

Grid connected electricity generation plant using natural gas at Jurong Island in Singapore



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Summary:**Verification purpose:**

PacificLight Power Pte. Ltd. has developed a new, grid connected 800 MW natural gas fired combined cycle power plant. The plant, through its use of natural gas and advanced combined cycle technology, provides consumers in Singapore with a clean, highly efficient source of electricity.

The purpose of the project activity is to construct and operate 800 MW natural gas based power plant. The electricity generated is exported to the Singapore national grid. The project activity helps to reduce carbon intensity.

At the site ambient conditions and a frequency of 50 Hz, the rated capacity of the plant is 800 MW (two units 400 MW each)¹. Each of the two units have one combustion turbine, one Heat recovery Steam Generator (HRSG) and one Steam Turbine Generator (STG). The heat content of the exhaust gas from the combustion turbine is recovered in individual heat recovery steam generators. The steam generated is then expanded in a condensing type steam turbine driving an electric generator.

Generator terminal voltage is at 22kV and the power generated is exported to grid through step-up transformer and onsite switch house, after voltage increased to 230kV. The 230kV onsite switch house is connected to Singapore grid through three power evacuation lines.

¹ As per technical specifications of the EPC contract with Siemens

The project activity is a new, independently owned, natural gas based power plant and thus no power generating equipment existed on the project site before the project activity plant. Thus, the pre-project scenario is continuation of existing higher carbon intensive fuel used to generate power for the grid.

As identified in CDM registered PDD (<https://cdm.unfccc.int/Projects/DB/BVQI1373973780.44/view>), the baseline scenario is generation of equivalent power from a coal based power plant (due to the lower cost of electricity generation from same and hence financially viable). There is at least one coal based power plant that operates in Singapore on imported coal.

In the absence of the project activity less efficient plant, including coal, would have been required to run to meet electricity demand. The project activity thus reduces anthropogenic GHG emissions into the atmosphere due to the use of relatively 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.

During the reported monitoring period 01/01/2014 to 13/07/2014 (First and last date included) the project activity has supplied 2,048,966.14 MWh of electricity, and thus contributed to the GHG reductions of 57,991 tCO₂e.

Assessment team confirms following during the verification site visit:

1. Start Date: The PP got commissioning generation facility (CGF) acceptance from EMA in 2013. Unit's commissioning started in June-2013 & Aug-2013 and completed by Dec-2013 & Jan-2014, respectively for Unit 10 & Unit 20. Unit 10 was synchronized to grid for the first time on 29/06/2013 and Unit 20 was first time synchronized on 30/08/2013. Subsequent to testing & commissioning, Units were declared as commercial operating facility (also called as GRF: Generation Registered facility) on 15/01/2014 & 06/02/2014 respectively for Unit 10 & Unit 20. The start date of the project activity is the initial date of commissioning of the first unit of the plant namely 29/06/2013. The power plant was in continuous operation since the inception. There has been no major downtime of equipment's, overhaul times or exchange of equipment's in the project activity during the current monitoring period observed. The plant undergone scheduled maintenance as per the manufacturer's recommendation. The same is thus acceptable to the assessment team.
2. An undertaking dated 26/02/2018 has been submitted by PP for double counting with any other GHG program. PP also has given a written declaration that project has not claimed other form of GHG credit for the concerned monitoring period.
3. The first crediting period of the project activity is for 10 years and it will be renewed twice. Though the project activity starts exporting electricity from June 2013, the first crediting period is considered from 01-01-2014 to 31-12-2023.

4. Project location (geographical coordinate) i.e. 1°17'24" N and 103°43'30" E is confirmed by the assessment team during the site visit. Assessment team also checked with the GPS meter regarding the latitude and longitude of the project site and confirm that the details as mentioned in the CDM registered PD is correct.

5. Project proponent of the project activity is as below

Organization name	PacificLight Power Pte. Ltd.
Contact person	Clare Savereux
Title	Senior Manager, Regulations & Corporate Communications
Address	PacificLight Power Pte Ltd, 47 Jurong Island Highway Singapore 627626
Telephone	-
Email	clare.savereux@pacificlight.com.sg

6. Other Entities Involved in the Project

Organization name	EKI Energy Services Limited
Role in the project	Project Consultant
Contact person	Ramakrishna Patil
Title	General Manager-Operations
Address	EnKing Embassy, Office no 201, Plot 48, Scheme 78, Part 2, Vijay Nagar, Indore- 452010, Madhya Pradesh, India
Telephone	+91 9096562065
Email	ramkrishna.patil@enkingint.org

7. Assessment team observed that the actual emission reductions is 61.95% lower than estimated. The estimation ER for the current monitoring period is 152,412 while actual achieved ER for the monitoring period is 57,991 due to low PLF during current monitoring period and also build margin emission factor is lower (0.4065 tCO₂/MWh is actual emission factor and 0.4578 tCO₂/MWh is estimated emission factor) than estimated, hence emissions reductions are lower than estimated.

8. Assessment team observed following deviation from the CDM registered PDD and confirm as per the requirement of Para 3.6 of VCS standard version 3.7, that deviation do not alter project additionality, applicability or baseline of the project activity. The deviation is sought in monitoring practices followed onsite. The deviation is acceptable because the same is as per the Singapore country grid code law which is the national law followed for all power plant. The detail deviation is described below:
1. Assessment team observed that the complete gas metering equipment is installed at consumer end (PP side) only and within the project activity premises. There is no separate meters for PP side and separate meter for supplier side, hence deviation is 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, the same is acceptable to the assessment team.
 2. As per CDM registered PDD, the diesel consumption should be monitored by using mass flow meter, however at actual site there is no 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. The same is thus acceptable to the assessment team.
 3. As per CDM registered PDD, source of data for Net Calorific Value of Natural Gas is invoice from gas supplier. However for current monitoring period, 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. The same is thus acceptable to the assessment team

Validation purpose: The main purpose of this project activity is to generate electricity through Gas turbine. The project is registered under CDM mechanism (reference number: 9687). The present validation (gap validation) is under VCS mechanism and assessment of clause 1.1, 1.2, 1.3, 1.5, 1.6, 1.7, 1.9, 1.10, 1.12.1, 1.12.2, 1.12.3, 1.12.4, 1.13 and 2.6 of the VCS Project Description Template. The same is in line with Para 3.11.10 of VCS standard version 3.7.

A risk based approach has been followed to perform this verification activity. In the course of verification, 06 Corrective Action request (CAR), 00 Clarification Requests (CLs) and 00 forward action request were raised and successfully closed. The review of the Monitoring report and additional documents related to baseline and monitoring methodology; the subsequent background investigation, follow-up interviews and PP have provided *LGAI Technological Center S.A. (Applus+ Certification)* with sufficient evidence to verify the fulfilment of the stated criteria of VCS.

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1 INTRODUCTION

1.1 Objective

LGAI Technological Center S.A.(Applus+ Certification) (hereinafter referred only to as Applus+ Certification) has been appointed by “PacificLight Power Pte Ltd” to perform the 1st periodic verification+ Gap Validation under VCS of the “Grid connected electricity generation plant using natural gas at Jurong Island in Singapore” under VCS standard and guideline version 3.7. The objective of this verification activity is to have an independent third party for the assessment of the VCS project design, Monitoring report and to ensure a thorough assessment of the proposed project activity against the applicable CDM and VCS requirements. In particular;

- the project's baseline is assessed against “AM0029 ver.3 - Baseline Methodology for Grid Connected Electricity Generation Plants using Natural Gas ”
- the project's monitoring plan is assessed against “AM0029 ver.3 - Baseline Methodology for Grid Connected Electricity Generation Plants using Natural Gas ”
- the projects compliance with, the requirements of Article 12 of the Kyoto Protocol, the CDM Modalities and Procedures as agreed in the Marrakech Accords under decision 3/CMP.1, the annexes to this decision, subsequent decisions and guidance made by COP/MOP & CDM Executive Board and other relevant rules, including the Host Country legislation and sustainability criteria along with VCS guideline and standard version 3.7
- CDM validation and verification standard for project activities Version 1.0
- CDM project standard for project activities Version 1.0
- CDM project cycle procedure for project activities Version 1.0
- VCS standard v3.7
- VCS program guide v3.7

Gap Validation and Verification is a requirement for all VCS projects and is seen as necessary to provide assurance to stakeholders of the quality of the project and its intended generation of verified emission reductions (VERs).

1.2 Scope and Criteria

The scope of the gap Validation and verification is the independent and objective review of the Monitoring report (MR) and VCS PD. The VCS PD and MR is reviewed against the relevant criteria (see 1.1) and decisions by the CDM Executive Board and VCS executive board, including the approved baseline and monitoring methodology. The verification was based on the guidance given in the CDM validation and verification standard for project activities Version 1.0, Registered CDM PDD version 05.1 dated 16/03/2014, Final Validation report dated 10/03/2014 version 06, CDM project standard for project activities Version 1.0, CDM project cycle procedure for project activities Version 1.0 and VCS program guideline and standard version 3.7.

The assessment team has employed a risk based approach to assess the completeness and accuracy of the claims and conservativeness of the assumptions in the MR. The main focus of the assessment team is to identify the significant risks for the project implementation and the generation of VERs. The verification is not meant to provide any consulting towards the project participants. However, stated requests for clarifications and/or corrective actions may have provided input for improvement of the Monitoring report.

The only purpose of the verification is its usage during the issuance process as part of the VCS project cycle. Therefore, Applus+ Certification can't be held liable by any party for decisions made or not made based on the verification opinion, which will go beyond that purpose.

1.3 Level of Assurance

The Gap Validation and verification has been planned and organized to achieve a Reasonable Level of assurance as per the requirement of VCS. No sampling procedure applied for site visit or document verifications. The entire documents like energy settlement report, Gas Invoices were checked for the power project verification of all the instances are conducted to arrive at positive verification +gap validation conclusions.

1.4 Summary Description of the Project

The purpose of the project activity is to construct and operate 800 MW natural gas based power plant. The electricity generated is exported to the Singapore national grid. The project activity helps to reduce carbon intensity.

At the site ambient conditions and a frequency of 50 Hz, the rated capacity of the plant is 800 MW (two units 400 MW each)². Each of the two units have one combustion turbine, one Heat recovery Steam

² As per technical specifications of the EPC contract with Siemens

Generator (HRSG) and one Steam Turbine Generator (STG). The heat content of the exhaust gas from the combustion turbine is recovered in individual heat recovery steam generators. The steam generated is then expanded in a condensing type steam turbine driving an electric generator.

Generator terminal voltage is at 22kV and the power generated is exported to grid through step-up transformer and onsite switch house, after voltage increased to 230kV. The 230kV onsite switch house is connected to Singapore grid through three power evacuation lines.

The project activity is a new, independently owned, natural gas based power plant and thus no power generating equipment existed on the project site before the project activity plant. Thus, the pre-project scenario is continuation of existing higher carbon intensive fuel used to generate power for the grid.

2 VERIFICATION PROCESS

The purpose of the project activity is to construct and operate 800 MW natural gas based power plant. The electricity generated is exported to the Singapore national grid. The project activity helps to reduce carbon intensity.

At the site ambient conditions and a frequency of 50 Hz, the rated capacity of the plant is 800 MW (two units 400 MW each)³. Each of the two units have one combustion turbine, one Heat recovery Steam Generator (HRSG) and one Steam Turbine Generator (STG). The heat content of the exhaust gas from the combustion turbine is recovered in individual heat recovery steam generators. The steam generated is then expanded in a condensing type steam turbine driving an electric generator.

Generator terminal voltage is at 22kV and the power generated is exported to grid through step-up transformer and onsite switch house, after voltage increased to 230kV. The 230kV onsite switch house is connected to Singapore grid through three power evacuation lines.

2.1 Method and Criteria

Validation and Verification Scope: The Validation scope is defined as an independent and objective review of the project design document (PD: relevant clause: 1.1, 1.2, 1.3, 1.5, 1.6, 1.7, 1.9, 1.10, 1.12.1, 1.12.2, 1.12.3, 1.12.4, 1.13 and 2.6) and Monitoring report (MR). The Verification scope is defined as an independent and objective review of the Monitoring report (MR) prepared as per the CDM registered PD and registered approved methodology AM0029 version 03. The MR is reviewed against the criteria stated in Article 12 of the Kyoto Protocol, the CDM modalities and procedures as agreed in the Marrakech Accords and the relevant decisions by the CDM Executive Board and VCS standard and program guideline version 3.7, including the approved baseline and monitoring methodology AM0029 version 03. The verification was based on the requirements in the CDM validation and verification standard for project activities Version 1.0,

³ As per technical specifications of the EPC contract with Siemens

CDM project standard for project activities Version 1.0, CDM project cycle procedure for project activities Version 1.0 and VCS program guideline and standard version 3.7.

The gap Validation verification is not meant to provide any consulting towards the project participants. However, stated requests for clarifications and/or corrective actions may have provided input for improvement of the Monitoring report.

Validation and Verification Process: The project assessment is based on the CDM validation and verification standard for project activities Version 1.0 and VCS standard and guideline version 3.7 and is conducted using standard auditing techniques to assess the correctness of the information provided by the project participants. Before the assessment begins, members of the team covering the technical scope(s), sectoral scope(s), and relevant host country experience for evaluating the VCS project activity are appointed.

Once the project is received by the assessment team, the members of the assessment team carried out:

1. A desk review of the Monitoring report against the VCS PD (Clause 1.1, 1.2, 1.3, 1.5, 1.6, 1.7, 1.9, 1.10, 1.12.1, 1.12.2, 1.12.3, 1.12.4, 1.13 and 2.6) and
2. Follow-up interviews with project participant;
3. The resolution of outstanding issues and the issuance of the final verification report and opinion.

The prepared verification report and other supporting documents then undergo an internal quality control at the HQ (Accredited office) before being submitted to the VCS executive board.

Appointment of the assessment team

According to the sectoral scope / technical area and experience in the sectoral or national business environment, Applus+Certification has composed a project assessment team in accordance with the appointment rules in the internal Quality Management System of Applus+Certification.

The composition of audit team shall be approved by the Applus+Certification ensuring that the required skills are covered by the team.

The four qualification levels for team members that are assigned by formal appointment rules are as presented below:

- Lead Auditor (LA).
- Auditor (A) / Auditor in Training (AiT).
- Technical Expert (TE).
- Technical Reviewer (TR).

The sectoral scope / technical area knowledge linked to the applied methodology/ies shall be

Covered by the assessment team.

Name	Role	SS Coverage	TA Coverage	Financial aspect	Host country experience
Mr. Sukanta Das	LA	YES	YES	YES	YES
Mr. Simon Shen	TR	YES	YES	NA	NA

The detail regarding the assessment team is provided below in this report as Appendix 3

Document review

The VCS PD and Monitoring report submitted by the Client was reviewed against the approved methodology, Registered CDM PDD version 05.1 dated 16/03/2014, Final Validation report dated 10/03/2014 version 06 and other relevant criteria to verify the correctness, credibility, and interpretation of the presented information. Furthermore, a cross-check between information provided and information from other sources has been done. A complete list of all documents and evidence material reviewed is included in this report below in appendix 1.

Follow-up interviews

A site visit is conducted by Applus+ Certification performed interviews, telephone conferences, and physical site inspection with project stakeholders to confirm selected information and to resolve issues identified in the document review. The detail is provided in this report section 2.3.

Resolution of Clarification and Corrective Action Request

The objective of this phase of the gap validation and Verification was to resolve the requests for corrective actions and clarification and any other outstanding issues which need to be clarified for Applus+ Certification's positive conclusion on the Monitoring report. The Corrective Action Requests and Clarification Requests raised by Applus+ Certification were resolved during communications between the Client and Applus+ Certification to guarantee the transparency of the verification process, the concerns raised and responses given are summarized below in the appendix 2.

The final MR Version 3.0 submitted by PP on 26/03/2018 and final VCS PD version 02 dated 05/03/2018 serves as the basis for the final assessment and positive gap validation and verification opinion. Additional changes to the project during the gap validation and verification process are not considered to be significant with respect to the main CDM/VCS objectives. The two CDM/VCS main objectives are the reduction of anthropogenic GHG emissions and the contribution of sustainable development to the host country.

Internal quality control

As final step of a gap validation and verification of the final documentation including the verification report and the checklist have to undergo an internal quality control by the technical review committee, i.e. each report has to be finally approved either by the head of the technical review committee or the deputy. In case one of these two persons is part of the assessment team approval can only be given by the other one to avoid any conflict of Interest.

After confirmation of the PP the positive gap validation and verification opinion and relevant documents are submitted to the VCS board through the VCS web-platform

2.2 Document Review

The details of the document observed during the verification process are listed below in Appendix 1 of this report

2.3 Interviews

No .	Interviewed			Date	Subject	Team member
	Last name	First name	Affiliation			
1.	Ravi Kumar	PVS	PP representative	09/02/2018- VCS Gap validation+ Verification	Implementation of project activity	Mr. Sukanta Das
2.	Kokchan	Kwong	PP representative	09/02/2018- VCS Gap validation+ Verification	Implementation of Monitoring practices	Mr. Sukanta Das
3.	Srinivasan	RDM	PP representative	09/02/2018- VCS Gap validation+ Verification	Emission reduction calculation formula and calculation details	Mr. Sukanta Das
4.	Savereux	Clare	PP representative	09/02/2018- VCS Gap validation+ Verification	Local and National regulations requirement for the project activity,	Mr. Sukanta Das

2.4 Site Inspections

Duration of on-site inspection: 09/02/2018- VCS Gap validation+ Verification				
No.	Activity performed on-site	Site location	Date	Team member
1.	Assessment team checked the implementation of the project, Baseline emission, Emission reduction calculation, technical description of the project and Monitoring. Assessment team also checked that whether the monitoring plan as described in the CDM PDD is actually practised onsite. Also assessment team checked any change in host country criteria which may affect the baseline of the project activity. The monitoring practices followed onsite is also checked with the requirement of the registered CDM PDD.	The project activity is located near City & District: Jurong Island, Singapore.	09/02/2018- VCS Gap validation+ Verification	Mr. Sukanta Das

2.5 Resolution of Findings

The objective of this phase of the Gap validation and Verification was to resolve the requests for corrective actions and clarification and any other outstanding issues from validation which need to be clarified for Applus+ Certification's positive conclusion on the Monitoring report. The Corrective Action Requests and Clarification Requests raised by Applus+ Certification were resolved during communications between the Client and Applus+ Certification to guarantee the transparency of the gap Validation and verification process, the concerns raised and responses given are summarized below in the appendix 2.

The final VCS PD Version 02 submitted by PP on 05/03/2018 and MR version 3.0 dated 26/03/2018 serves as the basis for the final positive gap Validation and verification opinion. Additional changes to the project during the Gap validation and verification process are not considered to be significant with respect to the main CDM/VCS objectives. The two CDM/VCS main objectives are the reduction of anthropogenic GHG emissions and the contribution of sustainable development to the host country.

Areas of validation and verification findings	No. of CL	No. of CAR	No. of FAR
Project design document and Monitoring report	00	02	00
Description of project activity	00	00	00
Application of selected baseline and monitoring methodology and selected standardized baseline			
- Applicability of methodology and standardized baseline	00	00	00
- Deviation from methodology	00	00	00
- Clarification on applicability of methodology, tool and/or standardized baseline	00	00	00
- Project boundary	00	00	00
- Establishment and description of baseline scenario	00	00	00

Areas of validation and verification findings	No. of CL	No. of CAR	No. of FAR
- Demonstration of additionality	00	00	00
- Emission reductions	00	01	00
- Calibration details	00	01	
- Monitoring plan	00	00	00
Others (please specify)-	00	02	00
1. Matter related to double counting			
2. Matter related to No Net Harm			
3. Matter related to Local stakeholder			
Total	00	06	00

The list of findings and there resolution is presented in Appendix 2 of this report.

2.5.1 Forward Action Requests

This is 1st periodic verification of the project activity under VCS and no FAR raised during validation and subsequent registration of CDM validation. No FAR raised during GAP validation of this project as well.

2.6 Eligibility for Validation Activities

As per the requirement of para 3.11.10 of VCS standard version 3.7:

“For projects registered under the CDM, the cover page and sections 1.1, 1.2, 1.3, 1.5, 1.6, 1.7, 1.9, 1.10, 1.12.1, 1.12.2, 1.12.3, 1.12.4, 1.13 and 2.6 of the VCS Project Description Template shall be completed. A validation/verification body shall undertake a validation of same, which shall be accompanied by a validation representation, to provide a gap validation for the project’s compliance with the VCS rules.”

Assessment team checked the requirement of 1.1, 1.2, 1.3, 1.5, 1.6, 1.7, 1.9, 1.10, 1.12.1, 1.12.2, 1.12.3, 1.12.4, 1.13 and 2.6 of the VCS Project Description Template and confirm that project is eligible under Gap validation rule of VCS standard version 3.7. The detail is provided below in the sections.

The Validation and verification body holds accreditation to carry out both Gap validation and verification activities. The accreditation scope can be checked from the below link:

<http://cdm.unfccc.int/DOE/list/DOE.html?entityCode=E-0032>

3 VALIDATION FINDINGS

3.1 Participation under Other GHG Programs

The present project activity is registered under CDM mechanism (UN reference number: 9687). The project can be traced via link

<https://cdm.unfccc.int/Projects/DB/BVQI1373973780.44/view>

The gap validation is performed for the project activity as per Para 3.11.10 of VCS standard version 3.7. As per the requirement of this template following are the observation of the assessment team:

1. The project is registered under CDM mechanism and UN reference number of the project is 9687. The project title is Grid connected electricity generation plant using natural gas at Jurong Island in Singapore
2. The project is eligible under Para 3.11.10 of VCS standard version 3.7.
3. Assessment team adopted a step wise procedure to assess the respective clause required for gap validation under VCS vide Para 3.11.10 of VCS standard version 3.7:

Clause 1.1: The purpose of the project activity is to construct and operate 800 MW natural gas based power plant. The electricity generated is exported to the Singapore national grid. The project activity helps to reduce carbon intensity. At the site ambient conditions and a frequency of 50 Hz, the rated capacity- of the plant is 800 MW (two units 400 MW each)⁴. Each of the two units have one combustion turbine, one Heat recovery Steam Generator (HRSG) and one Steam Turbine Generator (STG). The heat content of the exhaust gas from the combustion turbine is recovered in individual heat recovery steam generators. The steam generated is then expanded in a condensing type steam turbine driving an electric generator. Generator terminal voltage is at 22kV and the power generated is exported to grid through step-up transformer and onsite switch house, after voltage increased to 230kV. The 230kV onsite switch house is connected to Singapore grid through three power evacuation lines. Assessment team observed that the power plant is implemented as per the description of the registered CDM PDD and statutory and regulatory requirement of Host country Singapore. Project thus satisfies Clause 1.1 of VCS PD

Clause 1.2: According to the categorisation system of the Clean Development Mechanism, which is part of Green House Gas (GHG) program that has been approved by the VCS board, the project is categorised as:

Project type: Renewable energy projects

Sectoral Scope: 1- Energy Industries (renewable/non-renewable sources).

Assessment team checked the type and category of the project activity and found that the project is eligible under Type I and renewable category of project. Hence the project is eligible under Clause 1.2 of VCS PD.

Clause 1.3: Assessment team observed that the name, title, address, phone number of the project participant is same as per the CDM registered PDD. Assessment team checked the project participant details during the onsite visit with the help of commissioning generation facility, energy settlement report etc. Hence, Clause 1.3 as depicted in the VCS PD for gap validation is acceptable to the assessment team.

Clause 1.5: The PP got commissioning generation facility (CGF) acceptance from EMA in 2013. Unit's commissioning started in June-2013 & Aug-2013 and completed by Dec-2013 & Jan-2014, respectively for Unit 10 & Unit 20. Unit 10 was synchronized to grid for the first time on 29/06/2013

⁴ As per technical specifications of the EPC contract with Siemens

and Unit 20 was first time synchronized on 30/08/2013. Subsequent to testing & commissioning, Units were declared as commercial operating facility (also called as GRF: Generation Registered facility) on 15/01/2014 & 06/02/2014 respectively for Unit 10 & Unit 20.

The start date of the project activity is the initial date of commissioning of the first unit of the plant namely 29/06/2013. The power plant was in continuous operation since the inception. There has been no major downtime of equipment's, overhaul times or exchange of equipment's in the project activity during the current monitoring period observed. The plant undergone scheduled maintenance as per the manufacturer's recommendation. The same is thus acceptable to the assessment team. Hence, Clause 1.5 as depicted in the VCS PD for gap validation is acceptable to the assessment team.

Clause 1.6: The first crediting period of the project activity is for 10 years and it will be renewed twice. Though the project activity starts exporting electricity from June 2013, the first crediting period is considered from 01-01-2014 to 31-12-2023. Hence, Clause 1.6 as depicted in the VCS PD for gap validation is acceptable to the assessment team.

Clause 1.7: The emission reduction of the project activity is less than 300,000 tCO₂ e per annum and thus project falls under project category as per the requirement of VCS. Thus clause 1.7 as depicted in the VCS PD for gap validation is acceptable to the assessment team.

Clause 1.9: Project location (geographical coordinate) i.e. 1°17'24" N and 103°43'30" E is confirmed by the assessment team during the site visit. Assessment team also checked with the GPS meter regarding the latitude and longitude of the project site and confirm that the details as mentioned in the CDM registered PD is correct. Thus clause 1.9 as depicted in the VCS PD for gap validation is acceptable to the assessment team.

Clause 1.10: This is a Greenfield project. The project activity replaces the carbon intensive grid electricity. The proposed project activity effectively utilises NG to generate electricity which will be feed into the Grid. Thereby the project activity reduces the dependence on fossil fuel based generation units and as there are no associated emissions with this project it contributes to the reduction of greenhouse gases (GHG) emissions. Assessment team checked the same during the onsite visit and also cross checked with CDM PDD and validation report. Thus clause 1.10 as depicted in the VCS PD for gap validation is acceptable to the assessment team.

Clause 1.12.1: The ownership details were checked using (1) commissioning certificate- The letter from Energy Market Company (EMC) to PacificLight Power Pte. Ltd. for registration of commissioning of generation facility indicates that PP have the legal right to control and operate the project activities. and (2) contract with EPC contractor- The purchase order on the name of PacificLight Power Pte. Ltd. indicates that PP have the legal right to control and operate the

project activities..Thus clause 1.12.1 as depicted in the VCS PD for gap validation is acceptable to the assessment team.

Clause 1.12.2: The project is registered under CDM and UNFCCC⁵ (Registration ID -9687). The project is also approved by the DNA and a copy of the approval is available on the UNFCCC page. Project Proponent has submitted undertaking that they will not claim same GHG emission reductions of the project from CDM and VCS. PP would not use net GHG emission reductions by the projects for compliance with emission trading program to meet binding limits on GHG emissions. Thus clause 1.12.2 as depicted in the VCS PD for gap validation is acceptable to the assessment team.

Clause 1.12.3: Project has been registered with UNFCCC under Clean Development Mechanism program. Registration reference number is 9687. Project Proponent has submitted undertaking for not availing other forms of environmental credit for the same monitoring period under consideration. Thus clause 1.12.3 as depicted in the VCS PD for gap validation is acceptable to the assessment team

Clause 1.12.4: Project has been registered with UNFCCC under Clean Development Mechanism program, Registration reference number is 9687. PP also submitted undertaking for Project neither has any intends to generate any form of GHG related environmental credit for neither GHG emission reductions nor removals claimed under the VCS program. Thus clause 1.12.4 as depicted in the VCS PD for gap validation is acceptable to the assessment team.

Clause 1.13: Assessment team checked that project do not falls under AFLOU category as the project is electricity generation from Gas turbines. Leakage emission is involved as per the direction of AM 0029 and CDM registered PDD. The same is calculated as per the applied formula of AM0029 version 3.0. There is no commercially sensitive information accounted for the determination of baseline, net GHG removals and for demonstration of additionality for the present project activity. There are no information or incidents that will have bearing on the eligibility of the project, the net GHG emission reductions or removals, or the quantification of the project's net GHG emission reductions or removals. Thus clause 1.13 as depicted in the VCS PD for gap validation is acceptable to the assessment team

⁵<https://cdm.unfccc.int/Projects/DB/BVQI1373973780.44/view>

Clause 2.6: The project activity does not involve any methodology deviations. Thus clause 2.6 as depicted in the VCS PD for gap validation is acceptable to the assessment team.

3.2 Methodology Deviations

No methodology deviation observed for the project activity.

3.3 Project Description Deviations

Assessment team observed following deviation from the CDM registered PDD and confirm as per the requirement of Para 3.6 of VCS standard version 3.7, that deviation do not alter project additionality, applicability or baseline of the project activity. The deviation is sought in monitoring practices followed onsite. The deviation is acceptable because the same is as per the Singapore country grid code law which is the national law followed for all power plant. The detail deviation is described below:

- Assessment team observed that the complete gas metering equipment is installed at consumer end (PP side) only and within the project activity premises. There is no separate meters for PP side and separate meter for supplier side, hence deviation is 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, the same is acceptable to the assessment team.
- As per CDM registered PDD, the diesel consumption should be monitored by using mass flow meter, however at actual site there is no 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. The same is thus acceptable to the assessment team.
- As per CDM registered PDD, source of data for Net Calorific Value of Natural Gas is invoice from gas supplier. However for current monitoring period, 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. The same is thus acceptable to the assessment team.
- 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 has requested deviation to change the calibration frequency from annual to once in two years and this is found to be appropriate as per country code.
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As mentioned above the deviations are related to monitoring practises and current monitoring practise does not reduce the accuracy of monitoring for the project activity. Thus there is no any impact on the monitored data and on emission reductions. The above deviations does not impact the applicability of

the methodology, additionality or the appropriateness of the baseline scenario, and the project remains in compliance with the applied methodology. The deviation is sought in monitoring practices followed onsite. The deviation is acceptable because the same is as per the Singapore country grid code law which is the national law followed for all power plant.

Hence deviation mentioned in VCS MR are found to be appropriate and do not affect the project's compliance with VCS rules.

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3.4 Grouped Project

This section not applicable as the project is not a grouped project.

4 VERIFICATION FINDINGS

4.1 Project Implementation Status

During the verification site visit it was concluded that the project is implemented as per the requirement of the CDM registered PD and Final Validation report. The deviation as observed in the monitoring practice is however described and approved by assessment team above in the report as per the requirement of Para 3.11.10 of VCS standard version 3.7. During the current monitoring period it was observed that no unforeseen incident/event evolved which can impact the operation of the project activity. The project undergone continuous operation and only scheduled maintenance is observed as per the manufacturer's specification which is acceptable to the assessment team.

CAR 01 is however raised regarding details of the Feeder location of the individual project location and CAR 02 is raised for the details of downtime/breakdown records. Please refer Appendix 2 of this report for the detail closure of the CAR's.

Feeder details are provided which is confirmed by the assessment team during the verification site visit. The Feeder details are included in the MR and thus the CAR01 is closed.

Breakdown log sheets for individual power project i.e. Gas turbine power plant is submitted by PP. Scheduled maintenance was carried out as per the instruction of the manufacturer and the same is acceptable to the assessment team. No unforeseen incident observed during the monitoring period. CAR 02 is thus closed.

Project location is also confirmed by the assessment team with Google earth and confirm that the detail as mentioned in the PD is correct.

The project commissioning generation facility details are checked by the assessment team against the commissioning certificates and found that the details as provided in the MR correct.

The PP got commissioning generation facility (CGF) acceptance from EMA in 2013. Unit's commissioning started in June-2013 & Aug-2013 and completed by Dec-2013 & Jan-2014, respectively for Unit 10 & Unit 20. Unit 10 was synchronized to grid for the first time on 29/06/2013 and Unit 20 was first time synchronized on 30/08/2013. Subsequent to testing & commissioning, Units were declared as commercial operating facility (also called as GRF: Generation Registered facility) on 15/01/2014 & 06/02/2014 respectively for Unit 10 & Unit 20.

The start date of the project activity is the initial date of commissioning of the first unit of the plant namely 29/06/2013. Assessment team observed that the actual emission reductions is 61.95% lower than estimated. The estimation ER for the current monitoring period is 152,412 while actual achieved ER for the monitoring period is 57,991 due to low PLF during current monitoring period and also build margin emission factor is lower (0.4065 tCO₂/MWh is actual emission factor and 0.4578 tCO₂/MWh is estimated emission factor) than estimated, hence emissions reductions are lower than estimated.

No overestimation of VERs is thus envisaged and thus assessment team confirms that the actual emission reduction calculation achieved is conservative and correct.

The assessment team confirmed that there is no proposed or actual change to the project design of the project activity occurred during this monitoring period. The project design for the power plant as mentioned in the registered PD is implemented and thus no deviation is envisaged for the same.

All required monitoring equipment's and procedures as mentioned in the registered PD are available and implemented in an appropriate manner.

It was observed that the monitoring plan was implemented as per the requirement of the registered PD, approved methodology AM0029 version 3.0. The deviation as observed in the monitoring practice is however described and approved by assessment team above in the report as per the requirement of Para 3.11.10 of VCS standard version 3.7. The organisational role and responsibility as mentioned in the registered PD is followed onsite. All the monitoring equipment was calibrated as per the specified interval in the registered PD. All the emergency preparedness as mentioned in the CDM registered PD is followed onsite and no discrepancies were found regarding the same.

It was also observed during the verification process is that project is not rejected by any other GHG program around the world. CAR 05 however is raised for the same. Please refer Appendix 2 of this report for the detail closure of the CAR. The project activity has participated under other GHG program i.e. Project has been registered with UNFCCC under Clean Development Mechanism (CDM) program. Registration reference number is 9687⁶. The project proponent has not claimed any GHG credits under CDM mechanism during current monitoring period. The CDM Monitoring reports are web hosted from 14/07/2014 onwards and there is no any overlapping of current VCS monitoring period and CDM monitoring period as per web hosted CDM Monitoring Reports. Currently CDM verification is ongoing and CDM monitoring period is distinct and independent from VCS monitoring period.

Thus there is no any double accounting occurred during current VCS monitoring period.

The assessment team observed that the project is in line with the registered PD, Final Validation report and approved methodology and thus no clarification/deviation is sought.

Assessment team also checked the technical specification of the power plant and confirm that the technical specification from the Manufacturer specification as mentioned in the registered PDD is correct. The details are as below:

1) List and the arrangement of the main manufacturing/production technologies: The project activity has chosen advanced Siemens Gas Turbine SGT5-4000F6. The project activity plant will have two units of net capacity of 385.5 MW each. The plant will use natural gas and / or re-gasified LNG as primary fuel. Diesel oil will be used as back up fuel for which LPG is start up fuel. The HRSG is unfired type and no supplementary fuel firing will happen in it. No other start-up or auxiliary fuel is envisaged for the plant. The

⁶ <http://cdm.unfccc.int/Projects/DB/BVQI1373973780.44/view>

plant is expected to operate at 72% annual capacity utilization and the power will be sold to the Singapore grid.

2) Systems and equipment involved (1) Gas Turbines - two numbers; (2) Heat recovery steam generators – two numbers; (3) steam turbine generator – two numbers; (4) two Power transformers; (5) Auxiliary equipment's of Gas Turbines and Generators, HRSGs and Steam Turbines and Generators; meters (gas, electricity) and gas supply pipelines.

There is no technology transfer from Annex I countries involved in the project activity.

This technology is generally considered to be a safe technology and is used for Gas power generation worldwide.

4.2 Accuracy of GHG Emission Reduction and Removal Calculations

Means of verification	The verification team assessed whether the data and calculations of GHG emission reductions achieved resulting from the VCS PD. The verification team has checked whether calculations of baseline GHG emissions, project GHG emissions and leakage GHG emissions have been carried out in accordance with the formulae and methods described in the monitoring plan of the VCS PD.
Findings	CAR 03 was raised during the verification. The description of the CAR and its closure is described below in Appendix 2 of this report. PP was asked to submit JMR/Invoices for the complete monitoring period.
Conclusion	Ex-ante Parameter: $EF_{CO_2,NG,y}$ = Parameter is fixed ex-ante for the entire crediting period and as per the validated VCS PD same is fixed 56,100 kgCO₂e/TJ. Verification team found same value is used in the project emission calculations. The value is considered from Table 1.4, Chapter 1, Volume 2, 2006 IPCC Guidelines for National Greenhouse Gas Inventories which is as per the requirement of registered PDD. $OXID_{NG=}$ Parameter is fixed ex-ante for the entire crediting period and as per the validated VCS PD same is fixed 1. The value is unit less. Verification team found same value is used in the project emission calculations. The value is considered from Table 1.4, Chapter 1, Volume 2, 2006 IPCC Guidelines for National Greenhouse Gas Inventories which is as per the requirement of registered PDD. $EF_{NG, Upstream,CH_4=}$ Parameter is fixed ex-ante for the entire crediting period and as per the validated VCS PD same is fixed 296 t CH₄/PJ. Verification team found same value is used in the Leakage calculations. The value is considered from Table 2, page 9 of the approved methodology AM0029, version 03 which is as per the requirement of registered PDD. $EF_{CO_2,upstream,LNG=}$ Parameter is fixed ex-ante for the entire crediting period and as per the validated VCS PD same is fixed 6 t CO₂/TJ. Verification team found same value is used in the Leakage calculations. The value is considered from default value as per baseline methodology AM0029, Version 03, pg. 10 which is as per the requirement of registered PDD.

$EF_{BL, Upstream, CH_4}$ Parameter is fixed ex-ante for the entire crediting period and as per the validated VCS PD same is fixed 0.00228 CH₄/MWh from the NEA's 'Information on emission factors (for CDM projects in Singapore)', published 20/04/2012, 0.00213 t CH₄/MWh. As per latest published document "INFORMATION ON EMISSION FACTORS (For CDM projects in Singapore) (dated 28 June 2016), the value is 0.00213 t CH₄/MWh is considered for ER calculation. Verification team found same value is used in the Leakage calculations. The value is considered from NEA's 'Information on emission factors (for CDM projects in Singapore)', published 20/04/2012. Also latest published document "INFORMATION ON EMISSION FACTORS (For CDM projects in Singapore) (dated 28 June 2016) is referred for project activity which is as per the requirement of registered PDD.

$EF_{CO_2, FF, y}$ Parameter is fixed ex-ante for the entire crediting period and as per the validated VCS PD same is fixed 74,100 kgCO₂e/TJ. Verification team found same value is used in the Leakage calculations. The value is considered from Table 1.4, Chapter 1, Volume 2, 2006 IPCC Guidelines for National Greenhouse Gas Inventories which is as per the requirement of registered PDD.

Assessment team also 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 ($EF_{electricity, y}$), The Build Margin emission factor of Singapore national grid ($EF_{BM, y}$) and The Operating Margin emission factor of Singapore national grid ($EF_{OM, y}$) 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.

Baseline Emission, BE_y: The formula to calculate the Baseline emission is considered from the registered CDM PDD and same is used for the calculation purpose. Assessment team checked the individual values of the parameter and confirm that the Baseline emission calculation is correct and conservative.

As per the latest NEA's 'Information on emission factors (for CDM projects in Singapore)', the build margin emission factors are 0.4065 tCO₂/MWh for year 2014.

As per registered PDD, option 1, 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, $EB_{BLCO_2, y} = 0.4065 \text{ t CO}_2/\text{MWh}$ for year 2014

The baseline emissions are calculated as below

$$\begin{aligned}
 BE_y &= EG_{PJ, y} * EF_{BL, CO_2, y} \\
 &= 2,048,966.140 \text{ MWh} * 0.4065 \text{ t CO}_2 / \text{MWh} \\
 &= 832,904.74 \text{ t CO}_2
 \end{aligned}$$

Project Emission, PE_y: The formula to calculate the project emission is considered from the registered CDM PDD and same is used for the calculation purpose. Assessment team checked the individual values of the parameter and confirm that the project emission calculation is correct and conservative.

As per registered PDD, the project emissions are calculated as below

Volume of fuel combusted in project plant (FC_{f,y}) : XX m³ (Please refer ER sheet for data)

Calculation of CO₂ Emission Co-efficient of natural gas (COEF_{f,y})

CO₂ Emission Co-efficient of natural gas is calculated as per equation number-1a of AM0029 Values of sub-variables:

1) Net Calorific Value of gas (NCV_y): XXX kcal/m³ (Please refer ER sheet for data)

2) CO₂ emission factor (EF_{CO₂,f,y}): 56.1 t CO₂/TJ

3) Oxidation factor of gas (OXID_f): 1

$$\begin{aligned}\text{COEF}_{f,y} &= \text{NCV}_{f,y} * \text{EF}_{\text{CO}_2,f,y} * \text{OXID}_f \\ &= 0.03536 \text{ GJ/m}^3 * 0.0561 \text{ t CO}_2/\text{GJ} * 1 \\ &= 0.001984 \text{ t CO}_2/\text{m}^3\end{aligned}$$

$$\begin{aligned}\text{PE}_y &= \text{FC}_{f,y} * \text{COEF}_{f,y} + \text{FC}_{\text{Diesel},y} * \text{COEF}_{\text{Diesel},y} \\ &= 359459340.40 \text{ m}^3 * 0.001984 \text{ t CO}_2/\text{m}^3 + 215.25 \text{ KL} * 0.8348 \text{ Tonns/KL} * 3.18630 \text{ tCO}_2/\text{tonns} \\ &= 713114.10 \text{ t CO}_2 + 572.56 \text{ t CO}_2 \\ &= 713686.66 \text{ t CO}_2\end{aligned}$$

Leakage emission, LE_y: The formula to calculate the Leakage emission is considered from the registered CDM PDD and same is used for the calculation purpose. Assessment team checked the individual values of the parameter and confirm that the Leakage emission calculation is correct and conservative.

$$\text{LE}_y = \text{LE}_{\text{CH}_4,y} + \text{LE}_{\text{LNG},\text{CO}_2,y}$$

LE_{CH₄,y} is calculated as:

As per registered PDD, Leakage emissions due to fugitive upstream CH₄ emissions are calculated as below

$$\begin{aligned}\text{LE}_{\text{CH}_4,y} &= [\text{FC}_{f,y} * \text{NCV}_{f,y} * \text{EF}_{\text{NG},\text{upstream},\text{CH}_4} - \text{EG}_{\text{PJ},y} * \text{EF}_{\text{BL},\text{upstream},\text{CH}_4}] * \text{GWPCH}_4 \\ &= [359459340.40 \text{ m}^3 * 0.03536 \text{ GJ/m}^3 * 0.000296 \text{ tCH}_4/\text{GJ} - 2,048,966.14 \text{ MWh} * 0.00213 \text{ tCH}_4/\text{MWh}] * 25 \\ &= - 15,042.49 \text{ t CO}_2\end{aligned}$$

$$\begin{aligned}\text{LE}_{\text{LNG},\text{CO}_2,y} &= \text{FC}_y * \text{EF}_{\text{CO}_2,\text{upstream},\text{LNG}} \\ &= 12711.48 \text{ TJ} * 6 \text{ t CO}_2/\text{TJ}\end{aligned}$$

$$= 76268.89 \text{ t CO}_2$$

$$LE_y = LE_{CH_4,y} + LE_{LNG,CO_2,y}$$

$$= -15,042.49 + 76268.89$$

$$= 61,226.40 \text{ t CO}_2$$

Emission reduction:

$$= BE_y - PE_y - Ly$$

$$= 832,904.74 \text{ t CO}_2 - 713,686.66 \text{ t CO}_2 - 61,226.40 \text{ t CO}_2$$

$$= 57,991 \text{ t CO}_2$$

Monitoring Parameters: Ex-post Parameters:

1. $EG_{Export,y}$ = New electricity exported by the project plant in year y

Assessment team checked that as per plant records – there are two transmission lines (capable of export to grid and import from grid). Each of the two lines have separate main and check meter. These meters can monitor the total export and total import from grid. The net export used here is being calculated from 'export – import'. The Data is measured and recorded from energy meters installed in the plant and in substation. Since the value is calculated no QA/QC procedure is required. The value of Net electricity export can be Cross check by recipient of sales which is in line with the requirement of AM0029 and registered CDM PDD.

2. $FC_{NG,y}$ = Quantity of NG consumed in the project activity in year y

Assessment team observed that as per the onsite practice the complete gas metering equipment is installed at consumer end (PP side) only and within the project activity premises. There is no separate meters for PP side and separate meter for supplier side. However, 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 which is the requirement of AM 0029. Gas invoice 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. The Meter type: ultrasonic gas flow meter and Accuracy: $\pm 0.1\%$ of MV (linearity). The Calibration frequency of the flow meters is once in year as per the proposed deviation. Natural gas supply metering to the project is subject to regular (in accordance with stipulation of the meter supplier) maintenance and testing to ensure accuracy. The fuel consumption is cross checked by PP and Gas supplier (PP's gas flow meter at the gas skid/ receiving station) for cross verification which is as per the requirement of AM 0029 and registered CDM PDD.

3. $NCV_{NG,y}$ = Net Calorific Value of Natural Gas

The calorific value of the gas would be based on the measurement readings recorded by Gas Chromatograph (GC= self-calibration) located at the PP plant boundary. Gas Chromatograph will be subject to regular (in accordance with guidelines of the OEM) maintenance and testing to ensure accuracy. As per registered PDD, source of data for Net Calorific Value of Natural Gas is invoice from gas supplier. However for current monitoring period, 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 for calculation purpose. The conversion is carried out from publically available document. The onsite practice is acceptable to assessment team as the approach is followed across power plant.

4. $COEF_{NG,y}$ = CO₂ emission coefficient

CO₂ Emission Co-efficient of natural gas is calculated as per equation number-2a of AM0029 Values of sub variables:

- 1) Net Calorific Value of gas (NCV_y): Please refer excel sheet for same
- 2) CO₂ emission factor ($EF_{CO_2,f,y}$): 0.0561 t CO₂/GJ
- 3) Oxidation factor of gas ($OXID_f$): 1

The value is calculated and thus no QA/QC procedure is required.

5. $EF_{CO_2,NG,y}$ = Emission Factor of Natural Gas

The value is sourced from Table 1.4, Chapter 1, Volume 2, 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Assessment team checked latest version of IPCC Guidelines is used for the value which is as per the requirement of CDM registered PDD. The value is calculated and thus no QA/QC procedure is required.

6. $OXID_{NG}$ = Oxidation Factor of NG

The value is sourced from Volume 2, 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Assessment team checked latest version of IPCC Guidelines is used for the value which is as per the requirement of CDM registered PDD. The value is calculated and thus no QA/QC procedure is required.

7. PE_y = Project emission due to combustion of fuel

The project emission calculation is described above in the report. The procedure and formula adopted for the project emission calculation is as per the registered PDD. Assessment team checked the same and confirm that project emission calculation is correct. The value is calculated and thus no QA/QC procedure is required.

8. $EF_{BL,CO_2,y}$ = Baseline CO₂ emission factor

	The value is sourced as per latest published document "INFORMATION ON EMISSION FACTORS (For CDM projects in Singapore) dated 28 June 2016. The value is Calculated as per monitoring methodology AM0029 As 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. The latest value from National Environment Agency is used for the calculation. Assessment team thus confirm that the value is correct and as per the requirement of registered CDM PDD. 9. $FC_{FF,y}$ Quantity of fossil fuel (diesel) consumed in the project activity in year y Assessment team observed that at actual site there is no any mass flow meter and diesel consumption is measured through fuel oil tank level drop. The measurement procedure is checked and found correct by the assessment team. As per the registered PDD the measurement was with mass flow meter however as per the onsite practice the quantity is measured through fuel oil tank level drop. 10. $NCV_{FF,y}$ Net Calorific Value of fossil fuel The value is measured with the help of Invoice from fuel supplier. The same practice is followed onsite and thus found correct. NCV measurement equipment may not be available on project site and within project boundary. Thus, PP don't have control on its calibration frequency and Quality Control. As the value is sourced from Invoice thus assessment team accepted the procedure which is in line with the requirement of registered CDM PDD 11. Source of gas for project activity This parameter is monitored to establish that gas is used from imported LNG from the new SLNG terminal and not diverted from existing users in the host country. The source of data is gas supply invoice which is as per the requirement of registered CDM PDD. Assessment team also confirmed that Plant manager would be responsible for regular inspection of the records & shift in charge is responsible for recording the diesel consumed.
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4.3 Quality of Evidence to Determine GHG Emission Reductions and Removals

Means of verification	The verification team checked the Calibration details of the monitoring meters with the calibration certificates.
Findings	CAR 06 was raised during the verification process which is closed successfully. Please refer Appendix 2 of this report for the closure of the CAR.

Conclusion	Energy Meter: The metering arrangement is tri-vector bi-directional energy meters accuracy class 0.2s (main and check) at the State Electricity Board (SEB) substation for each project instances. These energy meters record several parameters including electricity exported & imported. During commissioning of the power plant monitoring meters of accuracy class i.e. 0.2s were installed. Meter is calibrated once in a 2 years by the meter testing division of the State board (which follows the guideline laid by Singapore government) Assessment team thus also checked the traceability of the calibration certificate and confirm that the calibration of the meters is done as per the requirement of National law. Though CDM registered PDD states calibration frequency as annual, the national regulation of Singapore states calibration frequency as once in two 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. Thus deviation is requested for this change in calibration frequency and once in two year calibration frequency is considered for the project activity. Thus the calibration done on 29/08/2012 is valid till 28/08/2014 and covers complete monitoring period. Gas Flow Meter: Gas flow meter (USM type) is having accuracy level of 0.1%. As per metering code, the gas flow meters need to calibrate annually and there is no any delay in USM flow meter. However, as per gas supply agreement, combined metering setup viz., gas flow meter, pressure & temperature transmitters' accuracy should be within $\pm 1.0\%$. The pressure and temp transmitter (which is a part of flow meter) need to calibrate once in six months and For period 01/01/2014 to 07/01/2014 -Error factor of 1% is applied conservatively due to delay in calibration for pressure and temp transmitter. PP have two GC having serial number as 61200687 and 61200688 and their calibration is done on dated 25/04/2013, 13/01/2014, 05/11/2014 GCs are configured for auto calibration (as per the manufacturer specification) once in every two weeks. Hence it complies with the Gas Metering Code requirement which is acceptable to the assessment team.
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4.4 Non-Permanence Risk Analysis

Not applicable for the project activity.

5 SAFEGUARDS

5.1 No Net Harm

No potential environment or socio-economic matter was found during the site visit. No negative impact observed onsite regarding the implementation of the project activity. CAR 04 is raised during the process and please refer Appendix 2 for the closure of the CAR.

The project activity promotes environmental and socio-economic well-being as it results in less GHG emissions due to installation and operation of clean, less carbon emission technology for electricity generation.

Under the Environment Protection and Management Act, Govt of Singapore written permission has been granted to PP to use the premises for the project activity. Thus there is not any harmful impact due to implementation of the project activity.

5.2 Local Stakeholder Consultation

All the stakeholders are happy with the implementation and operation of the project activity and no negative comments envisaged for the project activity. There was no change in technical project description from the registered CDM PDD. Assessment team confirmed the same during the verification site visit. However CAR 04 is raised during the verification process. Please refer Appendix 2 for the detail closure of the CAR. Also, as best practice method PP also placed a grievance register onsite to record any grievance from the stakeholders during and after the implementation of the project activity. Assessment team checked the grievance register maintained onsite and no negative comments were observed for the project activity. Local people are happy as the project generated employment opportunities and thus the living standards in and around the vicinity of the project is increased and thus assessment team confirms that local stakeholders have no issue with this project activity after implementation and continuous operation.

6 GAP VALIDATION AND VERIFICATION CONCLUSION

Applus+ Certification has been engaged by “PacificLight Power Pte Ltd” to perform the 1st periodic verification+ Gap Validation under VCS of the “Grid connected electricity generation plant using natural gas at Jurong Island in Singapore”.

The PacificLight Power Pte Ltd is responsible for the preparation of the GHG emissions data and the reported GHG emissions reductions on the basis set out within the project’s Monitoring Plan in the registered CDM PDD and the applied methodology AM 0029 version 3.0 for the project activity.

Our Gap Validation and verification approach was based on the requirements as defined under the Kyoto Protocol, Marrakesh accord, as well as those defined by the CDM Executive Board. Our approach is risk-based, drawing on an understanding of the risks associated with reporting GHG emissions data and the controls in place to mitigate these. The Gap Validation and verification can confirm that:

- the project is operated as planned and described in the project document;
- Clause for validation as per requirement of Para 3.11.10 of VCS standard version 3.7 is meet

- the monitoring plan is as per the applied methodology;
- the monitoring process in Monitoring Report is as per the PD
- the development and maintenance of records and reporting procedures are in accordance with the monitoring plan;
- the installed equipment being essential for generating emission reduction runs reliably and is calibrated appropriately;
- the monitoring system is in place and generates GHG emission reductions data;
- the GHG emission reductions are calculated without material misstatements.

Verification period: 01-January-2014 to 13-July-2014

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)
01/01/2014 to 13/07/2014	832,904.74	713,686.66	61,226.40	57,991
Total	832,904.74	713,686.66	61,226.40	57,991

APPENDIX 1: DOCUMENTS REVIEWED OR REFERENCED (VERIFICATION)

No.	Author	Title	References to the document	Provider
1.	NA	Commissioning generation facility of power plant implemented in the project site.	NA	Project participant
2.	NA	Contract of the project participant with the DOE	Contract document signed between PP and DOE	Project participant
3.	NA	Technical specifications of gas turbines from manufacturers	Manufacturer technical specifications	Project participant
4.	NA	VCS MR	VCS MR version 01, dated 01/02/2018 VCS MR version 02, dated 05/03/2018 VCS MR version 03, dated 26/03/2018	Project participant
5.	NA	VCS PD	VCS PD version 1.0 dated 01/02/2018 VCS PD version 2.0 dated 05/03/2018	Project participant
6.	NA	The operational lifetime of the project activity from the manufacturer=(Technical specifications)	Manufacturer technical specifications	Project participant
7.	NA	VCS: Verified Carbon Standard www.v-c-s.org	Reference link is provided.	Independent Search
8.	NA	Tools/ guidelines used in the project activity - Tool to determine the remaining lifetime of the project activity in line with Annex 15 EB 50 - Tool to calculate the emission factor for an electricity system - Glossary of CDM terms version 7.0 - VCS verification report template version 3.4	UNFCCC CDM web site	UNFCCC
9.	NA	Energy Settlement reports	Energy Settlement report	Project participant
10.	NA	Emission Calculation sheet version 1.0 Emission Calculation Sheet version 2.0	01/02/2018 05/03/2018	Project participant

No.	Author	Title	References to the document	Provider
11.	NA	CDM registered PDD Final Validation report for CDM	16/03/2014 version 5.1 10/03/2014 version 06	Project participant
12.	NA	Break down details of the complete monitoring period	Log sheet	Project participant
13.	NA	Undertaking letter from PP for double counting of emission reductions	Letter dated 26/02/2018	Project participant
14.	NA	Calibration Certificates of the onsite meters	The detail of Calibration is provided in Appendix 5 below in this report.	Project participant

APPENDIX 2: CLARIFICATION REQUESTS, CORRECTIVE ACTION REQUESTS, FORWARD ACTION REQUESTS (CL/CAR/FAR)

CAR ID	01	Date: 12/02/2018
Description of CAR		
During the site visit and subsequent document review it was observed that the details of feeder and S/S location of the power plant is missing in the MR. Corrective action is sought in the respective section of the MR. The details implementation of the project activity timeline is missing in the MR. supporting documents are sought for the same.		
Project participant response		Date: 05/03/2018
The feeder details and substation details are mentioned in VCS MR. The details of implementation of project activity has been mentioned in revised VCS MR.		
Documentation provided by project participant		
Revised VCS MR version 02		
DOE assessment		Date: 20/03/2018

The feeder details now forms the part of revised VCS MR version 02. The same is checked and found correct by the assessment team. Moreover, the detail implementation of the project activity now forms the part of revised MR version 02. CAR is thus closed.

CAR ID	02	Date: 12/02/2018
Description of CAR		
The breakdown details of the power plant for the monitoring period are missing in the MR. Moreover, the supporting document regarding the breakdown details are not provided to the assessment team. Corrective action is sought in this regard.		
Project participant response		Date: 05/03/2018
The breakdown details are provided in revised VCS MR and supporting for same is provided to DOE.		
Documentation provided by project participant		
Revised VCS MR version 02		
Log sheets		
DOE assessment		Date: 20/03/2018
The plant log records were checked and it is observed that the power plant undergone scheduled maintenance as per the manufactures specification and no unforeseen incident observed during the monitoring period. CAR is thus closed.		

CAR ID	03	Date: 12/02/2018
Description of CAR		
The Daily/Monthly Settlement report sheets and Invoice for the complete monitoring period is missing. Emission reduction value is thus reserved and will further be analysis on the submission of the documents.		
The comparison of actual VER and estimated VER is also missing in the MR.		
Corrective action is sought.		

Project participant response	Date: 05/03/2018
The supporting for electricity data and gas data, calorific value has been provided to DOE for verification.	
Documentation provided by project participant	
Revised VCS MR version 02 and Revised ER sheet version 02	
Supporting for electricity data and gas data, calorific value like gas bills, settlement report	
DOE assessment	Date: 20/03/2018
The supporting evidences like gas bills, electricity settlement report, invoices and gas data were checked and assessment team confirms that the emission reduction calculation is correct. No overestimation were envisaged. Error factor applied in case of delayed calibration of the measuring equipment and thus CAR is closed.	

CAR ID	04	Date: 12/02/2018
Description of CAR		
During the document review it is observed that “Local Stakeholder” and “No net Harm” are missing in the MR. Moreover, supporting documents are not shared with DOE. Corrective action is sought in this regard in the respective section of the MR.		
Project participant response		Date: 05/03/2018
The VCS MR has been revised with mention of “Local Stakeholder” and “No net Harm” and supporting documents are provided.		
Documentation provided by project participant		
Revised VCS MR version 02		
DOE assessment		Date: 20/03/2018
The local stakeholder’s consultation grievance register is checked and assessment team confirmed that no negative comments were observed for the project activity during the operation of the same. The No net Harm supporting documents were also checked and assessment team confirm that the guideline as prescribed by VCS is being followed. CAR is thus closed.		

CAR ID	05	Date: 12/02/2018
Description of CAR		
As per section 1.9 of the VCS MR, the project is not participated in other GHG program and has not intended to pursue credits from other GHG program for the concerned monitoring period. Supporting documents and details regarding the same is missing in the MR. Also, PP needs to justify whether other Green/White Certifications benefits is taken for the present Monitoring period covered under VCS. Corrective action is sought for the same.		
Project participant response		Date: 05/03/2018
The Project activity is not claiming any credits from other GHG program and not availing any Green/White Certifications benefits other than VCS benefits for current monitoring period. The PP declaration has been provided for the same.		
Documentation provided by project participant		
PP declaration for not claiming any credits from other GHG program and not availing any Green/White Certifications benefits other than VCS benefits for current monitoring period		
DOE assessment		Date: 20/03/2018
The declaration as presented by PP regarding no claiming of any credits from other GHG program and not availing any Green/White Certifications benefits other than VCS benefits for the present monitoring period is checked and found correct by the assessment team. CAR is thus closed.		

CAR ID	06	Date: 12/02/2018
Description of CAR		
The calibration certificates for the complete monitoring period is missing. The details are also missing in the MR. Corrective action sought for the same		
Project participant response		Date: 05/03/2018
The calibration certificates are submitted to DOE.		
Documentation provided by project participant		

Calibration Certificates	
DOE assessment	Date: 20/03/2018
The required calibration certificates for the monitoring equipment's were checked and found correct by the assessment team. The error factor if and when applicable is applied and thus emission reduction calculation is found correct. CAR is thus closed.	

CHD	00	Date:
Description of CI		
Project participant response		Date:
Documentation provided by project participant		
DOE assessment		Date:

FAR ID	00	Date:
Description of CAR		
Project participant response		Date:

Documentation provided by project participant	
DOE assessment	Date:

APPENDIX 3: COMPETENCE OF TEAM MEMBERS AND TECHNICAL REVIEWERS

Verification team member

No.	Role	Type of resource	Last name	First name	Affiliation (e.g. name of central or other office of DOE or outsourced entity)	Involvement in			
						Desk review	On-site inspection	Interview(s)	Verification findings
1.	Team Leader/Lead Assessor	OR	Das	Sukanta	TQC-Outsourced entity	Yes	Yes	Yes	Yes

Technical reviewer and approver of the verification and certification report

No.	Role	Type of resource	Last name	First name	Affiliation (e.g. name of central or other office of DOE or outsourced entity)
1.	Technical reviewer (TR)	IR	Shen	Simon	Applus+ Certification
2.	Approver	IR	Sendin	Juan	Applus+ Certification B.U. Managing Director

Short CVs of the Team:

- Mr. Sukanta DAS, has done M. SC in (Electronics and Photonics) and M. Tech in (Energy technology) from Tezpur Central University/ Indian Institute of technology Bombay in India. He is a certified lead auditor for ISO 14001 EMS LA and ISO 9001 QMS LA from International registry for Certified Auditors (IRCA) and Certified Lean Management practitioner from Quality Council of India

(QCI). He has more than Nine (9) years of working experience at TUV NoRD/ Re-consult/CRA/APPLUS certifications under various categories of projects stating from Renewable to waste to supercritical projects. He was JI/ CDM Lead Assessor in TUV NoRD and was involved in more than 100 CDM validation and verifications activities in Gold Standard, VCS, CDM projects as a team leader/technical reviewer / validator / verifier covering the sectoral scope 1, 13 technical areas 1.2/1.1/13.1. Currently he is associated with True Quality Certifications Private Limited and is empanelled with APPLUS certification to carry out GHG audit.

2. Meng (Simon) Shen (Master Degree in Thermal Energy Engineering, Bachelor Degree in Environmental Engineering) is a Lead Auditor appointed by Applus+ LGAI for the GHG project assessment. He is based in Shanghai. He has several years of work experience in environmental protection field. Before he joined Applus+ LGAI, he had been worked for TÜV SÜD as a GHG Validator/Assessment team and ISO 9001/14001 Lead Auditor for 3.5 years

APPENDIX 4: ABBREVIATIONS

Abbreviations	Full texts
BM	Build Margin
CAR	Corrective Action Request
CDM	Clean Development Mechanism
CER	Certified Emission Reduction(s)
CL	Clarification request
CM	Combined Margin
CMS	Central Monitoring system
CO ₂	Carbon dioxide
CO ₂ e	Carbon dioxide equivalent
DNA	Designated National Authority
DOE	Designated Operational Entity
DR	Document Review
EF	Emission Factor
EIA	Environmental Impact Assessment
ER	Emission Reductions
FAR	Forward Action Request
GHG	Greenhouse gas(es)
GWP	Global Warming potential
PP	Project Participant

APPENDIX 5: CALIBRATION DETAILS OF THE METERS

The Energy meter calibration details are as below

	Line 1 Main Meter	Line 1 Check Meter	Line 2 Main Meter	Line 2 Check Meter
Manufacturer	Landis+Gyr	Landis+Gyr	Landis+Gyr	Landis+Gyr
Serial Number	99654212	99654213	99654214	99654215
Accuracy class	0.2s	0.2s	0.2s	0.2s
Date of Calibration	29-08-2012	29-08-2012	29-08-2012	29-08-2012
	27-08-2014	27-08-2014	29-10-2014	29-10-2014
	29-12-2016	07-12-2016	29-12-2016	07-12-2016

The Gas flow meter and pressure and Temp transmitter calibration details are as below

Gas Flow Meter

Model	EX-I SFC 300	Flowsic 600	EX-I SFC 300	Flowsic 600
Serial Number	12359001	12098674	12359003	12098673
Accuracy class	0.1%	0.1%	0.1%	0.1%
Date of Calibration	25-04-2013	28-03-2013	25-04-2013	28-03-2013
	20-01-2014	20-01-2014	20-01-2014	08-01-2014
	02-07-2014	01-07-2014	02-07-2014	02-07-2014
	15-01-2015	15-01-2015	15-01-2015	16-01-2015

Pressure and Temperature Transmitter

Model	Pressure transmitter	Temp Transmitter	Pressure transmitter	Temp Transmitter
Serial Number	91M601972 220	C2M600274 216	91M601973 220	C2M600275 216
Accuracy class	0.25%	0.25%	0.25%	0.25%
Date of Calibration	28-03-2013	27-03-2013	28-03-2013	28-03-2013
	08-01-2014	08-01-2014	08-01-2014	08-01-2014
	01-07-2014	01-07-2014	02-07-2014	02-07-2014
	15-01-2015	15-01-2015	16-01-2015	16-01-2015

Gas Chromatograph calibration details

PP have two GC having serial number as 61200687 and 61200688 and their calibration is done on dated 25/04/2013, 13/01/2014, 05/11/2014

GCs are configured for auto calibration once every two weeks. Hence it complies with the Gas Metering Code requirement.