



VERIFICATION REPORT FOR

“GRID CONNECTED ELECTRICITY
GENERATION PLANT USING NATURAL GAS AT
JURONG ISLAND IN SINGAPORE”



Document Prepared By Earthood Services Private Limited

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Prepared By	Earthood Services Private Limited
Contact	409-410, Tower B4, Spaze I-Tech Park, Sector 49, Gurugram 122018, INDIA Tel: +91 124 4204599 Fax: +91 124 4204599 Website: www.earthood.in Email: info@earthood.in
Approved By	Dr.Kaviraj Singh
Work Carried Out By	Team Leader: Ravi Kant Soni Technical Expert (TA 1.2) and Meth Expert: Ravi Kant Soni Local Expert: Ravi Kant Soni Technical Reviewer: Shreya Garg Technical Expert (TA 1.2): Shreya Garg

Summary:

Earthood Services Private Limited (hereafter referred to as ESPL) has been contracted by Infinite Solutions to conduct the verification of the project - "Grid connected electricity generation plant using natural gas at Jurong Island in Singapore", VCS ID 1736 regarding the relevant requirements of VCS programme guidelines and standard (VCS standard version 4.1, & VCS program guide version 04.0). Relevant requirements of the UNFCCC for CDM project activities, as well as criteria for consistent project operations, monitoring and reporting has been applied for verification.

The monitoring period covers under this verification are from 01/01/2018 to 31/12/2020(both days included).

The verification includes confirming the implementation of the monitoring plan of the registered VCS PD and MR (VCS ID 1736) and the application of the monitoring methodology as per ACM0029 version 03: "Baseline Methodology for Grid Connected Electricity Generation Plants using Natural Gas".

The project activity involves installation of natural gas based combined cycle 800 MW power plant at Seraya Place, Juraong Island, Singapore and supplying the electricity to the Singapore national grid. In the absence of the project activity the PP would have opted for a coal-based power plant to generate the electricity. The project activity using the lower GHG intensive fuel (Natural Gas and / or Re-gasified-LNG) and much higher efficient power generation due to combined cycle operation in comparison to coal. Therefore, the project reduces greenhouse gas emissions and thereby contributes to sustainable development.

A risk-based approach has been followed to perform this verification. In the course of verification, 04 Corrective

Action request (CARs), 00 Forward Action request (FARs), and 01 Clarification request (CLs) were raised and successfully closed.

The review of the project design documentation, monitoring report and additional documents related to baseline and monitoring methodology; the subsequent background investigation, follow-up interviews (telephonic) and stakeholders have provided ESPL with sufficient evidence to validate the fulfillment of the stated criteria.

ESPL confirms that the project is implemented in accordance with the registered VCS PD. The monitoring system is in place and the emission reductions are calculated without material misstatements. Our opinion relates to the project's GHG emissions and the resulting GHG emission reductions reported and related to the valid and registered project baseline and monitoring and its associated documents. Based on the information seen and evaluated we confirm that the emission reductions from the project activity "Grid connected electricity generation plant using natural gas at Jurong Island in Singapore" in Singapore during the period 01/01/2018 to 31/12/2020 (including both days) amount to 576,680 tons of CO₂e.

CONTENTS

1	Introduction	5
1.1	Objective	5
1.2	Scope and Criteria	5
1.3	Level of Assurance.....	5
1.4	Summary Description of the Project	6
2	Verification Process.....	6
2.1	Method and Criteria.....	6
2.2	Document Review	7
2.3	Interviews.....	7
2.4	Site Inspections.....	8
2.5	Resolution of Findings	11
2.6	Eligibility for Validation Activities	11
3	Validation Findings.....	11
3.1	Participation under Other GHG Programs	12
3.2	Methodology Deviations.....	12
3.3	Project Description Deviations.....	12
3.4	Grouped Project	13
4	Verification Findings.....	13
4.1	Project Implementation Status	13
4.2	Safeguards	15
4.3	AFOLU-Specific Safeguards	16
4.4	Accuracy of GHG Emission Reduction and Removal Calculations	16
4.5	Quality of Evidence to Determine GHG Emission Reductions and Removals	20
4.6	Non-Permanence Risk Analysis.....	23
5	Verification conclusion	23
	APPENDIX 1: DOCUMENT REFERENCES.....	25
	APPENDIX 2: ABBREVIATIONS.....	27
	APPENDIX 3: Findings Overview	27
	APPENDIX 4: Competency Statements	29

1 INTRODUCTION

1.1 Objective

Earthood Services Private Limited (ESPL) has been contracted by Infinite Solutions , to undertake the verification of the renewable energy project titled “Grid connected electricity generation plant using natural gas at Jurong Island in Singapore” (VCS ID-1736) The verifiers have reviewed the GHG data collected to date for the monitoring period from 01/01/2018 to 31/12/2020 (both days included) covered in this verification. The objective of this verification is a thorough and independent assessment of registered project activities against the applicable VCS requirement by the VVB. The verification process shall determine whether the proposed project activity complies with the requirements of latest VCS guidelines, applicability conditions of the selected methodology, relevant host country regulations and guidance issued by the VCS Board.

1.2 Scope and Criteria

The scope of verification is to assess the claims and assumptions made in the VCS monitoring report (MR) against the VCS criteria, including but not limited to, VCS standard, applied methodology and other relevant rules and requirements established for VCS project activities.

The Verification is not meant to provide any consulting towards the project participants. However, stated requests for clarification and/or correction actions request may have provided inputs for improvement of the project design.

1.3 Level of Assurance

The level of assurance of the verification report falls under reasonable assurance engagements as selected by the VVB. Reasonable assurance is a high level of assurance regarding material misstatements, but not an absolute one.

Reasonable assurance includes the understanding that there is a remote likelihood that material misstatements will not be prevented or detected on a timely basis. To achieve reasonable assurance, the auditor needs to obtain sufficient appropriate audit evidence to reduce audit risk to an acceptably low level. This means that there is some uncertainty arising from the use of sampling, since it is possible that a material misstatement will be missed.

The evidence used to achieve a reasonable level of assurance is specified in section 2.3 and 2.4 of this report.

1.4 Summary Description of the Project

The project activity involves installation and operations of new natural gas based combined cycle 800 MW power plant. It includes two units (400 MW each) and each unit having, combustion turbine, HRSG unit (Heat recovery Steam Generator) and ancillary equipment's. Project is using combustion turbine generator with multi stage axial flow compressor with modulating vanes for natural gas combustion and the hot gases are recovered using unfired, three pressure, reheated natural circulation drum type HRSG's. The project activity results in reductions of greenhouse gas (GHG) emissions that are real, measurable, and verifiable and also plays beneficial role in the mitigation of climate change.

The project activity has geographical coordinates of latitude 1°17'24" N and longitude 103°43'30" E. Location of the project was verified through Google Map (<https://www.google.com/maps>) and found consistent with the data provided in the registered PD/01/.

The first and second unit of the project activity was commissioned on 29/06/2013 and 30/08/2013 respectively. The same was verified against the registered VCS PD/01/ and commissioning certificates/27/. The emission reductions from the project activity during the period 01/01/2018 – 31/12/2020 (including both days) amount to 576,680 tonnes of CO₂e. The verification team has also verified the latest photographs/19/ of all the equipment's (turbines, HRSG and transformers, energy meters) installed at plant site and online monitoring system submitted by the project proponent. The project activity is undergoing second verification and the implementation of project activity was also verified during first verification/02/. Based on the assessment of the documents, the assessment team can confirm that the project activity is fully functional and implemented as described in the registered VCS PD.

The emission reductions from the project activity during the period 01/01/2018 to 31/12/2020 (including both days) amount to 576,680 tons of CO₂e.

2 VERIFICATION PROCESS

The registered VCS project is undergoing second verification under VCS, the approach adopted to ensure the quality of emission reductions is described in the following sections.

2.1 Method and Criteria

The verification approach consists two phases.

In the first phase, ESPL completed a strategic review and risk assessment of the projects activities and processes in order to gain a full understanding of:

Activities associated with all the sources contributing to the project emissions and emission reductions, including leakage if relevant;

Protocols used to estimate or measure GHG emissions from these sources;

Collection and handling of data;

Controls on the collection and handling of data;

Means of verifying reported data; and

Compilation of the Monitoring Report.

At the end of this phase, ESPL produced a Verification Checklist which, based on the risk assessment of the parameters and data collection and handling processes for each of those parameters, describes the verification approach and the sampling plan.

In the second phase using the Verification checklist, ESPL verified the implementation of the monitoring plan and the data presented in the VCS MR/04/ for the period in question. This involved telephonic interviews of project proponent representative's and a desk review of the Monitoring Report. This verification report describes the findings of this assessment.

2.2 Document Review

The verification is performed primarily as a document review of the registered VCS PD/01/, previous MR and Joint validation & verification report/02/ and associated documents as stated in details in appendix 1 of this document. The assessment is performed by a verification team using a protocol. The cross checks between information provided in the Monitoring report, VCS PD and information from sources other than those used, if available, the team's sectoral or local expertise and, if necessary, independent background investigations.

2.3 Interviews

Due to the current situation with the global COVID-19 pandemic scenario ,an on-site inspection has not been performed by the assessment team. However, the representatives of the PP were interviewed during the virtual audit conducted on 16/06/2021 i.e. personnel responsible for monitoring of the project activity, data collection and management, and QA/QC procedure. The details of the people interviewed are mentioned in the table below:

Name	Organization	Topic covered
Mr. Vivek Zaveri	Infinite Solutions (consultant)	Project implementation, start date as per the VCS requirements. Electricity Generation Records Reliability & accuracy of readings considered for emission reduction calculations, Calibration procedure
Ms. Clare Savereux	PacificLight Power- Senior Manager, Regulations & Corporate Communications	

Mr. Ravikumar Pinnamraju	PacificLight Power (Deputy General Manager, Operations)	Consideration of monitoring period, monitoring methodology, project documentation and emission reduction calculations. Monitoring and measuring system, Collection of measurements Observations of established practices Data Verification of monitoring parameters QA/QC procedures, data management, internal audits to maintain data quality & reliability, maintenance Practices.
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2.4 Site Inspections

As discussed in the above section, physical site inspection is not done for the current verification. However, to achieve a reasonable level of assurance, the assessment team has followed the alternative means to substantiate the verification criteria as described in the below table:

Assessment Criteria	Means of verification/source documents	Assessment opinion
Description of project activity	Commissioning certificates /27/ technical specifications provided by EPC contractor for the project activity /11/ VCS gap validation & verification report for first monitoring period/02/. Virtual site visit conducted on 16/06/2021.	The information with reference to project capacity, technology, plant equipment's and commissioning dates as provided in section 1.1 of MR are found consistent with the documents.
Compliance of the project implementation with the registered project design document	Monthly Energy settlement reports/09/. Logbook records for diesel consumption/20/ Suppliers invoices for NG/22/ Geographical co-ordinates of project activity verified through Google Map ¹	Monthly Energy settlement reports indicate the name of project proponent and purchaser of electricity. Location of project is verified through Google Map and found consistent with registered VCS PD.

¹ <https://www.gps-coordinates.net/>

	Photograph of equipment's installed at site and screen shots of online monitoring system /19/ VCS gap validation & verification report for first monitoring period/02/. Virtual site visit conducted on 16/06/2021.	Photograph of equipment's and screen shots of online monitoring system are verified to check the operational status of project activity. All the information's regarding the project implementation as discuss above are further verified through VCS PD and found consistent.
Compliance of the registered monitoring plan with applied methodologies and standardized baselines	Virtual site visit conducted on 16/06/2021. Monthly Energy settlement reports/09/. Logbook records for diesel consumption/20/ Supplier's invoices for NG/22/ VCS gap validation & verification report for first monitoring period/02/.	The organizational structure, responsibilities and competencies of the personnel confirmed through virtual interview. Frequency of monitoring of parameters listed under approved monitoring plan is verified through energy settlement reports /Invoices. The methods used for measuring, recording, storing, aggregating, and reporting the data on monitored parameters are verified though previous verification records and conversations with site personnel.

Compliance with the calibration frequency requirements for measuring instruments	Calibration certificates of instruments used for monitoring/16/ Photograph of energy meters indicating sr. No, accuracy class, make /19/. Metering code by Energy Market Authority of Singapore, Published in Jan 2014, and April 2016 /25/	Calibration frequency and energy meter specifications (Sr. No, make accuracy class) is verified through calibration certificates and further verified through photographs and found consistent.
Assessment of data and calculation of emission reductions or net removals	INFORMATION ON EMISSION FACTORS (For CDM projects in Singapore) Electricity Grid/07/ Monthly Energy settlement reports/09/. Logbook records for diesel consumption/20/ Supplier's invoices for NG/22/ VCS gap validation & verification report for first monitoring period/02/. 2006 IPCC Guidelines for National Greenhouse Gas Inventories/26/	Monthly values of monitoring parameter used in ER calculation are verified through energy settlement reports and cross verified with the invoices. Methods, formulae and emission factor for calculating baseline emissions have been followed are in accordance with the applied methodology and as described in the approved VCS verification report /02/.

It is noteworthy that no sampling plan for verification is applied as 100% data is verified for the current monitoring period. Most of the reference document referred by the assessment team (above table) are either issued by an external government agency or publicly available official data, hence is deemed authentic.

Based on the above assessment it can be concluded that the assessment team has verified sufficient appropriate audit evidence, to reduce audit risk to an acceptably low level as requisite to achieve reasonable level of assurance for the current verification.

2.5 Resolution of Findings

The objective of this step is to identify, discuss and conclude on the issues related to the monitoring, implementation and operations of the registered project activity that could impair the capacity of the registered project activity to achieve emission reductions or influence the monitoring and reporting of emission reductions. This is done based on the desk review and interaction with site personnel over phone. The verification team prepares and/or updates a verification protocol (internal document) that records the conformities and non-conformities, which may be of following types;

CAR (Corrective Action Request) is raised if one of the following occurs:

Non-compliance with the monitoring plan, the methodology or the standardized baseline are found in monitoring and reporting and has not been sufficiently documented by the project participants, or if the evidence provided to prove conformity is insufficient;

Modifications to the implementation, operation and monitoring of the registered project activity has not been sufficiently documented by the project participants;

Mistakes have been made in applying assumptions, data or calculations of emission reductions that will impact the quantity of emission reductions;

Issues identified in a FAR during validation to be verified during verification or previous verification(s) have not been resolved by the project participants. Clarification request (CL) is raised if information is insufficient or not clear enough to determine whether the applicable CDM requirements have been met. All CARs and CLs raised by the ESPL during verification shall be resolved prior to submitting a request for issuance.

FAR (Forward Action Request) is raised during verification if the monitoring and reporting require attention and/or adjustment for the next verification period. During the current verification there are 4 CARs and 1 CL raised and resolved. All the findings that are raised and communicated to project participant during the verification are included under Appendix 3. The section also includes the response, if provided, by the project participants and an assessment by the verification team if it was closed out or otherwise.

2.5.1 Forward Action Requests

The project activity is undergoing second verification in VCS; there were no FARs raised during the validation or previous verification/02/.

2.6 Eligibility for Validation Activities

Not applicable.

3 VALIDATION FINDINGS

Not applicable.

3.1 Participation under Other GHG Programs

The project is registered under Clean Development Mechanism (CDM) with reference number 9687/15/. Through UNFCCC project webpage, the project is awaiting issuance request for the period from 14/07/2014 to 31/12/2017. The project is also registered under VCS (Project ID-1736) with 10 years crediting period (renewable twice) from 01/01/2014 to 31/12/2023/01/. As verified through the records available at VCS registry, VERs for the period from 01/01/2014 to 31/07/2014 are already issued. The current monitoring period is considered from 01/01/2018 to 31/12/2020, hence no double counting of credits is identified.

Even though the project has been registered under the CDM and crediting periods under both programme (CDM & VCS) overlaps, but credits for the same GHG emission reductions under the VCS and the CDM shall not be claimed. This was confirmed through a declaration/15/ submitted by the PP and hence accepted by the assessment team.

3.2 Methodology Deviations

There is no methodology deviation identified during the current monitoring period.

3.3 Project Description Deviations

The following project deviations identified during the current monitoring period and previous monitoring period are following:

Project deviation in the current monitoring period:

As per section 4.1 of the registered PDD, the parameters “Emission Factor of Natural Gas” ($EF_{CO_2,NG,y}$) and “Oxidation Factor” ($OXID_{NG}$) were determined as ex-ante parameter, however both the parameters were also reported under section 4.2 of registered PD as monitoring parameters. Since as per the actual monitoring process, the parameters ($EF_{CO_2,NG,y}$ and $OXID_{NG}$) are fixed, hence the PP has removed both the parameters from the section 4.2 and considered this change as project deviation during the current monitoring period.

Project deviation in the previous monitoring period:

- a) As per the project description provided in the registered PDD, separate metering system installed at plant side & supplier side for monitoring of NG, however in actual practice gas metering equipment is installed at consumer end (PP side) only and within the project activity premises. There are no separate meters for supplier side, hence deviation was requested. Flow measured through these instruments is transmitted to supplier as well as to Plant DCS. Thus it is ensured that cross verification of gas flow is done by supplier. Gas bill generated by supplier at the month end is finally cross checked by both parties before settlement. Thus supplier ensures that gas data is accurately monitored and there is no any impact on data measurement. Since the cross check is ensured which is as per the requirement of AM0029.
- b) As per CDM registered PDD, the diesel consumption should be monitored by using mass flow meter, however at actual site there is not any mass flow meter and diesel

consumption is measured through fuel oil tank level drop. This is the normal practice across power plant and followed onsite.

- c) As per CDM registered PDD, source of data for Net Calorific Value of Natural Gas is invoice from gas supplier. However, as per the actual monitoring procedure, Gross Calorific Value (GCV) is used from onsite GC for gas heating value measurement. The GCV was converted to NCV by using conversion factor of Natural Gas (The public available acceptable formula is used for the conversion). This is the normal practice across power plant and followed onsite.
- d) As per metering code by Energy Market Authority of Singapore, Jan 2014 and April 2016, the calibration frequency of energy meters is once in two years. However registered PDD has mentioned calibration frequency as annual. Thus, PP had requested deviation to change the calibration frequency from annual to once in two years and this is found to be appropriate as per the country code.

The assessment team is able to confirm that the deviations identified during the current and previous monitoring period is appropriately described and justified in section 3.2 of the monitoring report and the project remains in compliance with the VCS rules. Also, the deviation does not have an impact on the applicability of the methodology, additionality or the appropriateness of the baseline scenario.

3.4 Grouped Project

Not applicable. The project activity is not a grouped project

4 VERIFICATION FINDINGS

4.1 Project Implementation Status

The project activity involves implementation of 800 MW natural gas-fired power plant consists of two units of 400 MW each. Each unit consists of advance class (F Class) gas turbine (GT), matching triple pressure heat recovery steam generator, steam turbine and generator/02/,/12/. The hot exhaust from the gas combusted in the gas turbine enters the heat recovery steam generator (HRSG) and the steam generated would then be expanded in a condensing type of steam turbine driving an electric generator.

The project activity is already commissioned /27/ and functioning satisfactorily as verified through the generation records, actual photographs, and interactions with the plan personnel during the remote site visit/19/.

The power project will reduce the GHG emissions generated by the current generation energy mix in Singapore grid, which is dominated by fossil fuel-based grid connected power plants. The power generated through the proposed project activity being supplied to Singapore grid through the National Electricity Market of Singapore which is operated by the Energy Market Company (EMC). The technical specification of the project activity equipment's has been checked through the photographs of all the equipment's/19/ installed at site and are found to be consistent with the registered PD. The status of the project activity is verified through the screen shots of online monitoring system/19/, indicating the real-time generation data and hence it is confirmed that the project is fully functioning.

The monitoring plan includes all the parameters required to be monitoring for the project activity. The project O&M team has been entrusted with the responsibility of storing, recording the data related to the project activity. The project team is also responsible for calculation of actual creditable emission reduction in the most transparent and relevant manner.

The responsibility for calibration of the Gas fuel flow meter lies with the PP as stipulated in the Singapore Gas Metering code/25/. Installed meters are calibrated according to the maintenance schedule programmed at the start of the operation and recalibrated according to the plant's performance requirement.

During the remote audit, it is verified that the PP has provided adequate infrastructure i.e. Electricity Meters, gas meters etc. to monitor important parameters. It is also noticed that PP has made an emergency plan ready to avoid potential error in the Monitoring of parameters by keeping back up meters.

In case of emergency (i.e no supply of NG), there is provision to use Diesel as a backup fuel / auxiliary fuel. There are adequate arrangements in the monitoring plan to ensure that emergency situations where diesel is used for power generation are captured and diesel consumption is recorded. During the current monitoring period diesel is not used for power generation, however used as back-up fuel.

The monitoring plan provide procedures for the collection and archiving of all relevant data necessary for estimation or measuring the emission reductions within the project boundary during the crediting period. This is checked through discussion with consultant and the project participant during the virtual interview.

The VCS MR/04/ has been reviewed to check that the procedure for data uncertainty, emergency preparedness, roles and responsibility, operational and management structure are mentioned in the MR. The monitoring plan completely describes all measures to be implemented for monitoring all parameters required. The monitoring plan described the positioning of the equipment. Calibration frequency for Energy meters is once in 2 years. As per metering code by Energy Market Authority of Singapore, Jan 2014 and April 2016, the generation facility should have meter test cycle as once in every two years/25/, thus calibration frequency once in 2 years considered for the project activity is found to be appropriate.

The information relating to the project implementation, provided in the Monitoring Report /04/ is consistent with that stated in the registered PD /01/. The data and variables provided in the monitoring report are the same as stated in the registered PD/01/ (Except the project deviation as described under section 3.3 of this report). Total emission reductions achieved under this monitoring period 01/01/2018 to 31/12/2020 (including both days) is 576,680 tCO₂e.

Assessment team concludes the following:

- a) There are no material discrepancies between project implementation and the project description provided in the registered PD/01/.
- b) The monitoring plan is implemented completely and monitoring system (i.e., process and schedule for obtaining, recording, compiling and analysing the monitored data and parameters) is appropriate.
- c) There are no material discrepancies between the actual monitoring system, and the monitoring plan set out in the project description and the applied methodology/10/.
- d) The GHG emission reductions or removals generated by the project have not included in an emissions trading program or any other mechanism that includes GHG allowance trading/15/.
- e) The project has not received or sought any other form of environmental credit, or has become eligible to do so since validation or previous verification. The PP has submitted the declaration /15/.
- f) The project is registered under VCS and CDM as well.
- g) The project activity is complying with indicators for sustainable development in the interim approval guidelines for Clean Development Mechanism (CDM) projects from Singapore as discussed under section 1.11 of MR.

In view of the information's as verified above the assessment team is able to conclude that the project has been implemented as described in the project description.

4.2 Safeguards

4.2.1 No Net Harm

There is no negative impact to any socio-economic conditions of the region due to the project activity. The project participants conducted an analysis of the environmental impacts of the proposed project activity, including trans boundary impacts by appointing a third party agency Environmental Resources Management (S) Pte. Ltd. A complete EIA was carried on in the month of October 2010, to ascertain the impacts due to implementation of the proposed project in host country Singapore. This is found in accordance with local Environmental Regulation.

The project is implemented in Jurong Island, which is considered as an exclusive industrial area of Singapore. The Environmental impacts due to implementation of the proposed project will not be affecting any residential or environmentally sensitive area i.e. wild life sanctuary, natural forest or any water body. All impacts identified are local and are mainly pertaining to construction phase. There is no significant impact identified during the Study and the

same is found approved by the local environmental Authority i.e. NEA.

It can be confirmed that the project participants have undertaken an analysis of environmental impacts and an environmental impact assessment in accordance with procedures as required by the host Party.

4.2.2 Local Stakeholder Consultation

The project activity undergoing second verification (under VCS) and local stakeholder consultation was appropriately conducted prior to validation as a way to inform the design of the project and maximize participation from stakeholders during the validation.

The project proponent has implemented mechanism for ongoing communication with local stakeholders to allow stakeholders to raise concerns about potential negative impacts during implementation and operation of the project activity. The project proponent has placed a grievance register and a grievance box at plant office/21/, where the local villagers can register their concerns.

The assessment team has checked the copy of grievance register maintained at site office/21/ and confirmed that no formal complaints were received during the current monitoring period.

4.3 AFOLU-Specific Safeguards

Not applicable to the project activity.

4.4 Accuracy of GHG Emission Reduction and Removal Calculations

The calculation of the emission reductions is found to be correct. The details of the reported and the verified values for all parameters are listed in section 4.5 of this report.

The PP has provided the complete set of data for all the monitored parameters in the ER spreadsheet/06/. This data has been verified as described in section 4.5 below. The formulae & method used to calculate the baseline emissions, project emissions and leakage are appropriate and in line with the approved methodology AM0029 Version 03.0.

The following parameters are monitored ex-ante:

Parameter	Parameter	Value	Assessment team remark
1	Emission Factor of Natural Gas ($EF_{CO_2,NG,y}$)	56,100 kgCO ₂ e/TJ	The value is considered from Table 1.4, Chapter 1, Volume 2, 2006 IPCC Guidelines for National Greenhouse Gas Inventories/26/ which is consistent with the registered PDD.

2	Oxidation Factor of NG (OXID _{NG})	1 (no unit)	The value is considered from Table 1.4, Chapter 1, Volume 2, 2006 IPCC Guidelines for National Greenhouse Gas Inventories/26/ which is consistent with the registered PDD.
3	EF _{NG, Upstream,CH4}	296 tCH ₄ /PJ	The value is considered from Table 2, page 9 of the approved methodology AM0029, version 03 /10/, which is consistent with the registered PDD.
4	EF _{CO2,upstream,LNG}	6 tCO ₂ /TJ	The value is considered from Table 2, page 10 of the approved methodology AM0029, version 03/10/, which is consistent with the registered PDD.
5	EF _{BL, Upstream,CH4}	0.00213 tCH ₄ /MWh	As per latest published document "INFORMATION ON EMISSION FACTORS (For CDM projects in Singapore) dated 06/01/2020 /07/, the value is used in the Leakage calculations.
6	EF _{CO2,FF,y}	74,100 kgCO ₂ e/TJ	The value is considered from Table 1.4, Chapter 1, Volume 2, 2006 IPCC Guidelines for National Greenhouse Gas Inventories/26/, which is consistent with the registered PDD.

It is to be noted that the baseline CO₂ emission factor is Build Margin emission factor of Singapore national grid and is ex-post monitoring parameter. Hence the combined margin emission factor of Singapore national grid (EF_{electricity,y}), build margin emission factor (EF_{BM,y}) and the operating margin (EF_{OM,y}) are not mentioned as ex- ante parameter in monitoring report. These parameters were used just for ex-ante ER estimation and not used for ex-post/actual ER calculation.

Emission reductions calculations:

Baseline emissions:

The PP has calculated the baseline emissions by multiplying the electricity generated in the project plant ($EG_{PJ,y}$) with the baseline CO₂ emission factor ($EF_{BL,CO_2,y}$) using Equation (2). This is as per the requirement of applied methodology AM0029 Version 03 for the calculation of baseline emissions/10/. The project participant has considered the baseline CO₂ emission factor for the Singapore Power grid, the emission factor is published by the National environmental Agency (NEA) /07/.

As per the registered PDD, the baseline CO₂ emission factor is determined using option 1 of the applied methodology AM 0029.

The build margin, calculated according to “Tool to calculate emission factor for an electricity system has been followed for baseline CO₂ emission factor ($EF_{BL,CO_2,y}$),

Thus, $EB_{BLCO_2,y} = 0.4031 \text{ tCO}_2/\text{MWh}$ for year 2018

The baseline emissions are calculated as follows:

$$\begin{aligned} BE_y &= EG_{PJ,y} * EF_{BL,CO_2,y} \\ &= 14,218,331.9 \text{ MWh} * 0.4031 \text{ tCO}_2/\text{MWh} \\ &= 5,731,409.62 \text{ tCO}_2 \end{aligned}$$

Project Emissions (PE_y)

The project activity involves the generation of power using natural gas as the fuel. As natural gas is a fossil fuel, its consumption in the project activity as a fuel will lead to CO₂ emissions that will also need to be accounted for as project emissions.

The project emissions are calculated as per equation (1) of the methodology:

$$PE_y = FC_{f,y} * COEF_{f,y} + FC_{Diesel,y} * COEF_{Diesel,y}$$

Where,

$FC_{f,y}$ = Volume of fuel combusted in project plant m³

$COEF_{f,y}$ = CO₂ Emission Co-efficient of natural gas tCO₂/m³

$FC_{Diesel,y}$ = quantity of diesel combusted in project plant (Ton)

$COEF_{Diesel,y}$ = CO₂ Emission Co-efficient of natural gas tCO₂ /ton

$$COEF_{f,y} = NCV_{f,y} * EF_{CO_2,f,y} * OXID_f$$

Where ,

$NCV_{f,y}$ = Net Calorific Value of gas kcal/m³

$EF_{CO_2,f,y}$ = CO₂ emission factor: 56.1 t CO₂/TJ

$OXID_f$ = Oxidation factor of gas ,1

Density of diesel =0.8261 Tons/KL

The project emissions are calculated as following:

Year	$NCV_{f,y}$ (GJ/m ³)	$COEF_{f,y}$ (tCO ₂ / m ³)	$FC_{f,y}$ (m ³)	$FC_{Diesel,y}$ (KL)	PE _y (tCO ₂)
2018	0.03541	0.001987	803,321,022.38	328.59	1,596,887.95

2019	0.03527	0.001978	820,052,314.27	229.86	1,623,059.14
2020	0.03542	0.001987	780,947,937.38	219.48	1,552,463.25
Total					4,772,410.33

Leakage emissions:

As per the applied methodology AM0029 , leakage emissions need to be taken into account to calculate the emission reductions. The leakage emissions are due to

- Fugitive CH₄ emissions associated with fuel extraction, processing, liquefaction, transportation, re-gasification and distribution of natural gas used in the project plant and fossil fuels used in the grid in the absence of the project activity [LE_{CH₄, y}] &
- In the case LNG is used in the project plant: CO₂ emissions from fuel combustion/electricity consumption associated with the liquefaction, transportation, re-gasification and compression into a natural gas transmission or distribution system. [LE_{LNG,CO₂, y}]

The leakage emissions due to fugitive upstream CH₄ emissions are calculated as follows:

$$LE_{CH_4,y} = [FC_{f,y} * NCV_{f,y} * EF_{NG,upstream,CH_4} - EG_{PJ,y} * EF_{BL,upstream,CH_4}] * GWP_{CH_4}$$

Where

FC_{f,y} = quantity of natural gas combusted in the project activity during year “y”

EG_{PJ,y}= electricity generation by the project Power plant in year “y” (in MWh).

NCV_{f,y} : is the Net Calorific Value of Natural gas.

EF_{NG ,upstream,CH₄} : The Value applied is 296 tCO₂/PJ. This value is applicable for other Oil exporting Countries/ Rest of World, and is found in accordance with the Table 2 provided in AM0029.

EF_{BL ,upstream,CH₄} : The Value applied is 0.00228 kg CH₄/kWh. This value is obtained from the published emission factors by the Host country DNA i.e. NEA. This is found in accordance with Option 1 of AM0029.

GWP_{CH₄} : The value applied is 21 tCO₂e/tCH₄, which is a default IPCC value.

The Leakage emissions due to fossil fuel combustion/electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system during the monitoring period are calculated using following formula:

$$LE_{LNG,CO_2,y} = FC_y * EF_{CO_2,upstream,LNG}$$

Where,

FC_y = Quantity of natural gas combusted in the project plant during the year y in m³

EF_{CO₂,upstream,LNG} = Emission factor for upstream CO₂ emissions due to fossil fuel combustion/electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system. The default value mentioned in the baseline methodology 6 tCO₂/TJ is used for this parameter in the project activity.

The leakage emissions during the current monitoring period are verified as following:

Year	LE _{CH4,y} (tCO ₂)	LE _{LNG,CO2,y} (tCO ₂)	LE _{CH4,y} + LE _{LNG,CO2,y}
2018	- 43,554.57	170,697.65	127,143.08
2019	- 44,266.57	173,524.50	129,257.93
2020	- 40,059.34	165,977.06	125,917.73
Total			382,318.74

Emission reductions (ERy)-

From the values of baseline emissions, project emissions and leakage emissions, the emission reductions are calculated as given below

$$\begin{aligned}
 \text{ERy} &= \text{BEy} - \text{PEy} - \text{Ley} \\
 &= 5,731,409.62 - 4,772,409.54 - 382,318.74 \\
 &= \mathbf{576,680 \text{ tCO}_2}
 \end{aligned}$$

As per ER calculation excel spreadsheet/06/ submitted by the PP, the net emission reductions for the current monitoring period were verified as 576,680 tCO₂e for the current monitoring period.

The assessment team able to confirm that the GHG emission reductions and removals have been quantified correctly in accordance with the project description and applied methodology.

4.5 Quality of Evidence to Determine GHG Emission Reductions and Removals

The monitoring of the project activity is found to be in accordance with the monitoring methodology described in AM0029, Version 03 /10/. The monitoring mechanism is effective and reliable. During the remote audit, personnel involved at various levels of the operation of the project activity have been interviewed to confirm that the plant personnel are conscious of the importance of the monitoring activities. The verification of the plant records and latest photographs are also substantiating consistency in recording and reporting of monitored data.

The screen shots of online monitoring system system/19/ confirms that the monitoring systems have been installed and are operational. The meters comply with appropriate quality standards applicable for the used technology. The accuracy class of the meters installed for the project activity was verified through the registered VCS PD/01/, MR /04/, and calibration certificates/16/, latest photographs of meters and cross-checked against the calibration certificate certificate/16/ signed for the project activity, found to be consistent.

The supporting records of monthly JMRs /09/ and invoices for the entire monitoring period were checked and found to be sufficient to enable verification of emission reductions.

The following parameter has been verified for current monitoring period:

Parameter 1: Net electricity exported by the project plant in year y, $EG_{Export,y}$ (MWh):

This parameter is measured and recorded by the main and check meters installed at the project plant complying with grid code. The bidirectional electricity meters are capable to record the electricity exported and imported from the grid and these meters are of accuracy level 0.2s, as verified from the calibration certificates and actual photographs/19/ of meters indicating the accuracy class, which is as per the registered VCS PD/01/.The calibration frequency of the meters is once in two years that is in accordance with the national regulation of Singapore state.Value of this parameter during the current monitoring period is verified as 14,218,331.9 MWh. Monthly reported values of $EG_{Export,y}$ for the current monitoring period were further cross-checked with the monthly invoices raised by the PP /08/ and found to be consistent.

Calibration details of the energy meters is as following:

Meter Location	Meter type	Meter Sr.No	Calibration date
Line #1	Main meter	99654212	29/12/2016,06/12/2018 and 26/11/2020
	Check Meter	99654213	07/12/2016,09/11/2018 and 13/11/2020
Line #2	Main meter	99654214	29/12/2016,06/12/2018 and 26/11/2020
	Check Meter	99654215	07/12/2016,09/11/2018 and 13/11/2020

Parameter 2: Quantity of NG consumed in the project activity in year y, $FC_{NG,y}$ (m³)

The consumption of fuel (Natural gas and LNG) is metered daily using the turbine flow meters of the project activity which are located within the project boundary (PP end). The data recorded through the flow meters is transmitted to supplier as well as to Plant DCS. Value of this parameter during the current monitoring period is verified as 778,072,299 m³. The metered readings are cross verified with the Natural Gas Transporter(s) bills and found to be consistent.

The ultrasonic gas flow meter and Accuracy: $\pm 0.1\%$ of MV (linearity) is used for monitoring and the calibration frequency of the flow meters is once in year as per metering code.

Parameter 3: Net Calorific Value of Natural Gas, $NCV_{NG,y}$ (GJ/m³)

Net calorific value of the NG is monitored through the Gas Chromatograph located in the project boundary. Monthly values of the $NCV_{NG,y}$ are reported in the ER calculation sheet and found to be appropriate and consistent with the plant records.

The gas chromatograph is self-calibrated and undergone regular (in accordance with maintenance and testing to ensure accuracy during the monitoring period. The GCV was converted to NCV by using conversion factor of Natural Gas for calculation purpose.

Parameter 4: CO₂ emission coefficient, $COEF_{NG,y}$ (tCO₂/m³)

Value of this parameter is determined as 0.001987 tCO₂ /m³ value, which is a calculated value using equation 2 of AM0029 Version 03. This value is calculated using input values as given below

- i) Net Calorific Value of gas (NCV_{NG,y}): kcal/ m³ monthly values in the ER sheet
- ii) CO₂ emission factor (EF_{CO₂,f,y}): 0.0561 t CO₂/GJ
- iii) Oxidation factor of gas (OXID_f): 1

This is found in accordance with requirement of Methodology and hence acceptable.

Parameter 5: Project emission due to combustion of fuel, PE_y (tCO₂)

PP has calculated the value of PE_y using Eq (1) & (1a) of the applied methodology AM0029. The calculations of project emission are presented in the monitoring report as well as in the emission reduction calculation sheet. The value of PE_y, during the current monitoring period is verified as 4,772,409.54 tCO₂. The assessment team found the calculation correct and hence it is acceptable.

Parameter 6: Baseline CO₂ emission factor, EF_{BL,CO₂,y} (tCO₂/MWh)

The value of this parameter is sourced from "INFORMATION ON EMISSION FACTORS (For CDM projects in Singapore) dated 06/01/2020, this is the latest data published by NEA.

Value of baseline CO₂ emission factor is verified as 0.4031 CO₂/MWh for year 2018 and determined as per the option-1 as mentioned in the applied methodology AM0029 V 03.

As per the option-1 "build margin is chosen, this parameter is monitored ex- post and based on latest available database published from the National Environment Agency (www.nea.gov.sg), Singapore. Since the PP has used the latest value from latest database published by National Environment Agency for the calculation, hence accepted.

Parameter 7: Quantity of fossil fuel (diesel) consumed in the project activity in year y, FC_{FF,y} (ton or m³)

As per the registered monitoring plan, diesel can be used in emergency situations only and diesel consumption is through fuel oil tank level drop.

Diesel consumption is continuously monitored at plant and monthly values are reported in the ER sheet and found to be consistent with the plant logbook records. Natural Gas is the primary fuel to be used in the project activity. Back up fuel diesel and start up fuel is LPG. PP has made adequate arrangement to monitor the record the back-up fuel consumption and it is within the 1% of total fuel used on annual energy basis in the current monitoring period.

Parameter 8: Net Calorific Value of fossil fuel, NCV_{FF,y} (GJ/ m³)

Net calorific value of fossil fuel is directly sourced from the supplier's invoice and recorded on monthly basis. Since the parameter is considered from the supplier's report, hence no separate QA/QC process is to be followed. During the current monitoring period, NCV_{FF,y} is monitored in line with the provisions as outlined under registered monitoring plan, hence accepted.

Parameter 9: Source of gas for project activity

The assessment team has verified the supplier invoices for current monitoring period and confirmed that the gas is used from imported LNG from the new SLNG terminal and not diverted from existing users in the host country.

The parameter has been monitored appropriately, in accordance with the registered monitoring plan (as per measurement methods and procedures to be applied) and applied methodology. The monitoring results were recorded consistently as per the approved frequency in the monitoring plan.

The verification team confirms that appropriate methods and formulae for calculating baseline emissions have been followed. The assumptions, emission factors and default values that were applied in the calculations are justified. All the data were made available and have monitored as per required monitoring frequency. The means of verification for the values of parameters, used for baseline emission calculation, is described above.

4.6 Non-Permanence Risk Analysis

Not applicable for the project activity.

5 VERIFICATION CONCLUSION

Earthood Services Private Limited (ESPL), contracted by Infinite Solutions, to perform the independent verification of the emission reductions for the VCS project activity “Grid connected electricity generation plant using natural gas at Jurong Island in Singapore” (VCS ID- 1736) in Singapore for the monitoring period 01/01/2018 – 31/12/2020 as reported in the Monitoring Report Version 02 dated 05/07/2021. The The PacificLight Power Pte Ltd is responsible for the collection of data in accordance with the monitoring plan and the reporting of GHG emissions reductions from the project activity.

It is our responsibility to express an independent verification statement on the reported GHG emission reductions from the project activity. ESPL commenced the verification on the basis of the baseline and monitoring methodology ACM0029 Version 03, the monitoring plan contained in the registered VCS PD Version 02, dated 05/03/2018 and VCS guidelines version 4.0, Monitoring Report Version 02 dated 05/07/2021 as per the process described under Section 2 of this report. ESPL verification approach is based on the understanding of the risks associated with reporting of GHG emission data and the controls in place to mitigate these. ESPL planned and performed the verification by obtaining evidence and other information and explanations that ESPL considered necessary to give reasonable assurance that reported GHG emission reductions are fairly stated.

In our opinion the GHG emissions reductions reported for the project activity for the period 01/01/2018 – 31/12/2020 are fairly stated in the Monitoring Report Version 02 dated 05/07/2021. The GHG emission reductions were calculated correctly based on the approved baseline and monitoring methodology ACM0029, Version 03, and the VCS standard version 4.1. Verification period: From 01/01/2018 – 31/12/2020 (including both days)

Verified GHG emission reductions and removals in the above verification period:

Year	Baseline emissions or removals (tCO ₂ e)	Project emissions or removals (tCO ₂ e)	Leakage emissions (tCO ₂ e)	Net GHG emission reductions or removals (tCO ₂ e)
2018 (from 01/01/2018 to 31/12/2018)	1,923,386.29	1,596,887.95	127,143.08	199,356
2019 (from 01/01/2019 to 31/12/2019)	1,955,168.45	1,623,059.14	129,257.93	202,851
2020 (from 01/01/2020 to 31/12/2020)	1,852,854.88	1,552,463.25	125,917.73	174,473
Total	5,731,409.62	4,772,409.54	382,318.74	576,680

Approved by

Dr. Kaviraj Singh



Managing Director

Earthood Services Privated Limited

Date: 13/08/2021

Place: Gurugram, Haryana

APPENDIX 1: DOCUMENT REFERENCES

S.No	Title of Document	Version	Date
1.	Registered VCS PD	02	05/03/2018
2.	VCS GAP Validation and Verification Report for the monitoring period from 01/01/2014 to 13/07/2014	02	26/03/2018
3.	VCS Monitoring Report	01	08/06/2021
4.	VCS Monitoring Report (Final)	02	05/07/2021
5.	ER spread sheet	01	08/06/2021
6.	ER spread sheet (corresponding to the final monitoring report)	02	05/07/2021
7.	INFORMATION ON EMISSION FACTORS (For CDM projects in Singapore) Electricity Grid	-	06/01/2020
8.	Invoice issued by PP	For the period 01/01/2018 to 31/12/2020	-
9.	Energy Settlement reports (JMRs)	For the period 01/01/2018 to 31/12/2020	-
10.	AM0029: Baseline Methodology for Grid Connected Electricity Generation Plants using Natural Gas	Version 3.0	-
11.	Siemens Gas Turbine (SGT5-4000F) Brochure for Technical Specification of main Power plant equipment's i.e. Turbine and HRSG	-	-
12.	Schedule A To Electricity License for Generation Licensee, Effective on 16/09/2010 – For Capacity with commercial operation Dates		Unit 1 - 30/11/2013 and Unit 2 - 31/01/2014)
13.	Natural Gas / LNG Supply Agreement with BG Singapore Gas Marketing Pte.Ltd.	-	15/03/2010

S.No	Title of Document	Version	Date
14.	VCS webpage for the project, VCS ID 1736; https://registry.verra.org/app/projectDetail/VCS/1736	-	-
15.	Letter of declaration dated from PP regarding not having created or sought any other form of environmental credit for the same period	-	-
16.	Calibration records of the instruments	-	-
17.	VCS Standard	Version 4.0	19/09/2019
18.	VCS Program Guide	Version 4.0	19/09/2019
19.	Remote site visit (Con-call with PP representatives) Latest photographs of online monitoring system, gas turbines, flow meter and energy meters installed at site	-	16/06/2021
20.	Plant records for diesel consumptions	For the period 01/01/2018 to 31/12/2020	-
21.	Grievance register/suggestion box placed at site office	-	-
22.	Supplier's invoices for NG and diesel	For the period 01/01/2018 to 31/12/2020	-
23	CDM registered PDD	5.1	16/03/2014
24	CDM Validation report	06	10/03/2014
25	Metering code by Energy Market Authority of Singapore	-	Published in Jan 2014, and April 2016
26	2006 IPCC Guidelines for National Greenhouse Gas Inventories	Volume 2	-
27	Commissioning certificates (unit 1 and unit 2)	-	14/01/2014 (for Unit 1) 30/01/2014 (for Unit 2)

APPENDIX 2: ABBREVIATIONS

Abbreviations	Full texts
ABT	Availability Based Tariff
BEF	Baseline Emission Factor
BESCOM	Bangalore Electricity Supply Company
BM	Build Margin
CAR	Corrective Action Request
CL	Clarification Request
CMS	Central Monitoring System
CMP	Conference of Parties Serving as Meeting of Parties
CO2	Carbon dioxide
EMA	Energy Market Authority, Singapore
EMC	Energy Market Company, Singapore
FAR	Forward Action Request
GHG	Green House Gas
ISO	International Standards Organization
JMR	Joint Meter Reading
kW	Kilowatt
kWh	Kilowatt hour
MR	Monitoring Report
MWh	Megawatt-hour
NEA	National environmental Agency
PD	Project Description
PLF	Plant Load Factor
PP	Project Proponent
QA/QC	Quality Assurance and Quality Control
UNFCCC	United Nations Framework Convention on Climate Change
VCS	Voluntary Carbon Standard
VCSA	Voluntary Carbon Standard Association
VCS PD	VCS Project Description
VCUs	Voluntary Carbon Units

APPENDIX 3: FINDINGS OVERVIEW

Table 1. Remaining FAR from validation and/or previous verification

FAR ID	NA	Section no.	NA	Date :DD/MM/YYYY
Description of FAR				
No FAR from validation or verification				
Project participant response				Date :DD/MM/YYYY
NA				
Documentation provided by project participant				
NA				
DOE assessment				Date: DD/MM/YYYY
NA				

Table 1. CL from this verification

CL ID	01	Section no.	2.2	Date : 18/06/2021
Description of CL				
- Please submit the monthly electricity generation records for the current monitoring period - Please submit declaration confirming that the GHG Emission reductions or removals generated by the project activity will not be used for compliance with an emission trading program or to meet binding limits on GHG Emissions. - Please submit the approval granted for the project activity (consent to operate) from the relevant authority.				
Project participant response				Date : 10/07/2021
Following documents shall be submitted along with the revised set of documents: - Monthly electricity generation records - Declaration for no double accounting - Generation License				
Documentation provided by project participant				
1. Energy Settlement reports (Invoices) & Block 10 and 20 IEQ.xlsx for Daily generation 2. No Double Counting Declaration (PLP_8 June 2021).pdf 3. Generation License EMA-GE-005 - PLP (16 Sep 2002).pdf				
DOE assessment				Date: 20/07/2021
The project proponent has submitted the electricity generation records for the current monitoring period, found to be appropriate. The PP has submitted the declaration confirming that the GHG Emission reductions or removals generated by the project activity will not be used for compliance with an emission trading program or to meet binding limits on GHG Emissions. The PP has submitted the approval granted for the project activity (consent to operate) from the EMA, found to be satisfactory. CL #1 is closed.				

Table 2. CAR from this verification

CAR ID	01	Section no.	3.3	Date : 18/06/2021
Description of CAR				
It is not clear whether the project deviations as described under section 3.2.2 of the MR are taken during the current monitoring period or previous MP. It is not clarified whether the deviations impact the applicability of the methodology, additionality or the appropriateness of the baseline scenario, please provide an explanation of the outcome.				
Project participant response				Date : 10/07/2021

PP has revised section 3.2.2 of MR to transparently explain the deviations of the MR that taken during the previous MP. It does not impact the applicability of the methodology, additionality or the appropriateness of the baseline scenario since all the deviations are related to metering and monitoring.	
Documentation provided by project participant	
Revised MR Version 2	
DOE assessment	Date: 20/07/2021
The PP has appropriately described the project deviations taken during the previous and current monitoring period under section 3.2.2 of MR. It is confirmed that the deviations do not impact the applicability of the methodology, additionality or the appropriateness of the baseline scenario. CAR #1 is closed.	

CAR ID	02	Section no.	4.2.2	Date : 18/06/2021
Description of CAR				
Please clarify why the information regarding the ongoing communication with local stakeholders is not provided in section 2.2 of the MR, in line with the guidelines provided under the clause 3.16.3 and 3.16.4 of the VCS standard v 04.1. Please submit the copy of grievance register placed at plant site office.				
Project participant response				Date :10/07/2021
PP has revised section 2.2 of MR to transparently explain the mechanism for on-going communication with local stakeholders. The grievance copy is hereby submitted to the DOE.				
Documentation provided by project participant				
1. Revised MR version 2 2. Copy of Grievance reregister.				
DOE assessment				Date: 20/07/2021
The PP has provided the information regarding the ongoing communication with local stakeholder in section 2.2 of the MR, in line with the guidelines provided under the clause 3.16.3 and 3.16.4 of the VCS standard v 04.1. The grievance copy is submitted, found to be appropriate. CAR #2 is closed.				

Table 3. FAR from this verification

FAR ID	NA	Section No.	NA	Date :DD/MM/YYYY
Description of FAR				
No FAR rose during the verification.				
Project participant response				Date :DD/MM/YYYY
NA				
Documentation provided by project participant				
NA				
DOE assessment				Date: DD/MM/YYYY
NA				

APPENDIX 4: COMPETENCY STATEMENTS

Competence Statement	
Name	Ravi Kant Soni

Country	India		
Education	B. Tech. (Mechanical Engineering) M. Tech. (Energy Management)		
Experience	8 Years +		
Field	Energy and Climate Change		
Approved Roles			
Team Leader	YES		
Validator	YES		
Verifier	YES		
Methodology Expert	AMS-I.D., AMS-I.C., ACM0002		
Local expert	YES (India)		
Financial Expert	No		
Technical Reviewer	No		
TA Expert	YES (TA 1.2)		
Reviewed by	Shreya Garg	Date	04/06/2019
Approved by	Anshika Gupta	Date	04/06/2019

Name	Shreya Garg		
Country	India		
Education	M.Sc. (Climate Science & Policy), TERI University		
Experience	6 Years +		
Field	Climate Change		
Approved Roles			
Team Leader	YES		
Validator	YES		
Verifier	YES		
Methodology Expert	AMS.I.A., AMS.I.C., AMS.I.D., AMS.I.F., AMS.II.D., AMS.II.G., AMS.II.J., AMS.III.AV., ACM0002, ACM0012		
Local expert	YES (India)		
Financial Expert	NO		
Technical Reviewer	YES		
TA Expert	YES (TA 1.2, TA 3.1)		
Reviewed by	Abhishek Mahawar	Date	01/03/2018

Approved by	Ashok Gautam	Date	01/03/2018
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