data processing by AgCert

Is there a clear allocation of responsibility and authority for data processing and have persons assigned to specific tasks received sufficient training?

Is data processing carried out in a consistent manner?

Is there any QA/QC performed with regard to data processing?

Are there any written procedures for data processing and QA/QC of data processing?

Checklist 2: Project implementation and installation of monitoring equipment

It is assessed whether

- the project has been implemented as described in the Project Design Document
- the AWMS characteristics are as described in the Project Design Document and the monitoring report
- appropriate monitoring equipment has been installed and calibrated as required in the monitoring plan described in the Project Design Document

A forward action request (FAR) is issued where special attention has to be given in the subsequent monitoring and reporting period with regard to project implementation in order to ensure appropriate project performance maintenance and calibration of monitoring equipment to assure that relevant indicators are accurately measured

1) Project implementation and AWMS characteristics

Have anaerobic digesters been installed and is all manure produced at the farm treated in the anaerobic digesters before being treated in secondary lagoons?

Is biogas utilised for electricity generation and/or flared as described in the PDD?

Has the farm used the same or similar animal feed throughout the whole monitoring and reporting period?

Is the flush system as described in the PDD?

Have there been any significant changes to the flush volume during the selected monitoring and reporting period?

Is the land application of treated manure as described in PDD?

2) Digester performance

Is digester performance as anticipated?

Are the digesters' membranes regularly checked for possible leaks through visual checks? Are visual checks of the digesters' membrane integrity recorded?

3) Biogas handling system

Has the biogas handling system been tested and are the test results recorded?

Is the biogas handling system regularly checked for possible leaks through visual checks? Are visual checks of gas handling system recorded?

4) Electricity generation (if applicable)

Is the electricity generated from biogas measured with an electricity meter and recorded on a monthly basis?

Is the electricity meter used of adequate accuracy?

Has the electricity meter been calibrated in accordance with the meter producer's specifications for calibration?

5) Electricity consumption of project equipment

Has the electricity consumption of all equipment that needed to be installed as a consequence of the project been accounted?

6) Flare

Has the flare been tested as required by the flare's producer?

Has the flare been regularly inspected and has maintenance been carried out as required by the flare's producer and has flare inspections and maintenance been recorded?

7) Biogas flow meter

Has the biogas flow meter continuously monitored the biogas flow from the digesters to the generator and/or flare during the selected monitoring and reporting period?

Is the biogas flow meter used of adequate accuracy?

Has the biogas flow meter been tested as required by the flow meter's producer and have flow meter calibrations been recorded?

8) Measurements of CH₄ content of biogas

Has the CH₄ content of biogas been measured on a quarterly basis during the whole monitoring and reporting period?

Has the CH₄ content of biogas been accurately measured and have measurement results been recorded?

Checklist 3: Evidence and correctness of reported data

Data reported in the monitoring report (and if applicable, in more detailed data reports provided by AgCert) is assessed against data records kept at the farm owner office. Reported data may be verified by checking an adequate sample of data records kept at the farm owner office. The sample size may be selected based on the findings of the assessment of the management system/controls for data collection and recording. More data record samples should be verified if the assessment of the management system/controls indicated that there is a risk for misreporting due to inadequate management system/controls and lack of QA/QC procedures.

If deviations from reported data are observed, these deviations have to be documented below and all data records have to be verified in order to ensure that there are no other reporting errors.

A corrective action request (CAR) is issued where data reported in the monitoring report has to be corrected.

A forward action request (FAR) is issued where data evidence and archiving of records need to be improved in order to assure that adequate evidence for reported data is available for the subsequent monitoring and reporting period.

1) Data on biogas volume and CH₄ content of biogas

Is there evidence for the reported data for the selected verification period?

Is the data collected in accordance with required data collection and recording frequency?

2) Data on electricity generation (if applicable)

Is there evidence for the reported data for the selected verification period?

Is the data collected in accordance with required data collection and recording frequency?

Is the data in the monitoring report sustained by data records kept at the farm owner office and has data been correctly transferred from the farm owner data management system to AgCert's data management system?

3) Data on electricity consumption

Is the electricity consumption estimated using appropriate and conservative assumptions?

Checklist 4: Emission reduction calculations

Emission reduction calculations

It is assessed whether baseline and project emissions have been calculated correctly using correct emission factors

A Corrective Action Request (CAR) is issued where mistakes in the emission reduction calculations have to be corrected.

A Forward Action Request (FAR) is issued where special attention has to be given in the subsequent monitoring and reporting period with regard to

- the transparency of the emission reduction calculations
- reducing risks of calculation errors

1) Calculation of project and baseline emissions

Has correct input data been used in the calculations?

Have correct emission factors been applied?

Are the calculations correct and transparently presented and the results correctly reported in the monitoring report?

2) Calculation of baseline emission based on measured biogas volumes

Has correct input data been used in the calculations?

Have correct emission factors been applied?

Are the calculations correct and transparently presented and the results correctly reported in the monitoring report?

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APPENDIX D

CURRICULA VITAE OF THE VERIFICATION TEAM MEMBERS

Felipe Lacerda Antunes

Holds a Master's Degree in Production Engineering (Quality) and a Post Graduate Diploma in Environmental Management and Industrial Waste Management and Treatment. Possesses an International experience of more than 10 years in the field of quality and environmental auditing, working two years as the responsible of the QMS of Rede Metrológica RS and since 1999 as a QMS and EMS auditor in DNV.

He has experience of more than 3 years in validation and verification of numerous CDM projects in DNV, both in South America & abroad. He has also been actively involved in Management System Audits such as ISO 9001, ISO 140001 and OHSAS 18001 standards in various industrial sectors for more than 10 years in DNV.

His qualification and experience in CDM demonstrate him sufficient sectoral competence in energy generation from renewable energy sources, waste handling and disposal, and animal waste management.

Luis Filipe Aboim Tavares

Mr. Luis Filipe Tavares holds a Technician's Degree in Chemistry and Bachelor's Degree in Metallurgical Engineering having an overall experience of thirty tree years.

Prior to joining DNV having around twenty tree years experience in steel production industry covering utilities (water, steam, wastewater treatment), environment control (atmosphere emissions, water emission and waste dumping).

His experience also covers the development of nitrification biological wastewater station as well as other activities as head of Utilities and Environmental Laboratory control.

He has also been actively involved in implementation of Management Systems such as ISO 9001 standard on coke oven department of steel industry as well as the ISO 140001 standard in all steel plant (the second steel company certified in the world) for more than three years.

He has experience of around 8 years in validation and verification of numerous CDM projects in DNV, both in Brazil & South America.

His qualification, industrial experience and experience in CDM demonstrate his sufficient sectoral competence in Iron and Steel; Metal production; Oil and Gas industry, CMM recovery and use; Generation from renewable energy sources; Waste handling and disposal and Animal waste management.

Fabiana Philipi

Holds a bachelor degree in Environmental Engineering and has been working as a Greenhouse Gas – GHG Auditor in the Climate Change Services – CCS Business Area of Det Norske Veritas – DNV, since April 2009.

Prior to joining DNV, Fabiana has been working with Green House Gas reduction projects since 2006. Her first experience was in the Brazilian Mercantile and Future Exchange, where worked in the intern position doing researches of the UNFCCC methodologies. After it, she moved to SGS where she participated of the validation and verification of CDM projects, including hydro and wind energy and landfill. Then she moved to Volitalia developing PDDs (Project Design Documents) of small hydro projects, assisting them until registered in the UNFCCC.

Anali Araújo

Holds a bachelor in Chemical Engineering, a post-graduation in Urban Development and Environmental Management and a post-graduation on Safety Engineering, having an overall work experience of 12 years.

Prior to working with DNV, Anali has developed environmental and quality audits in several industries. Her working experience covers the fields of environmental management and management systems.

Michael Lehmann

Michael Lehmann holds a Master Degree in Environmental Sciences with a specialisation in environmental chemistry. He has an overall working experience of around 13 years.

Since 1999 he has worked in the climate change field and has closely followed the international response to the climate change challenge (UNFCCC, Kyoto Protocol) and the responses by national governments (EU ETS, UK ETS) and business. He has managed the validation and verification of many CDM and JI projects and has carried out the technical review of numerous climate change project validations and verifications.

Through his extensive work with validation and verification of CDM and JI projects, he has acquired sectoral competence within energy generation from renewable energy sources, electricity distribution, waste handling and disposal and animal waste management.

He has also experience with verifying corporate greenhouse gas emissions and emission reductions from verifying the emissions of the Norwegian process, paper & pulp and oil & gas industry.

Earlier, he has managed DNV Research's R&D activities with the objective to build and to enhance DNV's knowledge in the field of CO₂ capture and storage. He also conducted R&D to conclude on measuring systems and reporting formats necessary to accurately and trustworthy report greenhouse gas emission reductions, especially addressing uncertainties.

He also provided technical environmental advisory services to clients within the process industry, above all in the field of air emissions. Among others, he developed a methodology for Environmental Risk Assessment for accidental releases of chemicals.

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