



**Verified Carbon
Standard**

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



INFINITE
SOLUTIONS

Document Prepared by Infinite Solutions

Project Title	Grid connected electricity generation plant using natural gas at Jurong Island in Singapore
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1 PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

Pacific Light 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.

Purpose of the project activity

The purpose of the project activity is to construct and operate 800 MW natural gas based powerplant. 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 has 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.

Pre-project scenario: 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.

Baseline Scenario: As identified in Section B.4 of the CDM registered PDD, 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.

How the project activity reduces greenhouse gas emissions

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.

¹ As per technical specifications of the EPC contract with Siemens

Total emission reductions achieved in this monitoring period:

During the reported monitoring period 01-January-2021 to 31-December-2022 (First and last date included) the project activity has supplied 10,650,254 MWh of electricity, and thus contributed to the GHG reductions of 459,175 tCO₂e.

Audit Type	Period	Program	VVB Name	Number of years
Validation	14-July-2014	CDM	BUREAU VERITAS CERTIFICATION	NA
Validation	27-March-2018	VERRA	LGAI Technological Centre, S.A. (Applus+ Certification)	NA
Verification	01-January-2014–13-July-2014	VERRA	LGAI Technological Centre, S.A. (Applus+ Certification)	6 Months 13 days
Verification	14-July-2014 -- 31-December-2017	VERRA	LGAI Technological Center, S.A. (Applus+ Certification)	3 Years 5 Months 17 days
Verification	01-January-2018–31-December-2020	VERRA	Earthood Services Private Limited	3 Years
Verification	01-January-2021–31-December-2022	VERRA	LGAI Technological Center, S.A. (Applus+ Certification)	2 Years
Total	01-January-2014--31-December-2022	VERRA	-	9 Years

1.2 Sectoral Scope and Project Type

Project type: Renewable energy projects

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

1.3 Project Proponent

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

1.4 Other Entities Involved in the Project

Organization name	Infinite Solutions
Role in the Project	Project Consultant
Contact person	Mr. Sumeet Singhvi
Title	HOD – Carbon & Sustainability
Address	119, Milinda Manor, RNT Marg, Indore- 452001
Telephone	+91-9009748222
Email	sumeet@infisolutions.org

1.5 Project 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-June-2013 and Unit 20 was first time synchronized on 30-August-2013. Subsequent to testing & commissioning, Units were declared as commercial operating facility (also called as GRF: Generation Registered facility) on 15-January-2014 & 06-February-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-June-2013.

1.6 Project Crediting Period

Though the project activity starts exporting electricity from June 2013, the start date of first crediting period is considered as 01-January-2014.

Crediting Period Start date: 01-January-2014

Crediting Period End date: 31-December-2023

The project activity adopts renewable crediting period of 10 years period which can be renewed for 2 times.

1.7 Project Location

The project activity is located near City & District: Jurong Island, Singapore. The project site is located at 47 Jurong Island Highway Singapore 627626.

The geographical coordinates of the project activity are 1° 17' 4" N and 103° 43' 30" E.

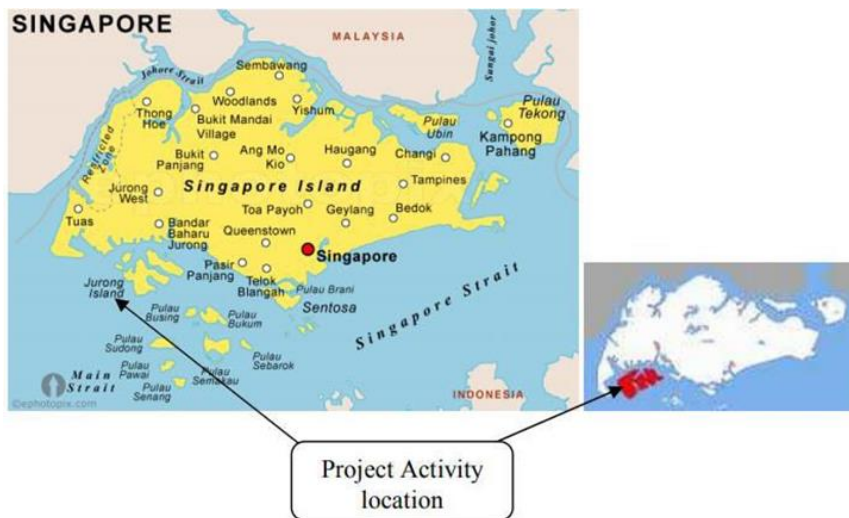


Figure 1: Map of (A) Singapore and (B) Map showing the site of project activity (Jurong Island)

1.8 Title and Reference of Methodology

The approved baseline methodology applied to this project is:

AM0029, version 03 titled: “Baseline Methodology for Grid Connected Electricity Generation Plants using Natural Gas”

Reference:

https://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_15YH7UTNQ40J8MGMVX62CGNE0K49Y0

- Tool for the demonstration and assessment of additionally (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)

1.9 Participation under other GHG Programs

The project activity does not involve any emission trading programs and other binding limits, thus there is no point to use the GHG emission reductions generated during current monitoring period for any compliance requirement.

The project activity has not sought or received another form of GHG-related environmental credit, including renewable energy certificates, during this current monitoring period.

The project activity is not eligible to create another form of GHG-related environment credit during this current monitoring period.

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 9687². The project proponent has not claimed any GHG credits under CDM mechanism during current monitoring period. The CDM Monitoring reports are only web hosted from 14-July-2014 till 31-December-2017 and the current monitoring period is 01-January-2021 to 31-December-2022. There is no any overlapping of current VCS monitoring period and CDM monitoring period as per web hosted CDM Monitoring Reports.

Thus, there is no any double accounting occurred during current VCS monitoring period & for the same declaration has been submitted.

1.10 Other Forms of Credit and Supply Chain (Scope 3) Emissions

Include the following information, as applicable:

- Emission Trading Programs and Other Binding Limits:

Net GHG emission reductions or removals generated by the Project will not be used for compliance with an emissions trading program or to meet binding limits on GHG emissions in any Emission Trading program or other binding limits.

- Other Forms of Environmental Credit:

The Project has no intend to generate any other form of GHG-related environmental credit for GHG emission reductions or removals claimed under the VCS Program

- Supply Chain (Scope 3) Emissions:

The main project activity is producing electricity using natural gas. The project activity does not involve supply chain emissions, so this section is not applicable.

² <https://cdm.unfccc.int/Projects/DB/BVQI1373973780.44/view>

1.11 Sustainable Development Contributions

The sustainable development criteria as per the Singapore DNA (National Environment Agency, NEA, Singapore Government) are as follows:

- **Environmental Sustainability:**

- i. The project activity will meet NEA's Environmental Protection requirements, standards and regulations
- ii. The electricity generated by project activity will be supplied to Singapore grid, which otherwise would have been generated by more carbon intensive fossil fuels and existing old power plants that are less efficient. Hence the project activity will help in reduction of the greenhouse gases emission and air pollutants (especially NO_x).

- **Economic Sustainability:**

- The project activity is utilizing latest F class turbines and this advanced technology is more efficient and environment friendly compared to older, existing power plants on the grid. This will result in the CO₂ emission reduction when compared with the build margin of the grid as discussed in Section B.6.3 of the registered CDM PDD.

- **Social Sustainability:**

The project activity provided direct employment to persons during construction and on an ongoing basis during normal operations. In addition, it is expected that additional persons will be directly benefited through casual work, subcontracts, trading etc. Thus, the project activity helps to improve quality of life by creating opportunities for jobs and business.

Thus, the project activity contributes to the sustainable development of the country.

Table 1: Sustainable Development Contributions

Row number	SDG Target	SDG Indicator	Net Impact on SDG Indicator	Current Project Contributions	Contributions Over Project Lifetime
<i>Sequential row number</i>	<i>SDG Target number</i>	<i>Number and text of SDG indicator or, if no official SDG indicator is applicable, user-defined indicator</i>	<i>Indicate the project's contribution to the SDG Indicator (implemented activities to increase or decrease)</i>	<i>Brief description of the quantifiable impact of the project's activities related to the SDG indicator, during the monitoring period.</i>	<i>Brief description of the cumulative quantifiable impact of the project's activities related to the SDG indicator, over the project lifetime.</i>
1)	8.5	Number of people Employed	Implemented activities to increase	15 number of people employed.	The project has employed 15 people since commissioning.
2)	7.2	7.2.1 Renewable energy share in the total final energy consumption	Implemented activities to increase	About 10,650,254 MWh, renewable electricity has supplied to the grid during the reported period that helps to increase the energy share in the energy mix.	Since Commissioning, 42,218,434.42 MWh (2,048,966.14+15,300,882.38+14,218,331.9+10,650,254) renewable electricity has supplied to the grid that helps to increase the energy share in the energy mix
3)	13.0	13.2.2 Tonnes of greenhouse gas emissions avoided or removed	Implemented activities to increase	By installation of 800 MW Natural Gas Power Plant, project has prevented the release of 459,175 tCO ₂ into the atmosphere during the monitoring period	Prevented the release of 1,659,441 tCO ₂ (57,991+565,595+576,680+459,175) into the atmosphere

2 SAFEGUARDS

2.1 No Net Harm

There are not any potential negative environmental and socio-economic impacts due to project activity and hence no mitigation is required.

Under the Environment Protection and Management Act 1999³, 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.

2.2 Local Stakeholder Consultation

Local Stakeholder consultation had been carried out during CDM registration of this project activity on 26/7/2012. There were no comments that required follow up action from PP. The PP also placed a grievance register onsite in where the stakeholder can put down his/her complain and the same if found genuine will be addressed immediately.

PP is open for continuous interaction with stakeholders and maintaining the stakeholder feedback register and grievance box place at the project site for the comments at any point of time during the project crediting period. PP has explained this mechanism for on-going communication to the local stakeholders and transparently kept the notice mentioning the grievance register and box at the project site.

The accounting of all and any input received during ongoing communication should be taken in consideration to take the appropriate measure to resolve the grievance. No issues and grievance for the project activity has been identified during the current monitoring period

2.3 AFOLU-Specific Safeguards

As this project falls in the category of non-AFOLU projects, this section is not required & therefore not applicable.

3 IMPLEMENTATION STATUS

3.1 Implementation Status of the 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 (two units 400 MW each). Each of the two units has one combustion turbine, one Heat recovery Steam Generators (HRSG) and

³ <https://sso.agc.gov.sg/act/epma1999>

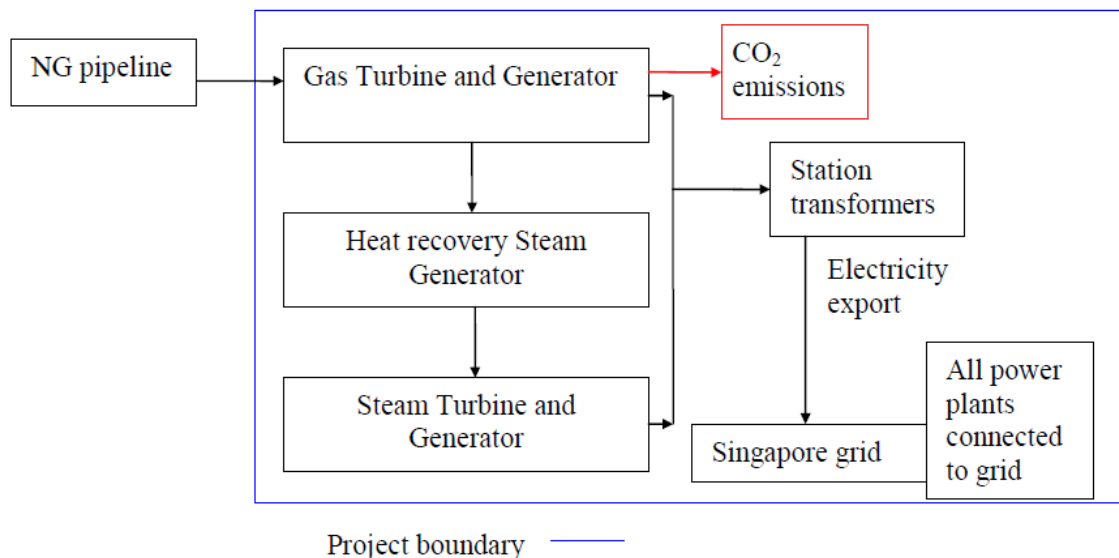
one Steam Turbine Generator (STG). The heat content of the exhaust gas from the combustion turbine is being recovered in individual heat recovery steam generators. The steam generated is then expanded in a condensing type steam turbine driving an electric generator.

The project activity has chosen advanced Siemens Gas Turbine SGT5-4000F. The project activity plant has 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 electricity which is sold to the Singapore grid.

Main Systems and equipment involved:

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

The project activity commenced commissioned in July 2013 and has been running satisfactorily since then. The schematic representation of installed technology, equipment's and process is shown as below).



The pre-project scenario is continuation of existing fuel mix in the grid to generate power. No power generation units existed at the project activity location in the pre-project scenario.

1) List and the arrangement of the main manufacturing/production technologies:

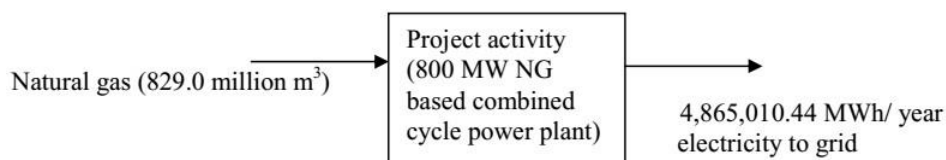
The project activity has chosen advanced Siemens Gas Turbine SGT5-4000F⁴. The project activity plant will have two units of net capacity of 385.5 MW each. The plant will use natural gas and / or re-gasified LNG as primary fuel. Diesel oil will be used as back up fuel for which LPG is start up fuel⁵. 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 plant is expected to operate at 72% annual capacity utilization⁶ 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 equipments of Gas Turbines and Generators, HRSGs and Steam Turbines and Generators; meters (gas, electricity) and gas supply pipelines.

3) Energy and mass flows:

The estimated energy and mass flow as per registered PDD is as below



The project activity will abide by all the regulatory norms of the pollution control board and will maintain environmentally safe and sound process.

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

In absence of the project activity, as identified in section B.4, the PP could have chosen a coal fired power plant of similar power output resulting in substantially higher GHG emissions. The main equipment in the baseline include coal fired boilers and turbine generators equivalent to the same electricity export as that of the project activity.

There are no any events that may impact the GHG emission reductions or removals and monitoring.

The major milestones of the implementation of project activity are as below

1. Minutes of the meeting of Board of Directors – CDM decision date as 14-June-2011
2. Letter from PP to EPC contractor – CDM start date as 08-December-2011
3. CDM prior consideration sent to UNFCCC and NCDMA – 09-March-2012
4. Local stakeholders' meeting – 26-July-2012
5. Unit 10 was synchronized to grid for the first time on 29-June-2013 and Unit 20 was

⁴ http://www.energy.siemens.com/hq/pool/hq/power-generation/gas-turbines/SGT5-4000F/downloads/SGT5-4000F_Brochure_2008.pdf

⁵ These will be monitored and is expected to be within 1% of total fuel used on annual energy basis

⁶ Based on estimated 72% capacity utilization annual operations from the PP's business plan

first time synchronized on 30-August-2013.

commissioning date – Unit 1 Commissioning Unit 2 i.e EMC registration of generation facility – 15-January-2014 for Unit1 and 06-February-2014 for unit.

3.2 Deviations

3.2.1 Methodology Deviations

Since there are no deviations, therefore it is not applicable.

3.2.2 Project Description Deviations

The below project description deviations were requested & approved in previous monitoring period.

1. The complete gas metering equipment is installed at consumer end (PP side) only and within the project activity premises. There are 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.
2. As per 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. Thus, deviation is requested for this change in monitoring approach for diesel consumption.
3. As per registered PDD, source of data for Net Calorific Value of Natural Gas is invoice from gas supplier. However 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. Thus, deviation is requested for this change in monitoring approach for NCV of gas.
4. 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.
5. Emission Factor of Natural Gas ($EF_{CO_2,NG,y}$) and Oxidation Factor ($OXID_{NG}$) is included in section 4.1 Data and Parameters available at Validation as well as in 4.2 Data and Parameters Monitored. However, both values are taken as ex-ante, hence both the parameters were now removed from the section 4.2.

There are two deviations requested in the current monitoring period as below:

The seconds (") is 4" instead of 24" in the actual latitude. The approved coordinates are 1°17'24" N and 103°43'30" E, however the actual coordinates of the site location are 1°17'4" N and 103°43'30" E. The revision has been made in the relevant section for the deviation.

In the Registered PDD, the parameters the Build Margin emission factor ($EF_{BM,y}$), Operating Margin emission factor ($EF_{OM,y}$) and Combined margin emission factor ($EF_{BL,CO2,y}$) are included in Section 4.1 'Data and Parameters fixed ex ante'. However as per the methodology AM0029 Version 3, project participants shall use for $EF_{electricity,y}$ the lowest emission factor among the build margin and combined margin. If either option 1 (BM) or option 2 (CM) are selected, they will be estimated ex post. Therefore, since the values are taken as ex-post, hence all the three parameters were now removed from the section 4.1 and is included in section 4.2 Data and Parameters Monitored.

Therefore, in the current monitoring period, a deviation is requested for this change in monitoring approach of all the 3 parameters.

3.3 Grouped Projects

As it doesn't fall into grouped projects category, therefore it is not applicable.

4 DATA AND PARAMETERS

4.1 Data and Parameters Available at Validation

Data / Parameter	$EF_{NG, Upstream, CH4}$
Data 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 applied	296
Justification of choice of data or description of measurement methods and procedures applied	In absence of the country specific data, default value given in the methodology for the world average is used.
Purpose of Data	Calculation of leakage emissions
Comments	-

Data / Parameter	EF _{CO2, Upstream, LNG}
Data 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 applied	6
Justification of choice of data or description of measurement methods and procedures applied	In absence of the country specific data, default value given in the methodology for the world average is used.
Purpose of Data	Calculation of leakage emissions
Comments	-

Data / Parameter	EF _{BL, Upstream, CH₄}
Data 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
Value applied	0.00228 t CH ₄ /MWh
Justification of choice of data or description of measurement methods and procedures applied	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	Calculation of leakage emissions
Comments	-

Data / Parameter	EF _{CO2,FF,y}
Data unit	kgCO2e/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 applied	74,100
Justification of choice of data or description of measurement methods and procedures applied	In absence of country specific data; IPCC default value used as recommended in methodology.
Purpose of Data	Calculation of leakage emissions
Comments	-

4.2 Data and Parameters Monitored

Data / Parameter	EG _{Export,y}
Data unit	MWh
Description	Net electricity exported by the project plant in year y
Source of data	Electrical Generation Reports
Description of measurement methods and procedures to be applied	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 will be calculated from ‘export – import’ Meter type: Accuracy: 0.2s Recording frequency: continuous measurement, monthly recording Calibration frequency: Annual Responsible entity: plant head
Frequency of monitoring/recording	Monthly

Value monitored	10,650,254
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: Once in 2 years Responsible entity: plant head
QA/QC procedures to be applied	Meters are calibrated as per the standard procedures and documents for the same are maintained throughout. Cross check by recipient of sales.
Purpose of the data	Calculation of baseline and project emission and leakage emission.
Calculation method	-
Comments	-

Data / Parameter	FC _{NG,y}
Data unit	m ³
Description	Quantity of Natural Gas combusted in the project plant
Source of data	Continuous monitoring is being done at project boundary
Description of measurement methods and procedures to be applied	The total fuel consumption is being monitored through gas metering equipment installed at consumer end (PP side) only and within the project activity at project site. The monitored data is cross verified by PP and gas supplier. The supplier gives the gas consumption data in mmbtu ⁷ and the same is converted into Sm ³ by using conversion factor of 25.2 (1mmbtu=25.2 Sm ³). Please refer Petroleum Planning & Analysis Cell (PPAC) ⁸ Meter type: ultrasonic gas flow meter Accuracy: As per latest Gas

⁷ Gas flow rate measurement is made in Normal cubic meter (Nm³/hr) by USM and sent to flow computer for integration & pressure/temperature compensation. Flow computer then convert and integrate gas consumption in terms of heat value (mmbtu) and standard cubic feet (SCF).

⁸ http://ppac.org.in/WriteReadData/userfiles/file/conversion_factor.xls

	Metering code ⁹ as it is regulation requirement for the company. Accuracy of the meter can be confirmed by calibration records. Recording frequency: continuous monitoring with daily recording Calibration frequency: Once in six months Responsible entity: plant head The pressure and temperature transmitter will follow six months calibration frequency as per gas metering code.									
Frequency of monitoring/recording	Daily									
Value monitored	<table><tr><td>Year</td><td>FC_{NG,y} (m³)</td></tr><tr><td>2020</td><td>815,431,628.55</td></tr><tr><td>2021</td><td>825,355,738.84</td></tr><tr><td>Total</td><td>1,640,787,367.39</td></tr></table>		Year	FC _{NG,y} (m ³)	2020	815,431,628.55	2021	825,355,738.84	Total	1,640,787,367.39
Year	FC _{NG,y} (m ³)									
2020	815,431,628.55									
2021	825,355,738.84									
Total	1,640,787,367.39									
Monitoring equipment	Meter type: ultrasonic gas flow meter Accuracy: ±0.1% of MV (linearity)									
QA/QC procedures to be applied	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.									
Purpose of the data	Calculation of project emission.									
Calculation method	Not Applicable									
Comments	-									

Data / Parameter	NCV _{NG,y}
Data unit	GJ/m ³
Description	Net Calorific Value of Natural Gas
Source of data	The data is sourced from onsite GC as per deviation request during previous verification. Please refer deviation requested for monitoring approach of this parameter.
Description of measurement methods	The calorific value of the gas would be based on the measurement readings recorded by Gas Chromatograph located

⁹ <https://www.ema.gov.sg/cmsmedia/Gas/Gas%20Metering%20Code%202017%20Jan.pdf>

and procedures to be applied	at the PP plant boundary. Suppliers' analysis/ report will be used to monitor this value.
Frequency of monitoring/recording	Monthly
Value monitored	for 2021, $NCV_{NG,y} = 0.03907$ for 2022, $NCV_{NG,y} = 0.03896$
Monitoring equipment	Gas Chromatograph will be subject to regular (in accordance with guidelines of the OEM) maintenance and testing to ensure accuracy.
QA/QC procedures to be applied	Gas Chromatograph is subject to regular (in accordance with guidelines of the OEM) maintenance and testing to ensure accuracy.
Purpose of the data	Calculation of Project Emission.
Calculation method	Where relevant, provide the calculation method, including any equations, used to establish the data/parameter.
Comments	

Data / Parameter	$COEF_{NG,y}$
Data unit	t CO ₂ /m ³
Description	CO ₂ emission coefficient
Source of data	Calculated under project activity
Description of measurement methods and procedures to be applied	Calculated CO ₂ Emission Co-efficient of natural gas is calculated as per equation number-2a of AM0029 Values of sub-variables.
Frequency of monitoring/recording	Annual
Value monitored	for 2021: 0.002192 tCO ₂ /m ³ for 2022: 0.002186 tCO ₂ /m ³
Monitoring equipment	NA
QA/QC procedures to be applied	Not applicable as it is a calculated value and also in line with the monitoring methodology AM0029

Purpose of the data	Calculation of Project Emission.
Calculation method	CO2 Emission Co-efficient of natural gas is calculated as per equation number- 2a of AM0029 Values of sub-variables.
Comments	-

Data / Parameter	EF _{CO2,NG,y}
Data 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
Description of measurement methods and procedures to be applied	In absence of country specific data; IPCC default value used as recommended in methodology.
Frequency of monitoring/recording	-
Value monitored	56,100
Monitoring equipment	In absence of country specific data; IPCC default value used as recommended in methodology.
QA/QC procedures to be applied	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	Calculation of project emissions
Calculation method	-
Comments	

Data / Parameter	PE _y
Data unit	t CO ₂
Description	Project emission due to combustion of fuel i.e., Diesel and Natural Gas
Source of data	Calculated under project activity
Description of measurement methods	

and procedures to be applied	Please refer to Section B.6.3 of the PDD for step wise calculation procedure
Frequency of monitoring/recording	-
Value monitored	3,591,775
Monitoring equipment	Calculated
QA/QC procedures to be applied	Not applicable as it is a calculated value
Purpose of the data	Calculation of Project Emission.
Calculation method	Please refer to Section B.6.3 of the CDM PDD for step wise calculation procedure
Comments	This value would be calculated ex-post in the monitoring period

Data / Parameter	EF _{BL,CO2,y}
Data unit	t CO ₂ /MWh
Description	Baseline CO ₂ emission factor
Source of data	As per latest published document "Information on Emission Factors (For CDM projects in Singapore) dated December 2020 ¹⁰
Description of measurement methods and procedures to be applied	-
Frequency of monitoring/recording	Yearly as Updated by relevant authorities
Value monitored	0.4024
Monitoring equipment	As per the methodology section para 29, The baseline emission factor for electricity supplied to the grid shall be determined as the minimum among emission factors EF1 and EF2. As per the calculation, the EF2: The combined margin is minimum and hence the same is used for the calculation.

QA/QC procedures to be applied	No QA/QC is required.
Purpose of the data	Calculation of baseline emission.
Calculation method	Please refer to Section B.6.3 of the CDM PDD for step wise calculation procedure
Comments	

Data / Parameter	FC _{FF,y}									
Data unit	Tons									
Description	Quantity of fossil fuel (diesel) consumed in the project activity in year y									
Source of data	Continuous monitoring is done at project boundary									
Description of measurement methods and procedures to be applied	The totalizer values are measured manually with the change in level of tank as per deviation request already approved during previous MP. Please refer deviation requested for monitoring approach of this parameter.									
Frequency of monitoring/recording	Continuous monitoring with monthly recording									
Value monitored	<table><tr><td>Year</td><td>FC_{FF,y} (Tons)</td></tr><tr><td>2020</td><td>164.140</td></tr><tr><td>2021</td><td>183.933</td></tr><tr><td>Total</td><td>348.073</td></tr></table>		Year	FC _{FF,y} (Tons)	2020	164.140	2021	183.933	Total	348.073
Year	FC _{FF,y} (Tons)									
2020	164.140									
2021	183.933									
Total	348.073									
Monitoring equipment	The total fuel consumption is monitored if used for start- up/ auxiliary Recording frequency: continuous monitoring with daily recording									
QA/QC procedures to be applied	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 the data	Calculation of project emission.									
Calculation method	Not Applicable									

Comments	
Data / Parameter	NCV _{FF,y}
Data unit	GJ/ m ³
Description	Net Calorific Value of fossil fuel
Source of data	Invoice from the fossil fuel supplier
Description of measurement methods and procedures to be applied	-
Frequency of monitoring/recording	Continuous monitoring with monthly recording
Value monitored	0.04300
Monitoring equipment	Suppliers' analysis/ report is used to monitor this value.
QA/QC procedures to be applied	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 the data	Calculation of project emission.
Calculation method	-
Comments	-

Data / Parameter	OXID _{NG}
Data 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 ¹¹
Value applied	1
Justification of choice of data or description of measurement methods and procedures applied	In absence of country specific data; IPCC default value used as recommended in methodology.

¹¹ chrome-extension://efaidnbmninnbpcjpcglclefindmkaj/https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf

Purpose of Data	Calculation of project emissions
Comments	This value is used for estimation and is being monitored ex-post throughout the crediting period

Data / Parameter	EF _{BM,y}
Data unit	tCO ₂ /MWh
Description	The Build Margin emission factor of Singapore national grid
Source of data	https://www.ema.gov.sg/Statistics.aspx https://www.ema.gov.sg/cmsmedia/Publications_and_Statistics/Statistics/18RSU.pdf
Description of measurement methods and procedures to be applied	The value is taken from the latest Singapore Government agency 'Information on emission factors' https://www.ema.gov.sg/Statistics.aspx https://www.ema.gov.sg/cmsmedia/Publications_and_Statistics/Statistics/18RSU.pdf
Frequency of monitoring/recording	-
Value monitored	0.4057
Monitoring equipment	The value is monitored ex-post and based on the available database published in the latest Singapore Government agency 'Information on emission factors.'
QA/QC procedures to be applied	-
Purpose of the data	This value is monitored ex-post as required by the monitoring methodology AM0029 Version 3.0.
Calculation method	NA
Comments	Calculation of baseline emissions

Data / Parameter	EF _{OM,y}
Data unit	tCO ₂ /MWh
Description	The Operating Margin emission factor of Singapore national grid
Source of data	https://www.ema.gov.sg/Statistics.aspx

	https://www.ema.gov.sg/cmsmedia/Publications_and_Statistics/Statistics/18RSU.pdf
Description of measurement methods and procedures to be applied	The value is taken from the latest Singapore Government agency 'Information on emission factors https://www.ema.gov.sg/Statistics.aspx https://www.ema.gov.sg/cmsmedia/Publications_and_Statistics/Statistics/18RSU.pdf
Frequency of monitoring/recording	-
Value monitored	0. 3992
Monitoring equipment	The value is monitored ex-post and based on the available database published in the latest Singapore Government agency 'Information on emission factors.
QA/QC procedures to be applied	-
Purpose of the data	This value is monitored ex-post as required by the monitoring methodology AM0029 Version 3.0.
Calculation method	NA
Comments	Calculation of baseline emissions

Data / Parameter	EF _{electricity,y}
Data unit	tCO ₂ /MWh
Description	The Combined Margin of Singapore national grid
Source of data	Calculated
Description of measurement methods and procedures to be applied	Calculated Value EF ₂ : The combined margin, calculated according to the latest version of the "Tool to calculate the emission factor for an electricity system", using a $w_{OM} = 0.5$ and $w_{BM} = 0.5$ weight ($EF_{BL,grid,CO2,y} = EF_{grid,CM,y}$)
Frequency of monitoring/recording	NA
Value monitored	0. 4024
Monitoring equipment	NA

QA/QC procedures to be applied	NA
Purpose of the data	Calculation of baseline emissions
Calculation method	EF2: The combined margin, calculated according to the latest version of the “Tool to calculate the emission factor for an electricity system”, using a $w_{OM} = 0.5$ and $w_{BM} = 0.5$ weight ($EF_{BL,grid,CO2,y} = EF_{grid,CM,y}$)
Comments	This value will be monitored ex-post as required by the monitoring methodology AM0029 Version 3.0.

Data / Parameter	Source of gas for project activity
Data 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.
Source of data	Gas supply Invoice
Description of measurement methods and procedures to be applied	-
Frequency of monitoring/recording	Once in monitoring period
Value monitored	-
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of the data	Demonstration of compliance to applicability condition on abundance availability of gas
Calculation method	-
Comments	-

4.3 Monitoring Plan

The project activity is operated and managed by the PP. The individual plant records 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 equipment 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 grid operator). These meters read both total export and import of electricity. The net export is being calculated from readings of these meters (total export – total import).

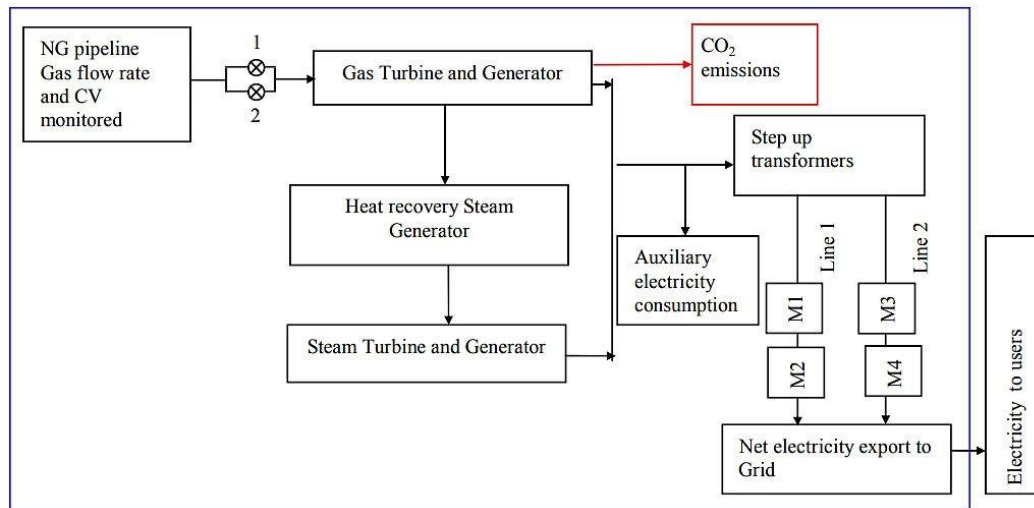
Emergency plan

The electricity meter (the main meter owned by PP) is being calibrated once in two years as per regulations in Singapore. 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.

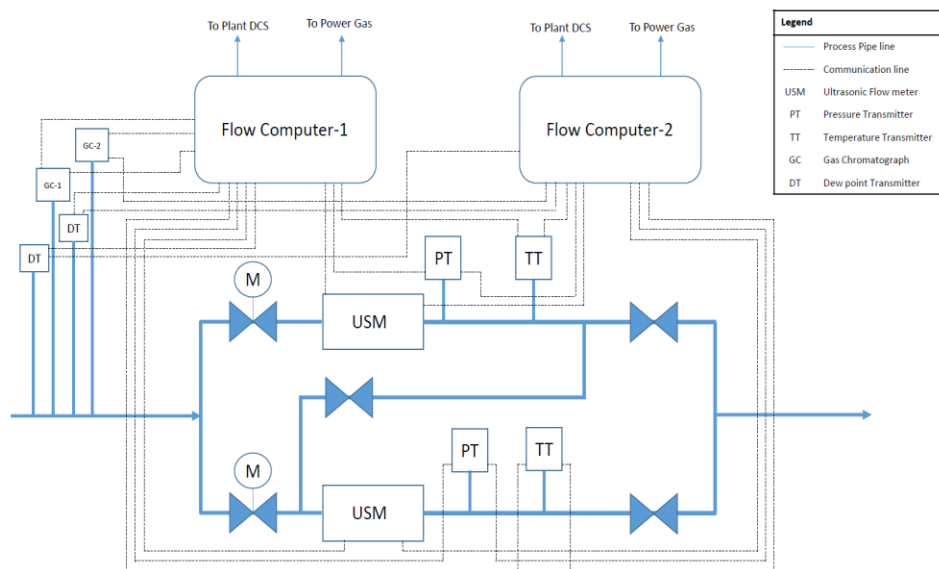
Monitoring of gas consumed in the project activity and NCV

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 meters 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 transporter has only gas supply terminal with motorized 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.



The gas metering arrangement is as below. There are only two flow meters (USM) and these flow meters are connected to two flow computers as shown in the schematic diagram below. Each flow metering stream has one pressure transmitter & temperature transmitter for compensation/correction. There are only two flow meters that are both located at PP. The data metered by these meters is recorded by both parties (supplier & consumer) for month end billing.



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 billing date after the registration date.

Similarly, for the gas consumed and NCV readings, billing is done in accordance with the Gas Supply Agreement with the Gas Supplier. The above incidence is not applicable for current monitoring period as daily data is monitored.

Monitoring of diesel (back up fuel)

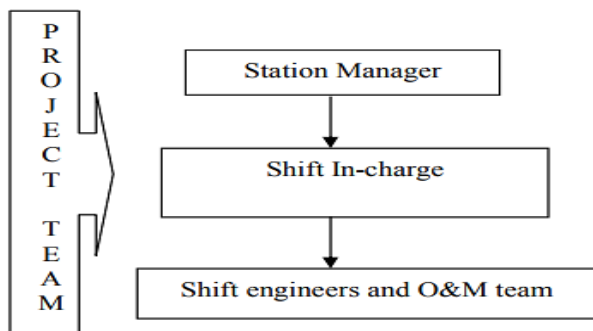
PP has installed 04 number of storage tanks of capacity 25,000 m³ each at site to store back up fuel i.e. diesel. The diesel fuel storage is provisioned to meet regulatory requirement of 'Electricity License for Generation Licensee' from EMA to the project activity. As per pg. 10, para. 10, PP is requirement 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 monitor 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 are cross checked with the monthly export data. Any non-conformity, if observed, would be corrected. No non-conformity has been observed during the 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 not to be done by the due date, the meters would be calibrated immediately and the correction factor will be applied to the monitored values. For the 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	- Registration - Project Execution
CDM coordinator	- 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	- Operation, Monitoring and Verification of Data - Data Recording - Storage of data
Operation and Maintenance team/ Contractor	- Operation and Maintenance - Storage of data - Data Recording - Data Collection - Archiving of data



5 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

5.1 Baseline Emissions

EF1: The build margin, calculated according to the latest version of the “Tool to calculate the emission factor for an electricity system” ($EF_{BL,grid,CO_2,y} = EF_{grid,BM,y}$);

(b) EF2: The combined margin, calculated according to the latest version of the “Tool to calculate the emission factor for an electricity system”, using a $w_{OM} = 0.5$ and $w_{BM} = 0.5$ weight ($EF_{BL,grid,CO_2,y} = EF_{grid,CM,y}$) for the first crediting period.

As per the latest EMA’s ‘Information on emission factors for year 2021 (for CDM projects in Singapore)¹²,

a). EF1: Build Margin (BM) = 0.4057 tCO₂/MWh, -----(i)

Operating Margin (OM) = 0.3992 tCO₂/MWh

Combined margin (CM)= BM x 0.5 + OM x 0.5

=0.4057 x 0.5 + 0.3992 x 0.5

(b) EF2: Combined margin = 0.4024 tCO₂/MWh -----(ii)

As per the methodology section para 29, The baseline emission factor for electricity supplied to the grid shall be determined as the minimum among emission factors EF1 and EF2

As per the calculation, the EF2: The combined margin is minimum and hence the same is used for the calculation.

Thus, $EB_{BLCO_2,y} = 0.4024 \text{ t CO}_2/\text{MWh}$. The baseline emissions are calculated as below

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

¹² <https://www.ema.gov.sg/cmsmedia/Publications and Statistics/Statistics/18RSU.pdf>

Year 2021

$$= 5,331,859.45 \text{ MWh} * 0.4024 \text{ t CO}_2 / \text{MWh}$$

$$= 2,145,540 \text{ t CO}_2$$

Year 2022

$$= 5,318,394.132 \text{ MWh} * 0.4024 \text{ t CO}_2 / \text{MWh}$$

$$= 2,140,121 \text{ t CO}_2$$

5.2 Project Emissions

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

Volume of Natural Gas combusted in project plant (FC_{NG}) in year 2021: 815,431,628.55 m³

Volume of Natural Gas combusted in project plant (FC_{NG}) in year 2022: 825,355,738.84 m³

Volume of Diesel combusted in project plant (FC_{diesel}) in year 2021: 164.14 tons

Volume of Diesel combusted in project plant (FC_{diesel}) in year 2022: 183.933 tons

Year 2021

$$PE_{y1} = \sum FC_{f,y} * COEF_{f,y}$$

$$COEF_{f,y} = NCV_{f,y} * EF_{CO2 f,y} * OXID_f$$

$$COEF_{f,y} = 0.03906 \text{ GJ/Sm}^3 * 0.0561 \text{ tCO}_2/\text{GJ} * 1$$

$$COEF_{f,y} = 0.002191 \text{ tCO}_2/\text{m}^3$$

$$PE_{y1} = 815,431,628.55 \text{ m}^3 * 0.002191 \text{ tCO}_2/\text{m}^3$$

$$PE_{y1} = 1,786,838.28 \text{ tCO}_2$$

$$PE_{y2} = FC_{Diesel,y} * COEF_{Diesel,y}$$

$$COEF_{Diesel,y} = NCV_{Diesel,y} * EF_{CO2 Diesel,y} * OXID_{Diesel}$$

$$COEF_{Diesel,y} = 0.043 \text{ TJ/tons} * 74.10 \text{ tCO}_2/\text{TJ} * 1$$

$$COEF_{Diesel,y} = 3.18630 \text{ tCO}_2/\text{tons}$$

$$PE_{y2} = 164.14 \text{ tons} * 3.18630 \text{ tCO}_2/\text{tons}$$

$$PE_{y2} = 522.99 \text{ tCO}_2$$

Total project emissions due to NG and Diesel during the monitoring period

$$PE_{2021} = PE_{y1} + PE_{y2}$$

$$PE_{2021} = PE_y = 1,787,362.00 \text{ tCO}_2$$

Year 2022

$$PE_{y1} = \sum FC_{f,y} * COEF_{f,y}$$

$$COEF_{f,y} = NCV_{f,y} * EF_{CO2,f,y} * OXID_f$$

$$COEF_{f,y} = 0.03896 \text{ GJ/Sm}^3 * 0.0561 \text{ tCO}_2/\text{GJ} * 1$$

$$COEF_{f,y} = 0.002186 \text{ tCO}_2/\text{m}^3$$

$$PE_{y1} = 825,355,738.84 \text{ m}^3 * 0.002186 \text{ tCO}_2/\text{m}^3$$

$$PE_{y1} = 1,803,927.94 \text{ tCO}_2$$

$$PE_{y2} = FC_{\text{Diesel},y} * COEF_{\text{Diesel},y}$$

$$COEF_{\text{Diesel},y} = NCV_{\text{Diesel},y} * EF_{CO2,\text{Diesel},y} * OXID_{\text{Diesel}}$$

$$COEF_{\text{Diesel},y} = 0.043 \text{ TJ/tons} * 74.10 \text{ tCO}_2/\text{TJ} * 1$$

$$COEF_{\text{Diesel},y} = 3.18630 \text{ tCO}_2/\text{tons}$$

$$PE_{y2} = 183.933 \text{ tons} * 3.18630 \text{ tCO}_2/\text{tons}$$

$$PE_{y2} = 586.07 \text{ tCO}_2$$

Total project emissions due to NG and Diesel during the monitoring period is

$$PE_{2022} = PE_{y1} + PE_{y2}$$

$$PE_{2022} = 1,803,927.94 + 586.07$$

$$PE_{2022} = 1,804,515.00 \text{ tCO}_2$$

Total project emissions:

$$PE_y = PE_{2021} + PE_{2022} = 1,787,362.00 + 1,804,515.00 = 3,591,877.00 \text{ tCO}_2$$

5.3 Leakage

$$LE_y = LE_{CH4,y} + LE_{LNG,CO2,y}$$

$$LE_{CH4,y} = (FC_{NG,y} * NCV_{NG,y} * EF_{NG,upstream,CH4} - EG_{PJ,grid,y} * EF_{BL,upstream,CH4}) * GWP_{CH4} \text{ ---(1)}$$

$$LE_{LNG,CO2,y} = FC_{LNG,y} * EF_{CO2,upstream,LNG} \text{ ---(2)}$$

Year 2021

$$LE_{CH4,y} = (815431628.55 * 0.03906023 * 0.0296 - 5331921.90 * 0.00228) * 28$$

$$LE_{CH_4,y} = -76,410.00 \text{ tCO}_2$$

$$LE_{LNG,CO_2,y} = 31850.95 \text{ TJ} * 6.00 \text{ t CO}_2 / \text{ TJ}$$

$$LE_{LNG,CO_2,y} = 191,105.70 \text{ tCO}_2$$

$$LE_{2021} = -76,410.00 + 191,105.70$$

$$LE_{2021} = 114,696 \text{ tCO}_2$$

Year 2022

$$LE_{CH_4,y} = (825355738.84 * 0.03895966 * 0.0296 - 5318394.13 * 0.00228) * 28$$

$$LE_{CH_4,y} = -73,020.85 \text{ tCO}_2$$

$$LE_{LNG,CO_2,y} = 32156 \text{ TJ} * 6.00 \text{ t CO}_2 / \text{ TJ}$$

$$LE_{LNG,CO_2,y} = 192,933.46 \text{ t CO}_2$$

$$LE_{2022} = -73,020.85 + 192,933.46$$

$$LE_{2022} = 119,913 \text{ tCO}_2$$

Therefore, leakage emissions are $LE_y = LE_{2021} + LE_{2022} = 114,696 + 119,913 = 234,609 \text{ tCO}_2$

5.4 Net GHG Emission Reductions and Removals

Emissions Reduction = $ER_y = BE_y - PE_y - LE_y$

Year 2021

$$= 2,145,540 - 1,787,362 - 114,696$$

$$= 243,482 \text{ t CO}_2$$

Year 2022

$$= 2,140,121 - 1,804,515 - 119,913$$

$$= 215,693 \text{ t CO}_2$$

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)
<u>2021 (01-January-2021–31-December-2021)</u>	2,145,540	1,787,362	114,696	243,482
<u>2022 (01-January-2022–31-December-2022)</u>	2,140,121	1,804,515	119,913	215,693

Total	4,285,661	35,91,877	234,609	459,175
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<u>Ex-ante emissions reductions/removals</u>	<u>Achieved emissions reductions/removals</u>	<u>Estimated Annual emissions reductions</u>	<u>Percent difference</u>	<u>Justification for the difference</u>
<u>2021 (01-January-2021–31-December-2021)</u>	<u>243,482</u>	<u>304,738</u>	<u>-20.10%</u>	Plant Break down
<u>2022 (01-January-2022–31-December-2022)</u>	<u>215,693</u>	<u>304,738</u>	<u>-29.22 %</u>	Plant Break down
<u>For Monitoring Period (01-January-2021–31-December-2022)</u>	<u>459,175</u>	<u>609,476</u>	<u>-24.66 %</u>	Plant Break down

APPENDIX 1: MAJOR BREAKDOWN DETAILS

Unit 10

S. No	Total Outage Duration			Reason for Shutdown
	Shutdown Time	Start Time	Outage Duration	
1	04-01-2021 00:27	06-01-2021 06:06	53:39	Shutdown due to low grid demand.
2	17-01-2021 23:26	20-01-2021 08:01	56:35	Shutdown due to low grid demand.
3	01-02-2021 23:56	07-02-2021 18:33	138:37	5th Minor inspection
4	23-02-2021 23:26	26-02-2021 04:32	53:06	Shutdown due to low grid demand.
5	07-03-2021 23:26	10-03-2021 04:32	53:06	Shutdown due to low grid demand.
6	09-03-2021 20:26	12-03-2021 22:32	74:06	Shutdown due to low grid demand.
12	13-03-2021 23:26	16-03-2021 04:32	53:06	Shutdown due to low grid demand.
13	07-04-2021 23:26	10-04-2021 04:32	53:06	Shutdown due to low grid demand.
14	24-06-2021 00:27	26-06-2021 06:02	53:35	IGV actuator connecting rod turn buckle retighting.
15	07-07-2021 23:26	17-07-2021 04:32	221:06	Shutdown due to low grid demand.
16	14-09-2021 23:27	17-09-2021 00:32	49:05	Shutdown due to low grid demand.
17	07-09-2021 23:26	10-09-2021 04:32	53:06	Shutdown due to low grid demand.
18	10-11-2021 14:27	16-11-2021 11:16	140:49	4th Minor inspection
19	30-11-2021 21:56	03-12-2021 05:44	55:48	Shutdown due to low grid demand.
20	21-12-2021 21:27	24-12-2021 14:02	64:35	Premix gas flowmeter leak rectification.
21	30-12-2021 14:58	02-01-2022 07:32	64:34	Shutdown due to low grid demand.
22	13-06-2022 19:56	16-06-2022 08:02	60:06	Shutdown due to low grid demand.
23	20-12-2022 22:56	23-12-2022 06:08	55:12	Shutdown due to low grid demand.

Unit 20

S. No	Total Outage Duration			Reason for Shutdown
	Shutdown Time	Start Time	Outage Duration	
1	02-03-2021 05:27	05-03-2021 06:32	73:05	CW debris filter inspection and cleaning
2	22-03-2021 00:28	12-04-2021 20:40	524:12	1st HGPI
3	28-12-2021 21:59	31-12-2021 07:34	57:35	Shutdown due to low grid demand.
4	25-01-2022 21:57	28-01-2022 05:32	55:35	Unit shutdown for CEC installation works.
5	07-02-2022 21:28	14-02-2022 10:52	157:24	4th Minor inspection + shaft balancing works
6	15-02-2022 21:58	17-02-2022 00:00	26:02	Shaft balancing works

7	06-08-2022 21:56	09-08-2022 07:01	57:05	SCW strainer (20PCB16AT001) isolation valve passing rectification
8	08-12-2022 22:57	13-12-2022 17:33	114:36	5th Minor inspection & Condenser rear water box replacement works
9	21-03-2020 02:27	23-03-2020 08:03	53:36	Shutdown due to low grid demand.
10	19-06-2020 22:29	22-06-2020 04:31	54:02	Shutdown due to low grid demand.

APPENDIX 2: CALIBRATION DETAILS

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	26-11-2020 12-10-2022	13-11-2020 28-10-2022	26-11-2020 12-10-2022	13-11-2020 28-10-2022

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

Gas Flow Meter

Model	EX-I SFC 3000	Flowsic 600	EX-I SFC 3000	Flowsic 600
Serial Number	12359001	12098674/13138357	12359003	12098673
Accuracy class	1%	0.3%	1%	0.3%
Date of Calibration	15-10-2020	15-10-2020	15-10-2020	14-10-2020
	13-10-2021	13-10-2021	13-10-2021	13-10-2021
	14-10-2021		14-10-2021	
	05-10-2022	05-10-2022	05-10-2022	06-10-2022
	06-10-2022		06-10-2022	

Pressure and Temperature Transmitter

	Pressure transmitter	Temp Transmitter	Pressure	Temp Transmitter
Serial Number	91N402226 317/ 90X719054127*	C2M600274216 /C2N500037317*	91M601973 220	C2M600275 216
Accuracy class	0.50%	0.20%	0.50%	0.20%
Date of Calibration	15-10-2020	15-10-2020	14-10-2020	14-10-2020
	14-04-2021	14-04-2021	15-04-2021	15-04-2021
	13-10-2021	13-10-2021	14-10-2021	14-10-2021
	14-04-2022	14-04-2022	13-04-2022	14-04-2022
	05-10-2022	06-10-2022	06-10-2022	05-10-2022

* Pressure transmitter and Temperature transmitters got replaced on 13-10-2021 and 14-10-2021 respectively which is within the calibration frequency of 6 months as per gas metering code.

Gas Chromatograph calibration details

PP has two GC having serial number as 61200687 and 61200688 which are configured for auto calibration once every two weeks. Hence it complies with the Gas Metering Code requirement.

GCs	Encal 3000 Quad 61200687			Encal 3000 Quad 61200688		
Date of Calibration	2020	2021	2022	2020	2021	2022
	06-02-2020	09-03-2021	29-03-2022	10-02-2020	10-03-2021	14-04-2022
	08-06-2020	28-06-2021	21-06-2022	09-06-2020	29-06-2021	22-06-2022
	29-09-2020	22-09-2021	19-09-2022	30-09-2020	23-09-2021	29-09-2022
	21-12-2020	22-12-2021	15-12-2022	22-12-2020	30-12-2021	16-12-2022