



Monitoring report form for CDM project activity
(Version 06.0)

MONITORING REPORT

Title of the project activity	Grid connected electricity generation plant using natural gas at Jurong Island in Singapore	
UNFCCC reference number of the project activity	9687	
Version number of the PDD applicable to this monitoring report	05.1	
Version number of this monitoring report	01	
Completion date of this monitoring report	16/01/2018	
Monitoring period number	06	
Duration of this monitoring period	01/07/2016 to 31/12/2016	
Monitoring report number for this monitoring report	01	
Project participants	PacificLight Power Pte. Ltd.	
Host Party	Singapore	
Sectoral scopes	01- Energy industries (renewable - / non-renewable sources)	
Applied methodologies and standardized baselines	AM0029 "Baseline Methodology for Grid Connected Electricity Generation Plants using Natural Gas" (Version 03, EB 39)	
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
	0	129,792
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	144,556	

SECTION A. Description of project activity

A.1. General description of project activity

PacificLight Power Pte. Ltd. has taken up development of 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.

Purpose of the project activity

The purpose of the project activity is construction and operation of a new 800 MW natural gas based power plant. The electricity generated is being exported to the Singapore national grid. The project activity is helping in reducing the carbon intensity and projected power deficit in the grid.

At the site ambient conditions and a frequency of 50 Hz, the rated capacity of plant is 800 MW $\pm 10\%$ (two units)¹. Each of the two units has one combustion turbine, one Heat recovery Steam Generators (HRSG) and one Steam Turbine Generator (STG). The heat content of the exhaust gas from the combustion turbine is being recovered in individual heat recovery steam generators. The steam generated is then expanded in a condensing type steam turbine driving an electric generator.

Pre-project scenario: The project activity is a new, independent natural gas based power plant and thus no power generating equipment existed in the project site before the project activity plant. Thus, the pre-project scenario is continuation of existing carbon intensive fuel mix in the grid to generate power.

Baseline Scenario: As identified in Section B.4 of the registered PDD, the baseline scenario is generation of equivalent power from coal based power plant (due to lower cost of electricity generation from same and hence financially viable). There is at least one coal based power plant that will operate based on imported coal and hence there is no restriction on coal based power plants and import of coal in Singapore.

How the project activity reduces greenhouse gas emissions

In the absence of the project activity the PP would have opted for a coal based power plant as described in the section B.4 of registered PDD. 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 efficient² power generation due to combined cycle operation in comparison to coal.

A.2. Location of project activity

The project activity is located near City & District: Jurong Island, Singapore
The project site is located at Lot 01962A PT MK34, Seraya Place, Jurong Island

Geographic location and accessibility:

Nearest airport: Singapore

The geographical coordinates of the project activity are 1°17'24" N and 103°43'30" E.

¹ As per technical specifications of the EPC contract with Siemens

² project activity uses Siemens F-class advanced turbines having net plant efficiency = 58.16% (Ref: Heat Flow Diagram of project activity from EPC contractor)

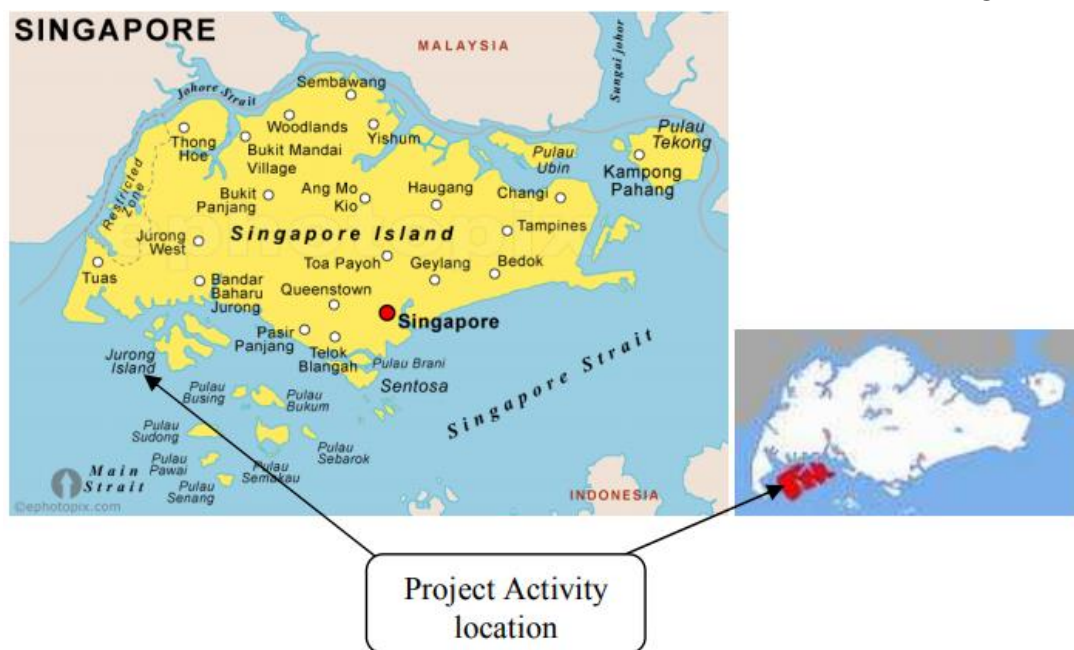


Figure 1: Map of (A) Singapore and (B) Map showing the site of project activity (Jurong Island)

A.3. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Singapore (host)	PacificLight Power Pte. Ltd. (Private entity)	No

A.4. Reference to applied methodologies and standardized baselines

The approved baseline methodology applied to this project is:

AM0029 Version 3, EB 39 titled: "Baseline Methodology for Grid Connected Electricity Generation Plants using Natural Gas".

Reference: <http://cdm.unfccc.int/methodologies/DB/WW4I82DG7LJUQE5E5YGT1NZE4PNS60>

- **Tool for the demonstration and assessment of additionality** (Version 07.0.0, EB 70, Annex 8)
- **Tool to calculate the emission factor for an electricity system** (Version 03.0.0, EB 70, Annex 22)

A.5. Crediting period type and duration

Renewable crediting period

7 years 0 months (twice renewable)

The current first crediting period is from 14/07/2014 to 13/07/2021(Renewable)

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

The project activity involves NG based power generation. At the site ambient conditions and a frequency of 50 Hz, the rated capacity of plant is 800 MW $\pm 10\%$ (two units)³. Each of the two units has one combustion turbine, one Heat recovery Steam Generators (HRSG) and one Steam Turbine Generator (STG). The heat content of the exhaust gas from the combustion turbine is being recovered in individual heat recovery steam generators. The steam generated is then expanded in a condensing type steam turbine driving an electric generator.

The project activity has chosen advanced Siemens Gas Turbine SGT5-4000F. The project activity plant have two units of net capacity of 385.5 MW each. The plant uses natural gas and / or re-gasified LNG as primary fuel. Diesel oil is used as back up fuel for which LPG is start up fuel. The HRSG is unfired type and no supplementary fuel firing is happened in it. No other start-up or auxiliary fuel is envisaged for the plant. The plant generates the power and is sold to the Singapore grid.

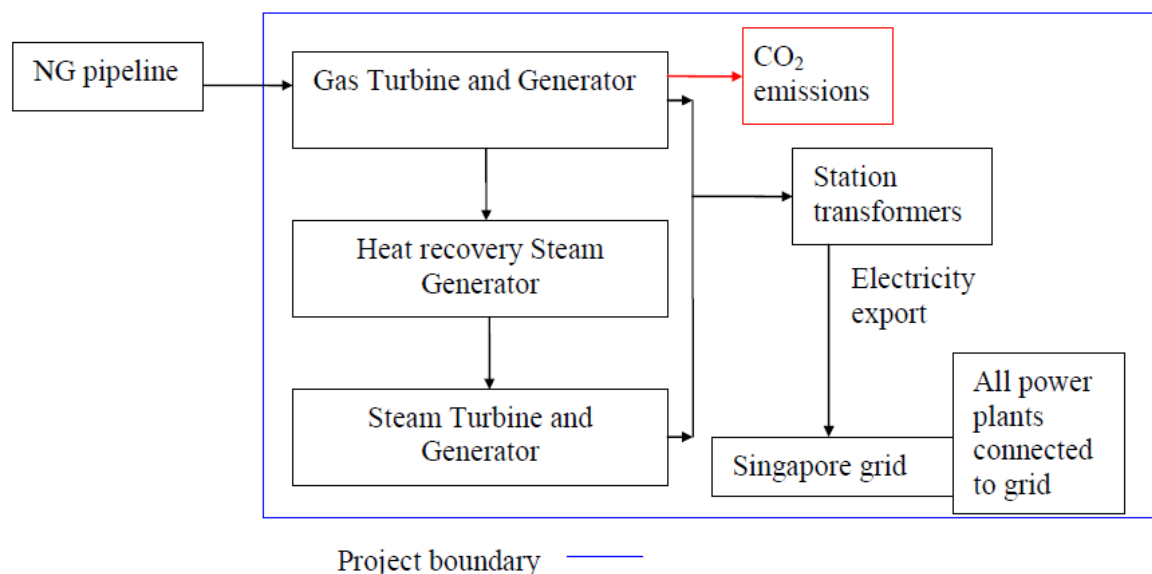
Main Systems and equipment involved:

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

The project activity is commissioned on Jan 2014 (unit 1) and Feb 2014 (unit 2) and running satisfactorily.

SN	Date	Project Implementation Step
1	15/01/2014	Commissioning date - Unit 1
2	06/02/2014	Commissioning date - Unit 2

The schematic representation of installed technology, equipments and process is shown as below



B.2. Post-registration changes

B.2.1. Temporary deviations from the registered monitoring plan, applied methodologies or standardized baselines

There is no request for deviation applied during this monitoring period.

³ As per technical specifications of the EPC contract with Siemens

B.2.2. Corrections

There have not been any corrections to project information or parameters fixed at validation during the current monitoring period.

B.2.3. Changes to the start date of the crediting period

There is no changes to the start date of the crediting period.

B.2.4. Inclusion of monitoring plan

There has not been any change in the monitoring plan during the current monitoring period.

B.2.5. Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other applied standards or tools

Not Applicable.

B.2.6. Changes to project design

There has not been any change in the PDD during the current monitoring period.

SECTION C. Description of monitoring system

The project activity is operated and managed by the PP. The individual plants record data related to their respective project activity. The natural gas based power project abides and would abide by all regulatory and statutory requirements as prescribed under the state and central laws and regulations.

A CDM project team is placed at the plant site immediately after start of crediting period. The project 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. Installed meters are calibrated according to the maintenance schedule programmed at the start of the operation and recalibrated according the plants performance requirement.

All the monitoring data is being stored, recorded and kept under safe custody of the Plant Manager at the plant site for a period of crediting period or the last issuance whoever later + 2 years. The data is achieved in both hard copies and electronic format (excel sheets). Also, any change within the project boundary, such as change in spare and or equipments is recorded and any change in the emission reduction due to such alteration is being also studied and recorded. No any change is observed during current monitoring period.

Monitoring of net electricity supplied to the grid

There are two transmission lines and each line has one main (by PP) and one check meter (by power purchaser). These meters reads both total export and import of electricity. The net export is being calculated from readings of these meters (total export – total import).

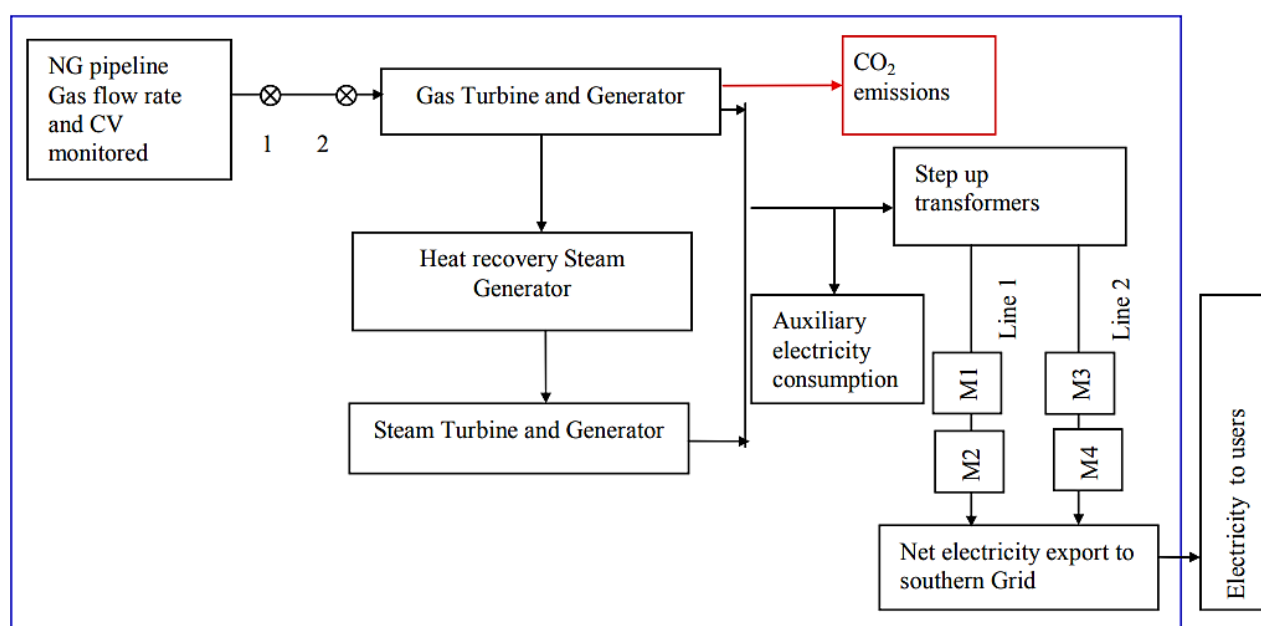
Emergency plan:

The electricity meter (the main meter owned by PP) is being calibrated annually. In case, both the meters have shown error more than the limit prescribed in the class, both the meters would be taken for the calibration and correction is applicable to the electricity generation recorded by the main meter. In case of delay in calibration, the error factor is applied for delayed calibration period

Monitoring of gas consumed in the project activity and NCV

Gas consumed is measured by PP owned fuel flow meter reading at project boundary. There are two such Gas Fuel flow meters designated as Main and Check meters. Piping arrangement is provided in such a way, that both main and check meter are always in service or any one of them can be in service. This provision is to take care of pulling out one of the meter for calibration or maintenance purpose. The responsibility for calibration of the Gas fuel flow meter lies with the PP as stipulated in the Singapore Gas Metering code. Fuel Flow meter can measure the gas quantity both in terms of energy flow and/or volumetric flow. Gas supplier has only gas supply terminal with motorised isolation valves near project boundary. Necessary metering and status signals are transmitted to the gas transporter through the remote terminal unit located in the project boundary.

The net calorific value of natural gas consumed is provided by PP. This is done on continuous basis using a Gas Chromatograph. The weighted average of NCV is taken from the invoice from gas supplier for each billing period.



Project boundary

1 – gas supplier's gas flow and NCV monitoring
2 – PP's gas flow and NCV monitoring

Line -1
M1- Main meter (owned by PP)
M2 – Check meter of APTRANSCO
Line 2
M3- Main meter (owned by PP)
M4 – Check meter of APTRANSCO

As the project activity registration may not coincide with the JMR date (both monitoring period start and the end),

- (1) the net electricity export for this period is being monitored from the main meter readings (Automatic/manual record daily by the PP's team). or
- (2) the monitoring period is being taken from the subsequent JMR date after the registration date.

Similarly, for the gas consumed and NCV readings, JMR is done in accordance with the Gas Supply Agreement with the Gas Supplier.

Monitoring of diesel (back up fuel)

PP has installed 04 number of Storage tanks of capacity 25000 m³ each at site to store back up fuel i.e. Diesel. The diesel fuel storage is provision to meet regulatory requirement of 'Electricity License for Generation Licensee' from EMA to the project activity. As per, pg. 10, para. 10, PP is requirement to maintain 90 days of fuel reserve 'on site'. This is in line with the energy security concerns of the

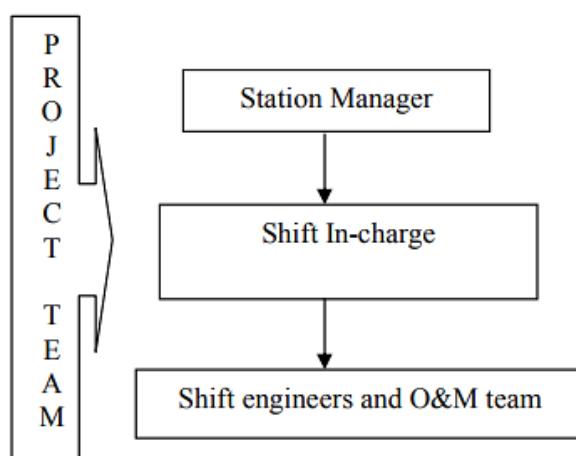
country and to be used only in case of emergencies. With effect from 21-Jul-16, the Energy Market Authority (EMA) has amended the back-up fuel requirement. Notably, PP should have exclusive right of use of storage tank capacity on site to last at least 60 days.

PP has also made a provision to monitoring diesel used and its energy content (NCV). The diesel usage is less than 1% of total fuel usage and considered for project emissions.

INTERNAL AUDIT AND PERFORMANCE REVIEWS

Monitoring team is responsible for the annual performance reviews. The monthly invoices from recipient is cross checked with the monthly export data. Any non-conformity if observed would be corrected. No any non-conformity is observed during current monitoring period. The energy meter calibration due dates is being informed to the O&M team. In the review meeting, if the calibrations are found to be not done on due date, the meters would be calibrated immediately and the correction factor will be applied to the monitored values. For current monitoring period, in case of delay in calibration (annual calibration frequency as per registered PDD), error factor as per CDM guideline is applied.

Designation	Responsibilities
Plant Manager and Operation Manager	<ul style="list-style-type: none"> Registration Project Execution
CDM coordinator	<ul style="list-style-type: none"> Operation Verification of data Inspection of data whenever necessary to independently check the authenticity of data and take corrective actions Storage/ Achieving of data Internal audit of monitored data and GHG reduction calculation
Shift in-charge & engineers, supported by operators	<ul style="list-style-type: none"> Operation, Monitoring and Verification of Data Data Recording Storage of data
Operation and Maintenance team/ Contractor	<ul style="list-style-type: none"> Operation and Maintenance Storage of data Data Recording Data Collection Archiving of data



SECTION D. Data and parameters**D.1. Data and parameters fixed ex ante**

Data/Parameter	EF _{CO₂,NG,y}
Unit	kgCO ₂ e/TJ
Description	Emission Factor of Natural Gas
Source of data	Table 1.4, Chapter 1, Volume 2, 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied	56,100
Choice of data or measurement methods and procedures	In absence of country specific data; IPCC default value used as recommended in methodology.
Purpose of data/parameter	Calculation of project emissions
Additional comments	--

Data/Parameter	OXID _{NG}
Unit	Unit less factor
Description	Oxidation Factor of NG
Source of data	Table 1.4, Chapter 1, Volume 2, 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied	1
Choice of data or measurement methods and procedures	In absence of country specific data; IPCC default value used as recommended in methodology.
Purpose of data/parameter	Calculation of project emissions
Additional comments	This value is used for estimation and is being monitored ex-post throughout the crediting period

Data/Parameter	EF _{NG, Upstream,CH₄}
Unit	t CH ₄ /PJ
Description	Emission factor for upstream fugitive methane emissions of natural gas from production, transportation, distribution, and, in the case of LNG, liquefaction, transportation, re-gasification and compression into a transmission or distribution system, in tCH ₄ per GJ fuel supplied to final consumers.
Source of data	Table 2, page 9 of the approved methodology AM0029, version 03
Value(s) applied	296
Choice of data or measurement methods and procedures	In absence of the country specific data, default value given in the methodology for the world average is used.
Purpose of data/parameter	Calculation of leakage emissions
Additional comments	--

Data/Parameter	EF _{CO₂,upstream,LNG}
Unit	tCO ₂ /TJ
Description	Emission factor for upstream CO ₂ 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
Source of data	default value as per baseline methodology AM0029, Version 03, pg. 10
Value(s) applied	6

Choice of data or measurement methods and procedures	In absence of country specific data, default value used as recommended in methodology is used.
Purpose of data/parameter	Calculation of leakage emissions
Additional comments	--

Data/Parameter	EF _{BL, Upstream,CH4}
Unit	t CH ₄ /MWh
Description	Emission factor for upstream fugitive methane emissions occurring in the absence of the project activity in terms of ton of methane per MWh
Source of data	The value is taken from the 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,
Value(s) applied	0.00228 CH ₄ /MWh from the NEA's 'Information on emission factors (for CDM projects in Singapore)', published 20/04/2012 0.00213 t CH ₄ /MWh As per latest published document NEA's "INFORMATION ON EMISSION FACTORS (For CDM projects in Singapore) (dated 28 June 2016), the value is 0.00213 t CH ₄ /MWh is considered for ER calculation.
Choice of data or measurement methods and procedures	Wherever necessary default values suggested in the approved methodology AM0029 are used in the formula above to arrive at the above value.
Purpose of data/parameter	Calculation of leakage emissions
Additional comments	--

Data/Parameter	EF _{CO2,FF,y}
Unit	kgCO ₂ e/TJ
Description	Emission Factor of diesel
Source of data	Table 1.4, Chapter 1, Volume 2, 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied	74,100 is IPCC default value
Choice of data or measurement methods and procedures	In absence of country specific data; IPCC default value used as recommended in methodology.
Purpose of data/parameter	Calculation of project emissions
Additional comments	--

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.

D.2. Data and parameters monitored

Data/Parameter	EG _{Export,y}
Unit	MWh
Description	New electricity exported by the project plant in year y
Measured/calculated/default	Measured

Source of data	Data measured and recorded from energy meters installed in the plant and in substation
Value(s) of monitored parameter	Please refer excel sheet for value of parameter
Monitoring equipment	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. Meter type: Accuracy: 0.2s Recording frequency: continuous measurement, monthly recording Calibration frequency: annual Responsible entity: plant head
Measuring/reading/recording frequency	Monthly
Calculation method (if applicable)	The net export used here is being calculated from 'export – import'
QA/QC procedures	Meters is calibrated as per the standard procedures and documents for the same is maintained throughout. Cross check by recipient of sales.
Purpose of data/parameter	Calculation of baseline and leakage emission.
Additional comments	-

Data/Parameter	FC_{NG,y}
Unit	m ³
Description	Quantity of NG consumed in the project activity in year y
Measured/calculated/default	Measured
Source of data	Continuous monitoring is being done at project boundary
Value(s) of monitored parameter	Please refer excel sheet for value of parameter
Monitoring equipment	The total fuel consumption is being monitored at project end for billing and measured in standard cubic meters/Energy flow in accordance with Gas Supply Agreement. Meter type: ultrasonic gas flow meter Accuracy: ±0.1% of MV (linearity) Recording frequency: continuous monitoring with monthly recording Calibration frequency: once in six months Responsible entity: plant head
Measuring/reading/recording frequency	Daily
Calculation method (if applicable)	Not Applicable
QA/QC procedures	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 at project end (PP's gas flow meter at the gas skid/ receiving station) for cross verification.
Purpose of data/parameter	Calculation of project emission.
Additional comments	--

Data/Parameter	NCV_{NG,y}
Unit	GJ/m ³
Description	Net Calorific Value of Natural Gas
Measured/calculated/default	Calculated
Source of data	Invoice from the gas supplier

Value(s) of monitored parameter	Please refer excel sheet for monthly value
Monitoring equipment	The total fuel consumption is being monitored both at project end for billing and measured in standard cubic meters/Energy flow in accordance with Gas Supply Agreement. Meter type: ultrasonic gas flow meter Accuracy: $\pm 0.1\%$ of MV (linearity) Recording frequency: continuous monitoring with monthly recording Calibration frequency: once in six months Responsible entity: plant head
Measuring/reading/recording frequency	--
Calculation method (if applicable)	Not Applicable
QA/QC procedures	Gas Chromatograph is subject to regular (in accordance with guidelines of the OEM) maintenance and testing to ensure accuracy. GC may not be available on project site and within project boundary. Thus, PP do not have control on its calibration frequency.
Purpose of data/parameter	Calculation of Project Emission.
Additional comments	--

Data/Parameter	COEF_{NG,y}
Unit	tCO ₂ /m ³
Description	CO ₂ emission coefficient
Measured/calculated/default	Calculated
Source of data	Calculated under project activity
Value(s) of monitored parameter	Please refer excel sheet for value of parameter
Monitoring equipment	CO ₂ 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 ER sheet 2) CO ₂ emission factor (EF CO _{2,f,y}): 0.0561 t CO ₂ /GJ 3) Oxidation factor of gas (OXID f): 1
Measuring/reading/recording frequency	Annual
Calculation method (if applicable)	Not Applicable as the approach is inline with the monitoring methodology AM0029.
QA/QC procedures	Not applicable as it is a calculated value and also in line with the monitoring methodology AM0029
Purpose of data/parameter	Calculation of Project Emission.
Additional comments	--

Data/Parameter	EF_{CO2,NG,y}
Unit	kgCO ₂ e/TJ
Description	Emission Factor of Natural Gas
Measured/calculated/default	Calculated
Source of data	Table 1.4, Chapter 1, Volume 2, 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) of monitored parameter	56,100

Monitoring equipment	In absence of country specific data; IPCC default value used as recommended in methodology.
Measuring/reading/recording frequency	--
Calculation method (if applicable)	Not Applicable as the approach is inline with the IPCC Guidelines for National Greenhouse Gas Inventories.
QA/QC procedures	Not Required as the default value from IPCC Guidelines for National Greenhouse Gas Inventories Table 1.4, Chapter 1, Volume 2, 2006 is used.
Purpose of data/parameter	Calculation of Project Emission.
Additional comments	If IPCC publishes another version of this report, the same would be used.

Data/Parameter	OXID_{NG}
Unit	Unit less factor
Description	Oxidation Factor of NG
Measured/calculated/default	Calculated
Source of data	Latest available version of IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) of monitored parameter	1
Monitoring equipment	In absence of country specific data; IPCC default value used as recommended in methodology.
Measuring/reading/recording frequency	Annual
Calculation method (if applicable)	Not Applicable as the approach is inline with the IPCC Guidelines for National Greenhouse Gas Inventories.
QA/QC procedures	Not required as this is default value published by IPCC and latest available report (IPCC Guidelines for National Greenhouse Gas Inventories) would be referred.
Purpose of data/parameter	Calculation of Project Emission.
Additional comments	This value is used for estimation and is being monitored ex-post throughout the crediting period.

Data/Parameter	PE_y
Unit	tCO ₂
Description	Project emission due to combustion of fuel
Measured/calculated/default	Calculated
Source of data	Calculated under project activity
Value(s) of monitored parameter	Please refer excel sheet for this value of parameter
Monitoring equipment	Not Applicable as this parameter is calculated.
Measuring/reading/recording frequency	--
Calculation method (if applicable)	Please refer to Section B.6.3 of the registered PDD for step wise calculation procedure
QA/QC procedures	Not applicable as it is a calculated value
Purpose of data/parameter	Calculation of Project Emission.
Additional comments	This value would be calculated ex-post in the monitoring period.

Data/Parameter	EF_{BL,CO2,y}
Unit	tCO ₂ /MWh
Description	Baseline CO ₂ emission factor

Measured/calculated/default	Calculated
Source of data	As per latest published document National Environment Agency (NEA) "INFORMATION ON EMISSION FACTORS (For CDM projects in Singapore) (dated 28 June 2016
Value(s) of monitored parameter	0.4126 for years 2015 onwards
Monitoring equipment	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
Measuring/reading/recording frequency	Annual
Calculation method (if applicable)	Calculated as per monitoring methodology AM0029
QA/QC procedures	No QA/QC is required.
Purpose of data/parameter	Calculation of baseline emission.
Additional comments	This value is being monitored ex-post as required by the monitoring methodology AM0029.

Data/Parameter	FC_{FF,y}
Unit	Ton OR m ³
Description	Quantity of fossil fuel (diesel) consumed in the project activity in year y
Measured/calculated/default	Calculated
Source of data	Continuous monitoring is done at project boundary
Value(s) of monitored parameter	Please refer excel sheet for this value
Monitoring equipment	The total fuel consumption is monitored if used for start-up/ auxiliary Meter type: mass flow meter Accuracy: ±1% Recording frequency: continuous monitoring with daily recording Calibration frequency: once in six months Responsible entity: plant head
Measuring/reading/recording frequency	Continuous monitoring with monthly recording
Calculation method (if applicable)	--
QA/QC procedures	Fossil fuel metering to the project is subject to regular (in accordance with stipulation of the meter supplier) maintenance and testing to ensure accuracy. This is cross checked with the purchase invoice/ receipts.
Purpose of data/parameter	Calculation of project emission.
Additional comments	--

Data/Parameter	NCV_{FF,y}
Unit	GJ/ m ³
Description	Net Calorific Value of fossil fuel
Measured/calculated/default	Calculated
Source of data	Invoice from the fossil fuel supplier
Value(s) of monitored parameter	Please refer excel sheet for value of this parameter

Monitoring equipment	Suppliers' analysis/ report is used to monitor this value.
Measuring/reading/recording frequency	--
Calculation method (if applicable)	--
QA/QC procedures	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 QC.
Purpose of data/parameter	Calculation of project emission.
Additional comments	--

Data/Parameter	Source of gas for project activity
Unit	-
Description	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.
Measured/calculated/default	Calculated
Source of data	Gas supply invoices
Value(s) of monitored parameter	NA
Monitoring equipment	Once in monitoring period
Measuring/reading/recording frequency	-
Calculation method (if applicable)	--
QA/QC procedures	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 QC.
Purpose of data/parameter	Demonstration of compliance to applicability condition on abundance availability of gas
Additional comments	--

D.3. Implementation of sampling plan

Not applicable for project activity. The project activity is monitoring all the data and would not use sampling.

SECTION E. Calculation of emission reductions or net anthropogenic removals

E.1. Calculation of baseline emissions or baseline net removals

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,CO₂,y}).

As per the latest NEA's 'Information on emission factors (for CDM projects in Singapore)', the build margin emission factors are 0.4126 tCO₂/MWh for year 2015.

Thus, EB_{BLCO₂,y} = 0.4126 tCO₂/MWh for year 2015

For period of year 2016 and year 2017, the latest available data i.e year 2015 year data is used for baseline emission calculations.

The baseline emissions are calculated as below

$$BE_y = EG_{PJ,y} \times EF_{BL,CO_2,y}$$

$$= 2,417,660.287 \text{ MWh} \times 0.4126 \text{ tCO}_2/\text{MWh}$$

$$= 997,526.63 \text{ tCO}_2$$

E.2. Calculation of project emissions or actual net removals

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

Volume of fuel combusted in project plant ($FC_{f,y}$) : 397,510,991.48 Sm^3

Calculation of CO_2 Emission Co-efficient of natural gas ($\text{COEF}_{f,y}$)

CO_2 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): 0.03460 GJ/Sm^3

2) CO_2 emission factor ($\text{EF}_{\text{CO}_2,f,y}$): 0.0561 $\text{t CO}_2/\text{GJ}$

3) Oxidation factor of gas (OXID_f): 1

$$\begin{aligned}\text{COEF}_{f,y} &= \text{NCV}_{f,y} \times \text{EF}_{\text{CO}_2,f,y} \times \text{OXID}_f \\ &= 0.03460 \text{ GJ}/\text{m}^3 \times 0.0561 \text{ tCO}_2/\text{GJ} \times 1 \\ &= 0.001941 \text{ tCO}_2/\text{m}^3\end{aligned}$$

$$\begin{aligned}\text{PE}_y &= \text{FC}_{f,y} \times \text{COEF}_{f,y} + \text{FC}_{\text{Diesel},y} \times \text{COEF}_{\text{Diesel},y} \\ &= 397,510,991.48 \text{ m}^3 \times 0.001941 \text{ tCO}_2/\text{m}^3 + 15,281.03 \text{ KL} \times 0.8348 \text{ Tonns/KL} \times 3.18630 \\ &\text{tCO}_2/\text{tonns} \\ &= 771,539.41 \text{ tCO}_2 + 40,646.37 \text{ tCO}_2 \\ &= 812,185.77 \text{ tCO}_2\end{aligned}$$

E.3. Calculation of leakage emissions

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

Where:

LE_y : = Leakage emissions during the year y in tCO_2e

$\text{LE}_{\text{CH}_4,y}$: = Leakage emissions due to fugitive upstream CH_4 emissions in the year y in $\text{t CO}_2\text{e}$

$\text{LE}_{\text{LNG},\text{CO}_2,y}$: = 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 year y in $\text{t CO}_2\text{e}$

As per registered PDD, $\text{LE}_{\text{CH}_4,y}$ is calculated as:

$$\begin{aligned}\text{LE}_{\text{CH}_4,y} &= [\text{FC}_{f,y} \times \text{NCV}_{f,y} \times \text{EF}_{\text{NG, upstream,CH}_4} - \text{EG}_{\text{PJ},y} \times \text{EF}_{\text{BL, upstream, CH}_4}] \times \text{GWP}_{\text{CH}_4} \\ &= [397,510,991.48 \text{ m}^3 \times 0.03460 \text{ GJ}/\text{m}^3 \times 0.000296 \text{ tCH}_4/\text{GJ} - 2,417,660.287 \text{ MWh} \\ &\quad \times 0.00213 \text{ tCH}_4/\text{MWh}] \times 25 \\ &= -26,968.72 \text{ tCO}_2\end{aligned}$$

As per registered PDD, $\text{LE}_{\text{LNG},\text{CO}_2,y}$ is calculated as:

$$\begin{aligned}\text{LE}_{\text{LNG},\text{CO}_2,y} &= \text{FC}_y \times \text{EF}_{\text{CO}_2,\text{upstream,LNG}} \\ &= 13,752.93 \text{ TJ} \times 6 \text{ t CO}_2/\text{TJ} \\ &= 82,517.58 \text{ tCO}_2\end{aligned}$$

$$\begin{aligned}\text{LE}_y &= \text{LE}_{\text{CH}_4,y} + \text{LE}_{\text{LNG},\text{CO}_2,y} \\ &= -26,968.72 + 82,517.58 \\ &= 55,548.86 \text{ tCO}_2\end{aligned}$$

Emissions Reduction (ER_y)

$$= \text{BE}_y - \text{PE}_y - \text{LE}_y$$

$$= 997,526.63 - 812,185.77 - 55,548.86$$

$$= 129,792 \text{ tCO}_2 \text{ (Rounded down)}$$

E.4. Calculation of emission reductions or net anthropogenic removals

	Baseline GHG emissions or baseline net GHG removals (t CO ₂ e)	Project GHG emissions or actual net GHG removals (t CO ₂ e)	Leakage GHG emissions (t CO ₂ e)	GHG emission reductions or net anthropogenic GHG removals (t CO ₂ e)		
				Before 01/01/2013	From 01/01/2013	Total amount
Total	997,526.63	812,185.77	55,548.86	0	129,792 ⁴	129,792

E.5. Comparison of emission reductions or net anthropogenic removals achieved with estimates in the registered PDD

Amount achieved during this monitoring period (t CO ₂ e)	Amount estimated ex ante (t CO ₂ e)
129,792	144,556

E.6. Remarks on increase in achieved emission reductions

The actual ER value for current monitoring period is less than estimated value by 10.21%. This is mainly due to low PLF; hence, no further explanation is required.

⁴ Rounded down

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Document information

<i>Version</i>	<i>Date</i>	<i>Description</i>
06.0	7 June 2017	Revision to: <ul style="list-style-type: none"> • Ensure consistency with version 01.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN); • Make editorial improvements.
05.1	4 May 2015	Editorial revision to correct version numbering.
05.0	1 April 2015	Revisions to: <ul style="list-style-type: none"> • Include provisions related to delayed submission of a monitoring plan; • Provisions related to the Host Party; • Remove reference to programme of activities; • Overall editorial improvement.
04.0	25 June 2014	Revisions to: <ul style="list-style-type: none"> • Include the Attachment: Instructions for filling out the monitoring report form (these instructions supersede the "Guideline: Completing the monitoring report form" (Version 04.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for completing the CDM-MR-FORM in A.6 and Appendix 1; • Change the reference number from <i>F-CDM-MR</i> to <i>CDM-MR-FORM</i>; • Editorial improvement.
03.2	5 November 2013	Editorial revision to correct table in page 1.
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB 70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01.0	28 May 2010	EB 54, Annex 34. Initial adoption.
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